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Quantifying Brexit: From Ex Post to Ex Ante Using Structural Gravity

Gabriel Felbermayr, Jasmin Gröschl, Marina Steininger

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Abstract

Exploiting changes in the geography of economic integration in Europe, we quantify the economic consequences of Brexit using a quantitative general equilibrium model that captures inter- and intranational production networks. We isolate three important layers of EU integration for the UK: First, we distinguish directional treatment heterogeneity in the relation between the UK and the EU27 economies. Second, we disentangle tariff and non-tariff barriers in EU agreements affecting the UK, which show differential effects on the gains from trade. Third, next to European integration agreements, we consider fiscal transfers, which affect the terms-of-trade of countries. The analysis reveals that directional effects matter for the size and distribution of the welfare effects from Brexit. Neglecting asymmetries in EU-UK relations overestimates the costs from Brexit by up to 40%. The welfare costs of Brexit are higher in the UK than in most other EU counties. However, heterogeneity tends to attenuate overall costs while giving rise to substantial heterogeneity between EU27 members and between sectors. We introduce a scenario that could shift the bargaining power and eliminates asymmetries in the costs from Brexit as soon as the UK fully liberalizes its market.

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1   Introduction

The relationship between the European Union (EU) and the United Kingdom (UK) has always been fraught with complexity for reasons related to history, culture and geography. Differences over the long term goal of the EU integration process – whether the objective is a political union or just the establishment of a common market – date back at least to 1983 when the term "ever closer union" was coined.[1] The creation of the European Monetary Union – from which the UK opted out – and even more so the emergence of deficiencies in the construction of the Eurozone made the necessity of further political integration apparent, and widened the gap between the UK and the continent. At the same time, the relative importance of Europe as a trade partner for the UK fell from about 65% in the early 1990s to less than 45% in 2016, presumably because trade costs with third countries dropped more than costs of intra-EU trade.[2] This fact, together with rising net budgetary contribution to the EU, seems to imply that the relative costs of a withdrawal from the EU are lower today than what they would have been 25 years ago.

The objective of this paper is to disentangle and decompose the layers of European integration for the UK that the previous literature mostly ignores. We ask: If, in 2014, the UK had not been part of the EU? What would counterfactual real consumption, trade volumes, and sectoral value added have looked like? This provides us with an estimate of UK benefits from EU membership, which – in turn – we take as a proxy of what the costs of leaving the EU would be. To answer this question, we first conduct an ex post evaluation to back out trade cost changes. These can be used as proxies for non-tariff barriers in different counterfactual Brexit scenarios. More specifically, we exploit different integration steps of the UK and the EU members (i.e. becoming a member of the European Union Single Market, or joining a free trade agreement) on the sector-level. To correctly estimate trade cost shocks, we consider directionality in the treatment effects of UK-EU relations. Second, we run ex ante simulations of the effects from reversing those trade cost savings in a quantitative Ricardian trade model. We focus on the trade effects and do so in great detail, distinguishing 22 goods and 28 services industries and 43 countries representing more than 90% of world GDP.

We are not the first to study the potential economic consequences of UK's withdrawal from the EU, but we believe we offer the most detailed and most data-driven analysis of the trade-related effects of Brexit. We embed a careful ex post evaluation of British EU membership

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[1]The term first appeared in European Council (1983), "A Solemn Declaration on European Union" at the Council Meeting in Stuttgart, Germany. The document prepared the creation of the Single Market, a central request of Margaret Thatcher, but also led to the granting of annual budget rebates to the UK in 1984.

[2]Exports of goods and services; see Ward (2017).

into an ex ante analysis of its dissociation from the EU. We contribute by isolating three important layers of EU integration for the UK: First, we estimate directional treatment effects of the British EU membership or of EU trade agreements with third countries (such as with Korea) and allow these to differ across industries.[3] Second, separating tariff and non-tariff barrier (NTB) trade effects in EU membership, we use the estimated trade cost shocks to carry out our comparative statics exercise in the year 2014, for which we have real data.[4] This allows us to put special emphasis on sectoral heterogeneity. In contrast, Dhingra et al. (2017) use estimates of NTBs by Berden et al. (2013) for the US-EU relationship dating from the year 2007 and assume a uniform increase by 25% across all sectors. Moreover, they also assume that the UK would not be able to participate in future NTB reductions. To make our results independent of other policy components, we estimate the changes of non-tariff barriers and not the levels.[5] Trade elasticities are estimated on exactly the same data that we calibrate our model with and which also defines the baseline that we compare our counterfactual equilibrium with. This is in the spirit of structural gravity modeling and allows for a tight connection between theory, estimation and calibration.[6] Moreover, the econometric exercise supplies us with the necessary information to simulate confidence intervals for all of our endogenous variables. By quantifying uncertainty, we also go beyond Dhingra et al. (2017) and Steinberg (2019). Third, when evaluating the possible effects of new bilateral trade agreements of the UK with third parties, we do not make educated guesses about the size and distribution of sectoral changes in NTBs. Rather, we estimate the potentially asymmetric sectoral trade effects of the EU-Korea trade agreement for the UK and assume that new agreements could implement what has proven feasible in the past. The EU-Korea deal has been in force since 2011 and is one of the most ambitious (and successful) FTAs of the EU (Lakatos and Nilsson, 2017). Third, next to tariffs and NTBs, we consider fiscal transfers within the EU as an important component of EU membership. Hence, we evaluate their impact on disintegration by decomposing welfare effects into tariff, NTB, and fiscal transfer components in the context of Brexit.

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[3]Baier et al. (2019) show that asymmetries in trade agreements occur particularly within pairs and play an important role for their exports and imports. Graziano et al. (2018) estimate uncertainty effects surrounding the probability of Brexit considering such asymmetries.

[4]Steinberg (2019) uses a dynamic general equilibrium model with firm heterogeneity, but relies on the calibration of parameters from different sources of data and on several specific assumptions surrounding e.g. future technology adoption. Our focus lies on the identification of the trade cost shocks surrounding Brexit by separating tariffs and NTBs, considering the directionality of treatment effects, and the consideration of fiscal transfer systems within the EU. Relying on a single source of data has the advantage to rely on fewer assumptions, but obviously limits us with respect dynamic adaptions in case of Brexit.

[5]Sampson (2017) provides an excellent overview of trade and other issues related to Brexit.

[6]see Yotov et al. (2016) for an excellent survey and Mayer et al. (2019) for an application to the costs of non-Europe

We use a computable general equilibrium framework (see Costinot and Rodriguez-Clare, 2014). A common feature of these models is that they give rise to a theoretical foundation of the gravity equation of international trade and that they can be solved in changes, a feature referred to as "exact hat algebra" in the literature (Dekle et al., 2008). This has obvious computational advantages but also helps with calibration as unknown constants drop out. More specifically, our modeling framework is based on Caliendo and Parro (2015)'s multi-sector input-output version of the Ricardian trade model by Eaton and Kortum (2002). We extend this setup to include services trade, non-tariff barriers and the directional treatment heterogeneity of trade agreements. Our parameter estimation and the calibration of the model are based on data provided by the World Input-Output Database (WIOD) as described by Timmer et al. (2015). Importantly, the model features a detailed account of international input-output linkages.[7]

We consider four scenarios: (i) a WTO scenario (hard Brexit) in which the UK loses preferential access to EU27 countries and to third countries with which the EU currently maintains free trade agreements; most favored nations (MFN) tariffs apply and non-tariff barriers (NTBs) are reintroduced; (ii) a scenario with a modern and ambitious trade agreement between the EU27 and the UK, comprising tariffs and NTBs, and modeled after the EU-Korea FTA; (iii) a global Britain scenario, with tariffs and NTBs as defined in the WTO scenario, but bilateral FTAs between the UK with USMCA countries, Asian countries and non-European members of the Commonwealth; and (iv) a hard but smart Brexit scenario in which the UK decreases its tariffs to zero for all trading partners and does not impose additional non-tariff barriers against the European Union, while the EU27 increase tariffs against the UK to MFN levels and impose non-tariff barriers against the UK.

The main results of our ex post evaluation of EU integration steps are that the EU has been very successful in reducing trade costs between its members. While, in the partial equilibrium, EU integration has boosted goods exports of the UK to the other EU countries by about 24%, it has increased other EU members' exports to the UK by as much as 76%. In services trade, we find that UK exports to EU27 countries are 64% higher due to EU membership, while bilateral services exports of other EU27 countries to the UK have almost doubled. Ignoring this important directional heterogeneity, one could easily overestimate the costs of Brexit to the UK and underestimate it for the rest of the EU. At the finer sectoral level, a lot of heterogeneity exists, but the general picture remains. For example, EU membership has increased exports of the UK to the EU in the air transport sector substantially, while it has not affected exports in its postal and courier sector. The opposite

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[7]Recent work by Vandenbussche et al. (2019) highlights the importance of such networks in the context of Brexit.

pattern holds for the UK's imports in these sectors. Also, the results suggest that the EU-Korea FTA from 2011 has not had any positive effects on UK overall exports of goods, but on services trade.

We use these partial equilibrium estimates to define directional trade cost shocks for the counterfactual general equilibrium analysis. It turns out that effects depend on treatment heterogeneity. We show that sectoral heterogeneity and asymmetries in trade cost changes matters for the size of macroeconomic outcomes. Ignoring heterogeneity, the costs of Brexit could be inflated by as much as 25% for the UK. Next, we fully account for the directionality of effects and simulate four Brexit scenarios to assess the general equilibrium effects on real consumption, trade, and sectoral value added for 43 countries and a rest of the world component. We find substantial heterogeneity among EU27 members. A hard Brexit reduces real consumption more in Ireland, Luxembourg and Malta than in the UK, where the 90% confidence interval is [-3.32%,-2.19%]. The core EU economies France, Germany, and Italy face losses in the intervals [-0.66%,-0.38%],[-0.84%,-0.59%], and [-0.50%,-0.31%], respectively. The conclusion of a modern FTA, drafted after the existing EU-Korea FTA, allows avoiding three quarters of the loss from Brexit in the EU27 countries and two thirds in the UK compared to the hard Brexit scenario. If the UK concludes FTAs with many countries outside of the EU27, the change in real consumption is contained in the 90% interval [-2.10%,-0.76%] for the UK. Due to trade diversion effects, losses in EU countries would be higher than under the hard Brexit scenario. For third countries, real consumption changes are mostly not statistically different from zero. An exception is Switzerland, who could slightly benefit from a hard Brexit and a subsequent relocation of financial services. With a hard but smart Brexit strategy, the UK decreases tariffs across all goods sectors to zero for all trade partners and does not impose additional controls on imports from the EU27, while the EU imposes tariffs and additional non-tariff barriers against the UK. With this strategy, the UK could lower its economic damage to half a percent. The existing asymmetry between Britain and the EU27 would vanish and the bargaining power would shift from Brussels to London.

The remainder of this paper is organized as follows. Section 2 presents the methodological framework. Section 3 discusses the main data sources, explains the empirical estimation method, and discusses gravity results. Based on the defined Brexit scenarios, we examine general equilibrium consistent results on trade and welfare in section 4.

2 Model

The model follows Caliendo and Parro (2015), who provide a multi-sector version of the Eaton and Kortum (2002) gravity model with input-output linkages.

2.1 Setup

There are N countries indexed by i and n, as well as J sectors indexed by j and k. Sectoral goods are either used as inputs in production or consumed, with the representative consumer having Cobb-Douglas preferences over consumption C_n^j of sectoral final goods with expenditure shares $\alpha_n^j \in (0,1)$ and $\sum_j \alpha_n^j = 1$.

Labor is the only production factor and labor markets clear. The labor force L_n is mobile across sectors such that $L_n = \sum_{j=1}^{J} L_n^j$, but not between countries. In each sector j, there is a continuum of intermediate goods producers indexed $\omega^j \in [0,1]$ who combine labor and composite intermediate input and who differ with respect to their productivity $z_i^j(\omega^j)$. Intermediate goods are aggregated into sectoral composites using CES production functions with elasticity η^j. On all markets, there is perfect competition.

A firm in country i can supply its output at price

$$p_{in}^j(\omega^j) = \kappa_{in}^j \frac{c_i^j}{z_i^j(\omega^j)} \text{ with } c_i^j = \Upsilon_i^j \, w_i^{\beta_i^j} \left[\prod_{k=1}^{J} p_i^{k \, \gamma_i^{k,j}} \right]^{(1-\beta_i^j)}. \tag{1}$$

The minimum cost of an input bundle is c_i^j, where Υ_i^j is a constant, w_i is the wage rate in country i, p_i^k is the price of a composite intermediate good from sector k, $\beta_i^j \geq 0$ is the value added share in sector j in country i and $\gamma_i^{k,j}$ denotes the cost share of source sector k in sector j's intermediate costs, with $\sum_{k=1}^{J} \gamma_i^{k,j} = 1$. κ_{in}^j denotes trade costs of delivering sector j goods from country i to country n such that

$$\kappa_{in}^j = (1 + t_{in}^j) D_{in}^{\rho^j} e^{\delta^j \mathbf{Z}_{in}}, \tag{2}$$

where $t_{in}^j \geq 0$ denotes ad-valorem tariffs, D_{in} is bilateral distance, and $\mathbf{Z}_{in}$ is a vector collecting trade cost shifters (such as FTAs or other trade policies).

Productivity of intermediate goods producers follows a Fréchet distribution with a location parameter $\lambda_n^j \geq 0$ that varies by country and sector (a measure of absolute advantage) and shape parameter θ^j that varies by sector (and captures comparative advantage).[8]

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[8]Convergence requires $1 + \theta^j > \eta^j$.

Producers of sectoral composites in country n search for the supplier with the lowest cost such that

$$p_n^j = \min_i \left\{ p_{in}^j(\omega^j); i = 1, \ldots, N \right\}. \tag{3}$$

Caliendo and Parro (2015) show that it is possible to derive a closed form solution of composite intermediate goods price

$$p_n^j = A^j \left(\sum_{i=1}^N \lambda_i^j \left(c_i^j \kappa_{in}^j \right)^{\frac{-1}{\theta^j}} \right)^{-\theta^j}, \tag{4}$$

where $A^j = \Gamma \left[1 + \theta^j(1 - \eta^j) \right]^{\frac{1}{1-\eta^j}}$ is a constant.

Similarly, a country n's expenditure share π_{in}^j for source country i's goods in sector j is

$$\pi_{in}^j = \frac{\lambda_i^j \left[c_i^j \kappa_{in}^j \right]^{\frac{-1}{\theta^j}}}{\sum_{i=1}^N \lambda_i^j \left[c_i^j \kappa_{in}^j \right]^{\frac{-1}{\theta^j}}}, \tag{5}$$

which forms the core of a gravity equation.

2.2 General Equilibrium

Let Y_n^j denote the value of gross production of varieties in sector j. For each country n and sector j, Y_n^j has to equal the value of demand for sectoral varieties from all countries $i = 1, \ldots, N$.[9] The goods market clearing condition is given by

$$Y_n^j = \sum_{i=1}^N \frac{\pi_{ni}^j}{(1 + t_{ni}^j)} X_i^j \qquad \text{with} \qquad X_i^j = \sum_{k=1}^J \gamma_i^{j,k}(1 - \beta_i^k) Y_i^k + \alpha_i^j I_i, \tag{6}$$

where national income consists of labor income, tariff rebates R_i and the (exogenous) trade surplus S_i, i.e. $I_i = w_i L_i + R_i - S_i$ and X_i^j is country i's expenditure on sector j goods. We keep the trade surplus relative to GDP constant. Quite mechanically, this forces additional asymmetry on the change in trade flows even if trade cost shocks are rather similar. We do not eliminate the trade surplus through reparameterization as in Caliendo and Parro (2015). We assume that $s_n \equiv S_n/B$, where $B \equiv \sum_n w_n L_n$ is global labor income, to make sure that the system is homogeneous of degree zero in prices. In the Brexit scenarios, we will

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[9]Our exposition differs from Caliendo and Parro (2015) in that they use total expenditure on composite goods instead of total production of varieties as endogenous variable. So in Caliendo and Parro (2015) the value of gross production comprises all foreign varieties that are bundled into the composite good without generation of value added.

redistribute the fiscal transfers of the EU budget by adjusting the trade surplus S_n.

The first term on the right hand side gives demand of sectors k in all countries i for intermediate usage of sector j varieties produced in country n, the second term denotes final demand. Tariff rebates are $R_i = \sum_{j=1}^{J} X_i^j \left(1 - \sum_{n=1}^{N} \frac{\pi_{ni}^j}{(1+t_{ni}^j)}\right)$.[10]

The second equilibrium condition requires that, for each country n, the value of total imports, domestic demand and the trade surplus has to equal the value of total exports including domestic sales, which is equivalent to total output Y_n:

$$\sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^j}{(1+t_{in}^j)} X_n^j + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{ni}^j}{(1+t_{ni}^j)} X_i^j = \sum_{j=1}^{J} Y_n^j \equiv Y_n \qquad (7)$$

Conditions (6) and (7) close the model.

2.3 Comparative Statics in General Equilibrium

We are interested in the effects of different Brexit scenarios on trade flows, wages, sectoral value added, and real consumption (as our measure of welfare). Hence, we need to quantify the comparative static effects of changes in trade costs (tariffs and non-tariff barriers) κ_{in}^j on endogenous quantities such as trade flows, wages, sectoral value added, production and tariff income. As shown by Dekle et al. (2008), we solve the model in changes. Let z denote the initial level of a variable and z' its counterfactual level. Then, trade cost shocks are given by $\hat{\kappa}_{in}^j = \frac{1+t_{in}^{j'}}{1+t_{in}^j} e^{\delta^j(Z_{in}' - Z_{in})}$ and the change in real consumption is

$$\hat{W}_n = \frac{\hat{X}_n}{\prod_{j=1}^{J} \left(\hat{p}_n^j\right)^{\alpha_n^j}}. \qquad (8)$$

In Appendix A.1, we present the system of equations in changes required to solve the model. An important advantage of solving the model in changes is that certain constant parameters such as the absolute advantage or the elasticity of substitution between input varieties ω drop out and need not be estimated. This reduces the data needs and lowers the scope for measurement error – of course, at the price of functional assumptions.

Our comparative statics exercise refers to the long-run, i.e., to a new equilibrium in which all relevant general equilibrium interactions have already fully taken place. Short-run effects

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[10]Instead of the goods market clearing condition, one can also use the expenditure equation $X_i^j = \left(\sum_{k=1}^{J} \gamma_i^{j,k}(1-\beta_i^k)(F_i^k X_i^k + S_i^k) + \alpha_i^j I_i\right)$ as in Caliendo and Parro (2015).

can differ from those long-run predictions. Moreover, we hold technology fixed and abstract from endogenous innovation or technology adoption. The latter would require leaving the bedrock of a standard and widely accepted modeling framework.

3 Empirical Model, Data, and Parameter Estimates

3.1 Empirical Model

From equations (2) and (5) we derive the following sector-level gravity equations which we use to estimate the parameters θ and δ:

$$
M_{in,t}^{j} = \exp\left[-\frac{1}{\theta^{j}}\ln(1+t_{in,t}^{j}) + \frac{\delta_{1}^{j}}{\theta^{j}}EU27_{in,t}^{j} + \frac{\delta_{2}^{j}}{\theta^{j}}EU_{UKn,t}^{j} + \frac{\delta_{3}^{j}}{\theta^{j}}EU_{iUK,t}^{j} + \frac{\delta_{4}^{j}}{\theta^{j}}Euro_{in,t}^{j} + \frac{\delta_{5}^{j}}{\theta^{j}}Schengen_{in,t}^{j}\right.
$$

$$
\left.+ \frac{\delta_{6}^{j}}{\theta^{j}}EU27KOR_{in,t}^{j} + \frac{\delta_{7}^{j}}{\theta^{j}}UKKOR_{in,t}^{j} + \frac{\delta_{8}^{j}}{\theta^{j}}FTA_{in,t}^{j} + \nu_{in}^{j} + \nu_{i,t}^{j} + \nu_{n,t}^{j}\right] + \varepsilon_{in,t}^{j}. \tag{9}
$$

$M_{in,t}^{j}$ denotes the value of imports of country i to country n in sector j at time t, the ad valorem tariff factor is given by $1+t_{in,t}^{j}$, and the trade elasticity is $1/\theta^{j} > 0$. $\nu_{i,t}^{j}$ and $\nu_{n,t}^{j}$ denote importer- and exporter-specific year fixed effects, respectively. ν_{in}^{j} denotes bilateral country-pair fixed effects which account for all time-invariant determinants of trade, such as geographical distance, or initial conditions. The time-varying importer and exporter effects control for multilateral resistance. By triangulation, they also account for the effects of exchange rate variation. $\varepsilon_{in,t}^{j}$ is a random error term.

For the simulation, we require estimates of $\delta_{k}^{j}/\theta^{j}$. Whenever an agreement affects the UK, we allow for treatment heterogeneity, hence, its effect to differ for the UK and the other 27 EU members (EU27). For example, we impose symmetry in the trade cost effect of EU membership amongst the EU27, but allow the EU membership for the UK to differ from that average; moreover, we also allow for directionality (UK exports to be affected differently than imports). We deal similarly with the conclusion of the EU-Korea agreement in 2011. Because the UK is neither a member of the Schengenzone nor the Eurozone, we do not further differentiate those effects.[11]

All integration measures are defined as binary variables taking the value one in a year if countries i and j are both members of an agreement. $Schengen_{in,t}^{j}$ is different; it systematically treats European countries as heterogeneous, as land-borne trade within Europe from i

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[11]The same approach is taken for FTAs other than the EU-Korea agreement.

to n may cross one or up to eight Schengen-internal borders. Aside, even if i and/or n are outsiders to the Schengen area, a pair in may experience lower transit costs. We thus use a variable $\text{Schengen}_{in,t}^j = \{1,\ldots,8\}$ that counts the number of Schengen-internal borders between a pair in (see Felbermayr et al., 2018).

Econometric identification relies on countries joining the EU, the Euro, the Schengenzone or FTAs in the period 2000-2014. Thus, the trade cost effect of the Single Market is identified through the various waves of Eastern enlargement (2004, 2007, 2013). The Eurozone was created in 1999 by 11 EU members; until 2014 seven additional countries joined. Similarly, Schengen was gradually expanded. The EU-Korea FTA entered into force in 2011 (the latest trade agreement of the EU available in our data), as did a number of other FTAs amongst non-EU countries.

The selection of country pairs into trade agreements with many members such as the EU is not random; the same is true for the setting of tariffs. To obtain unbiased estimates of θ^j and δ_k^j we require that the covariances between the error term $\varepsilon_{in,t}^j$ and the integration dummy on the one hand and between $\varepsilon_{in,t}^j$ and the sectoral tariff rate on the other are zero conditional on controls. Note that we include bilateral fixed effects ν_{in}^j to account for all time invariant variables that jointly affect policy variables and bilateral trade flows. Next to potential endogeneity, this also addresses omitted variable bias in integration agreements (see, e.g., Baier and Bergstrand, 2007).

As recommended by Santos Silva and Tenreyro (2006) and Fally (2015), we estimate the model using Poisson Pseudo Maximum Likelihood (PPML) methods. We cluster standard errors at bilateral pairs.

3.2 Data Sources

To calibrate the model and to estimate the possible effects of the UK leaving the EU Single Market and Customs Union, we need comprehensive data.

The World Input-Output Database (WIOD) comprises our main data source. It contains information on sectoral production, value added, and bilateral trade in final and intermediate goods in producer and consumer prices detailed by sector. This allows us to extract bilateral input-output tables and expenditure levels. WIOD includes 43 countries and a rest-of-the-world (RoW) aggregate for the years 2000 to 2014. It captures 56 sectors, which we aggregate into 50 industries as some sectors display zero output for some countries (see Table A1 in the Appendix). This aggregation concerns mostly services; we keep the sectoral detail in the

manufacturing and agricultural industries.[12]

Data on bilateral preferential and MFN tariffs stem from the World Integrated Trade Solutions (WITS-TRAINS) and the WTO's Integrated Database (IDB).[13] Data on tariffs and on trade from WIOD are used to estimate trade elasticities for the 22 manufacturing sectors – jointly with the ad valorem equivalent changes in NTBs associated with the different steps of European and trade integration in general.[14] We use data on FTA membership from the WTO.[15] Data on membership in the EU, the Eurozone and the successive accession of countries to the Schengen agreement stem from the European Commission. We capture membership in the EU, the Euro or in FTAs by indicator variables. To obtain a geographical measure of Schengen, we follow Felbermayr et al. (2018) and use the count of the number of Schengen borders crossed by truck and ferry when moving from economic centers of i to n in year t.

We use those data to structurally estimate the elasticities θ and coefficients δ. Input-output tables provide us with data on the expenditure shares α, and the cost shares β and γ. Further, data on bilateral trade shares π, countries' total value added $w_n L_n$, and trade surpluses S are calculated from input-output tables.

We take information on net fiscal transfers of EU members to the EU budget from the European Commission. Transfer redistribution is calculated based on the operating budgetary balance for the 2010-2014 UK average, relative to each country's gross national income (see Table A2 in the Appendix). The year 2014 is the latest year available in the WIOD data and thus serves as our baseline. Our simulation exercise compares the status quo in 2014 with a hypothetical situation in which the UK would leave the European Union in that year.

3.3 The UK's Europe Exposure in Comparison

Our analysis is based on one important conjecture, namely that inward and outward market access costs of the UK have benefited differently – possibly by less – from EU membership than other countries, and one key assumption, namely that the analysis of sector-level trade

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[12] We use the approach outlined in Aichele and Heiland (2018) to account for the fact that WIOD expenditure shares are valued in "basic" (or "producer") prices (net of tariffs), while expenditure shares in the model are defined in "market" prices (including tariffs). Further, we utilize their approach to account for changes in inventory as part of the accounting system of WIOD but do not feature in our model.

[13] As tariffs are not available for every year and every pair within our time frame, we interpolate tariff levels forward and backward.

[14] For services sectors, we borrow an average estimate of the elasticity of services trade with respect to trade cost from Egger et al. (2012). We adapt their method to obtain a trade elasticity of services and apply it to our estimated goods elasticity from our aggregated gravity estimation.

[15] The RTA gateway is accessible via `http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx`.

data for the years 2000 to 2014 is informative about the unwinding of integration steps between the UK and continental European countries that happened much earlier. In fact, through Brexit, we assume that trade costs between the EU and the UK go up by the amount that the Eastern enlargement has brought them down. While this is innocuous for trade costs between the UK and the new EU members, it may underestimate the effect of EU membership on trade costs between the UK and old EU member states.

Here, we present very simple facts suggesting that our presumptions are plausible. Consistent with our formal model, we compute a simple index of average inverse trade frictions of the form

$$\Omega_{in} \equiv \ln[X_{in}^{1/2} X_{ni}^{1/2} Y^w / (Y_i Y_n)], \tag{10}$$

where Y_i and Y_n denote country i's and n's GDPs, $Y^w = \sum_i Y_i$ is world GDP and X_{in} are country i's exports to country n.[16]

Figure 1 plots countries' inverse trade frictions with other EU members and with trade partners outside of the EU. The upper row looks at goods trade; the lower row at services trade. The left column compares inverse trade frictions of countries with EU members and with non-EU members. The right column compares countries' inverse trade frictions with 'old' EU and with 'new' EU members. The pictures suggest that all 25 countries (the 'old' 15 EU members and the ten countries that joined in 2004) have lower frictions amongst themselves than with the rest of the world. This is no surprise and reflects lower geographical and political trade costs. However, intra-EU goods trade frictions $\Omega_{i,EU}^{-1}$ are nowhere higher than in Greece, Cyprus and the UK, while the latter occupies a middle ground when looking at trade frictions with third parties. Hence, the UK seems less strongly tied to intra-European goods trade than other countries of similar size such as Italy, France, Spain, or Germany. This also implies that it has less to lose should it exit the union. With services trade, the UK's position is slightly better.

The right-hand diagram in Figure 1 plots inverse trade frictions of countries relative to 'old' (EU15) and 'new' (EU10) EU members. Again, the UK lies in the bottom-lower corner, signaling relatively high trade costs with both groups of countries. Importantly, it lies on the 45-degrees line, both for goods and services trade. This suggests that UK exporters and importers face similar situations in both new and old member states. This leaves us confident

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[16]A simple way of writing a model-consistent gravity equation is to posit $X_{in} = (Y_i Y_n / Y^w) \tilde{\Omega}_{in}$. Total bilateral trade is characterized by the geometric mean $(X_{in} X_{ni})^{1/2} = (Y_i Y_n / Y^w) \left(\tilde{\Omega}_{in} \tilde{\Omega}_{ni} \right)^{1/2}$. The inverse, non-directional (i.e., average) index of bilateral trade costs $\Omega_{in} \equiv \ln[\left(\tilde{\Omega}_{in} \tilde{\Omega}_{ni} \right)^{1/2}]$ can be calculated by available data. We know that this index is only an approximation; however, we do not calculate the Head-Ries-Index, as this would require trade cost symmetry and our point is that trade costs involving the UK and the EU are indeed asymmetric.

Figure 1: Inverse Trade Frictions with Different Trade Partners, 2014
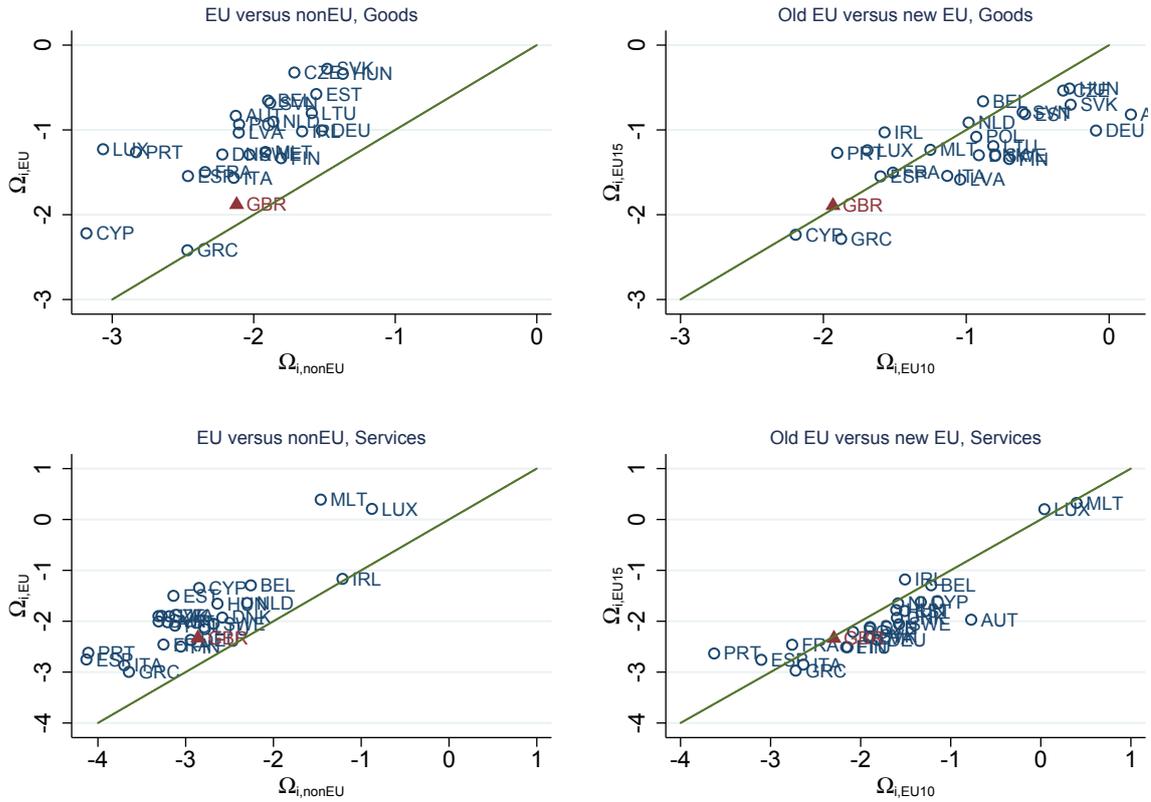
Note: Data from WIOD 2016. The straight line is the 45-degrees line.

that, even though our strategy identifies the effects of EU membership using accessions within the period 2000-2014, the estimates are, on average, also sensible with regard to the UK's trade relationship with the old EU15 countries.

3.4 Gravity Analysis of Aggregate Data

Table 1 shows results from regressions on aggregate data. Columns (1) to (6) report the effects on integration arrangements on goods trade; columns (7) to (10) on services trade. It reveals four insights that are of paramount importance for the following quantitative analysis.

Table 1: The Impact of EU Integration Steps on Bilateral Imports (2000 - 2014)

Dep. var.:	Bilateral Imports									
	Goods						Services			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Both EU	0.542*** (0.05)	0.470*** (0.05)	0.466*** (0.06)	0.294*** (0.07)	0.468*** (0.06)	0.294*** (0.07)	0.667*** (0.06)	0.594*** (0.06)	0.515*** (0.07)	0.512*** (0.07)
EU27-UK			0.398*** (0.09)	0.232** (0.10)					0.601*** (0.13)	
Exp: EU27, imp: UK					0.564*** (0.11)	0.399*** (0.11)				0.687*** (0.20)
Exp: UK, imp: EU27					0.213*** (0.08)	0.039 (0.08)				0.497*** (0.17)
Euro		0.060 (0.04)	0.056 (0.04)	0.058 (0.04)	0.056 (0.04)	0.058 (0.04)		0.152*** (0.06)	0.153*** (0.06)	0.152*** (0.06)
Schengen		0.093*** (0.01)	0.093*** (0.01)	0.090*** (0.01)	0.094*** (0.01)	0.090*** (0.01)		0.076*** (0.02)	0.077*** (0.02)	0.077*** (0.02)
EU-KOR			0.370*** (0.05)	0.253*** (0.06)					0.516*** (0.08)	
EU27-KOR					0.203*** (0.07)	0.117* (0.07)				0.378*** (0.06)
UK-KOR					0.078 (0.24)	−0.007 (0.23)				0.182*** (0.06)
Other FTAs	0.122*** (0.04)	0.122*** (0.04)	0.108** (0.05)	0.029 (0.05)	0.110** (0.05)	0.029 (0.05)	0.073 (0.05)	0.072 (0.05)	−0.007 (0.06)	−0.009 (0.06)
Tariff				−3.443*** (0.91)		−3.471*** (0.92)				
Chi2-Test										
Prob > chi2	0.000	0.000	0.403	0.451	0.002	0.002	0.000	0.000	0.486	0.470

Note: ***, **, * denote significance at the 1%, 5%, 10% levels, respectively. All models estimated use Poisson Pseudo Maximum Likelihood (PPML) methods. Robust standard errors (in parentheses) allow for clustering at the country-pair level. Pair as well as year specific importer and exporter fixed effects included but not reported. Specifications (1), (2), (7) and (8) use EU28 and other RTA excluding the EU. All other use EU27, treating the UK separately, and other RTA exclude the EU and the EU - Korea RTA. Number of observations: 27,735. Chi2-Tests compare "Both EU" to "Other RTA" in columns (1), (2), (7) and (8); "Both EU" and "EU-UK, symmetric" in columns (3), (4), and (9); and "EU->UK, asymmetric" with "EU<-UK,asymmetric" in columns (5), (6), and (10).

First, on average, EU membership is associated with substantial trade creation. Coefficients on goods (column (1)) and on services (column (7)), both statistically significant at the 1% level, imply trade creation of 72% and 95%, respectively. Assuming an elasticity of 3.5 for goods and 1.5 for services,[17] the estimates imply trade cost reductions of 14% and 36%, respectively. FTAs other than the EU create less trade and indicate trade cost reductions of 3.4% and 4.8%, respectively. The Chi2-test clearly rejects equality of EU and FTA effects; for services, FTAs are not even significant.

Second, accounting for other steps of European integration is important to correctly isolate the role of EU membership. Columns (2) and (8) add Eurozone and Schengen membership. It turns out that Schengen matters, both, for goods and services trade; but Eurozone membership is not statistically significant. However, controlling for those, the coefficient for the EU membership falls to 0.470 for goods and 0.594 for services, implying a fall in the trade cost reduction relative to columns (1) and (7).

Third, the effect of EU membership on trade may differ between country pairs involving the UK and those involving only EU27 members (excluding UK). For goods, the coefficient in column (3) is smaller for pairs involving the UK than for non-UK pairs; column (4) indicates that estimated trade cost reductions due to EU membership are 13% for EU27-pairs and 11% for pairs involving the UK. Note that the difference is not statistically significant. For services, trade cost reductions in pairs involving the UK are stronger than for EU27 (column (9)). Again, the difference is not statistically different from zero. Importantly, adding tariffs for goods trade in column (4) yields a very plausible estimate of the trade elasticity (3.5), with a variance of 0.92. Accounting for tariffs reduces trade costs of EU membership from 12.5% to 8.1% for EU27 pairs and from 10.7% to 6.4% for EU27-UK pairs. This is crucial, as tariffs imply very different welfare implications than iceberg trade costs (non-tariff barriers, NTBs); mistaking tariffs with NTBs would lead to an overestimate of the welfare damage of Brexit.

Fourth, allowing exports of the UK to EU27 to be affected differently than imports, i.e., turning to directional FTA effects, columns (5), (6) and (10) provide evidence for strong asymmetries. Columns (5) and (6) show that EU27 goods exports to the UK have increased through EU membership of the UK, but UK exports to EU27 countries have benefited only through the elimination of tariffs but not through NTBs. The difference between UK exports and imports is statistically significantly different from zero at the 1%-level. In the area of services, UK exports seem to have benefited more, but here the difference is not statistically different from zero.

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[17]See below for more details.

3.5 Gravity Analysis of Sectoral Data

Table 2 reports key results from sector-level gravity regressions which are replica of the equations on aggregate data described in columns (6) and (10) of Table 1. It documents substantial heterogeneity across the 22 goods and 28 services sectors with respect to the trade elasticity, and regarding effects of EU membership or the EU-Korea FTA.[18]

We find reasonable trade elasticities (estimated coefficients on tariffs) for most goods sectors; in sectors where the estimates violate regularity conditions, we report estimates based on tariff adjusted imports and replace elasticities with estimates obtained for aggregate data; see Table 1, column (6). Economic integration arrangements have very different effects on different sectors. Bilateral trade between the EU27 and the UK is shown to increase unambiguously through EU integration in 33 out of 50 sectors (both UK exports and imports go up with at least one effect statistically significant at the 10%-level). In 16 cases (mostly manufacturing), UK imports increase by more than UK exports; in 15 sectors (mostly services) the opposite is true. In the automotive sector (20), UK imports are affected very positively, but UK exports are not. A strong asymmetry exists in the chemicals sector, too, while in basic metals the situation is relatively balanced. In services sectors, postal & courier and financial services stand out, where, against the trend, UK imports have grown by more than UK exports due to EU integration.

4 General Equilibrium Results

4.1 Counterfactual Scenarios

We have now paved the way to simulate general equilibrium effects of the UK leaving the European Union Single Market and Customs Union. For each sector, the gravity model provides us with estimates of the (inverse) trade elasticity θ and of the NTB effects δ of various integration steps, as well as with estimates of the associated variance-covariance matrices. For services, we have no trade cost shifters such as tariffs. We turn to Egger et al. (2012) to infer a trade elasticity of $1/\hat{\theta}_{\text{Services}} = 1.446$.[19]

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[18]To save space, the table drops other covariates included in the model; see Tables A3 and A4 in the Appendix for full detail.

[19]Importantly, Egger et al. (2012) state that services trade reacts more elastically to trade liberalization than goods trade. Hence, assuming an elasticity of 5 as in Caliendo and Parro (2015) seems not to be a reasonable choice in our context. This is supported by recent applications of Hobijn and Nechio (2019) using VAT data for the EU25 and Marquez (2006) using price and income data for the US. Both find a range for services elasticities between 1 and 3. More specifically, Egger et al. (2012) estimate a parameter β in their model (which belongs to a related class of new quantitative trade models), which is given by

Table 2: EU Integration Steps and Bilateral Imports (2000 - 2014)

Dep. var.:	Bilateral Imports				
Sector Description	exp: EU27 imp: UK	exp: UK imp: EU27	EU27 - KOR	UK - KOR	Tariff
1 Crops & Animals°	1.254***	0.733***	0.327	−0.212	−3.471***
2 Forestry & Logging°	0.194	0.267	0.091	−0.919***	−3.471***
3 Fishing & Aquaculture°	0.003	1.057	−0.174	0.605	−3.471***
4 Mining & Quarrying°	−0.797***	−0.192	1.136***	2.792***	−3.471***
5 Food, Beverages & Tobacco	0.736***	0.555***	0.18	−0.611***	−1.066
6 Textiles, Apparel, Leather°	0.117	0.295	0.345***	−0.414*	−3.471***
7 Wood & Cork°	0.076	−0.109	0.410***	0.479***	−3.471***
8 Paper°	0.369	0.307**	0.341***	−0.167	−3.471***
9 Recorded Media Reproduction	−0.111	−0.011	0.879***	0.174	−1.254
10 Coke, Refined Petroleum	−0.292	−0.029	0.512*	0.372***	−6.020***
11 Chemicals	0.777***	0.253**	0.318***	0.166**	−3.531***
12 Pharmaceuticals	1.098***	0.828***	−0.061	−0.088	−11.390 ***
13 Rubber & Plastics	0.698***	0.448***	0.307***	0.116*	−2.258**
14 Other non-Metallic Mineral	0.265	0.223*	0.029	0.033	−1.366*
15 Basic Metals	0.681**	0.641***	0.308***	0.075	−3.191***
16 Fabricated Metal	0.551***	0.254	0.275***	0.135	−1.543***
17 Electronics & Optical Products	0.694***	−0.208	−0.15	−0.809***	−7.780***
18 Electrical Equipment	0.601***	0.151	0.370***	−0.003	−6.001***
19 Machinery & Equipment	0.568***	0.214*	0.119*	0.180***	−7.873***
20 Motor Vehicles	0.730***	0.364	0.311***	0.144	−4.611***
21 Other Transport Equipment	0.188	−0.303	0.315	0.169	−2.947
22 Furniture & Other Manufacturing	−0.086	−0.149	−0.571***	−1.110***	−3.727***
23 Electricity & Gas	0.895**	1.068**	0.355	−1.653***	−1.446***
24 Water Supply	−0.334	0.001	0.629***	0.623***	−1.446***
25 Sewerage & Waste	1.314***	0.893***	−0.015	−0.015	−1.446***
26 Construction	1.239***	2.154***	0.137	0.234	−1.446***
27 Trade & Repair of Motor Vehicles	1.503**	2.256***	0.736***	1.097***	−1.446***
28 Wholesale Trade	1.515***	2.611***	0.471***	1.299***	−1.446***
29 Retail Trade	1.374***	1.571***	0.425*	0.847***	−1.446***
30 Land Transport	0.333*	1.047***	0.327*	0.384	−1.446***
31 Water Transport	0.679**	0.759**	0.302	−1.020**	−1.446***
32 Air Transport	0.198	0.700***	0.108	−0.859**	−1.446***
33 Aux. Transportation Services	0.24	0.638***	0.04	−0.025	−1.446***
34 Postal & Courier	1.266***	0.245	0.680**	−0.163	−1.446***
35 Accommodation & Food	0.002	−0.018	−0.456***	−1.576***	−1.446***
36 Publishing	0.23	0.542*	−0.191	−0.096	−1.446***
37 Media Services	0.027	0.565**	0.071	0.063	−1.446***
38 Telecommunications	0.466	0.323	0.604***	−0.06	−1.446***
39 Computer & Information Services	1.067***	0.532**	0.848**	−0.221	−1.446***
40 Financial Services	1.809***	0.484	0.899***	−0.366*	−1.446***
41 Insurance	−0.121	−0.609	0.058	−0.147	−1.446***
42 Real Estate	0.832**	1.104***	0.04	0.544	−1.446***
43 Legal & Accounting	0.520**	0.599**	0.16	0.018	−1.446***
44 Business Services	0.999***	0.993***	0.809***	0.413***	−1.446***
45 Research & Development	−0.134	−0.049	−0.138	−1.095***	−1.446***
46 Admin. & Support Services	0.229	−0.097	0.046	−0.509***	−1.446***
47 Public & Social Services	0.438	0.657	0.095	1.085***	−1.446***
48 Education	1.062***	1.503***	0.555	1.065***	−1.446***
49 Human Health & Social Work	0.271	0.959**	0.971***	1.058***	−1.446***
50 Other Services, Households	0.824	0.397	0.023	0.919***	−1.446***

Note: ***, **, * denote significance at the 1%, 5%, 10% levels, respectively. All models estimated use Poisson Pseudo Maximum Likelihood (PPML) methods. Robust standard errors (not reported) allow for clustering at the country-pair level. Pair as well as year specific importer and exporter fixed effects included but not reported. Sectors marked with ° report estimates based on tariff adjusted imports, applying overall trade elasticities for goods trade from Table (1) column (5). For services sectors, we calculate the trade elasticity for services according to Egger et al. (2012). Varying observations between 23,085 and 27,735. Detailed effects for the 22 goods and 28 services sectors can be found in Tables A3 and A4 in the Appendix.

$\beta = \beta_{\text{Goods}} - \beta_{\text{Services}}$. Given their estimate $\hat{\beta} = 2.026$ and our own estimate $\hat{\beta}_{\text{Goods}} = 1/\hat{\theta}_{\text{Goods}}$, we can infer $\hat{\beta}_{\text{Services}} = 1/\hat{\theta}_{\text{Services}}$, with a variance 0.144.

Assuming that parameters are jointly normally distributed, we draw a value of θ to calibrate the model, and a full set of NTB shifters δ to inform the counterfactual analysis.[20] We repeat this procedure 1,000 times and obtain a distribution of NTB cost shocks and a distribution of changes of endogenous variables. This allows us to construct confidence intervals.[21]

We define the following counterfactual scenarios. Figure 2 illustrates trade cost shocks $\hat{\kappa}$ (equation (2)) and their distribution for each sector.

S1 **WTO Scenario ("Hard Brexit")**: The UK is no longer part of the European Single Market and Customs Union and there is no new FTA substituting for it. The EU27 and the UK apply MFN tariffs as currently granted under WTO rules on imports of third countries.[22] In addition, directional NTBs are reintroduced between the EU27 and the UK according to the sectoral trade costs calculated from the gravity estimations. Figure 2a shows NTB changes for the UK (importer) with EU27 countries; Figure 2b shows respective barriers for EU27 members with the UK (exporter). Moreover, the UK loses all existing tariff and non-tariff preferences that it currently enjoys with third countries with whom the EU has an FTA in force. We apply the heterogeneous UK-Korea agreement effect from the gravity model and effects from further pre-EU accession treaties. Additionally, we consider fiscal transfers by correcting the specific trade balances for fiscal transfers between the EU27 and the UK.

S2 **FTA Scenario ("Soft Brexit")**: The UK exits the EU Single Market and Customs Union, but the EU27 and the UK negotiate a modern free trade agreement (FTA), which comprises not only tariffs but also affects NTBs on goods and services. We model the FTA scenario as a replication of the EU-Korea agreement of 2011 – the latest and most comprehensive trade agreement of the EU covered in the data. We utilize the estimated trade cost reductions of the EU-Korea FTA from our gravity model as a proxy for a potential NTB effects between the EU27 and the UK (see Figure 2c).

S3 **Global Britain Scenario**: We model the same relationship regarding tariffs and

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[20]The choice of normal distribution implies that we will always obtain some draws that violate the model-imposed parameter constraint $1/\theta > 0$. To circumvent this problem we drop the (very few) parameter draws of θ that violate the constraint. This comes at the expense of a small upward bias of the mean parameter estimate and a downward bias of the standard errors.

[21]The underlying normality assumption is not completely innocuous, given that the model outcomes are potentially highly non-linear functions of the parameters. The distribution of model outcomes might be highly asymmetric even if the size of the underlying sample is large enough for the normal approximation to work well for parameter estimation.

[22]Figure 4 in the Appendix shows sectoral trade-weighted MFN tariffs granted at the product-level by the EU to third countries in 2014. These are used for simulation in the WTO scenario.

NTBs between the EU27 and the UK as under the WTO scenario, but now the UK unilaterally eliminates tariffs and concludes FTAs with various third countries in order to lower NTBs. The scenario is divided into three stages:

(a) The UK concludes an FTA with the USMCA countries the US, Mexico, and Canada. NTBs are reduced as under the EU-Korea FTA.

(b) Further, the UK concludes an FTA with selected non-EU Commonwealth countries, namely Australia and India.

(c) Finally, we assume that the UK also concludes additional FTAs with selected Asian countries (JPN, KOR, CHN).

S4 **Hard but Smart Brexit**: Similar to S1, the UK is no longer part of the European Single Market and Customs Union with no new FTA in place. The EU27 apply MFN tariffs to the UK as currently granted under WTO rules on imports to third countries. Directional NTBs are reintroduced in the EU27 for UK's exports according to the sectoral trade costs calculated from the gravity estimations. In contrast to S1, the UK now decreases all existing tariffs for all its trading partners to zero. Additionally, we account for fiscal transfers within the EU by correcting the specific trade balances between the EU27 and the UK.

Figure 2: Change in Non-Tariff Barriers, in %

(a) Hard Brexit (S1 and S3): Change in costs of NTBs $\hat{\tau}_{EU,UK}^{j}$

(b) Hard Brexit (S1 and S3): Change in costs of NTBs $\hat{\tau}_{UK,EU}^{j}$

(c) Soft Brexit (S2 and S3): Change in costs of NTBs $\hat{\tau}_{UK,KOR}^{j} = \hat{\tau}_{KOR,UK}^{j}$

equal-tailed 95% CI   ● Mean

Note: Dots depict percentage changes of non-tariff barriers. Bars show 90%-confidence bounds, which are based on 1,000 replications and approximate normal distribution. Sector 1 to 4 are agricultural and natural resources sectors, 5 to 22 are manufacturing sectors, and 23 to 50 are services sectors.

4.2   The Role of Treatment Heterogeneity

Before turning to the detailed general equilibrium analysis, we illustrate the importance of considering heterogeneity in trade cost shocks for quantitative results. Table 3 shows the real wage changes for various model specifications under the hard Brexit scenario (S1).[23] While allowing for the heterogeneity of treatment effects, Panel A uses the broad sector specification of Table 1, while Panel B allows elasticities to vary across the 50 sectors in our data (cp. Table 2).

Panel A reveals that moving from a simple dummy treatment of EU membership (row [1]) to

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[23]We focus on real wages which are less strongly affected by whether trade cost shocks are modeled as affecting tariffs or iceberg trade costs, a distinction that is lost when lumping together different steps of European integration.

a more subtle measurement allowing for variable geometry (row [2]), to asymmetry between the effects on EU27 pairs and pairs involving the UK (row [3]), and to directionality in the EU27-UK effects (row [4]) gradually reduces the real wage losses due to Brexit from 0.57% in row [1] to 0.41% in row [4] for the EU27 and from 3.20% to 2.53% for the UK. Hence, a simple dummy approach overestimates the costs from Brexit by about 40% for the EU27 average and 25% for the UK.

Table 3: Average Real Wage Changes in a Hard Brexit Scenario (S1), in %, Based on Various NTB Estimations

	EU27	UK	RoW
Panel A: Broad sectoral disaggregation (estimates from Table 1)			
[1] Single EU dummy (col. (1) and (7))	-0.57	-3.20	-0.01
[2] Variable geometry (col. (2) and (8))	-0.51	-2.88	-0.01
[3] UK and EU treated differently (col. (3) and (9))	-0.49	-2.76	-0.01
[4] Allowing for directionality (col. (5) and (10))	-0.41	-2.53	-0.01
Panel B: Detailed sectoral disaggregation (estimates from Table 2)			
[5] Single EU dummy (col. (1) and (7))	-0.59	-3.50	-0.01
[6] Variable geometry (col. (2) and (8))	-0.43	-2.61	0.00
[7] UK and EU treated differently (col. (3) and (9))	-0.56	-3.29	0.00
[8] Allowing for directionality (col. (5) and (10))	-0.60	-3.45	0.00

Note: RoW: Rest of the World. The baseline year is 2014. All reported numbers are statistically different from zero at the 10%-level based on 1,000 replications. Panel A uses estimates from Table 1, while those of Panel B stem from Table A3 for goods sectors and Table A4 for services sectors in the Appendix.

If trade elasticities and treatment effects vary across sectors (rows [5] to [8]), we find higher simulated costs from Brexit relative to estimates based on a two-sector model (goods and services) – but only for the combination of sectoral heterogeneity and directional UK-specific treatments. Consequently, being precise in the econometric identification of NTB effects matters for macroeconomic outcomes, even if the most simplistic treatment (row[1]) and our preferred, more sophisticated specification (row[8]) show rather similar effects.

4.3 Effects on Real Consumption

We now turn to the detailed general equilibrium analysis of Brexit by using the trade cost shocks described in the counterfactual scenarios in our general equilibrium trade model. Table 4 starts by reporting changes in real consumption, our preferred measure of welfare, for 44 countries and the four Brexit scenarios. The advantage of reporting real consumption

compared to real wage changes (see Table A11 in the Appendix) is that real consumption accounts for the direct effects of tariff income, transfers, and trade imbalances.

Table 4: Change in Real Consumption, in %

	S1	S2	S3	S4		S1	S2	S3	S4
UK	**-2.76**	**-0.93**	**-1.43**	**-0.50**	Portugal	**-0.45**	-0.12	**-0.46**	**-0.40**
	[-3.32, -2.19]	[-1.65, -0.21]	[-2.10, -0.76]	[-0.63, -0.37]		[-0.56, -0.35]	[-0.25, 0.01]	[-0.56, -0.35]	[-0.50, -0.29]
Austria	**-0.35**	**-0.09**	**-0.38**	**-0.28**	Romania	**-0.37**	**-0.16**	**-0.39**	**-0.32**
	[-0.42, -0.27]	[-0.19, -0.00]	[-0.45, -0.30]	[-0.35, -0.20]		[-0.45, -0.29]	[-0.25, -0.08]	[-0.47, -0.31]	[-0.39, -0.24]
Belgium	**-1.40**	-0.29	**-1.46**	**-0.96**	Slovakia	**-0.73**	**-0.33**	**-0.77**	**-0.38**
	[-1.71, -1.09]	[-0.71, 0.13]	[-1.77, -1.15]	[-1.28, -0.64]		[-0.86, -0.60]	[-0.52, -0.15]	[-0.91, -0.64]	[-0.46, -0.30]
Bulgaria	**-0.51**	**-0.24**	**-0.50**	**-0.46**	Slovenia	**-0.42**	**-0.17**	**-0.46**	**-0.33**
	[-0.62, -0.40]	[-0.36, -0.11]	[-0.60, -0.39]	[-0.56, -0.36]		[-0.50, -0.35]	[-0.25, -0.08]	[-0.54, -0.38]	[-0.41, -0.25]
Croatia	**-0.34**	-0.04	**-0.34**	**-0.29**	Spain	**-0.39**	**-0.13**	**-0.42**	**-0.29**
	[-0.43, -0.24]	[-0.17, 0.09]	[-0.43, -0.24]	[-0.38, -0.20]		[-0.48, -0.30]	[-0.23, -0.02]	[-0.50, -0.33]	[-0.38, -0.20]
Cyprus	**-1.37**	**-0.35**	**-1.36**	**-1.08**	Sweden	**-0.75**	-0.11	**-0.79**	**-0.64**
	[-1.80, -0.94]	[-0.91, 0.21]	[-1.79, -0.93]	[-1.50, -0.66]		[-0.91, -0.58]	[-0.34, 0.12]	[-0.95, -0.62]	[-0.80, -0.47]
Czech R.	**-0.75**	**-0.35**	**-0.84**	**-0.51**	Australia	-0.00	-0.00	**0.12**	**0.01**
	[-0.90, -0.60]	[-0.51, -0.20]	[-0.99, -0.69]	[-0.65, -0.36]		[-0.01, 0.00]	[-0.01, 0.00]	[0.08, 0.15]	[0.01, 0.01]
Denmark	**-0.89**	-0.12	**-0.91**	**-0.71**	Brasil	**-0.01**	0.00	**-0.01**	0.00
	[-1.10, -0.67]	[-0.46, 0.22]	[-1.12, -0.70]	[-0.93, -0.49]		[-0.01, -0.01]	[-0.00, 0.00]	[-0.01, -0.00]	[0.00, 0.01]
Estonia	**-0.70**	**-0.27**	**-0.71**	**-0.62**	Canada	0.00	-0.01	**0.26**	**0.01**
	[-0.88, -0.51]	[-0.46, -0.07]	[-0.89, -0.52]	[-0.79, -0.44]		[-0.00, 0.01]	[-0.03, 0.00]	[0.15, 0.37]	[0.00, 0.01]
Finland	**-0.50**	-0.08	**-0.52**	**-0.45**	China	**0.05**	**0.02**	**0.13**	**0.06**
	[-0.60, -0.39]	[-0.22, 0.06]	[-0.62, -0.41]	[-0.55, -0.35]		[0.04, 0.05]	[0.00, 0.03]	[0.11, 0.14]	[0.05, 0.06]
France	**-0.52**	-0.10	**-0.54**	**-0.40**	India	**0.02**	0.00	**0.20**	**0.07**
	[-0.66, -0.38]	[-0.32, 0.12]	[-0.68, -0.40]	[-0.54, -0.25]		[0.01, 0.02]	[-0.00, 0.01]	[0.16, 0.25]	[0.06, 0.08]
Germany	**-0.72**	**-0.20**	**-0.80**	**-0.48**	Indonesia	**0.01**	-0.00	**0.00**	**0.02**
	[-0.84, -0.59]	[-0.36, -0.04]	[-0.92, -0.67]	[-0.61, -0.36]		[0.01, 0.01]	[-0.01, 0.00]	[0.00, 0.01]	[0.01, 0.02]
Greece	**-0.39**	-0.12	**-0.37**	**-0.37**	Japan	-0.00	0.00	**0.06**	**-0.00**
	[-0.48, -0.29]	[-0.23, 0.00]	[-0.47, -0.28]	[-0.46, -0.27]		[-0.00, 0.00]	[-0.00, 0.01]	[0.05, 0.08]	[-0.01, -0.00]
Hungary	**-0.87**	**-0.34**	**-0.94**	**-0.60**	Korea	-0.03	**-0.09**	**0.15**	**0.06**
	[-1.01, -0.74]	[-0.49, -0.18]	[-1.07, -0.80]	[-0.74, -0.46]		[-0.08, 0.02]	[-0.16, -0.02]	[0.09, 0.21]	[0.05, 0.08]
Ireland	**-8.16**	**-3.08**	**-8.22**	**-5.39**	Mexico	-0.01	**-0.01**	**0.04**	**0.01**
	[-9.60, -6.72]	[-4.82, -1.34]	[-9.66, -6.78]	[-6.80, -3.98]		[-0.01, 0.00]	[-0.02, -0.00]	[0.02, 0.05]	[0.00, 0.01]
Italy	**-0.40**	-0.09	**-0.43**	**-0.31**	Norway	**0.52**	0.23	**0.61**	**-0.15**
	[-0.50, -0.31]	[-0.21, 0.04]	[-0.53, -0.34]	[-0.41, -0.22]		[0.10, 0.94]	[-0.37, 0.84]	[0.13, 1.09]	[-0.26, -0.04]
Latvia	**-0.58**	-0.16	**-0.58**	**-0.51**	Russia	0.01	**-0.08**	-0.02	**0.05**
	[-0.76, -0.40]	[-0.36, 0.04]	[-0.75, -0.40]	[-0.67, -0.34]		[-0.02, 0.03]	[-0.16, -0.01]	[-0.05, 0.00]	[0.02, 0.07]
Lithuania	**-0.51**	-0.07	**-0.55**	**-0.42**	Switzerland	-0.01	0.04	-0.04	**0.12**
	[-0.66, -0.35]	[-0.28, 0.14]	[-0.71, -0.40]	[-0.56, -0.29]		[-0.16, 0.14]	[-0.12, 0.20]	[-0.19, 0.11]	[0.05, 0.19]
Luxembourg	**-5.23**	2.15	**-5.46**	-3.15	Taiwan	**0.13**	0.06	**0.09**	**0.10**
	[-8.61, -1.85]	[-2.64, 6.95]	[-8.82, -2.09]	[-6.67, 0.36]		[0.11, 0.16]	[-0.49, 0.61]	[0.06, 0.12]	[0.08, 0.12]
Malta	**-5.19**	-0.76	**-5.16**	**-3.36**	Turkey	**-0.04**	**-0.07**	**-0.08**	**0.05**
	[-6.65, -3.73]	[-2.94, 1.43]	[-6.63, -3.69]	[-4.40, -2.32]		[-0.07, -0.01]	[-0.10, -0.04]	[-0.11, -0.05]	[0.05, 0.06]
Netherlands	**-1.64**	-0.37	**-1.71**	**-1.06**	USA	**-0.01**	-0.00	**0.11**	**-0.01**
	[-1.94, -1.33]	[-0.84, 0.10]	[-2.01, -1.40]	[-1.36, -0.76]		[-0.02, -0.01]	[-0.01, 0.00]	[0.08, 0.14]	[-0.01, -0.00]
Poland	**-0.69**	**-0.25**	**-0.73**	**-0.47**	ROW	-0.02	0.02	-0.02	0.02
	[-0.81, -0.57]	[-0.38, -0.12]	[-0.85, -0.61]	[-0.59, -0.35]		[-0.05, 0.01]	[-0.02, 0.06]	[-0.05, 0.01]	[-0.01, 0.06]
EU27	**-0.78**	**-0.20**	**-0.83**	**-0.56**					
	[-0.93, -0.63]	[-0.38, -0.01]	[-0.97, -0.68]	[-0.71, -0.40]					
ROW	0.00	0.00	**0.08**	**0.02**					
	[-0.00, 0.01]	[-0.01, 0.01]	[0.06, 0.10]	[0.02, 0.02]					

Note: The baseline year is 2014. Mean effects and [p5, p95] intervals. Bold characters indicate significance at the 10%-level based on 1,000 replications. Confidence intervals in square brackets. The results for EU27 and ROW are calculated as GDP weighted averages.

A hard Brexit (S1) decreases the UK's real consumption by 2.76% per annum relative to the status quo in the year 2014.[24] This compares to a reduction of 0.93% in the case of

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[24]This effect is different from Table 3 as it treats changes in tariffs and NTB changes separately. It uses

a modern FTA (S2). Opening the British market toward non-EU countries (S3) cannot fully compensate for the negative effect of Brexit and causes the UK's real consumption to fall by 1.43%. This indicates that the well-established trade ties between EU27 economies and the UK cannot easily be compensated through trade agreements between the UK and other Commonwealth countries, Japan, Korea, or China, and the USMCA economies. Real consumption effects for the UK and the EU27 average are statistically significant at the 10%-level. The changes in real consumption for the EU27 are on average smaller than those for the UK in the first three scenarios. The reason is that a smaller trade share per EU27 country is affected by Brexit compared to the UK. The EU27 real consumption losses are nearly four times as large under a hard Brexit (-0.78%) compared to a FTA (-0.20%). Global Britain slightly increases the losses (-0.83%) for the EU27 economies, as a hard Brexit with additional FTAs between the UK and non-EU countries would cause trade diversion away from Europe.

EU27 countries are affected very differently; mean losses lie between -8.16% in Ireland and -0.34% in Croatia. This reflects the initial strength of trade ties by taking input-output linkages involving third countries into account.[25] In case of a hard Brexit, Luxembourg and Malta would face higher losses than the UK and the Netherlands, Belgium, and Cyprus would experience drops in real consumption of more than one percent each. Malta and Cyprus are former colonies; Luxembourg has strong linkages to the UK financial services industry, and the Netherlands and Belgium are geographically very close to the UK. Larger EU countries would experience smaller losses as they are protected by larger home markets and also tend to have more diversified trade ties. In case of a hard Brexit, Germany faces a decrease in real consumption of 0.72%, while France loses 0.52%. A FTA between the EU27 and the UK nearly divides the size of real consumption losses for EU27 by four. With a FTA, Ireland's real consumption decrease is 3.08%, still substantially more than the UK's with 0.93%. Germany would have to face a loss of 0.20%, almost identical to the EU27 average, and statistically different from zero at the 10% level. France, in contrast, would suffer a loss of 0.10% only, which is statistically not distinguishable from a zero effect. Compared to a hard Brexit, losses in real consumption slightly worsen for EU27 countries under a global Britain scenario, as countries are negatively affected by trade diversion caused by the conclusion of trade agreements between the UK and third countries. Germany and France would experience a drop in real consumption of 0.80% and 0.54%, respectively; the EU average goes from -0.78% under S1 to -0.83% under S3.

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detailed trade costs derived from Table 2.

[25]The relatively strong effect on Hungary or Slovakia from Brexit is related to their role in German production networks.

Turning to non-EU countries, we find small losses for Brazil, Turkey, or the US and slight benefits for China, India, Indonesia, Norway and Taiwan from a hard Brexit. Countries with whom the UK would conclude a new FTA would mostly benefit in real consumption terms; but the relative gains are rather small: India's real consumption would go up by about 0.20% or the real consumption of the US by 0.11%. Canada, with its relatively small home market, would benefit most: its real consumption could increase by 0.26%. All those gains are statistically different from zero.

The EU's dominating power in the Brexit negotiations rests upon the believe that the UK would suffer substantially more in the case of an unsorted, non-cooperative Brexit than the EU27 on average. Our counterfactual scenarios S1 to S3, next to the existing literature that quantifies the outcome of Brexit (see, e.g. Dhingra et al., 2017; Sampson, 2017; Steinberg, 2019) support this believe. While under any previous scenario the UK would lose substantially more than the EU27 on average, the question is whether a hard Brexit that reintroduces MFN tariffs and NTBs is feasible. London could shift the bargaining power with a simple trick: the hard but smart Brexit strategy (S4). Under S4, the UK would no longer suffer fundamentally more than the EU27. The UK's real income would decrease by half a percent (see Table 4) – which is more than 5 times less than under a hard Brexit, and about half the loss from a soft Brexit. The effect is mainly driven by two channels: First, the absence of tariffs does not lead to additional price increases for British consumers, in contrast to the hard Brexit scenario (S1). In fact, the complete tariff liberalization even leads to price decreases. A negative nominal income effect still outweighs these positive price effects. As the EU27 increase their barriers (tariffs and non-tariff barriers), exporting British goods and services to the EU27 becomes more expensive and thereby decreases the nominal income. Overall, the reduction in nominal income dominates. Still, no other scenario is more endurable for the UK than this one, even though the EU27 increase their barriers. The effects for the remaining EU members do not substantially differ from the hard Brexit scenario.

In a next step, we decompose the hard Brexit scenario to identify the key components of the overall welfare effects; see Figure 3a for the UK and Figure 3b for the EU27.[26] We distinguish between the effects of (a) fiscal transfers, (b) tariffs on agriculture, and (c) tariffs on manufacturing, (d) NTBs on agriculture, (e) NTBs on manufacturing, and (f) NTBs on services.[27]

Ending net fiscal transfers has direct effects on real consumption, but it also affects countries'

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[26]Detailed results are provided in Tables A5 and A6 in the Appendix.

[27]Note that separate welfare effects of (a) to (f) do not add up to the total effect of all components together, as the different barriers may complement or substitute each other.

terms-of-trade; see the famous debate about the German transfer problem between Keynes (1929) and Ohlin (1929). In Keynes's logic, transfers worsen the terms of trade (TOT) since exports would have to increase and imports to decrease so that the price for exported relative to imported goods would have to fall. Transfers, thus, impose an additional burden on the paying countries. As shown in Table A2, UK net transfers to the EU27 amounted to an average of about 6.5 billion Euro in the 2010-2014 period or slightly more than 0.30% of GDP. Figure 3a shows that unwinding those transfers would allow UK consumers to increase real consumption by 0.29%, slightly less than the pure transfers themselves. In line with Keynes (1929), the UK benefits from an end to transfers not only from a direct effect but also from an amelioration of its TOT, even though this gain is extremely small. Regarding the remaining EU27 members, we assume that the end of UK transfers is borne by all countries proportionally to their GDP. This amounts to an average reduction of net transfers by 0.06% of GDP. Not surprisingly, the real consumption losses from such a scenario are indeed centered around 0.06%; losses in Ireland or Luxembourg, the Netherlands, or Germany are increased by adverse movements in TOT: these countries seem to benefit from the system of EU transfers as this drives up the relative demand for their exports.

Figure 3a and 3b also show that the reintroduction of agricultural tariffs yields a very small positive consumption effect in the UK; the UK benefits as the negative allocation effects are outweighed by positive TOT effects. Tariffs are at least partly absorbed by the UK's trading partners while agricultural tariff income remains in the country. A similar picture emerges in manufacturing. However, gains and losses on real consumption from reintroducing tariffs are very minor, as tariff income is rebated and welfare damages are always of a "triangular" form.

4.4   Effects on Bilateral Trade

Table 5 reports changes in bilateral trade flows in our four scenarios for the EU27, the UK and the rest of the world (ROW). Sectors are aggregated into three broad categories: agriculture, manufacturing, and service. Bold face characters denote mean effects that are statistically different from zero.[28] Trade flows are impacted by changes in bilateral trade costs and by general equilibrium forces through changes in total expenditure and revenue, and by multilateral resistance terms. Note that we keep the trade surplus of countries relative to GDP constant; quite mechanically, this forces some additional asymmetry in the rates of change in trade flows even if trade cost shocks are very similar.

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[28]Tables A7 to A9 in the Appendix provide details.

Figure 3: Decomposing the Real Consumption Effects of a Hard Brexit

(a) United Kingdom (b) EU27
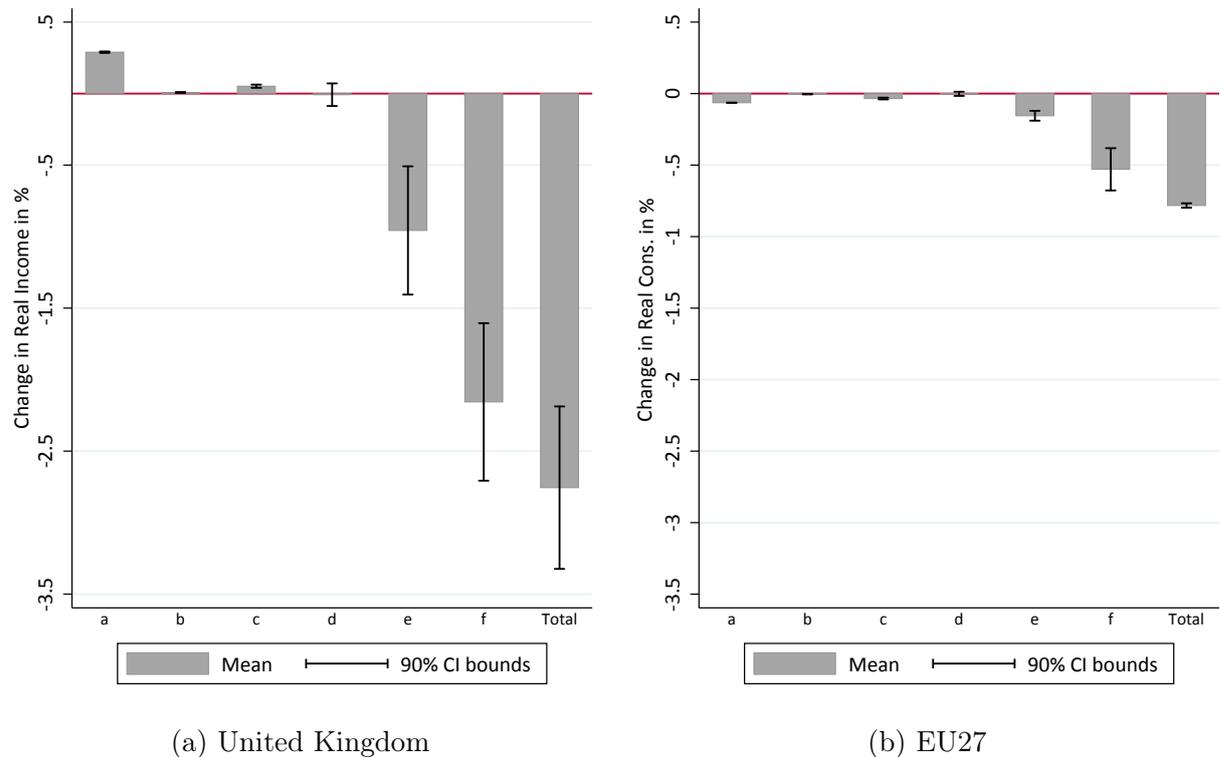
Note: a: fiscal transfers; b: tariffs in agriculture; c: tariffs in manufacturing; d: NTBs in agriculture; e: NTBs in manufacturing; f: NTBs in services. The baseline year is 2014. Bars depict real consumption percentage changes; details are shown in Tables A5 and A6 in the Appendix. The black solid lines show 90%-confidence bounds, which are based on 1,000 replications.

Our analysis implies that EU27 exports to the UK would fall by 27% in the hard Brexit scenario (S1), with 90% of the probability mass lying in the interval [-30,-25]. Exports would fall by 29% in the global Britain scenario (S3). With a FTA (S2), exports would fall by an expected effect of 4%, but the associated confidence interval is large: [-9,1]. So, if the EU27 and the UK sign an ambitious FTA, it is no longer certain that trade will actually fall. Interestingly, this does not apply to services transactions, where we report a statistically significant expected drop of 8%. In all other scenarios, EU27 exports to the UK would contract in all sectors, with the largest effects expected in manufacturing. In the hard but smart Brexit scenario (S4), the UK offers a liberal market access for exporters from the EU27 and the RoW. Hence, EU27 exports to the UK fall by only 9%, and thereby decrease by less than half compared to a hard Brexit.

Overall, we find that UK exports to the EU27 fall by 25% in S1 and S3, which is 3 to 4 percentage points less than what is expected to happen to EU27 exports to the UK. However, the difference is not statistically distinguishable from zero. UK manufacturing exports suffer most; in agriculture, effects are not significant, reflecting the lack of trade cost reductions

| | EU27 Exports to | | | UK Exports to | | ROW Exports to | | |
| | Percentage Changes of | | | | | | | |
	EU27	UK	ROW	EU27	ROW	EU27	UK	ROW
S1								
Agriculture	-0.24	**-22.74**	**0.85**	-4.46	**-6.31**	**-1.19**	**10.05**	**0.25**
Manufacturing	-0.14	**-30.63**	**1.15**	**-32.19**	**-10.00**	**-0.91**	**9.80**	**0.24**
Services	**-0.30**	**-21.21**	**0.44**	**-20.85**	**-0.43**	**-0.96**	0.07	**0.20**
Total	**-0.18**	**-27.42**	**0.87**	**-24.69**	**-4.57**	**-0.97**	**7.16**	**0.23**
S2								
Agriculture	-1.34	40.06	-0.13	96.05	**-7.20**	-1.96	9.62	-0.04
Manufacturing	-0.31	-4.71	**0.35**	7.16	**-7.58**	**-0.68**	1.80	0.06
Services	0.25	**-7.55**	**0.32**	**-7.16**	**-0.76**	-0.33	1.04	0.01
Total	-0.20	-4.15	**0.33**	3.15	**-3.80**	**-0.75**	2.40	0.03
S3								
Agriculture	-0.34	**-19.87**	**0.95**	-6.70	7.11	**-1.49**	**22.05**	**0.27**
Manufacturing	**-0.35**	**-34.35**	**1.14**	**-32.33**	**14.80**	**-1.35**	**34.19**	0.03
Services	**-0.48**	**-19.76**	**0.37**	**-21.33**	**4.49**	**-1.13**	**9.04**	**0.11**
Total	**-0.39**	**-29.31**	**0.84**	**-25.11**	**8.81**	**-1.30**	**26.05**	**0.08**
S4								
Agriculture	-0.28	**-10.90**	-0.12	2.50	**7.61**	-0.57	-2.51	**0.25**
Manufacturing	**-0.22**	**-11.52**	**-0.51**	-17.84	**9.93**	0.19	**9.96**	**0.16**
Services	**0.28**	**-4.29**	**0.21**	-18.79	1.44	-0.07	**-4.28**	**0.19**
Total	-0.09	**-9.23**	**-0.23**	-17.47	**5.15**	-0.01	**4.77**	**0.18**

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications. Table reports cross-border trade only (no domestic trade). Full results are presented in Tables A7, A8, and A9 in the Appendix.

in this area. Services exports of the UK fall by about 21% in S1 and S3; with a FTA, they drop by 7% only, but trade effects in other sectors are indistinguishable from zero. With a hard but smart Brexit, it is not surprising that UK's exports towards the EU27 would also decrease by -18%, as the market access to the EU27 is simulated similarly to a hard Brexit, where tariff and non-tariff barriers against the UK exist.

EU27 exports to RoW increase by about 1% in S1 and S3, signaling the presence of some trade diversion. Interestingly, exports from one EU27 member to the other barely change; and if they do, the sign is negative. It appears that the increased trade costs with the UK lead to an overall reduction of intra-EU27 trade flows along the highly-integrated EU production networks. Similarly, the model does not predict that UK exports to the RoW go up from Brexit scenarios S1 and S2, as increased trade costs with Europe reduce the UK's competitiveness with third countries. Of course, in the context of global Britain, UK exports to third countries would go up quite substantially and slightly less with a hard but smart

Brexit; in manufacturing, the increase can be expected to be about 15% in S3 and 10% in S4; exports of third countries to the UK are expected to go up by much more with an FTA. Again, this reflects the lack of evidence for strong trade creating effects of FTAs with third countries for the UK.

4.5   Effects on Overall Trade

Next, we turn to the effect on overall trade in Table 6. We show baseline trade levels for 2014, where the UK features a small deficit in goods and services trade, while the EU27 has a substantial surplus of 780 bn USD. Across all scenarios, overall UK exports and imports drop; compared to the change in GDP, trade falls by more such that the openness of the UK economy (measured as total trade over GDP) drops quite substantially. With a hard Brexit (S1), the reduction in both exports and imports is strongest in manufacturing, but UK services imports drop substantially as well, as domestic output is increasingly absorbed by domestic rather than foreign demand. Total EU27 exports fall by 1.43% and total imports by 1.75%; manufacturing exports fall the most; while the import side is dominated by services. Trade effects for the RoW are relatively low yet statistically significant and typically positive.

Table 6: Changes in Overall Trade

	Initial Exports	Changes in Exports in %				Initial Imports	Changes in Imports in %			
	bn USD	S1	S2	S3	S4	bn USD	S1	S2	S3	S4
UK										
Agriculture	29.93	-5.52	36.83	1.22	5.43	50.44	1.50	**17.56**	**11.12**	**-4.70**
Manufacturing	304.41	**-18.50**	-1.94	-3.25	-0.71	489.57	**-12.19**	-1.74	**-3.08**	**-1.72**
Services	413.60	**-8.35**	**-3.24**	**-5.52**	**-6.41**	225.95	**-11.96**	**-3.81**	**-7.24**	**-4.29**
Total	747.93	-12.36	-1.11	-4.33	-3.61	765.96	-11.22	-1.08	-3.37	-2.67
EU27										
Agriculture	194.46	**-1.45**	1.80	-1.30	**-0.96**	462.82	**-1.02**	0.91	**-1.32**	**-0.41**
Manufacturing	4177.81	**-1.55**	-0.32	**-1.90**	**-1.06**	3474.84	**-1.48**	-0.18	**-1.76**	**-0.67**
Services	2064.33	**-1.20**	-0.20	**-1.22**	-0.04	1721.33	**-2.49**	**-0.68**	**-2.69**	**-1.64**
Total	6,436.60	**-1.43**	-0.22	**-1.67**	-0.73	5,659.00	**-1.75**	-0.25	**-2.01**	**-0.95**
ROW										
Agriculture	2039.67	**0.20**	-0.17	**0.39**	0.07	1750.78	**0.21**	-0.11	**0.35**	**0.31**
Manufacturing	8115.92	**0.34**	0.00	**0.77**	**0.43**	8633.73	**0.20**	-0.05	**0.57**	**0.24**
Services	3209.29	**-0.07**	-0.03	**0.10**	-0.01	3739.93	**0.23**	0.05	**0.48**	**0.28**
Total	13,364.88	0.22	-0.03	**0.55**	**0.27**	14,124.44	**0.21**	-0.03	**0.52**	**0.26**

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications. Confidence intervals can be retrieved from Table A10 in the Appendix.

With a FTA (S2), trade losses for all parties are strongly reduced, but they remain about five times as large for the UK as compared to the EU27, and the effects are mostly not statistically significant. As expected, UK trade losses fall by about two thirds under global Britain (S3) compared to a hard Brexit, while they increase slightly for the EU27. RoW

can expect a small and statistically significant increase in its overall trade, most pronounced in manufacturing. With a hard but smart Brexit, the UK's overall exports still decrease by 4%, but this is almost solely driven by the decrease of exports in services.

4.6 Changes in Sectoral Value Added

Changes in bilateral trade depend on the sectoral composition of value added trade flows. The dependence on (imported) intermediate inputs varies greatly across sectors, but it is generally more important for complex manufacturing goods than for raw materials or services. We show the changes in sectoral value added for the UK and the EU27 average in Table 7.[29] Sectoral value added is affected by a price and a quantity effect. Brexit changes the wage rate by the same in all sectors (roughly by the same effect as GDP per capita; see Table A11 in the Appendix), and it reallocates labor between sectors. For the UK, for example, sectors whose value added falls by less than 3.37% under a hard Brexit (S1) experience an increase in employment, while sectors whose value added falls by more see their employment shrink.

Within manufacturing, the largest sectors for the UK in terms of value added are food, beverages & tobacco, mining & quarrying (includes oil and gas extraction), machinery & equipment, fabricated metals, pharmaceuticals, and motor vehicles, with 47, 43, 32, 28, 22, and 21 bn USD value added, respectively. Amongst these, mining & quarrying and machinery & equipment are expected to lose most with a hard Brexit (-8% and -7%, respectively). The other mentioned sectors feature changes that are not statistically significant; the food sector even is expected to expand as higher trade costs force the UK to move into this comparative disadvantaged sector. The same is true for crops & animals. The largest percentage loss is expected in basic metals (-17%) and fishing & aquaculture (-16%), but initial value added positions in these sectors are relatively small.

Value added changes from a FTA (S2) differ from those in S1 in sign, size and statistical significance, because the structure of trade cost savings available under the FTA may deviate from those obtained in the EU Single Market. Nonetheless, the overall picture remains: Brexit drives the UK into the agri-food sectors and out of manufacturing sectors, such as basic metals. Note, however, that changes are statistically insignificant for many UK sectors in S2. Global Britain (S3) yields sectoral value added gains where trade cost reductions with third countries are expected. This is the case in transportation, for example, but not in chemicals or pharmaceuticals, where reductions in NTBs are usually harder to realize. The

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[29]Full results and initial VA per sector in 2014 are provided in Tables A12, A13, A14, and A15 in the Appendix. Country-sector level results on all remaining economies in the sample can be obtained from the authors on request.

Table 7: Changes in Sectoral Value Added, in %

		UK				EU 27			
		S1	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1	Crops & Animals	**7.87**	**6.71**	**8.30**	**-2.22**	**-1.36**	**-0.70**	**-1.46**	**-0.54**
2	Forestry & Logging	-1.96	-1.28	-1.22	-0.10	**-0.52**	0.04	**-0.63**	**-0.70**
3	Fishing & Aquaculture	**-15.83**	-7.68	-10.36	**-15.11**	1.08	0.91	1.00	0.71
4	Mining & Quarrying	**-7.93**	8.22	-3.60	6.77	**2.51**	**5.86**	**2.75**	**-1.07**
5	Food, Beverages & Tabacco	1.86	**2.39**	**3.50**	**-3.06**	**-1.55**	**-0.53**	**-1.67**	**-0.63**
6	Textiles, Apparel,Leather	**-6.82**	**-2.97**	**-10.62**	**-4.02**	-0.38	0.93	**-0.83**	**-1.15**
7	Wood & Cork	0.43	-3.86	-1.78	0.45	**-0.72**	0.16	**-0.88**	**-0.84**
8	Paper	0.81	0.36	1.00	0.46	**-0.83**	-0.29	**-0.88**	**-0.85**
9	Recorded Media Reproduction	**-1.13**	1.10	0.55	0.40	**-0.47**	-0.23	**-0.62**	**-0.49**
10	Coke, Refined Petroleum	4.13	18.84	**19.89**	0.75	-0.44	2.02	-0.82	**-1.02**
11	Chemicals	**-5.71**	0.34	**-4.12**	**-3.74**	**-1.10**	**-0.64**	**-1.33**	**-0.80**
12	Pharmaceuticals	-3.08	-5.82	**-11.94**	8.75	-0.67	**-2.16**	-0.02	**-1.92**
13	Rubber & Plastics	-0.68	0.93	0.66	**-3.25**	**-1.16**	**-0.49**	**-1.37**	**-0.51**
14	Other non-Metallic Mineral	-1.01	0.94	0.71	**-0.93**	**-0.70**	**-0.23**	**-0.84**	**-0.54**
15	Basic Metals	**-16.95**	**-9.73**	-6.11	-2.13	**-0.43**	-0.14	**-0.74**	**-0.43**
16	Fabricated Metal	-0.49	1.44	**2.63**	**1.21**	**-0.79**	**-0.26**	**-1.00**	**-0.61**
17	Electronics & Optical Products	-3.05	-2.15	-6.60	**13.07**	**-1.73**	**-2.69**	**-1.48**	**-2.43**
18	Electrical Equipment	**-8.48**	-0.35	**-8.93**	3.67	**-0.60**	-0.25	**-1.18**	**-1.10**
19	Machinery & Equipment	**-6.86**	-3.93	-4.11	**8.38**	-0.12	-0.24	-0.16	**-1.04**
20	Motor Vehicles	-2.52	-1.49	**5.13**	-3.33	**-1.57**	**-0.21**	**-2.24**	**-0.81**
21	Other Transport Equipment	-2.80	11.80	**23.45**	**10.01**	**-0.77**	1.22	**-3.86**	**-1.40**
22	Furniture & Other Manufacturing	-3.10	-1.29	-2.29	4.39	-0.27	**-0.58**	-0.05	**-1.34**
23	Electricity & Gas	**-1.08**	0.67	**0.99**	**-0.53**	**-0.67**	-0.12	**-0.86**	**-0.52**
24	Water Supply	**-0.67**	0.46	**0.91**	-0.35	**-0.61**	-0.07	**-0.80**	**-0.48**
25	Sewerage & Waste	**-1.72**	-0.79	-0.84	**-2.45**	**-0.62**	-0.14	**-0.79**	-0.16
26	Construction	-0.46	0.87	**1.15**	**-0.70**	**-0.70**	-0.18	**-0.89**	**-0.50**
27	Trade & Repair of Motor Vehicles	**-2.14**	-0.74	0.38	**-2.62**	**-0.45**	0.09	**-0.69**	-0.07
28	Wholesale Trade	**-7.91**	**-6.50**	**-5.40**	**-9.32**	0.05	**0.51**	-0.10	**0.52**
29	Retail Trade	-0.60	0.49	**1.01**	**-1.02**	**-0.65**	-0.14	**-0.83**	**-0.39**
30	Land Transport	**-1.86**	-0.58	-0.30	**-1.87**	**-0.51**	-0.01	**-0.68**	**-0.40**
31	Water Transport	0.78	-1.00	0.97	**1.45**	**-0.41**	0.33	**-0.52**	**-0.37**
32	Air Transport	-0.84	-0.25	0.96	-0.18	**-0.62**	0.06	**-0.68**	**-0.76**
33	Aux. Transportation Services	**-3.28**	**-2.08**	**-1.76**	**-3.15**	**-0.39**	0.06	**-0.55**	**-0.29**
34	Postal and Courier	0.03	**1.71**	**1.41**	-0.31	**-0.86**	**-0.48**	**-1.01**	**-0.43**
35	Accommodation & Food	**-0.76**	0.47	0.53	0.16	**-0.57**	-0.15	**-0.75**	**-0.46**
36	Publishing	**-1.59**	-0.73	-0.64	-0.18	**-0.82**	-0.18	**-0.96**	**-0.77**
37	Media Services	**-1.77**	-0.54	-0.67	-0.78	-0.17	0.15	**-0.34**	-0.08
38	Telecommunications	-0.65	0.62	0.64	-0.83	**-0.68**	-0.17	**-0.82**	**-0.45**
39	Computer & Information Services	-0.64	**1.02**	0.89	-0.22	**-0.43**	-0.23	**-0.56**	**-0.35**
40	Financial Services	0.38	**1.78**	**1.43**	0.16	**-0.78**	**-0.43**	**-0.94**	**-0.48**
41	Insurance	1.17	**3.17**	2.29	**2.73**	**-0.94**	**-0.61**	**-1.09**	**-0.94**
42	Real Estate	-0.35	0.73	**1.09**	-0.58	**-0.67**	**-0.17**	**-0.85**	**-0.45**
43	Legal and Accounting	**-1.51**	0.66	0.74	-0.87	**-0.46**	-0.05	**-0.62**	**-0.34**
44	Business Services	**-2.57**	0.51	0.78	**-2.05**	**-0.39**	-0.12	**-0.58**	-0.06
45	Research and Development	-0.68	0.41	0.52	0.38	**-0.56**	-0.12	**-0.73**	**-0.52**
46	Admin. & Support Services	-0.17	1.47	1.16	0.90	**-0.77**	**-0.37**	**-0.90**	**-0.69**
47	Public & Social Services	**-0.59**	0.61	**0.93**	**-0.56**	**-0.67**	-0.15	**-0.87**	**-0.50**
48	Education	**-0.66**	0.49	**0.84**	**-0.56**	**-0.68**	-0.14	**-0.87**	**-0.50**
49	Human Health and Social Work	-0.52	0.60	**0.94**	-0.51	**-0.71**	-0.14	**-0.91**	**-0.54**
50	Other Serivces, Households	-0.22	0.89	0.80	-0.37	**-0.70**	**-0.21**	**-0.89**	**-0.45**

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications.
Full results and initial value added per sector in 2014 are provided in Tables A12, A13, A14, and A15 in the
Appendix.

expansion of agri-food remains, as historical experience does not suggest significant trade
costs savings from FTAs with third countries in these sectors. UK textiles is expected to
shed employment as import competition goes up. Compared to the other three scenarios, a
hard but smart Brexit (S4) leads to stronger sectoral divergences. The liberalization of the
agrifood sector puts pressure on British farmers, while effects in the manufacturing industry

are quite heterogeneous. The value added increases in sectors that import a large amounts of intermediate products and simultaneously export only few final goods (i.e. pharmaceuticals, chemicals, machinery, and electronics). The explanation is simple: the intermediate product imports are cheaper than before.

Turning to services, the largest losses from a hard Brexit (S1) in the UK are expected in wholesale trade (-8%), a sector that generates value added worth 88 bn USD in 2014; legal & accounting and business services, both quantitatively important sectors, also have to expect sizable losses of 2% and 3%, respectively. Interestingly, financial services are not affected in a statistically significant way. The reason is the combination of two effects: First, the ex post analysis of trade integration does not suggest large trade cost savings in the first place; Second, the UK has a strong comparative advantage over its competitors. This is less true for publishing and media services, two sectors with smaller quantitative importance which would lose about 2% of their value added. With a hard but smart Brexit (S4), the services sectors lose more compared to manufacturing and agriculture, as potential tariff reductions are not relevant for services.

In the EU27, sectoral value added effects are generally less pronounced. One sector worth pointing out is motor vehicles, where losses of about 2% are to be expected, as the relatively high EU tariffs of 10% kick in and strongly affect the tight production network between the EU27 and the UK. With global Britain (S3), the loss increases as EU firms face tougher competition from third country suppliers in the UK. In contrast, if the EU and the UK strike a FTA (S2), losses for the EU car industry disappear. With a unilateral reduction of UK tariffs, losses from a hard Brexit in the automotive industry are reduced by half under a hard but smart Brexit (S4).

5 Robustness

Finally, we analyze the robustness of our findings with regard to the choice of trade elasticities. We focus on changes in real consumption for the hard Brexit scenario. Results are summarized in Table A17 in the Appendix.

First, even though our calculated services elasticities are in line with the above discussed literature on services elasticities, we now rely on elasticities of a value of five as assumed in Caliendo and Parro (2015) and Costinot and Rodriguez-Clare (2014). Overall, we find that real consumption losses are slightly smaller due to the down weighting of trade cost changes in services. We need to keep in mind that services sectors are extremely important for the UK, hence, assuming a much higher trade elasticity might strongly affect results. For a hard

Brexit, losses are 5.4 times smaller compared to the baseline in Table 4 for the most extreme case (Luxembourg) with its very strong reliance on services sectors. Other EU27 countries experience losses that are two to three times smaller compared to the baseline. The UK faces losses of -1.17% of real consumption, which is 2.4 times smaller than in the baseline of -2.76%.

Second, we apply sectoral elasticities estimated by Caliendo and Parro (2015) (see Table A16 in the Appendix). To be empirically consistent, we re-estimate our sector-level gravity equations constraining θ to equal the external estimate and backing out new NTB changes. We find that countries lose less from a hard Brexit comparing magnitudes to the baseline. In relative terms, EU27 countries real consumption losses are doubled compared to the baseline. On the contrary, the UK loses 0.8 times more (-3.27% compared to -2.76%). Note, that 10% confidence intervals in the baseline are [-3.32, -2.19] and [-3.95, -2.59] for the UK, such that the slightly higher losses are still close to the range of our baseline estimates.

Further, while the magnitudes of real consumption changes vary slightly with the choice of elasticities, the ranking of countries does not vary much. Countries with the highest losses in the baseline and both robustness checks are Ireland, the UK, Malta, Luxembourg and the Netherlands. EU27 countries with the lowest losses are Greece, Romania, Austria, Croatia. Germany varies between rank 11 and 15, while France switches between rank 17 and 19. Hence, we are confident that our baseline results represent reasonable estimates for the changing trade policy environment with Brexit.

6 Conclusion

In this paper, we conduct an ex ante analysis of trade and welfare effects of Brexit based on an econometric ex post assessment of EU integration and other trade agreements. We quantify the economic consequences of Brexit through a quantitative trade theory framework and isolate the role of EU membership for the UK in three distinct ways: First, we allow for directional treatment heterogeneity in the relation between the UK and EU27 economies. Second, we distinguish different steps of European integration that affect tariffs and iceberg trade costs separately to model trade cost shocks. Third, we consider fiscal transfers within the EU, which affect the terms-of-trade of countries, and their role in the economic costs of Brexit. The analysis is based on the integration of parameter calibration and scenario definition based on the estimation of sector-level gravity equations. It allows to account for parameter uncertainty for all endogenous variables.

We find that the EU and trade agreements have been very successful in reducing trade

costs and boosting trade between its members, but effects turn out to be directional, in particular, with respect to the UK. We make use of the treatment heterogeneity identified at the finer sectoral level and of the model structure to back out the trade cost effects of European integration for the counterfactual general equilibrium analysis. Our analysis shows that allowing for treatment heterogeneity in the ex post analysis turns out relevant quantitatively for the overall economic costs of Brexit and its distribution between the UK and the EU27 economies. Neglecting the asymmetry in EU-UK relations overestimates the costs from Brexit by up to 40%.

While we find a lot of heterogeneity in real consumption, gross and value added trade changes across the 43 geographical countries, a general pattern persists. Both, the UK and EU27 countries lose welfare in any of the four Brexit scenarios. Small EU27 countries with very close trade ties to the UK, such as Ireland, Luxembourg, and Malta, lose even more than the UK itself. Overall, conducting new trade agreements outside of the EU cannot fully compensate the losses suffered from Brexit for the UK, while EU27 countries lose 0.8% or 0.05pp in real consumption more compared to a hard Brexit due to trade diversion. A comprehensive trade agreement between the EU and the UK would mitigate the losses to 0.2% and 0.9%, respectively. But in the current light of the staggering process around an agreement, we offer an alternative hard but smart Brexit – where besides falling back to WTO rules, the UK eliminates all existing tariffs against any trade partners. For the UK, this generates the smallest losses with 0.5% or 2.3pp less than under a hard Brexit, while the EU27 would loose 0.2pp less in real consumption. Our analysis shows that a lot of potential still exists in trade relations between the UK and the remaining EU27 countries.

Overall, our paper is probably the most ambitious amongst the existing studies on Brexit in mapping out the trade effects. But it does not feature labor or capital mobility. Needless to say, a careful analysis of these facets of European integration would be important but faces both modeling and data-related issues. Brexit underlines the urgency for additional research in these areas.

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A   Appendix

A.1   The Model in Changes

We solve for counterfactual changes in all variables of interest using the following system of equations:[30]

$$\hat{c}_n^j = \hat{w}_n^{\beta_n^j} \left(\prod_{i=1}^{N} [\hat{p}_n^j]^{\gamma_n^{k,j}} \right)^{1-\beta_n^j}, \tag{11}$$

$$\hat{p}_n^j = \left(\sum_{i=1}^{N} \pi_{in}^j [\hat{\kappa}_{in}^j \hat{c}_i^j]^{-1/\theta^j} \right)^{-\theta^j}, \tag{12}$$

$$\hat{\pi}_{in}^j = \left(\frac{\hat{c}_i^j}{\hat{p}_n^j} \hat{\kappa}_{in}^j \right)^{-1/\theta^j}, \tag{13}$$

$$X_n^{j'} = \sum_{j=1}^{J} \gamma_n^{j,k}(1-\beta_n^k) \left(\sum_{i=1}^{N} \frac{\pi_{ni}^{k'}}{1+t_{ni}^{k'}} X_i^{k'} \right) + \alpha_n^j I_n', \tag{14}$$

$$\frac{1}{B} \sum_{j=1}^{J} F_n^{j'} X_n^{j'} + s_n = \frac{1}{B} \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}}{1+t_{ni}^{j'}} X_i^{j'}, \tag{15}$$

where $\hat{w}_n$ are wage changes, X_n^j are sectoral expenditure levels, $F_n^j \equiv \sum_{i=1}^{N} \frac{\pi_j^{in}}{(1+t_{in}^j)}$, $I_n' = \hat{w}_n w_n L_n + \sum_{j=1}^{J} X_n^{j'}(1 - F_n^{j'}) - S_n$, L_n denotes country n's labor force, and S_n is the (exogenously given) trade surplus. We fix $s_n \equiv S_n/B$, where $B \equiv \sum_n w_n L_n$ is global labor income, to make sure that the system is homogenous of degree zero in prices.

The shift in unit costs due to changes in input prices (i.e., wage and intermediate price changes) is laid out in equation (11). Trade cost changes directly affect the sectoral price index p_n^j, while changes in unit costs have an indirect effect (see equation (12)). Trade shares change as a reaction to changes in trade costs, unit costs, and prices. The productivity dispersion θ^j indicates the intensity of the reaction. Higher θ^j's imply bigger trade changes. Equation (14) ensures goods market clearing in the new equilibrium and the counterfactual income-equals-expenditure or balanced trade condition is given by equation (15).

To solve the system for multiple sectors, we again relate to Caliendo and Parro (2015), who extend the single-sector solution algorithm proposed by Alvarez and Lucas (2007). We start

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[30]See also Caliendo and Parro (2015). Solving for counterfactual changes rather than levels strongly reduces the set of parameters and moments that have to be estimated or calibrated. In particular, no information on price levels, iceberg trade costs, or productivity levels is needed.

with an initial guess about a vector of wage changes. Using (11) and (12), it computes changes in prices, trade shares, expenditure levels, evaluates the trade balance condition (15), and updates the change in wages based on deviations in the trade balance.

A.2 Details on Data and Results

Figure 4: Average MFN Tariffs on Intra-EU Trade, 2014
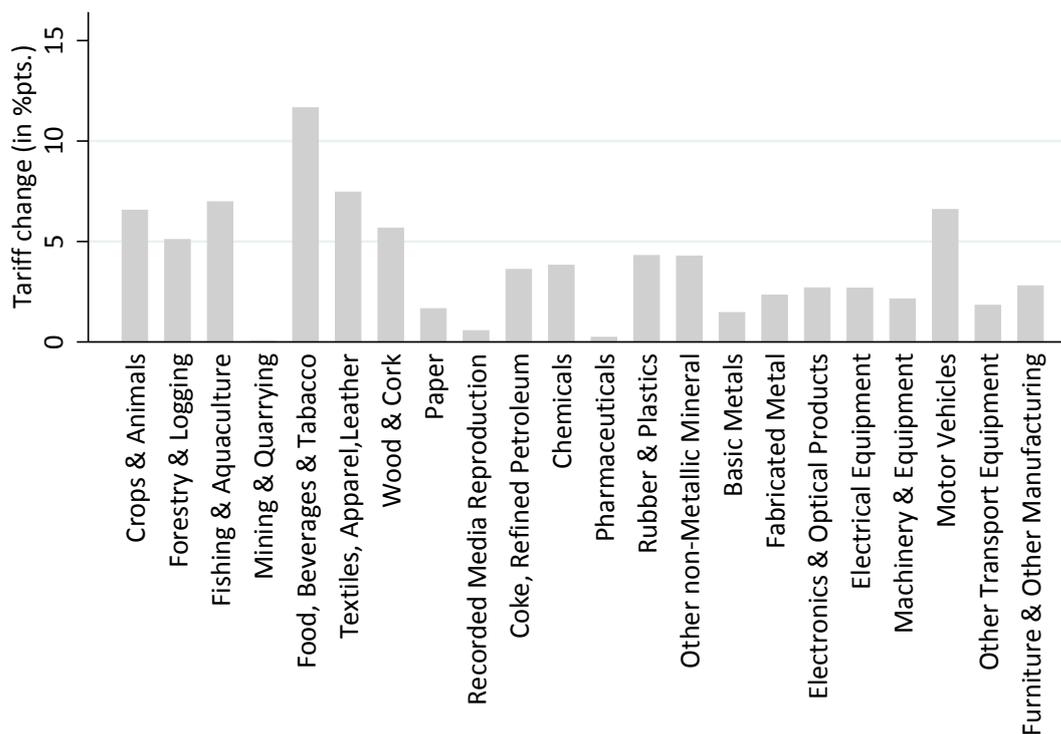
Note: Averages of sectoral bilateral tariffs across intra-EU country-pairs. Sectoral bilateral tariffs are trade-weighted MFN averages of the product-level MFN tariffs imposed by the EU in 2014.

Table A1: List of WIOD Manufacturing Sectors

Sector ID	Sector Name	ISIC Rev. 4
1	Crops & Animals	A01
2	Forestry & Logging	A02
3	Fishing & Aquaculture	A03
4	Mining & Quarrying	B
5	Food, Beverages & Tabacco	C10-C12
6	Textiles, Apparel,Leather	C13-C15
7	Wood & Cork	C16
8	Paper	C17
9	Recorded Media Reproduction	C18
10	Coke, Refined Petroleum	C19
11	Chemicals	C20
12	Pharmaceuticals	C21
13	Rubber & Plastics	C22
14	Other non-Metallic Mineral	C23
15	Basic Metals	C24
16	Fabricated Metal	C25
17	Electronics & Optical Products	C26
18	Electrical Equipment	C27
19	Machinery & Equipment	C28,C33
20	Motor Vehicles	C29
21	Other Transport Equipment	C30
22	Furniture & Other Manufacturing	C31_C32
23	Electricity & Gas	D35
24	Water Supply	E36
25	Sewerage & Waste	E37-E39
26	Construction	F
27	Trade & Repair of Motor Vehicles	G45
28	Wholesale Trade	G46
29	Retail Trade	G47
30	Land Transport	H49
31	Water Transport	H50
32	Air Transport	H51
33	Aux. Transportation Services	H52
34	Postal and Courier	H53
35	Accommodation and Food	I
36	Publishing	J58
37	Media Services	J59_J60
38	Telecommunications	J61
39	Computer & Information Services	J62_J63
40	Financial Services	K64
41	Insurance	K65_K66
42	Real Estate	L68
43	Legal and Accounting	M69_M70
44	Business Services	M71,M73-M75
45	Research and Development	M72
46	Admin. & Support Services	N
47	Public & Social Services	O84
48	Education	P85
49	Human Health and Social Work	Q
50	Other Services, Households	R-U

Table A2: Gross National Income and Transfer Redistribution

	Gross National Income in mn EUR	Fiscal Transfers
Austria	328,897	183
Belgium	402,665	224
Bulgaria	40973	23
Cyprus	16,583	9
Czech Republic	144473	81
Germany	2,972,188	1657
Denmark	264,873	148
Spain	1,052,245	587
Estonia	19,049	11
Finland	203,977	114
France	2,179,155	1215
United Kingdom	2,174,280	-6549
Greece	178,381	99
Croatia	41,773	23
Hungary	100,695	56
Ireland	159,732	89
Italy	1,613,795	900
Lithuania	35,203	20
Luxembourg	29,477	16
Latvia	23,868	13
Malta	7,629	4
Netherlands	662,465	369
Poland	396,058	221
Portugal	171,108	95
Romania	146,462	82
Slovak Republic	73,854	41
Slovenia	36,676	20
Sweden	445,168	248
EU27	11,747,422	6549

Note: Redistribution calculated based on the operating budgetary balance as stated by the European Commission for the 2010-2014 UK average, relative to each country's gross national income. The value of fiscal transfers that get redistributed make up 0.06% of EU27 member states' GNI and 0.30% of UK's GNI.

Table A3: EU Integration Steps and Bilateral Imports, Goods (2000 - 2014)

Dep. var.:	Bilateral Imports									
Sector Description	Both EU27	exp: EU27 imp: UK	exp: UK imp: EU27	Euro	Schengen	EU27-KOR	UK-KOR	Other FTAs	Tariffs	Obs.
1 Crops & Animals°	1.154***	1.254***	0.733***	0.236***	0.184***	0.327	−0.212	0.144	−3.471***	27,735
2 Forestry & Logging°	0.075	0.194	0.267	0.414***	0.179***	0.091	−0.919***	−0.204	−3.471***	26,490
3 Fishing & Aquaculture°	0.711***	0.003	1.057	0.097	0.053	−0.174	0.605	−0.213	−3.471***	25,755
4 Mining & Quarrying°	0.013	−0.797***	−0.192	0.936***	0.016	1.136***	2.792***	−0.519***	−3.471***	27,705
5 Food, Beverages & Tobacco	0.706***	0.736***	0.555***	0.061	0.216***	0.18	−0.611***	0.106	−1.066	27,735
6 Textiles, Apparel, Leather°	0.440***	0.117	0.295	−0.035	0.032	0.345***	−0.414*	0.173	−3.471***	27,735
7 Wood & Cork°	0.298**	0.076	−0.109	0.131**	0.013	0.410***	0.479***	0.054	−3.471***	27,735
8 Paper°	0.438***	0.369	0.307**	0.037	0.041***	0.341***	−0.167	−0.003	−3.471***	27,735
9 Recorded Media Reproduction	−0.040	−0.111	−0.011	−0.175	0.052	0.879***	0.174	−0.203	−1.254	26,520
10 Coke, Refined Petroleum	−0.067	−0.294	−0.031	0.198*	0.217***	0.512*	0.372***	−0.108	−6.021***	26,795
11 Chemicals	0.459***	0.778***	0.254**	0.128**	0.106***	0.318***	0.166**	0.032	−3.530***	27,735
12 Pharmaceuticals	1.003***	1.099***	0.829***	0.008	0.178***	−0.061	−0.088	0.336**	−11.388 ***	26,310
13 Rubber & Plastics	0.609***	0.698***	0.448***	0.069*	0.154***	0.307***	0.116*	0.289***	−2.258**	27,735
14 Other non-Metallic Mineral	0.389***	0.265	0.223*	0.176***	0.069***	0.029	0.033	0.188*	−1.365*	27,735
15 Basic Metals	0.574***	0.681**	0.641***	0.154	0.130***	0.308***	0.075	0.280***	−3.191***	27,735
16 Fabricated Metal	0.457***	0.551***	0.254	0.121***	0.065***	0.275***	0.135	0.217***	−1.543***	27,090
17 Electronics & Optical Products	0.130	0.694***	−0.208	−0.176	−0.028	−0.150	−0.809***	−0.044	−7.780***	27,735
18 Electrical Equipment	0.554***	0.601***	0.151	0.053	0.092***	0.370***	−0.003	0.207***	−6.001***	27,090
19 Machinery & Equipment	0.264***	0.570***	0.214*	0.040	0.065***	0.119*	0.180***	0.053	−7.870***	27,735
20 Motor Vehicles	0.525***	0.731***	0.364	−0.088	0.117**	0.311***	0.144	0.249***	−4.610***	27,735
21 Other Transport Equipment	−0.041	0.187	−0.303	0.270**	−0.043	0.315	0.169	0.026	−2.948	27,090
22 Furniture & Other Manufacturing	0.008	−0.086	−0.149	0.076	0.130***	−0.571***	−1.110***	−0.164	−3.727***	27,735

Note: ***, **, * denote significance at the 1%, 5%, 10% levels, respectively. All models estimated use Poisson Pseudo Maximum Likelihood (PPML) methods. Robust standard errors (not reported) allow for clustering at the country-pair level. Pair as well as year specific importer and exporter fixed effects included but not reported. Sectors marked with ° report estimates based on tariff adjusted imports, applying overall trade elasticities for goods trade from Table (1) column (5).

Table A4: EU Integration Steps and Bilateral Imports, Services (2000 - 2014)

Dep. var.:	Bilateral Imports								
Sector Description	Both EU27	exp: EU27 imp: UK	exp: UK imp: EU27	Euro	Schengen	EU27-KOR	UK-KOR	Other FTAs	Obs.
23 Electricity & Gas	0.903**	0.895**	1.068**	−0.169	0.065	0.356	−1.653***	0.605*	27,225
24 Water Supply	−0.098	−0.336	0.000	0.105	0.117**	0.628***	0.623***	−0.530***	23,085
25 Sewerage & Waste	1.183***	1.314***	0.893***	0.080	0.016	−0.015	−0.015	0.716***	24,435
26 Construction	1.269***	1.239***	2.154***	0.000	0.102	0.137	0.234	0.763***	27,210
27 Trade & Repair of Motor Vehicles	0.705**	1.501**	2.251***	−0.030	0.518***	0.735***	1.096***	−0.051	25,770
28 Wholesale Trade	0.753***	1.515***	2.611***	0.105	0.215***	0.471***	1.299***	0.198**	27,285
29 Retail Trade	0.710***	1.373***	1.571***	−0.063	0.198***	0.425*	0.847***	0.105	25,740
30 Land Transport	0.617***	0.333*	1.047***	0.291**	−0.039	0.327*	0.384	−0.199**	27,630
31 Water Transport	0.782***	0.679**	0.759**	0.050	−0.015	0.302	−1.020**	0.141	27,480
32 Air Transport	0.344**	0.198	0.700***	−0.097	0.054	0.108	−0.859**	−0.289**	27,735
33 Aux. Transportation Services	0.246*	0.240	0.638***	−0.194**	0.082***	0.040	−0.025	−0.260**	27,525
34 Postal and Courier	0.620***	1.266***	0.245	−0.343**	0.445***	0.680**	−0.163	0.638***	23,475
35 Accommodation and Food	−0.315*	0.002	−0.018	0.382***	−0.305***	−0.457***	−1.576***	−0.450***	25,455
36 Publishing	0.200	0.230	0.542*	−0.487***	−0.010	−0.191	−0.096	−0.286**	24,270
37 Media Services	0.347*	0.027	0.565**	0.246*	−0.084	0.071	0.063	−0.144	24,165
38 Telecommunications	0.166	0.466	0.323	0.281***	0.103***	0.604***	−0.060	−0.067	27,720
39 Computer & Information Services	0.825***	1.067***	0.532**	0.207**	0.154***	0.848**	−0.221	−0.084	26,955
40 Financial Services	0.616**	1.809***	0.484	0.558***	−0.067	0.899***	−0.366*	−0.055	27,015
41 Insurance	−0.103	−0.121	−0.609	0.471***	−0.143	0.058	−0.147	−0.246	26,370
42 Real Estate	0.336	0.832**	1.104***	0.208	−0.008	0.040	0.544	−0.095	23,565
43 Legal and Accounting	0.451***	0.520**	0.599**	−0.011	0.143***	0.160	0.018	0.243*	24,960
44 Business Services	1.116***	0.999***	0.993***	−0.028	0.063	0.809***	0.413***	0.632***	25,635
45 Research and Development	0.163**	−0.134	−0.049	0.097	0.035	−0.138	−1.095***	−0.024	24,647
46 Admin. & Support Services	0.450***	0.229	−0.097	0.176	0.133***	0.046	−0.509***	−0.140	26,910
47 Public & Social Services	0.533***	0.438	0.656	0.027	0.084**	0.095	1.085***	0.272*	25,785
48 Education	0.427***	1.062***	1.503***	0.289**	0.292***	0.555	1.065***	0.021	25,950
49 Human Health and Social Work	0.377*	0.271	0.959**	0.317**	0.456***	0.971***	1.058***	0.036	26,160
50 Other Services, Households	0.963	0.824	0.397	−0.243**	−0.089	0.023	0.919***	0.078	27,495

Note: ***, **, * denote significance at the 1%, 5%, 10% levels, respectively. All models estimated use Poisson Pseudo Maximum Likelihood (PPML) methods. Robust standard errors (not reported) allow for clustering at the country-pair level. Pair as well as year specific importer and exporter fixed effects included but not reported. For services sectors, we calculate the trade elasticity for services according to Egger et al. (2012).

Table A5: Change in Real Consumption of Welfare Decomposition (S1), in %

	All Sub-Scenarios	Transfers Only	Agri. Tariffs Only	Manuf. Tariffs Only	Agri.	Manuf NTBs Only	Serv.
UK	**-2.61**	**0.29**	**0.01**	**0.05**	0.03	**-0.73**	**-2.31**
	[-3.21, -2.00]	[0.29, 0.29]	[0.00, 0.01]	[0.04, 0.06]	[-0.04, 0.11]	[-1.11, -0.36]	[-2.79, -1.83]
Austria	**-0.33**	**-0.06**	0.00	**-0.01**	0.00	**-0.03**	**-0.23**
	[-0.38, -0.27]	[-0.06, -0.06]	[-0.00, 0.00]	[-0.02, -0.01]	[-0.00, 0.01]	[-0.05, -0.02]	[-0.28, -0.18]
Belgium	**-1.36**	**-0.06**	**-0.00**	**-0.07**	0.02	**-0.20**	**-1.04**
	[-1.60, -1.12]	[-0.07, -0.06]	[-0.00, -0.00]	[-0.09, -0.06]	[-0.01, 0.04]	[-0.27, -0.13]	[-1.26, -0.82]
Bulgaria	**-0.46**	**-0.04**	0.00	**-0.00**	0.00	**-0.07**	**-0.35**
	[-0.54, -0.38]	[-0.04, -0.04]	[-0.00, 0.00]	[-0.01, -0.00]	[-0.00, 0.01]	[-0.11, -0.03]	[-0.42, -0.28]
Croatia	**-0.37**	**-0.05**	0.00	-0.00	-0.00	**-0.03**	**-0.28**
	[-0.44, -0.29]	[-0.05, -0.05]	[-0.00, 0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[-0.05, -0.02]	[-0.35, -0.21]
Cyprus	**-1.45**	**-0.05**	**-0.01**	0.00	-0.00	**-0.19**	**-1.21**
	[-1.80, -1.09]	[-0.05, -0.05]	[-0.01, -0.00]	[-0.00, 0.01]	[-0.01, 0.01]	[-0.33, -0.05]	[-1.55, -0.88]
Czech R.	**-0.54**	**-0.07**	-0.00	**-0.04**	**0.01**	**-0.06**	**-0.37**
	[-0.65, -0.44]	[-0.07, -0.07]	[-0.00, 0.00]	[-0.05, -0.04]	[0.00, 0.02]	[-0.11, -0.00]	[-0.46, -0.28]
Denmark	**-0.93**	**-0.07**	**-0.00**	**-0.03**	-0.00	**-0.12**	**-0.72**
	[-1.10, -0.77]	[-0.07, -0.07]	[-0.00, -0.00]	[-0.03, -0.02]	[-0.03, 0.03]	[-0.16, -0.08]	[-0.87, -0.57]
Estonia	**-0.64**	**-0.06**	**-0.00**	**-0.02**	0.00	**-0.11**	**-0.46**
	[-0.79, -0.50]	[-0.06, -0.06]	[-0.00, -0.00]	[-0.03, -0.01]	[-0.01, 0.01]	[-0.21, -0.01]	[-0.57, -0.35]
Finland	**-0.49**	**-0.06**	-0.00	-0.01	0.01	**-0.05**	**-0.39**
	[-0.58, -0.41]	[-0.06, -0.06]	[-0.01, 0.01]	[-0.01, 0.00]	[-0.00, 0.03]	[-0.08, -0.01]	[-0.46, -0.31]
France	**-0.52**	**-0.06**	-0.00	**-0.02**	0.01	**-0.07**	**-0.38**
	[-0.63, -0.40]	[-0.06, -0.06]	[-0.00, 0.00]	[-0.02, -0.02]	[-0.00, 0.02]	[-0.10, -0.04]	[-0.50, -0.27]
Germany	**-0.60**	**-0.07**	-0.00	**-0.05**	0.02	**-0.09**	**-0.41**
	[-0.69, -0.50]	[-0.07, -0.07]	[-0.01, 0.00]	[-0.05, -0.04]	[-0.00, 0.05]	[-0.13, -0.05]	[-0.49, -0.33]
Greece	**-0.38**	**-0.04**	0.00	0.00	0.00	**-0.04**	**-0.31**
	[-0.46, -0.31]	[-0.04, -0.04]	[0.00, 0.00]	[-0.00, 0.00]	[-0.00, 0.01]	[-0.07, -0.02]	[-0.38, -0.23]
Hungary	**-0.68**	**-0.06**	0.00	**-0.04**	**0.01**	**-0.05**	**-0.52**
	[-0.78, -0.58]	[-0.07, -0.06]	[-0.00, 0.00]	[-0.05, -0.04]	[0.00, 0.02]	[-0.09, -0.01]	[-0.60, -0.43]
Ireland	**-7.25**	**-0.09**	**-0.16**	**-0.25**	**-0.21**	**-1.48**	**-5.14**
	[-8.36, -6.14]	[-0.10, -0.09]	[-0.21, -0.12]	[-0.40, -0.09]	[-0.38, -0.03]	[-1.81, -1.14]	[-5.92, -4.36]
Italy	**-0.40**	**-0.06**	-0.00	**-0.02**	0.00	**-0.04**	**-0.28**
	[-0.47, -0.32]	[-0.06, -0.06]	[-0.00, 0.00]	[-0.02, -0.02]	[-0.00, 0.01]	[-0.06, -0.02]	[-0.34, -0.21]
Latvia	**-0.58**	**-0.05**	-0.00	**-0.03**	0.00	-0.10	**-0.41**
	[-0.72, -0.43]	[-0.05, -0.05]	[-0.00, 0.00]	[-0.04, -0.02]	[-0.00, 0.01]	[-0.21, 0.01]	[-0.51, -0.30]
Lithuania	**-0.47**	**-0.06**	0.00	**-0.07**	**-0.01**	-0.07	**-0.27**
	[-0.60, -0.33]	[-0.06, -0.06]	[-0.00, 0.00]	[-0.08, -0.06]	[-0.01, -0.00]	[-0.17, 0.03]	[-0.34, -0.19]
Luxembourg	**-6.36**	**-0.12**	**-0.01**	**-0.06**	-0.02	**-0.09**	**-6.05**
	[-8.79, -3.93]	[-0.12, -0.12]	[-0.01, -0.00]	[-0.07, -0.06]	[-0.05, 0.00]	[-0.16, -0.02]	[-7.69, -4.40]
Malta	**-4.63**	**-0.03**	0.00	**0.02**	0.01	**-0.32**	**-4.32**
	[-5.78, -3.47]	[-0.03, -0.03]	[0.00, 0.00]	[0.02, 0.03]	[-0.01, 0.03]	[-0.48, -0.15]	[-5.50, -3.14]
Netherlands	**-1.63**	**-0.09**	**-0.01**	**-0.10**	-0.05	**-0.24**	**-1.15**
	[-1.85, -1.41]	[-0.09, -0.09]	[-0.02, -0.01]	[-0.11, -0.09]	[-0.11, 0.02]	[-0.32, -0.16]	[-1.31, -0.99]
Poland	**-0.63**	**-0.06**	0.00	**-0.04**	0.01	**-0.08**	**-0.45**
	[-0.71, -0.54]	[-0.06, -0.06]	[0.00, 0.00]	[-0.05, -0.04]	[-0.01, 0.02]	[-0.12, -0.04]	[-0.52, -0.37]

Table A6: Change in Real Consumption of Welfare Decomposition (S1), continued, in %

	All Sub-Scenarios	Transfers Only	Agri.	Manuf.	Agri.	Manuf	Serv.
			Tariffs Only		NTBs Only		
Portugal	**-0.45**	**-0.05**	**0.00**	**-0.02**	-0.00	**-0.05**	**-0.34**
	[-0.56, -0.35]	[-0.05, -0.05]	[0.00, 0.00]	[-0.02, -0.02]	[-0.01, 0.01]	[-0.08, -0.03]	[-0.44, -0.23]
Romania	**-0.37**	**-0.05**	**0.00**	**-0.01**	**-0.00**	**-0.05**	**-0.26**
	[-0.45, -0.29]	[-0.05, -0.05]	[0.00, 0.00]	[-0.01, -0.00]	[-0.00, -0.00]	[-0.07, -0.03]	[-0.33, -0.18]
Slovakia	**-0.73**	**-0.06**	**-0.00**	**-0.04**	0.00	**-0.16**	**-0.48**
	[-0.86, -0.60]	[-0.06, -0.06]	[-0.00, -0.00]	[-0.05, -0.04]	[-0.01, 0.01]	[-0.19, -0.12]	[-0.62, -0.35]
Slovenia	**-0.42**	**-0.06**	**-0.00**	**-0.01**	-0.00	**-0.07**	**-0.28**
	[-0.50, -0.35]	[-0.07, -0.06]	[-0.00, -0.00]	[-0.01, -0.01]	[-0.01, 0.00]	[-0.09, -0.05]	[-0.36, -0.20]
Spain	**-0.39**	**-0.06**	**-0.00**	**-0.01**	-0.00	**-0.07**	**-0.23**
	[-0.48, -0.30]	[-0.06, -0.06]	[-0.00, -0.00]	[-0.02, -0.01]	[-0.02, 0.01]	[-0.09, -0.05]	[-0.31, -0.14]
Sweden	**-0.75**	**-0.07**	**-0.00**	**-0.02**	0.00	**-0.09**	**-0.58**
	[-0.91, -0.58]	[-0.07, -0.07]	[-0.00, -0.00]	[-0.02, -0.02]	[-0.03, 0.04]	[-0.14, -0.04]	[-0.75, -0.42]
Australia	-0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	-0.00
	[-0.01, 0.00]	[0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.00]	[0.00, 0.01]	[-0.00, 0.01]	[-0.00, 0.00]
Brazil	**-0.01**	**-0.00**	0.00	**-0.00**	0.00	-0.00	**-0.00**
	[-0.01, -0.01]	[-0.00, -0.00]	[-0.00, 0.00]	[-0.00, -0.00]	[0.00, 0.00]	[-0.00, 0.00]	[-0.01, -0.00]
Canada	0.00	0.00	0.00	**-0.00**	-0.01	0.01	-0.01
	[-0.00, 0.01]	[-0.00, 0.00]	[-0.00, 0.00]	[-0.00, -0.00]	[-0.01, -0.00]	[0.00, 0.02]	[-0.01, 0.00]
China	**0.05**	**-0.00**	0.00	**0.01**	-0.00	**0.02**	**0.02**
	[0.04, 0.05]	[-0.00, -0.00]	[-0.00, 0.00]	[0.01, 0.01]	[-0.00, 0.00]	[0.01, 0.03]	[0.01, 0.03]
India	**0.02**	**0.00**	0.00	**0.00**	**0.00**	**0.00**	**0.01**
	[0.01, 0.02]	[0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.01]	[0.00, 0.00]	[0.00, 0.01]	[0.00, 0.01]
Indonesia	**0.01**	**-0.00**	0.00	0.00	-0.00	**0.00**	**0.00**
	[0.01, 0.01]	[-0.00, -0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.00]	[0.00, 0.01]
Japan	-0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**-0.01**
	[-0.00, 0.00]	[0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.00]	[-0.01, -0.00]
Korea	-0.03	**0.00**	0.00	-0.00	0.00	**0.04**	**0.04**
	[-0.08, 0.02]	[0.00, 0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.00]	[0.02, 0.05]	[0.03, 0.06]
Mexico	-0.01	**0.00**	**0.00**	**0.00**	**-0.00**	**0.01**	0.00
	[-0.01, 0.00]	[0.00, 0.00]	[0.00, 0.00]	[0.00, 0.00]	[-0.00, -0.00]	[0.01, 0.01]	[-0.00, 0.00]
Norway	**0.52**	**0.01**	0.00	**0.01**	-0.09	0.02	-0.05
	[0.10, 0.94]	[0.01, 0.01]	[-0.00, 0.00]	[0.01, 0.01]	[-0.19, 0.01]	[-0.05, 0.08]	[-0.17, 0.06]
Russia	0.01	**-0.00**	0.00	0.00	-0.01	0.00	0.01
	[-0.02, 0.03]	[-0.00, -0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[-0.03, 0.01]	[-0.01, 0.02]	[-0.01, 0.03]
Switzerland	-0.01	**-0.00**	**-0.00**	**0.01**	0.00	**0.10**	0.06
	[-0.16, 0.14]	[-0.00, -0.00]	[-0.00, -0.00]	[0.01, 0.01]	[-0.00, 0.00]	[0.06, 0.14]	[-0.01, 0.14]
Taiwan	**0.13**	**-0.00**	0.00	**0.02**	-0.00	**0.05**	**0.07**
	[0.11, 0.16]	[-0.00, -0.00]	[-0.00, 0.00]	[0.02, 0.02]	[-0.00, 0.00]	[0.03, 0.08]	[0.04, 0.09]
Turkey	**-0.04**	**0.00**	**0.00**	**0.03**	**0.00**	**0.03**	-0.01
	[-0.07, -0.01]	[0.00, 0.00]	[0.00, 0.00]	[0.02, 0.03]	[0.00, 0.00]	[0.02, 0.04]	[-0.02, 0.00]
USA	**-0.01**	**0.00**	**0.00**	**0.00**	**0.00**	-0.00	**-0.01**
	[-0.02, -0.01]	[0.00, 0.00]	[0.00, 0.00]	[0.00, 0.00]	[0.00, 0.00]	[-0.00, 0.00]	[-0.02, -0.01]
ROW	-0.02	**0.00**	0.00	**0.00**	**-0.00**	**0.01**	-0.02
	[-0.05, 0.01]	[0.00, 0.00]	[-0.00, 0.00]	[0.00, 0.01]	[-0.01, -0.00]	[0.00, 0.01]	[-0.05, 0.01]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A7: Bilateral Exports of EU27, in %

| | Exports to EU27 | | Exports to UK | | Exports to ROW | |
	Initial mn USD	Δ in %	Initial in mn USD	Δ in %	Initial in mn USD	Δ in %
S1						
Agriculture	126230.6	-0.24	13150.26	**-22.74**	55078.38	**0.85**
		[-0.72, 0.25]		[-41.40, -4.09]		[0.50, 1.19]
Manufacturing	2185370	-0.14	266238	**-30.63**	1726202	**1.15**
		[-0.34, 0.07]		[-34.45, -26.81]		[0.86, 1.44]
Services	839322.2	**-0.30**	127694	**-21.21**	1097312	**0.44**
		[-0.53, -0.06]		[-24.98, -17.43]		[0.25, 0.63]
Total	3150923	**-0.18**	407082.2	**-27.42**	2878593	**0.87**
		[-0.36, -0.01]		[-30.14, -24.71]		[0.67, 1.08]
S2						
Agriculture	126230.6	-1.34	13150.26	40.06	55078.38	-0.13
		[-2.97, 0.30]		[-15.79, 95.91]		[-0.50, 0.23]
Manufacturing	2185370	-0.31	266238	-4.71	1726202	**0.35**
		[-0.62, 0.00]		[-10.75, 1.34]		[0.00, 0.69]
Services	839322.2	0.25	127694	**-7.55**	1097312	**0.32**
		[-0.02, 0.51]		[-13.07, -2.03]		[0.05, 0.59]
Total	3150923	-0.20	407082.2	-4.15	2878593	**0.33**
		[-0.45, 0.04]		[-9.03, 0.72]		[0.07, 0.58]
S3						
Agriculture	126230.6	-0.34	13150.26	**-19.87**	55078.38	**0.95**
		[-0.84, 0.15]		[-39.10, -0.64]		[0.54, 1.35]
Manufacturing	2185370	**-0.35**	266238	**-34.35**	1726202	**1.14**
		[-0.56, -0.15]		[-38.42, -30.29]		[0.82, 1.47]
Services	839322.2	**-0.48**	127694	**-19.76**	1097312	**0.37**
		[-0.72, -0.24]		[-23.72, -15.81]		[0.18, 0.56]
Total	3150923	**-0.39**	407082.2	**-29.31**	2878593	**0.84**
		[-0.56, -0.21]		[-32.21, -26.41]		[0.62, 1.07]
S4						
Agriculture	126230.6	-0.28	13150.26	**-10.90**	55078.38	-0.12
		[-0.75, 0.19]		[-14.53, -7.27]		[-0.39, 0.14]
Manufacturing	2185370	**-0.22**	266238	**-11.52**	1726202	**-0.51**
		[-0.44, -0.00]		[-12.98, -10.06]		[-0.70, -0.33]
Services	839322.2	**0.28**	127694	**-4.29**	1097312	**0.21**
		[0.03, 0.52]		[-5.12, -3.46]		[0.02, 0.40]
Total	3150923	-0.09	407082.2	**-9.23**	2878593	**-0.23**
		[-0.28, 0.09]		[-10.37, -8.09]		[-0.36, -0.09]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets. Domestic trade is not taken into account.

| | Exports to EU27 | | Exports to ROW | |
	Initial mn USD	Δ in %	Initial in mn USD	Δ in %
S1				
Agriculture	12761.92	-4.46	17163.94	**-6.31**
		[-37.27, 28.35]		[-8.11, -4.52]
Manufacturing	116610.8	**-32.19**	187800.8	**-10.00**
		[-38.09, -26.28]		[-11.98, -8.02]
Services	160391.2	**-20.85**	253204.4	**-0.43**
		[-26.24, -15.45]		[-0.80, -0.06]
Total	289763.9	**-24.69**	458169.1	**-4.57**
		[-28.29, -21.08]		[-5.49, -3.65]
S2				
Agriculture	12761.92	96.05	17163.94	**-7.20**
		[-14.14, 206.25]		[-9.57, -4.82]
Manufacturing	116610.8	7.16	187800.8	**-7.58**
		[-6.68, 21.00]		[-10.24, -4.93]
Services	160391.2	**-7.16**	253204.4	**-0.76**
		[-14.19, -0.13]		[-1.33, -0.20]
Total	289763.9	3.15	458169.1	**-3.80**
		[-4.83, 11.12]		[-5.15, -2.45]
S3				
Agriculture	12761.92	-6.70	17163.94	7.11
		[-38.26, 24.86]		[-5.83, 20.04]
Manufacturing	116610.8	**-32.33**	187800.8	**14.80**
		[-38.11, -26.55]		[8.30, 21.31]
Services	160391.2	**-21.33**	253204.4	**4.49**
		[-26.50, -16.16]		[2.94, 6.03]
Total	289763.9	**-25.11**	458169.1	**8.81**
		[-28.70, -21.53]		[6.07, 11.56]
S4				
Agriculture	12761.92	2.50	17163.94	**7.61**
		[-32.46, 37.46]		[3.75, 11.46]
Manufacturing	116610.8	**-17.84**	187800.8	**9.93**
		[-24.12, -11.56]		[7.92, 11.94]
Services	160391.2	**-18.79**	253204.4	**1.44**
		[-24.25, -13.33]		[1.10, 1.77]
Total	289763.9	**-17.47**	458169.1	**5.15**
		[-21.12, -13.82]		[4.20, 6.10]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets. Domestic trade is not taken into account.

Table A9: Bilateral Exports of the Rest of the World, in %

| | Exports to EU27 | | Exports to UK | | Exports to ROW | |
	Initial mn USD	Δ in %	Initial in mn USD	Δ in %	Initial in mn USD	Δ in %
S1						
Agriculture	323832.4	**-1.19** [-2.13, -0.25]	37293.41	**10.05** [1.73, 18.37]	1678540	**0.25** [0.17, 0.33]
Manufacturing	1172862	**-0.91** [-1.18, -0.65]	223334.2	**9.80** [7.46, 12.14]	6719728	**0.24** [0.19, 0.29]
Services	721619.4	**-0.96** [-1.27, -0.65]	98251.83	0.07 [-0.89, 1.03]	2389414	**0.20** [0.16, 0.23]
Total	2218314	**-0.97** [-1.23, -0.71]	358879.5	**7.16** [5.24, 9.08]	1.08e+07	**0.23** [0.19, 0.28]
S2						
Agriculture	323832.4	-1.96 [-4.55, 0.62]	37293.41	9.62 [-3.23, 22.47]	1678540	-0.04 [-0.20, 0.12]
Manufacturing	1172862	**-0.68** [-1.12, -0.24]	223334.2	1.80 [-1.35, 4.94]	6719728	0.06 [-0.02, 0.14]
Services	721619.4	-0.33 [-0.67, 0.02]	98251.83	1.04 [-0.37, 2.46]	2389414	0.01 [-0.05, 0.07]
Total	2218314	**-0.75** [-1.22, -0.28]	358879.5	2.40 [-0.29, 5.09]	1.08e+07	0.03 [-0.05, 0.11]
S3						
Agriculture	323832.4	**-1.49** [-2.42, -0.55]	37293.41	**22.05** [11.28, 32.81]	1678540	**0.27** [0.14, 0.39]
Manufacturing	1172862	**-1.35** [-1.64, -1.06]	223334.2	**34.19** [28.66, 39.73]	6719728	0.03 [-0.05, 0.10]
Services	721619.4	**-1.13** [-1.42, -0.83]	98251.83	**9.04** [6.21, 11.87]	2389414	**0.11** [0.07, 0.14]
Total	2218314	**-1.30** [-1.58, -1.02]	358879.5	**26.05** [21.96, 30.13]	1.08e+07	**0.08** [0.02, 0.15]
S4						
Agriculture	323832.4	-0.57 [-1.38, 0.23]	37293.41	-2.51 [-5.76, 0.74]	1678540	**0.25** [0.21, 0.29]
Manufacturing	1172862	0.19 [-0.10, 0.48]	223334.2	**9.96** [8.06, 11.87]	6719728	**0.16** [0.12, 0.20]
Services	721619.4	-0.07 [-0.40, 0.26]	98251.83	**-4.28** [-5.07, -3.50]	2389414	**0.19** [0.16, 0.21]
Total	2218314	-0.01 [-0.25, 0.24]	358879.5	**4.77** [3.35, 6.18]	1.08e+07	**0.18** [0.15, 0.21]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets. Domestic trade is not taken into account.

Table A10: Changes in Gross Trade Flows in %

	Initial Exports bn USD	Changes in Exports in %				Initial Imports bn USD	Changes in Imports in %			
		S1	S2	S3	S4		S1	S2	S3	S4
UK										
Agriculture	29.93	-5.52	36.83	1.22	5.43	50.44	1.50	**17.56**	**11.12**	**-4.70**
		[-19.64, 8.59]	[-9.66, 83.33]	[-14.70, 17.13]	[-9.96, 20.81]		[-7.01, 10.02]	[0.76, 34.35]	[1.00, 21.24]	[-7.32, -2.08]
Manufacturing	304.41	**-18.50**	-1.94	-3.25	-0.71	489.57	**-12.19**	-1.74	**-3.08**	**-1.72**
		[-21.23, -15.76]	[-7.27, 3.40]	[-7.57, 1.06]	[-3.11, 1.70]		[-13.65, -10.72]	[-4.25, 0.77]	[-5.17, -1.00]	[-2.70, -0.74]
Services	413.60	**-8.35**	**-3.24**	**-5.52**	**-6.41**	225.95	**-11.96**	**-3.81**	**-7.24**	**-4.29**
		[-10.44, -6.26]	[-5.93, -0.56]	[-7.62, -3.43]	[-8.39, -4.42]		[-14.09, -9.82]	[-7.05, -0.58]	[-9.64, -4.83]	[-5.09, -3.48]
Total	747.93	-12.36	-1.11	-4.33	-3.61	765.96	-11.22	-1.08	-3.37	-2.67
		[-24.80, 0.07]	[-42.83, 40.62]	[-15.28, 6.63]	[-15.91, 8.69]		[-22.82, 0.38]	[-20.09, 17.93]	[-17.67, 10.93]	[-5.37, 0.02]
EU27										
Agriculture	194.46	**-1.45**	1.80	-1.30	**-0.96**	462.82	**-1.02**	0.91	**-1.32**	**-0.41**
		[-2.80, -0.11]	[-1.23, 4.84]	[-2.67, 0.07]	[-1.40, -0.51]		[-1.49, -0.54]	[-0.30, 2.12]	[-1.77, -0.86]	[-0.81, -0.01]
Manufacturing	4177.81	**-1.55**	-0.32	**-1.90**	**-1.06**	3474.84	**-1.48**	-0.18	**-1.76**	**-0.67**
		[-1.80, -1.30]	[-0.70, 0.06]	[-2.16, -1.64]	[-1.26, -0.87]		[-1.63, -1.32]	[-0.46, 0.09]	[-1.92, -1.60]	[-0.80, -0.55]
Services	2064.33	**-1.20**	-0.20	**-1.22**	-0.04	1721.33	**-2.49**	**-0.68**	**-2.69**	**-1.64**
		[-1.46, -0.94]	[-0.60, 0.20]	[-1.49, -0.95]	[-0.22, 0.13]		[-2.91, -2.07]	[-1.30, -0.06]	[-3.11, -2.28]	[-2.07, -1.22]
Total	6,436.60	**-1.43**	-0.22	**-1.67**	-0.73	5,659.00	**-1.75**	-0.25	**-2.01**	**-0.95**
		[-2.27, -0.59]	[-2.66, 2.22]	[-2.62, -0.71]	[-1.54, 0.07]		[-2.79, -0.71]	[-1.59, 1.10]	[-2.99, -1.03]	[-1.85, -0.05]
ROW										
Agriculture	2039.67	**0.20**	-0.17	**0.39**	0.07	1750.78	**0.21**	-0.11	**0.35**	**0.31**
		[0.11, 0.29]	[-0.58, 0.24]	[0.29, 0.49]	[-0.05, 0.19]		[0.12, 0.29]	[-0.27, 0.04]	[0.20, 0.51]	[0.25, 0.37]
Manufacturing	8115.92	**0.34**	0.00	**0.77**	**0.43**	8633.73	**0.20**	-0.05	**0.57**	**0.24**
		[0.27, 0.41]	[-0.12, 0.12]	[0.66, 0.88]	[0.38, 0.49]		[0.17, 0.23]	[-0.13, 0.03]	[0.47, 0.67]	[0.20, 0.27]
Services	3209.29	**-0.07**	-0.03	**0.10**	-0.01	3739.93	**0.23**	0.05	**0.48**	**0.28**
		[-0.12, -0.01]	[-0.10, 0.03]	[0.01, 0.19]	[-0.06, 0.05]		[0.17, 0.28]	[-0.05, 0.15]	[0.37, 0.59]	[0.23, 0.33]
Total	13,364.88	0.22	-0.03	**0.55**	0.27	14,124.44	**0.21**	-0.03	**0.52**	**0.26**
		[-0.06, 0.50]	[-0.32, 0.25]	[0.10, 1.00]	[-0.06, 0.60]		[0.14, 0.27]	[-0.20, 0.14]	[0.33, 0.71]	[0.19, 0.33]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution.

Table A11: Changes in Real Wage, in %

	S1	S2	S3	S4		S1	S2	S3	S4
UK	**-3.37**	**-0.95**	**-1.78**	**-0.36**	Portugal	**-0.45**	**-0.13**	**-0.47**	**-0.38**
	[-3.38, -3.37]	[-0.96, -0.94]	[-1.79, -1.77]	[-0.37, -0.36]		[-0.46, -0.45]	[-0.13, -0.13]	[-0.47, -0.47]	[-0.38, -0.38]
Austria	**-0.28**	**-0.08**	**-0.29**	**-0.25**	Romania	**-0.33**	**-0.16**	**-0.35**	**-0.29**
	[-0.28, -0.28]	[-0.08, -0.08]	[-0.29, -0.29]	[-0.25, -0.25]		[-0.33, -0.33]	[-0.16, -0.16]	[-0.35, -0.35]	[-0.29, -0.29]
Belgium	**-1.27**	**-0.27**	**-1.31**	**-0.94**	Slovakia	**-0.58**	**-0.28**	**-0.59**	**-0.35**
	[-1.28, -1.27]	[-0.27, -0.27]	[-1.31, -1.30]	[-0.94, -0.94]		[-0.58, -0.58]	[-0.28, -0.28]	[-0.60, -0.59]	[-0.35, -0.34]
Bulgaria	**-0.51**	**-0.25**	**-0.51**	**-0.44**	Slovenia	**-0.35**	**-0.15**	**-0.35**	**-0.30**
	[-0.51, -0.51]	[-0.25, -0.24]	[-0.52, -0.51]	[-0.44, -0.44]		[-0.35, -0.34]	[-0.15, -0.15]	[-0.36, -0.35]	[-0.30, -0.30]
Croatia	**-0.30**	**-0.04**	**-0.30**	**-0.26**	Spain	**-0.35**	**-0.13**	**-0.37**	**-0.26**
	[-0.30, -0.30]	[-0.04, -0.04]	[-0.30, -0.30]	[-0.26, -0.26]		[-0.35, -0.35]	[-0.14, -0.13]	[-0.37, -0.37]	[-0.27, -0.26]
Cyprus	**-1.49**	**-0.37**	**-1.48**	**-1.09**	Sweden	**-0.68**	**-0.14**	**-0.69**	**-0.60**
	[-1.49, -1.48]	[-0.37, -0.36]	[-1.49, -1.48]	[-1.10, -1.09]		[-0.68, -0.67]	[-0.15, -0.14]	[-0.70, -0.69]	[-0.60, -0.60]
Czech R.	**-0.57**	**-0.28**	**-0.61**	**-0.45**	Australia	**-0.00**	**-0.00**	**0.14**	**0.01**
	[-0.57, -0.57]	[-0.28, -0.28]	[-0.61, -0.60]	[-0.46, -0.45]		[-0.00, -0.00]	[-0.00, -0.00]	[0.14, 0.14]	[0.01, 0.01]
Denmark	**-0.75**	**-0.15**	**-0.75**	**-0.65**	Brasil	**-0.00**	**-0.00**	**-0.00**	**0.01**
	[-0.75, -0.75]	[-0.15, -0.14]	[-0.76, -0.75]	[-0.65, -0.65]		[-0.00, -0.00]	[-0.00, -0.00]	[-0.00, -0.00]	[0.01, 0.01]
Estonia	**-0.67**	**-0.26**	**-0.67**	**-0.60**	Canada	**-0.00**	**-0.01**	**0.28**	**0.01**
	[-0.67, -0.66]	[-0.27, -0.26]	[-0.67, -0.67]	[-0.60, -0.60]		[-0.00, -0.00]	[-0.01, -0.01]	[0.28, 0.28]	[0.01, 0.01]
Finland	**-0.46**	**-0.08**	**-0.47**	**-0.42**	China	**0.00**	**0.00**	**0.08**	**0.02**
	[-0.46, -0.46]	[-0.08, -0.08]	[-0.47, -0.47]	[-0.42, -0.42]		[0.00, 0.00]	[0.00, 0.00]	[0.08, 0.08]	[0.02, 0.02]
France	**-0.50**	**-0.10**	**-0.52**	**-0.38**	India	**0.00**	0.00	**0.18**	**0.05**
	[-0.50, -0.50]	[-0.10, -0.10]	[-0.52, -0.52]	[-0.38, -0.37]		[0.00, 0.00]	[-0.00, 0.00]	[0.18, 0.18]	[0.05, 0.05]
Germany	**-0.53**	**-0.14**	**-0.55**	**-0.42**	Indonesia	**0.00**	-0.00	-0.00	**0.01**
	[-0.53, -0.53]	[-0.14, -0.14]	[-0.55, -0.55]	[-0.42, -0.42]		[0.00, 0.00]	[-0.00, 0.00]	[-0.00, 0.00]	[0.01, 0.01]
Greece	**-0.40**	**-0.13**	**-0.40**	**-0.35**	Japan	**0.00**	**0.01**	**0.07**	**0.01**
	[-0.40, -0.39]	[-0.13, -0.13]	[-0.40, -0.40]	[-0.35, -0.35]		[0.00, 0.01]	[0.01, 0.01]	[0.07, 0.07]	[0.01, 0.01]
Hungary	**-0.69**	**-0.27**	**-0.71**	**-0.54**	Korea	**-0.08**	**-0.09**	**0.09**	**0.01**
	[-0.69, -0.69]	[-0.27, -0.27]	[-0.71, -0.71]	[-0.54, -0.54]		[-0.08, -0.08]	[-0.09, -0.09]	[0.09, 0.09]	[0.01, 0.01]
Ireland	**-5.13**	**-1.59**	**-5.13**	**-4.01**	Mexico	**-0.01**	**-0.02**	**0.04**	**-0.00**
	[-5.13, -5.12]	[-1.60, -1.59]	[-5.14, -5.12]	[-4.02, -4.01]		[-0.01, -0.01]	[-0.02, -0.02]	[0.04, 0.04]	[-0.00, -0.00]
Italy	**-0.34**	**-0.08**	**-0.36**	**-0.28**	Norway	**0.04**	**-0.03**	**0.08**	**-0.08**
	[-0.34, -0.34]	[-0.08, -0.08]	[-0.36, -0.36]	[-0.28, -0.28]		[0.03, 0.04]	[-0.04, -0.02]	[0.08, 0.09]	[-0.08, -0.08]
Latvia	**-0.58**	**-0.16**	**-0.58**	**-0.50**	Russia	**-0.02**	**-0.06**	**-0.02**	**0.01**
	[-0.58, -0.58]	[-0.16, -0.16]	[-0.59, -0.58]	[-0.50, -0.50]		[-0.02, -0.02]	[-0.06, -0.05]	[-0.02, -0.02]	[0.01, 0.01]
Lithuania	**-0.42**	**-0.10**	**-0.44**	**-0.38**	Switzerland	**-0.05**	**0.00**	**-0.05**	**0.04**
	[-0.43, -0.42]	[-0.10, -0.10]	[-0.44, -0.44]	[-0.38, -0.38]		[-0.05, -0.05]	[0.00, 0.00]	[-0.05, -0.05]	[0.04, 0.04]
Luxembourg	**-3.61**	**0.70**	**-3.66**	**-2.85**	Taiwan	**0.02**	**0.02**	**0.02**	**0.02**
	[-3.62, -3.60]	[0.69, 0.71]	[-3.67, -3.66]	[-2.85, -2.84]		[0.02, 0.03]	[0.02, 0.02]	[0.02, 0.02]	[0.02, 0.02]
Malta	**-5.54**	**-0.81**	**-5.51**	**-3.48**	Turkey	**-0.06**	**-0.08**	**-0.09**	**0.01**
	[-5.55, -5.53]	[-0.83, -0.80]	[-5.52, -5.50]	[-3.49, -3.48]		[-0.06, -0.06]	[-0.08, -0.08]	[-0.10, -0.09]	[0.01, 0.01]
Netherlands	**-1.14**	**-0.33**	**-1.15**	**-0.89**	USA	**-0.00**	**-0.00**	**0.12**	**0.01**
	[-1.14, -1.14]	[-0.34, -0.33]	[-1.15, -1.15]	[-0.89, -0.89]		[-0.00, -0.00]	[-0.00, -0.00]	[0.12, 0.12]	[0.01, 0.01]
Poland	**-0.61**	**-0.23**	**-0.63**	**-0.45**	ROW	**-0.00**	**0.01**	**-0.01**	**0.04**
	[-0.61, -0.60]	[-0.23, -0.23]	[-0.63, -0.63]	[-0.45, -0.44]		[-0.00, -0.00]	[0.01, 0.01]	[-0.01, -0.01]	[0.04, 0.04]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A12: Changes of UK's Sectoral Value Added of Agricultural and Manufacturing Goods, in %

	initial VA in mn USD	Change of Sectoral Value Added in %			
		S1	**S2**	**S3**	**S4**
Crops & Animals	18168	**7.87**	**6.71**	**8.30**	**-2.22**
		[3.63, 12.11]	[0.91, 12.50]	[4.14, 12.46]	[-3.24, -1.20]
Forestry & Logging	300	-1.96	-1.28	-1.22	-0.10
		[-7.28, 3.35]	[-7.47, 4.90]	[-6.59, 4.15]	[-1.87, 1.67]
Fishing & Aquaculture	1099	**-15.83**	-7.68	-10.36	**-15.11**
		[-27.09, -4.56]	[-27.12, 11.76]	[-22.42, 1.71]	[-26.85, -3.36]
Mining & Quarrying	43315	**-7.93**	8.22	-3.60	6.77
		[-14.07, -1.79]	[-9.03, 25.48]	[-10.54, 3.33]	[-0.59, 14.12]
Food, Beverages & Tabacco	47220	1.86	**2.39**	**3.50**	**-3.06**
		[-0.84, 4.55]	[0.21, 4.57]	[0.95, 6.04]	[-4.35, -1.77]
Textiles, Apparel,Leather	10096	**-6.82**	-2.97	**-10.62**	**-4.02**
		[-10.17, -3.47]	[-7.70, 1.76]	[-15.84, -5.39]	[-7.70, -0.33]
Wood & Cork	4056	0.43	-3.86	-1.78	0.45
		[-5.22, 6.08]	[-12.01, 4.29]	[-7.91, 4.34]	[-0.46, 1.37]
Paper	7484	0.81	0.36	1.00	0.46
		[-5.49, 7.12]	[-6.77, 7.48]	[-5.37, 7.36]	[-1.25, 2.18]
Recorded Media Reproduction	8128	**-1.13**	1.10	0.55	0.40
		[-1.94, -0.31]	[-0.38, 2.59]	[-0.37, 1.47]	[-0.48, 1.28]
Coke, Refined Petroleum	7602	4.13	18.84	**19.89**	0.75
		[-10.10, 18.35]	[-14.06, 51.75]	[0.11, 39.66]	[-8.71, 10.20]
Chemicals	16774	**-5.71**	0.34	**-4.12**	**-3.74**
		[-8.85, -2.58]	[-4.15, 4.84]	[-7.67, -0.58]	[-6.65, -0.83]
Pharmaceuticals	22050	-3.08	-5.82	**-11.94**	8.75
		[-10.73, 4.57]	[-14.87, 3.23]	[-21.46, -2.41]	[-2.04, 19.53]
Rubber & Plastics	16810	-0.68	0.93	0.66	**-3.25**
		[-2.26, 0.90]	[-1.03, 2.89]	[-1.28, 2.61]	[-4.68, -1.82]
Other non-Metallic Mineral	8577	-1.01	0.94	0.71	**-0.93**
		[-2.24, 0.22]	[-0.51, 2.40]	[-0.53, 1.96]	[-1.55, -0.30]
Basic Metals	7651	**-16.95**	**-9.73**	-6.11	-2.13
		[-23.43, -10.47]	[-16.10, -3.36]	[-13.20, 0.98]	[-5.85, 1.59]
Fabricated Metal	28099	-0.49	1.44	**2.63**	**1.21**
		[-2.14, 1.17]	[-0.28, 3.17]	[0.83, 4.43]	[0.35, 2.06]
Electronics & Optical Products	19366	-3.05	-2.15	-6.60	**13.07**
		[-10.83, 4.72]	[-11.46, 7.17]	[-15.11, 1.92]	[2.23, 23.90]
Electrical Equipment	8910	**-8.48**	-0.35	**-8.93**	3.67
		[-12.88, -4.07]	[-6.79, 6.09]	[-13.93, -3.93]	[-0.40, 7.73]
Machinery & Equipment	32117	**-6.86**	-3.93	-4.11	**8.38**
		[-11.18, -2.54]	[-8.87, 1.01]	[-8.63, 0.41]	[4.42, 12.34]
Motor Vehicles	20517	-2.52	-1.49	**5.13**	-3.33
		[-7.15, 2.11]	[-8.46, 5.49]	[0.17, 10.10]	[-6.94, 0.28]
Other Transport Equipment	17066	-2.80	11.80	**23.45**	**10.01**
		[-7.70, 2.11]	[-0.21, 23.81]	[4.48, 42.43]	[2.53, 17.48]
Furniture & Other Manufacturing	16106	-3.10	-1.29	-2.29	4.39
		[-6.72, 0.53]	[-4.46, 1.87]	[-6.45, 1.87]	[-0.54, 9.31]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A13: Changes of UK's Sectoral Value Added of Services, in %

| | initial VA in mn USD | Change of Sectoral Value Added in % | | | |
		S1	S2	S3	S4
Electricity & Gas	43740	**-1.08**	0.67	**0.99**	**-0.53**
		[-1.74, -0.42]	[-0.49, 1.84]	[0.14, 1.85]	[-1.03, -0.03]
Water Supply	8828	**-0.67**	0.46	**0.91**	-0.35
		[-1.29, -0.05]	[-0.63, 1.54]	[0.14, 1.68]	[-0.87, 0.18]
Sewerage & Waste	21167	**-1.72**	-0.79	-0.84	**-2.45**
		[-3.15, -0.30]	[-2.70, 1.11]	[-3.24, 1.56]	[-4.11, -0.79]
Construction	179017	-0.46	0.87	**1.15**	**-0.70**
		[-1.10, 0.19]	[-0.24, 1.98]	[0.34, 1.95]	[-1.27, -0.12]
Trade & Repair of Motor Vehicles	52638	**-2.14**	-0.74	0.38	**-2.62**
		[-3.23, -1.04]	[-2.25, 0.78]	[-0.79, 1.56]	[-3.64, -1.61]
Wholesale Trade	87853	**-7.91**	**-6.50**	**-5.40**	**-9.32**
		[-11.18, -4.65]	[-10.11, -2.89]	[-8.60, -2.20]	[-12.92, -5.71]
Retail Trade	151457	-0.60	0.49	**1.01**	**-1.02**
		[-1.23, 0.03]	[-0.52, 1.51]	[0.25, 1.77]	[-1.60, -0.43]
Land Transport	52683	**-1.86**	-0.58	-0.30	**-1.87**
		[-2.68, -1.04]	[-1.77, 0.62]	[-1.24, 0.64]	[-2.68, -1.06]
Water Transport	11472	0.78	-1.00	0.97	**1.45**
		[-0.63, 2.20]	[-3.90, 1.90]	[-0.47, 2.40]	[0.99, 1.91]
Air Transport	14985	-0.84	-0.25	0.49	-0.18
		[-2.59, 0.90]	[-2.37, 1.87]	[-1.35, 2.33]	[-0.81, 0.45]
Aux. Transportation Services	30772	**-3.28**	**-2.08**	**-1.76**	**-3.15**
		[-4.45, -2.12]	[-3.45, -0.70]	[-2.99, -0.52]	[-4.40, -1.90]
Postal and Courier	19150	0.03	**1.71**	**1.41**	-0.31
		[-0.93, 1.00]	[0.41, 3.02]	[0.40, 2.41]	[-1.22, 0.61]
Accommodation & Food	85664	**-0.76**	0.47	0.53	0.16
		[-1.37, -0.16]	[-0.42, 1.35]	[-0.18, 1.24]	[-0.33, 0.66]
Publishing	17750	**-1.59**	-0.73	-0.64	-0.18
		[-2.58, -0.60]	[-2.02, 0.56]	[-1.66, 0.39]	[-1.13, 0.77]
Media Services	23527	**-1.77**	-0.54	-0.67	-0.78
		[-2.77, -0.76]	[-2.14, 1.06]	[-1.76, 0.43]	[-1.70, 0.14]
Telecommunications	46927	-0.65	0.62	0.64	-0.83
		[-2.46, 1.15]	[-1.58, 2.82]	[-1.20, 2.47]	[-1.88, 0.23]
Computer & Information Services	78127	**-0.64**	**1.02**	**0.89**	-0.22
		[-1.27, -0.01]	[0.00, 2.04]	[0.14, 1.64]	[-0.82, 0.38]
Financial Services	125534	0.38	**1.78**	**1.43**	0.16
		[-0.51, 1.27]	[0.39, 3.17]	[0.50, 2.35]	[-0.52, 0.85]
Insurance	109604	1.17	**3.17**	2.29	**2.73**
		[-1.15, 3.49]	[0.07, 6.27]	[-0.07, 4.65]	[0.33, 5.13]
Real Estate	303820	-0.35	0.73	**1.09**	**-0.58**
		[-0.97, 0.28]	[-0.33, 1.78]	[0.32, 1.87]	[-1.14, -0.02]
Legal and Accounting	96495	**-1.51**	0.66	0.74	-0.87
		[-2.57, -0.44]	[-0.86, 2.18]	[-0.44, 1.92]	[-1.85, 0.11]
Business Services	87560	**-2.57**	0.51	0.78	**-2.05**
		[-3.69, -1.45]	[-0.92, 1.95]	[-0.50, 2.06]	[-3.17, -0.93]
Research and Development	15230	-0.68	0.41	0.52	0.38
		[-1.66, 0.30]	[-0.77, 1.60]	[-0.55, 1.60]	[-0.38, 1.13]
Admin. & Support Services	128914	-0.17	1.47	1.16	0.90
		[-2.35, 2.00]	[-1.10, 4.04]	[-1.10, 3.41]	[-0.77, 2.56]
Public & Social Services	154785	**-0.59**	0.61	**0.93**	**-0.56**
		[-1.18, -0.01]	[-0.39, 1.62]	[0.19, 1.66]	[-1.10, -0.03]
Education	171370	**-0.66**	0.49	**0.84**	**-0.56**
		[-1.23, -0.10]	[-0.47, 1.45]	[0.12, 1.56]	[-1.08, -0.04]
Human Health and Social Work	199282	-0.52	0.60	**0.94**	-0.51
		[-1.11, 0.06]	[-0.41, 1.61]	[0.21, 1.67]	[-1.05, 0.03]
Other Serivces, Households	120406	-0.22	0.89	0.80	-0.37
		[-1.19, 0.74]	[-0.42, 2.20]	[-0.33, 1.94]	[-1.10, 0.37]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A14: Changes of EU27's Sectoral Value Added of Agricultural and Manufacturing Goods, in %

	initial VA in mn USD	Change of Sectoral Value Added in %			
		S1	**S2**	**S3**	**S4**
Crops & Animals	221514	**-1.36**	**-0.70**	**-1.46**	**-0.54**
		[-1.65, -1.08]	[-1.14, -0.25]	[-1.75, -1.18]	[-0.68, -0.41]
Forestry & Logging	29863	**-0.52**	0.04	**-0.63**	**-0.70**
		[-0.85, -0.20]	[-0.38, 0.47]	[-0.97, -0.29]	[-0.80, -0.60]
Fishing & Aquaculture	7486	1.08	0.91	1.00	0.71
		[-0.29, 2.45]	[-1.21, 3.04]	[-0.35, 2.36]	[-0.59, 2.01]
Mining & Quarrying	78597	**2.51**	**5.86**	**2.75**	**-1.07**
		[0.46, 4.56]	[1.48, 10.24]	[0.60, 4.89]	[-1.94, -0.20]
Food, Beverages & Tabacco	311327	**-1.55**	**-0.53**	**-1.67**	**-0.63**
		[-1.94, -1.15]	[-0.90, -0.16]	[-2.07, -1.28]	[-0.81, -0.45]
Textiles, Apparel,Leather	83953	-0.38	0.93	**-0.83**	**-1.15**
		[-1.05, 0.29]	[-0.22, 2.08]	[-1.53, -0.14]	[-1.61, -0.69]
Wood & Cork	44213	**-0.72**	0.16	**-0.88**	**-0.84**
		[-1.19, -0.26]	[-0.54, 0.87]	[-1.36, -0.41]	[-1.03, -0.65]
Paper	55968	**-0.83**	-0.29	**-0.88**	**-0.85**
		[-1.57, -0.08]	[-1.15, 0.56]	[-1.64, -0.12]	[-1.11, -0.59]
Recorded Media Reproduction	40974	**-0.47**	**-0.23**	**-0.62**	**-0.49**
		[-0.61, -0.33]	[-0.46, -0.01]	[-0.77, -0.47]	[-0.64, -0.33]
Coke, Refined Petroleum	60143	-0.44	2.02	-0.82	**-1.02**
		[-1.52, 0.64]	[-0.25, 4.29]	[-1.87, 0.23]	[-1.74, -0.29]
Chemicals	178271	**-1.10**	**-0.64**	**-1.33**	**-0.80**
		[-1.42, -0.79]	[-1.05, -0.24]	[-1.66, -1.01]	[-1.06, -0.54]
Pharmaceuticals	121944	-0.67	**-2.16**	-0.02	**-1.92**
		[-2.38, 1.04]	[-3.70, -0.61]	[-1.93, 1.89]	[-3.06, -0.77]
Rubber & Plastics	113713	**-1.16**	**-0.49**	**-1.37**	**-0.51**
		[-1.39, -0.93]	[-0.81, -0.17]	[-1.62, -1.12]	[-0.68, -0.34]
Other non-Metallic Mineral	84895	**-0.70**	**-0.23**	**-0.84**	**-0.54**
		[-0.85, -0.54]	[-0.42, -0.04]	[-0.99, -0.69]	[-0.64, -0.44]
Basic Metals	91464	**-0.43**	-0.14	**-0.74**	**-0.43**
		[-0.79, -0.07]	[-0.60, 0.32]	[-1.12, -0.37]	[-0.69, -0.16]
Fabricated Metal	220110	**-0.79**	**-0.26**	**-1.00**	**-0.61**
		[-0.97, -0.61]	[-0.47, -0.05]	[-1.20, -0.81]	[-0.71, -0.52]
Electronics & Optical Products	126896	**-1.73**	**-2.69**	**-1.48**	**-2.43**
		[-2.54, -0.92]	[-3.58, -1.80]	[-2.33, -0.63]	[-3.29, -1.58]
Electrical Equipment	124261	**-0.60**	-0.25	**-1.18**	**-1.10**
		[-1.09, -0.10]	[-0.88, 0.38]	[-1.66, -0.71]	[-1.42, -0.78]
Machinery & Equipment	381086	-0.12	-0.24	-0.16	**-1.04**
		[-0.55, 0.30]	[-0.67, 0.19]	[-0.61, 0.28]	[-1.36, -0.72]
Motor Vehicles	249064	**-1.57**	-0.21	**-2.24**	**-0.81**
		[-2.03, -1.10]	[-0.84, 0.42]	[-2.74, -1.73]	[-1.23, -0.38]
Other Transport Equipment	68303	-0.77	1.22	**-3.86**	**-1.40**
		[-1.87, 0.33]	[-0.69, 3.14]	[-5.85, -1.87]	[-2.32, -0.49]
Furniture & Other Manufacturing	103874	-0.27	**-0.58**	-0.05	**-1.34**
		[-0.88, 0.34]	[-1.14, -0.01]	[-0.76, 0.67]	[-1.96, -0.72]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A15: Changes of EU27's Sectoral Value Added of Services, in %

	initial VA in mn USD	Change of Sectoral Value Added in %			
		S1	**S2**	**S3**	**S4**
Electricity & Gas	284959	**-0.67** [-0.77, -0.57]	-0.12 [-0.27, 0.02]	**-0.86** [-0.96, -0.75]	**-0.52** [-0.62, -0.43]
Water Supply	37499	**-0.61** [-0.71, -0.51]	-0.07 [-0.21, 0.08]	**-0.80** [-0.90, -0.70]	**-0.48** [-0.57, -0.39]
Sewerage & Waste	99891	**-0.62** [-0.84, -0.41]	-0.14 [-0.38, 0.10]	**-0.79** [-1.00, -0.58]	-0.16 [-0.41, 0.09]
Construction	751630	**-0.70** [-0.80, -0.60]	**-0.18** [-0.31, -0.04]	**-0.89** [-1.00, -0.79]	**-0.50** [-0.59, -0.40]
Trade & Repair of Motor Vehicles	209725	**-0.45** [-0.70, -0.20]	0.09 [-0.22, 0.41]	**-0.69** [-0.94, -0.44]	-0.07 [-0.31, 0.17]
Wholesale Trade	762831	0.05 [-0.31, 0.42]	**0.51** [0.11, 0.90]	-0.10 [-0.46, 0.26]	**0.52** [0.09, 0.95]
Retail Trade	600221	**-0.65** [-0.77, -0.53]	-0.14 [-0.29, 0.01]	**-0.83** [-0.96, -0.71]	**-0.39** [-0.51, -0.27]
Land Transport	357195	**-0.51** [-0.61, -0.41]	-0.01 [-0.15, 0.13]	**-0.68** [-0.78, -0.57]	**-0.40** [-0.49, -0.31]
Water Transport	42166	**-0.41** [-0.71, -0.12]	0.33 [-0.37, 1.03]	**-0.52** [-0.83, -0.21]	**-0.37** [-0.42, -0.31]
Air Transport	43027	**-0.62** [-1.20, -0.04]	0.06 [-0.67, 0.78]	**-0.68** [-1.28, -0.08]	**-0.76** [-0.87, -0.65]
Aux. Transportation Services	266620	**-0.39** [-0.49, -0.28]	0.06 [-0.07, 0.19]	**-0.55** [-0.66, -0.43]	**-0.29** [-0.40, -0.19]
Postal and Courier	60266	**-0.86** [-1.09, -0.64]	**-0.48** [-0.77, -0.19]	**-1.01** [-1.23, -0.78]	**-0.43** [-0.63, -0.23]
Accommodation & Food	407634	**-0.57** [-0.67, -0.47]	**-0.15** [-0.28, -0.03]	**-0.75** [-0.86, -0.64]	**-0.46** [-0.56, -0.37]
Publishing	79566	**-0.82** [-1.02, -0.63]	-0.18 [-0.42, 0.06]	**-0.96** [-1.16, -0.76]	**-0.77** [-0.95, -0.59]
Media Services	73756	-0.17 [-0.44, 0.09]	0.15 [-0.26, 0.55]	**-0.34** [-0.60, -0.09]	-0.08 [-0.33, 0.17]
Telecommunications	185217	**-0.68** [-1.09, -0.27]	-0.17 [-0.68, 0.34]	**-0.82** [-1.23, -0.40]	**-0.45** [-0.66, -0.23]
Computer & Information Services	315976	**-0.43** [-0.53, -0.32]	**-0.23** [-0.38, -0.07]	**-0.56** [-0.67, -0.45]	**-0.35** [-0.46, -0.24]
Financial Services	498840	**-0.78** [-0.95, -0.60]	**-0.43** [-0.69, -0.16]	**-0.94** [-1.11, -0.76]	**-0.48** [-0.63, -0.33]
Insurance	249245	**-0.94** [-1.35, -0.52]	**-0.61** [-1.17, -0.06]	**-1.09** [-1.50, -0.69]	**-0.94** [-1.39, -0.49]
Real Estate	1574061	**-0.67** [-0.77, -0.57]	**-0.17** [-0.30, -0.04]	**-0.85** [-0.96, -0.75]	**-0.45** [-0.55, -0.35]
Legal and Accounting	439618	**-0.46** [-0.63, -0.28]	-0.05 [-0.27, 0.17]	**-0.62** [-0.79, -0.44]	**-0.34** [-0.50, -0.19]
Business Services	328994	**-0.39** [-0.60, -0.18]	-0.12 [-0.36, 0.12]	**-0.58** [-0.79, -0.38]	-0.06 [-0.29, 0.16]
Research and Development	121236	**-0.56** [-0.69, -0.43]	-0.12 [-0.28, 0.05]	**-0.73** [-0.87, -0.60]	**-0.52** [-0.62, -0.42]
Admin. & Support Services	581599	**-0.77** [-1.19, -0.35]	-0.37 [-0.84, 0.11]	**-0.90** [-1.33, -0.47]	**-0.69** [-0.97, -0.41]
Public & Social Services	993571	**-0.67** [-0.78, -0.57]	**-0.15** [-0.28, -0.02]	**-0.87** [-0.97, -0.76]	**-0.50** [-0.60, -0.40]
Education	731363	**-0.68** [-0.79, -0.58]	-0.14 [-0.27, 0.00]	**-0.87** [-0.98, -0.76]	**-0.50** [-0.61, -0.39]
Human Health and Social Work	1096971	**-0.71** [-0.82, -0.61]	-0.14 [-0.28, 0.00]	**-0.91** [-1.02, -0.80]	**-0.54** [-0.64, -0.43]
Other Serivces, Households	504146	**-0.70** [-0.88, -0.52]	-0.21 [-0.43, 0.00]	**-0.89** [-1.07, -0.70]	**-0.45** [-0.60, -0.30]

Note: The baseline year is 2014. Bold characters indicate significance at the 10%-level based on 1,000 replications and an approximate normal distribution. Confidence intervals in square brackets.

Table A16: Sectoral Elasticities from Caliendo & Parro (2015)

Sector ID	Sector Name	Trade Elasticity
1	Crops & Animals	8.11
2	Forestry & Logging	8.11
3	Fishing & Aquaculture	8.11
4	Mining & Quarrying	15.72
5	Food, Beverages & Tobacco	2.55
6	Textiles, Apparel,Leather	5.56
7	Wood & Cork	10.83
8	Paper	9.07
9	Recorded Media Reproduction	9.07
10	Coke, Refined Petroleum	51.08
11	Chemicals	4.75
12	Pharmaceuticals	4.75
13	Rubber & Plastics	1.66
14	Other Non-Metallic Mineral	2.76
15	Basic Metals	7.99
16	Fabricated Metal	4.3
17	Electronics & Optical Products	10.60
18	Electrical Equipment	10.60
19	Machinery & Equipment	1.52
20	Motor Vehicles	1.01
21	Other Transport Equipment	0.37
22	Furniture & Other Manufacturing	5.00
23	Electricity & Gas	5.00
24	Water Supply	5.00
25	Sewerage & Waste	5.00
26	Construction	5.00
27	Trade & Repair of Motor Vehicles	5.00
28	Wholesale Trade	5.00
29	Retail Trade	5.00
30	Land Transport	5.00
31	Water Transport	5.00
32	Air Transport	5.00
33	Aux. Transportation Services	5.00
34	Postal and Courier	5.00
35	Accommodation & Food	5.00
36	Publishing	5.00
37	Media Services	5.00
38	Telecommunications	5.00
39	Computer & Information Services	5.00
40	Financial Services	5.00
41	Insurance	5.00
42	Real Estate	5.00
43	Legal and Accounting	5.00
44	Business Services	5.00
45	Research and Development	5.00
46	Admin. & Support Services	5.00
47	Public & Social Services	5.00
48	Education	5.00
49	Human Health and Social Work	5.00
50	Other Services, Households	5.00

Table A17: Change in Real Consumption, in %

Elasticities:	Services = 5	Caliendo & Parro (2015)		Services = 5	Caliendo & Parro (2015)
UK	**-1.17**	**-3.27**	Portugal	**-0.16**	**-0.24**
	[-1.65, -0.68]	[-3.95, -2.59]		[-0.18, -0.13]	[-0.27, -0.20]
Austria	**-0.15**	**-0.20**	Romania	**-0.14**	**-0.19**
	[-0.16, -0.13]	[-0.24, -0.17]		[-0.16, -0.12]	[-0.22, -0.17]
Belgium	**-0.49**	**-0.72**	Slovakia	**-0.48**	**-0.46**
	[-0.55, -0.42]	[-0.82, -0.62]		[-0.58, -0.39]	[-0.54, -0.39]
Bulgaria	**-0.17**	**-0.25**	Slovenia	**-0.17**	**-0.22**
	[-0.21, -0.14]	[-0.28, -0.22]		[-0.19, -0.15]	[-0.25, -0.19]
Croatia	**-0.13**	**-0.15**	Spain	**-0.17**	**-0.22**
	[-0.16, -0.10]	[-0.21, -0.09]		[-0.19, -0.14]	[-0.27, -0.18]
Cyprus	**-0.48**	**-0.82**	Sweden	**-0.23**	**-0.40**
	[-0.63, -0.34]	[-1.01, -0.63]		[-0.28, -0.19]	[-0.47, -0.34]
Czech R.	**-0.33**	**-0.40**	Australia	**-0.01**	**-0.02**
	[-0.37, -0.30]	[-0.44, -0.36]		[-0.01, -0.00]	[-0.02, -0.01]
Denmark	**-0.30**	**-0.40**	Brazil	**-0.00**	**-0.01**
	[-0.35, -0.26]	[-0.45, -0.35]		[-0.00, -0.00]	[-0.01, -0.00]
Estonia	**-0.25**	**-0.39**	Canada	0.00	**-0.02**
	[-0.34, -0.17]	[-0.47, -0.32]		[-0.00, 0.01]	[-0.03, -0.01]
Finland	**-0.16**	**-0.29**	China	**0.03**	**0.02**
	[-0.19, -0.13]	[-0.35, -0.23]		[0.02, 0.03]	[0.02, 0.03]
France	**-0.21**	**-0.27**	India	**0.01**	-0.00
	[-0.24, -0.18]	[-0.31, -0.22]		[0.01, 0.01]	[-0.01, 0.01]
Germany	**-0.32**	**-0.36**	Indonesia	**0.01**	**0.00**
	[-0.35, -0.29]	[-0.44, -0.28]		[0.00, 0.01]	[0.00, 0.01]
Greece	**-0.13**	**-0.19**	Japan	**0.00**	**-0.00**
	[-0.16, -0.10]	[-0.23, -0.16]		[0.00, 0.01]	[-0.01, -0.00]
Hungary	**-0.35**	**-0.42**	Korea	0.00	-0.06
	[-0.38, -0.32]	[-0.46, -0.38]		[-0.03, 0.04]	[-0.29, 0.16]
Ireland	**-2.94**	**-4.40**	Mexico	0.00	**-0.01**
	[-3.22, -2.66]	[-4.70, -4.10]		[-0.00, 0.00]	[-0.02, -0.01]
Italy	**-0.17**	**-0.22**	Norway	**0.47**	0.08
	[-0.19, -0.15]	[-0.26, -0.18]		[0.27, 0.67]	[-0.06, 0.23]
Latvia	**-0.23**	**-0.30**	Russia	0.00	**-0.03**
	[-0.32, -0.13]	[-0.37, -0.23]		[-0.01, 0.02]	[-0.05, -0.02]
Lithuania	**-0.17**	**-0.36**	Switzerland	0.03	**-0.08**
	[-0.22, -0.12]	[-0.42, -0.29]		[-0.01, 0.07]	[-0.15, -0.00]
Luxembourg	-0.97	-0.96	Taiwan	**0.07**	**0.08**
	[-2.64, 0.70]	[-2.60, 0.68]		[0.06, 0.08]	[0.08, 0.09]
Malta	**-2.55**	**-2.77**	Turkey	0.01	**-0.08**
	[-3.52, -1.58]	[-3.65, -1.89]		[-0.01, 0.03]	[-0.10, -0.05]
Netherlands	**-0.67**	**-0.86**	USA	**-0.01**	**-0.02**
	[-0.74, -0.60]	[-0.94, -0.77]		[-0.01, -0.01]	[-0.02, -0.01]
Poland	**-0.31**	**-0.39**	ROW	-0.00	-0.01
	[-0.34, -0.28]	[-0.43, -0.35]		[-0.01, 0.00]	[-0.03, 0.00]
EU27	**-0.31**	**-0.41**			
	[-0.35, -0.28]	[-0.46, -0.35]			
ROW	**0.01**	**-0.01**			
	[0.00, 0.01]	[-0.02, -0.00]			

Note: The baseline year is 2014. Mean effects and [p5,p95] intervals. Bold characters indicate significance at the 10%-level based on 1,000 bootstrap replications. Confidence intervals in square brackets. The results for EU27 and ROW are calculated as GDP weighted averages. Caliendo & Parro (2015) results use elasticities from Table A16 and tariff adjusted imports in all goods sectors in the underlying gravity estimations to back out NTB changes.