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1. Introduction

On 29 March 2017, the United Kingdom (UK) Government notified its exit to the EU in accordance with Article 50 of the EU Treaty.[1] Brexit is therefore officially initiated. On 29 April, the Heads of State and Government of the European Council adopted the guidelines for negotiations between the EU and the UK in accordance with Article 50 TEU. Negotiations between the EU27 and the UK on the important issues of exit and discussions on future political and economic relations between the EU27 and the UK have begun in July 2017 and have proven difficult since then.

The EU has put down a number of **red lines**. It has ruled out the possibility of participating in the EU single market à la carte, e.g., by selecting certain rights and obligations but opting out from others (such as the free mobility of labour). The UK government has made clear that it accepts this condition. Whether it aims at a "hard Brexit", i.e. an exit from the EU Single Market and the EU Customs Union, and a refusal of the European Court of Justice's (ECJ) authority, or some form of "soft Brexit" with some continued participation is, however, still very much unclear.

According to the **EU's negotiation strategy**, in the first stage of the talks, priority is given to the settlement of the "divorce", i.e., to financial questions, to the pressing issues of providing clarity for EU citizens in Britain and British citizens living in Europe, and to the possible consequences of the re-emergence of a tough border between the Republic of Ireland and Northern Ireland. Only in a second step, when "sufficient" progress on the mentioned areas has been made, will official negotiations on the future of the economic relationship between the UK and the remaining EU27 countries start.

Clearly, the two areas of talks are connected: to be able to strike sensible compromises in the first stage, negotiators need to anticipate trade-offs and possible outcomes in the second stage. Reversely, the outcomes at the first stage will determine the set of options available in the second stage. The second stage is about ensuring the largest possible gains from continued cooperation; it is largely about economic efficiency. The first stage is about distributing the costs of the separation between the parties. Even if negotiations were carried out sequentially, to achieve the best possible outcomes, the final political decision should be simultaneously about both areas. Ideally, the second stage talks would **maximize the overall (in the EU plus the UK) gains from cooperation** under the mentioned constraints, while the first stage would offer the possibility of

[1] Article 50 has been included in the EU Treaty since 2009, as part of the Treaty of Lisbon, and regulates the withdrawal of an EU member state from the European Union.

side payments to enable political compromise. Of course, the two stage structure suggested by the EU makes an agreement difficult precisely because the appropriate side payments will depend on the agreement about future economic relations.

In this note, we wish to provide some empirical foundations for the political process. First, we characterize the value chains that tie the UK and the EU together. Second, we identify how the different goods and services sectors have benefitted from the UK's membership in the EU Single Market and Customs Union. These benefits – on both the UK and the EU side – are now at risk due to Brexit. Third, we simulate different scenarios, utilizing the ifo trade model, to quantify the consequences of Brexit for the UK and EU countries.

The study uses increasingly complex models to meet the above objectives. First, in our **descriptive analysis**, to determine the value added of bilateral trade between the EU and the UK, a global input-output table must be inverted and linked with bilateral trade data. Second, for a causal ***ex-post analysis*** of the different steps of EU integration we require (i) detailed bilateral panel data on goods and services, (ii) an appropriate method to separate other integration steps (common currency, Schengen area) from the EU Single Market and Customs Union, in which the UK does not take part, and (iii) an econometric method in order to deal with unobservable determinants of bilateral trade and to identify causal effects on effective trade costs. Finally, we carry out an **ex-ante analysis** to quantify the possible consequences of various future arrangements between the EU and the UK on income, trade, and prices we utilize the ex-post estimation results to construct scenarios that enter into a general equilibrium model.

When using models, we need to make assumptions and to rely on statistical estimation. Thus, the results of the analyses are also subject to uncertainty. In a representation of value-added links, uncertainty is relatively minor; with econometrics, uncertainty can be identified with standard methods by reporting standard errors; with counterfactual simulation, uncertainty is avoided by presenting a variety of scenarios. The scenarios reflect the conceivable possibilities for a redesign of economic relations between the EU and the UK. They have several points in common:

The EU Single Market and Customs Union provide the deepest possible economic integration of a region. Any deviation from this standard will involve economic losses for all stakeholders. The further the deviation from this gold standard, the higher the macroeconomic costs.

With Brexit, in each scenario, **some sectors are better off, even if aggregate GDP falls**. This applies, for instance, to the financial sector in some EU27 member states or to the agri-food sector in the UK.

We use a Ricardian standard model for all scenarios, where trade is driven by differences in productivity. The model extends Caliendo and Parro (2015). The gains from trade are static: with low trade costs, each country specializes in sectors where it holds comparative advantages. The reallocation effects are not realized immediately and underestimate true trade effects. The model does not consider pro-competitive gains from trade (trade reduces the monopoly power of firms) or dynamic effects (trade creates additional incentives, innovation, new technologies and accumulation of human capital). These effects are empirically well proven, but for the simulation exercise we need a standard model that is undebated in research. The Ricardian model fulfils this

criterion. The modelling strategy is very conservative; hence, we provide a **lower bound of true effects in all scenarios.**

The second chapter in this note presents the economic links between the EU and the UK. We focus on the value added of trade relations. The third chapter describes the empirical methods including also the empirical analysis of the trade creation effects of integration agreements and in particular of the UK's EU membership. From this, we draw conclusions on how Brexit would affect non-tariff barriers (NTBs) between the UK and the EU in different scenarios. The fourth chapter describes policy scenarios and the results to quantify the economic consequences for income, trade or sectoral value added. Chapter five presents key facts and a discussion connected to budgetary issues and fiscal transfers between the EU and the UK. It compares trade effects with effects from cutting down fiscal transfers due to Brexit. The final chapter concludes.

2. Economic Links between the United Kingdom and the European Union

Gross and Value Added Trade Flows

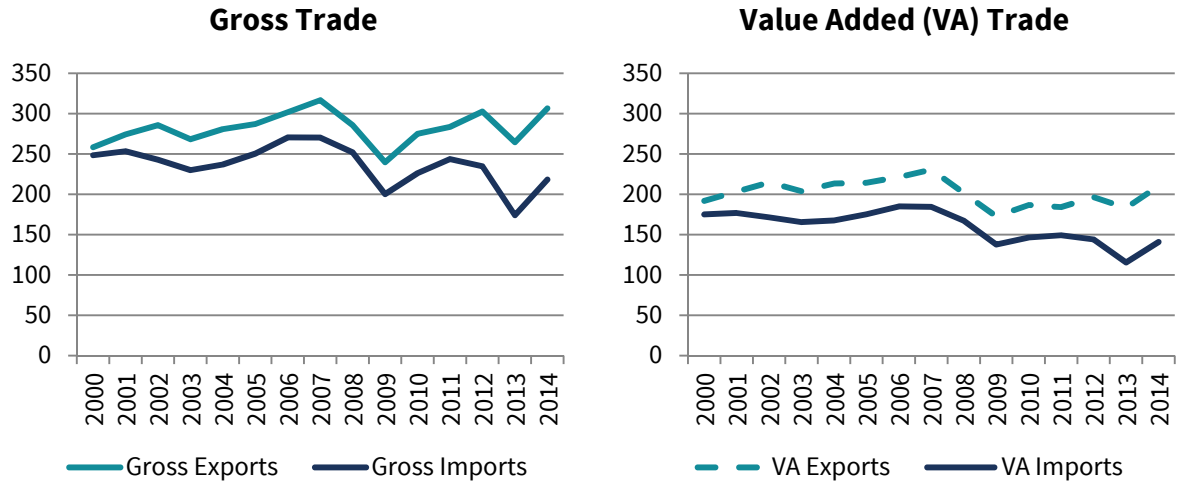
Official trade statistics can provide a general description of economic relations between the EU and the UK. They are, however, only partly informative on the role of trade for domestic value added. We will thus be brief on the description of official statistics but allocate more space to the analysis of value added content of trade.

Table A1 in the Appendix shows the export and import shares for goods and services sectors between the EU27 member states and the UK, as well as top 3 export and import sectors for each EU27 member state with the UK in the year 2014. EU27 countries differ with respect to the shares of goods exports destined for the UK between 0.6% in Greece and 18.6% in Ireland. The EU27 average is 3%. The share of goods imports from the UK varies between 0.5% in the Slovak Republic and 20.6% in Ireland. On average, EU27 states show an import share with the UK of 2.2%. For services trade the picture looks slightly different. Export shares of EU27 countries with the UK in services sectors range between 0.14% in Lithuania and 15% in Malta. The Irish export share of services with the UK is the second strongest with 2.9%. The EU27 average of services export shares with the UK is 0.5%. Similarly, services import shares amount to 0.6%. The lowest services import share with the UK has Spain (0.2%); the largest has Luxembourg with 13.4%. The top three export and import sectors for EU27 members with the UK are dominated by wholesale services, the automobile sector and chemicals.

A major problem of official bilateral trade data is that these inform only on turnover, but not on the domestic or foreign value added incorporated in international transactions. The German export surplus with the UK measured in terms of sales is about 25% higher than when measured in terms of value added. The reason is that German exports include added value from abroad. In addition, the supply of intermediate products to Germany from abroad also contains value added from the UK and this may again contain German added value. In order to correctly allocate export activities

to domestic (sectoral) value added, we construct a global input-output table and evaluate it using appropriate methods, as described in Wang et al. (2013) and Aichele et al. (2014).

Figure 1 Gross and Value Added Trade between EU27 and UK, in bn Euro



Source: World Input Output Table (2017), Eurostat (2017), calculations of ifo Institute.

Figure 1 on the left shows EU27 exports to the UK and EU27 imports from the UK in gross (i.e., transaction values) terms. Figure 1 on the right depicts the same in value added terms. The trend points upwards and follows well-known patterns: gross trade flows do not yet reach pre-crisis levels of the year 2007, as exports in 2014 only recovered from a slump in 2013 (-13%). Over the entire period, real gross exports have risen by 19%. This slight downward trend in EU27 imports from the UK may also reflect the diminishing importance that UK exporters attach to continental European markets. This argument has been part of the campaign for exiting the EU. Between 2000 and 2014, EU gross imports fell by 12% in real terms. At the same time, it is striking that exports measured in value added are growing by less (10%). The share of value added in exports thus dropped from 74% to 69%. Measured in value added, imports fell by as much as 20%. As a result, the share of value added decreased by five percentage points from 70% to 65%. This illustrates the increasing content of foreign value added in UK exports.

Looking at net trade volumes, it becomes clear that EU27 countries accumulated a foreign trade surplus against the UK between 2000 and 2014. In 2000, the German surplus made up the entire surplus of the EU27. Currently it fell to 41%. Hence, many other EU27 countries now have a positive trade balance with the UK. For the EU27, we see a decoupling of the balance of gross trade and the value added balance since the year 2012.

Looking at absolute value added exports relative to the respective economic output, the EU27 as a whole exports about 1% of economic output to the UK. This share dropped in the wake of the financial crisis, but returned to pre-crisis levels in 2014. Vice versa, the UK exports relatively more to EU27 countries. Value added exports for a long time ranged between 4% and 4.5% of UK economic output. The previously observed slump in value added exports in 2013 is also evident

here. Value added exports fell to a record low with only 3.2% of GDP. They rose again to 3.5% in 2014.

Foreign Direct Investment

Next we focus on the economic interdependencies with regard to foreign direct investment (FDI) between the EU27 and the UK. Foreign trade and FDI can be complements and substitutes. If FDI is needed to build up a sales company in a foreign country, this vertical type of FDI essentially is a precondition for exports and therefore a complement. Similar, if FDI is required for the working of international production chains, it is complementary to trade. If FDI, however, leads to the establishment of production facilities in the foreign country to meet local demand, possibly with the objective to jump trade barriers such as tariffs or non-tariff measures, this type of horizontal FDI will replace and thus substitute direct exports. A special type of FDI which plays an important role for FDI from third parties is platform FDI: Corporations from Asia or the US invest in the UK to serve the entire EU market. Higher trade costs across the Channel will therefore tend to diminish vertical FDI but may boost horizontal tariff-jumping FDI while third country FDI could be redirected from the UK to continental Europe.

From 2008 to 2015 EU27 FDI to the UK has increased without exception with a growth rate of 75% over the period. It reached a record high of 1,635bn Euro in 2015. A sharp increase in FDI positions is particularly striking in the years 2014 and 2015, which alone accounted for more than two-thirds of the total increase. On the other hand, there is no clear trend for UK FDI in the EU. Although FDI rose over the entire period from 539bn Euro to 612bn Euro (14%), it reached the maximum in 2011.

Migration

The total population in the UK has grown considerably since the early 1980s. While the share of immigrants before the EU Eastern enlargement was 4.7%, it increased to 7.7% in 2013. The number of migrants from other EU member states in the UK has been relatively constant since 1985. Around 3 million migrants from the EU live in the UK. Poland accounts for the largest share with 783,000, followed by 372,000 Irish in 2014. A large proportion of EU foreigners also stem from Germany, Romania, France, Lithuania and Italy. In 2014, around 1.1 million British lived outside the EU. Of these 286,000 live in Spain, 281,000 in Ireland, 170,000 in France and 102,000 in Germany. As part of the Brexit negotiations, it is thus also necessary to decide on how to deal with migrants in the UK, but also with Britons living in the EU.

As immigration has likely played a major role for many British to vote for an exit from the EU, the UK government stated unequivocally that it did not want to be part of the internal market due of the free movement of workers. The right of UK citizens living in the EU and EU citizens living in the UK are to be discussed and agreed upon in the negotiations between the EU and the UK. This implies that in a first round of negotiations, exit arrangements such as the UK payment obligations against the EU and the status of EU citizens in the UK should be dealt with first. Only when the European Council has made sufficient progress in this regard, discussions on the future relations between the EU and the UK will be on the table. We believe that at least one far-reaching transitional rule is required after the likely exit of the UK in 2019, in order to prevent human tragedies and the loss of skilled workers to firms on both sides of the Channel. Consequences on

adaptation would be extremely costly. If Brexit leads to outmigration of EU citizens from the UK, it is possible that this will result in re-imports of ceased value added (if possible) or inflationary price adjustments in non-tradable sectors.

In this quantitative study, we do not consider migration effects in the counterfactual analysis. This has several reasons: first, the data situation is problematic. To consider migration, information on the stock of foreign workers by nationality in all 50 sectors and for all countries would be required. Adding to this we would need comparable information on the welfare state treatment of migrants and a model that, in addition to the economic incentives of labour mobility, also models the welfare state in a satisfactory manner.[2]

Mobility of workers and international trade can be in a substitute or complementary relationship. This is described in Felbermayr et al. (2015). In connection with Brexit, two channels might be of importance: First, the mobility of specialists is necessary for the cross-border provision of services, which are often necessary for the successful export of industrial products. In addition, foreign workers often hold important knowledge about foreign markets, which might reduce the trade costs of their employers. Thus, a restriction of migration could lead to a disruption in trade. Second, classical foreign trade theory emphasizes that the international mobility of workers leads to a balance of comparative advantages and thus a reduction of trade volumes. Conversely, the restriction of migration increases the economic advantage of international trade.

3. Ex-Post Analysis: Gravity Model Results

Remarks on the Methodology

In our quantitative analysis of cross-border trade, we understand Brexit in two steps: First, Brexit implies the reverse processing of existing EU integration agreements. Particularly, we assume that the measurable trade-cost-reducing effects of the UK's membership in the EU are cancelled. This means that tariffs and behind-the-border non-tariff barriers (NTBs) are reintroduced. Second, negotiations could lead to a new bilateral treaty based on measurable trade-cost-reducing effects of existing deep (i.e., ambitious), or more shallow (i.e., conservative) EU trade agreements. In this case, barriers reintroduced by Brexit partially disappear again. The analysis is based on the following elements:

Ex-post evaluation of the various steps of EU and international integration. We estimate the trade effects of the European Union, the Eurozone, the Schengen Agreement and other FTAs with the help of a so called gravity model. In particular, we allow the trade effects of EU membership to differ for the UK and EU27 countries. We also distinguish between goods and services.

[2] A first promising quantitative approach was presented by Di Giovanni (2015). Battisti et al. (2017) propose a quantitative model framework for the analysis of international migration.

Based on empirical estimates and trade elasticities, we calculate the extent to which Brexit creates new trade barriers. We get counterfactual ad valorem trade cost reductions for 50 sectors and a set of plausible scenarios.

Finally, we apply estimated trade barriers in a simulation model to assess the effects of various scenarios on sectoral and aggregated economic variables, taking third country effects into account. We use the ifo trade model (see Felbermayr et al., 2017a) to obtain static effects based on efficiency gains through the reallocation of production factors and the reduction of bureaucratic hurdles. However, the assumption that Brexit implies a reverse of integration agreements is plausible only in the long-run. We expect no immediate divergence of regulatory practices in the short-run.

A key element for the simulation scenarios is to distinguish the effects of integration steps and tariffs, to estimate their impact on non-tariff trade costs and the elasticity of substitution. Based on the standard gravity model of Head and Mayer (2014), we carry out an econometric study of the integration steps of the EU – either aggregated for goods and services trade, or for each of the 50 sectors separately. We examine the effects of the European Union, the Eurozone, the Schengen Agreement and other FTAs on trade using a non-linear Poisson Pseudo Maximum Likelihood (PPML) approach that takes zero trade into account (Santos Silva and Tenreyro, 2006).[3]

The data used in the empirical exercise is described in the Appendix.

Estimation Results

Table 1 shows the results of an ex-post analysis of trade integration agreements through the gravity model in an aggregated regression for goods and services trade. Coefficients show approximate percentage increases in bilateral trade due to the European Union (excluding UK), the membership of the UK in the EU and vice versa (asymmetric), the Eurozone, the Schengen Agreement, the EU-Korea free trade agreement from 2011 and other FTAs. Estimations are based on yearly data. By including bilateral fixed effects, we implicitly control for all constant determinants of trade between two countries, including also existing trade agreements before the year 2000 and country pair combinations that have been part of the European Union, the Eurozone or the Schengen Agreement. The coefficients for the number of Schengen internal borders, the EU, the Eurozone and other FTAs are to be considered relative to a counterfactual situation in which the counted borders are non-Schengen borders or in which states of a pair are not both members of the EU, the Eurozone or do not have a FTA.

[3] See Felbermayr et al. (2017d) for econometric details and for the special challenges arising from the modelling of the Schengen Agreement.

Table 1 European Integration and Imports (2000 - 2014)

Dep. Var.:	Bilateral Imports	
	Goods	Services
	(1)	(2)
Both EU27	0.485***	0.518***
	(0.07)	(0.07)
EU – UK, asymmetric	0.500**	0.632**
	(0.12)	(0.17)
UK – EU, asymmetric	0.167	0.468**
	(0.10)	(0.17)
Both Euro	0.083**	0.147**
	(0.04)	(0.06)
Schengen	0.090***	0.064***
	(0.01)	(0.02)
EU – KOR	0.312**	0.347**
	(0.06)	(0.07)
Other FTA	0.111*	0.011
	(0.06)	(0.06)

Source: Felbermayr et al., 2017c. Notes: *** p<0.01, ** p<0.05, * p<0.1. All regressions estimated by Poisson-Pseudo-Maximum-Likelihood (PPML) methods. The estimated standard errors are robust against heteroscedasticity. All regressions comprise time-varying importer and exporter, as well as bilateral fix effects. Number of observations is 27,735.

We show that bilateral imports in goods trade between the EU27 states (excluding the UK) has increased by about 62.4% between 2000 and 2014, while bilateral services imports have increased by 67.9% in the same period. The effect is highly significant at the 1%-level and combines the impact of the EU27 Single Market and Customs Union. We can show that the membership effect for the UK in the EU is asymmetric. We find that the imports of the EU27 members from the UK increased by 64.7% for goods and 88.1% for services, while those of the UK from other EU27 states were pushed only by 18.2% for goods but by 59.7% for services. This illustrates that the abolition of tariffs and the harmonization of standards through the European Union have a clear positive impact on bilateral imports. A comprehensive dismantling with regard to tariffs and standards would make a country correspondingly worse.

Findings on the EU membership are comparable to results found in the literature. Overall, the trade effects of FTAs are systematically larger in PPML regressions than under OLS (see Santos Silva and Tenreyro, 2006). Dai et al. (2014) show an impact of FTAs on goods trade of 57.3%, while Bergstrand et al. (2015) estimate trade-creating effects of 66% to 157%, depending on the specification. In a meta-analysis, Head and Mayer (2014), Table 3, show that FTAs lead on average to about 60% more trade.[4] The size of the respective effects depends on the specific sample considered and the empirical estimation method used.

[4] For the EU, they have a median effect of 26% (with mean effects of 15%). This is, however, associated with a relatively high standard deviation.

A common membership in the Eurozone leads to an increase in goods trade of 8.7% and 15.8% for services. Again, the relevant literature shows different effects between zero and 40% (see Micco et al., 2003; Flam and Nordström, 2006; Baldwin and Taglioni, 2007; Bun and Klaassen, 2007; Berger and Nitsch, 2008; Bergin and Lin, 2012; Camarero et al., 2014). Baldwin et al. (2008) explain the heterogeneity of results by misspecified models. By use of state-of-the-art econometric modelling and the inclusion of other EU integration steps, the estimates presented here range at the lower end of effects – comparable to those found in the more recent literature on the effects of the Euro.

Each Schengen-internal border (in contrast to external borders there are no identity checks) pushes goods trade by about 9.4% and services by 6.6%[5] – comparable to estimates found in Felbermayr et al. (2017b) and Felbermayr et al. (2017c), but lower than those presented in earlier studies. Most of which did either not account for other EU integration steps and/or utilized an indicator variable of Schengen that does not account for its geographic component.

The most comprehensive and deep FTA between the European Union and another country, which deals with both goods and services and for which data are already available, has been with South Korea since 2011. We thus treat the agreement separately in the estimation. Our estimates of the EU-Korea FTA show that this agreement has increased trade in goods by 36.6% and services by 41.5%. Few other trade agreements have entered into force during the 2000 to 2014 period. But those who have pushed goods trade by 11.7% and services by 1.1%. In our counterfactual exercises, we deploy the effects estimated from the EU-Korea FTA as a proxy for a deep and comprehensive trade agreement between the EU and the UK. We take it as an approximation for the CETA agreement – which has not yet entered into force within our time frame; hence we have no ex-post evaluation effects on its success.

In Felbermayr et al. (2017b), we extend this estimation exercise to 50 different sectors. The results broadly confirm the pattern detected in Table 1; in the following simulation exercise, we use these more detailed estimates.

4. Ex-ante Analysis: Scenario Evaluations using CGE modelling

Computable General Equilibrium (CGE) Model

The ifo trade model, described in detail in Felbermayr et al. (2017a) is a static, general equilibrium model of international trade in which 44 countries in 50 goods and services sectors can interact with one another and where trade flows are interrupted by tariffs and NTBs. The model accounts for more than 90% of global value added and trade. A special feature of the model is the detailed picture of international value-added chains. The data are derived from the World Input-Output Database (WIOD). A further advantage of the model is that it can be parametrized using relatively simple econometric equations resulting from the equilibrium conditions. The central relation is the gravity equation discussed above, which provides the basis for estimation.

[5] These effects are calculated from the estimated coefficients β using the transformation $100\% \times (\exp(\beta) - 1)$.

Two industry-specific parameters are of particular importance: the elasticity with which tariff changes affect trade flows (trade elasticity) and the effect of non-tariff barriers on trade. We use established methods to assess the elasticity through tariffs and the experience with existing integration agreements in order to estimate their impact on the sectoral trade flows using a structural gravity model.[6] The separation of integration agreements (European Single Market and Customs Union, European Monetary Union, Schengen Agreement, and other FTAs) allows us to estimate welfare and trade effects for the various steps of trade liberalization in our scenarios.

The trade-policy scenarios, described in detail below, are based on the following thought experiment: If the UK, in the world we today, would withdraw from the EU, including the reintroduction of tariffs and the establishment of NTBs, how would trade flows, sectoral production structures, and the real income look like in this counterfactual world?

Our baseline year for the comparative static simulations is the year 2014, for which we have a complete dataset with the technological conditions for all countries and sectors. The parameter estimates are based on annual data for the period 2000-2014. The calculated level effects on real income and trade flows are static. The dynamic effects of trade - e.g., due to innovation activities of firms or the diffusion of technologies – are not considered. This implies that the model depicts lower limits for real long-term effects.[7]

Scenarios

Due to existing uncertainties regarding the potential design of Brexit, it is useful to examine a number of scenarios when quantifying the effects of the UK leaving the European Union. In a thought experiment, various policy scenarios are possible, ranging from continuous trade integration between the UK and the EU similar to the status of Norway or Switzerland, to the application of general WTO rules between the EU and the UK.

We thus approximate the economic cost of Brexit applying scenarios that differ with respect to the assumptions on trade costs between the EU and the UK. The three selected scenarios are described in more detail below. We apply top-down scenarios where the experience with existing institutional arrangements provides the starting point for the expectations of a future regime between the EU and the UK. The simulations can generally be divided into a hard and soft Brexit. No precise definition exists, but we try to express how close the UK will still be to the EU after the exit. We speak of a hard Brexit if only the general WTO rules are applied and of a soft Brexit if a trade integration agreement is concluded between the EU and the UK.

The structural gravity estimations provide us with two sets of sector specific parameters needed for the simulation – the elasticity of trade with respect to tariffs (ad-valorem trade costs) and

[6] As the estimates are subject to statistical uncertainty, the simulation results are also subject to uncertainty. However, Monte Carlo simulations show that the precision of the econometric estimation is high. The confidence bands for the model variables are rather narrow so that there are hardly any changes in the interpretation of the results.

[7] Dynamic gains from commercial liberalization have been demonstrated in many studies; see Sampson (2016) for a current example and other references.

estimates on trade integration agreements (cost equivalents of NTB reductions). We use them to inform the policy variable in the counterfactual scenarios.

WTO scenario ("Hard Brexit"): The UK is no longer part of the European Single Market and Customs Union. There will be no new trade integration agreement between the EU27 and the UK, as we assume they do not come to a mutual understanding of potential future cooperation. The EU27 and the UK will then apply MFN tariffs as currently granted under WTO rules on imports of third countries. Sectoral trade-weighted MFN tariffs granted at the product-level by the EU to third countries in 2014 are used for simulation in the WTO scenario. In addition, asymmetric NTBs will be reintroduced between the EU27 and the UK according to the sectoral trade costs calculated from the gravity estimations. Moreover, the UK loses all existing tariff and non-tariff preferences that it currently enjoys with third countries with whom the EU has a FTA in force (e.g., EU-Korea).

Global Britain scenario: We model the same relationship regarding tariffs and NTBs between EU27 and UK as under the WTO scenario, but now the UK unilaterally eliminates tariffs and NTBs through free trade agreements with the U.S., Canada and Japan. Tariffs are symmetrically phased out and set to zero between the countries. NTBs are reduced as under the EU-Korea FTA – utilized as a proxy.

Deep and comprehensive trade agreement (DCFTA) scenario ("Soft Brexit"): The UK exits the EU Single Market and Customs Union, but the EU27 and the UK negotiate a deep and comprehensive free trade agreement. The DCFTA comprises not only tariffs but also low behind the border non-tariff trade impediments (such as NTBs on services, investments etc.). The DCFTA replicates the achievements of the EU-Korea agreement of 2011 – the latest and most comprehensive trade agreement of the EU available in the data period. We thus utilize the estimated trade cost reductions of the EU-Korea FTA from our gravity results as a proxy for a DCFTA.

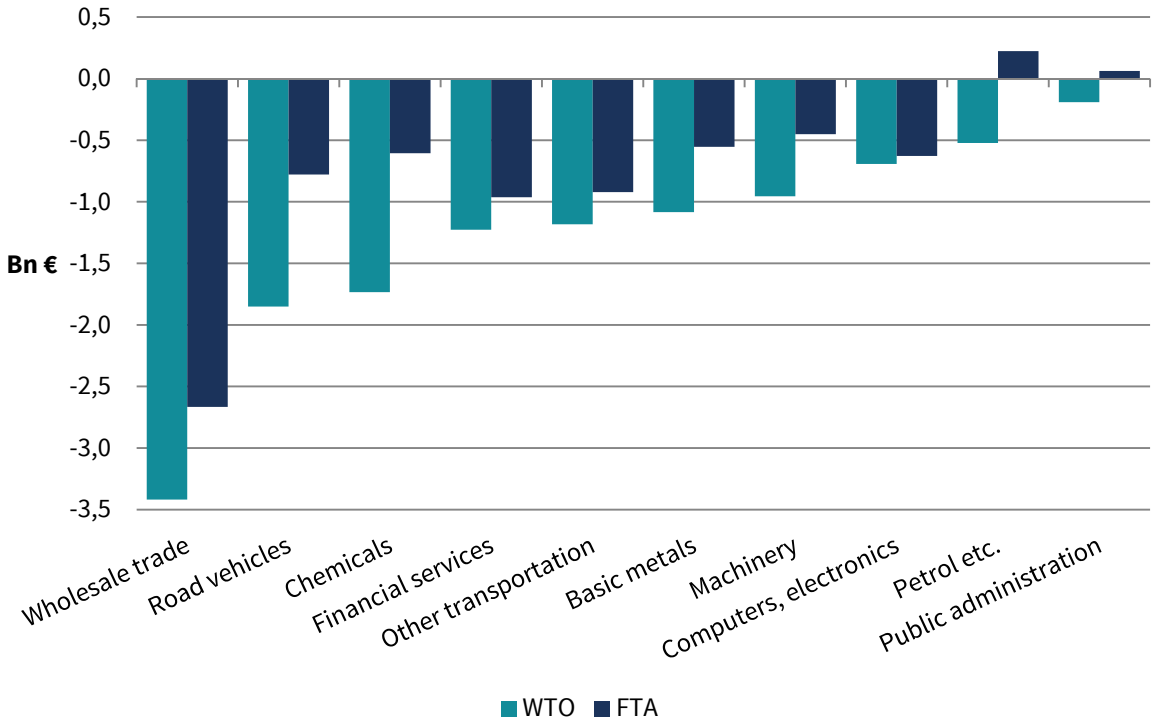
Trade Effects

Higher trade costs, such as NTBs or tariffs, increase the price of UK exports to EU27 states and vice versa. This may cause trade destruction and trade diversion - such that trade between the UK or the EU27 and third countries increases - both in private consumer demand and in the sourcing decisions of firms. Trade diversion effects are, however, likely to be small in the case of Brexit due to the interconnectedness of value added chains.

Simulation results show that Brexit would in fact lead to a considerable decline of goods and services trade between the UK and EU27 countries. Both, price effects (through higher barriers to trade) and income effects (due to falling GDP) are important mechanisms. In the WTO scenario, UK exports to Germany fall by 50%; the counterfactual exercises show a similar drop in exports in the Global Britain scenario. Even with a deep and comprehensive FTA between the UK and the EU27, UK exports to Germany fall by 24%. Services exports are the most pronounced. We find comparable trade effects in the WTO scenario (FTA scenario) for the other EU27 countries. These range between -53% (-28%) for Lithuania and -22% (-6%) for Luxembourg (a clear outlier). German exports to the UK would drop by 33% in the WTO scenario and by 9% under a DCFTA.

Figure 2 and Figure 3 show the changes in sectoral trade effects between the UK and Germany. The vertical axis depicts levels in bn Euro for the WTO and FTA scenarios.[8] Wholesale trade and road vehicles show the strongest drop in UK exports to Germany. Even with a DCFTA, UK exports to Germany in both sectors fall by -2.7bn Euro (-52%) and -0.8bn Euro (-25%), respectively. The financial services sector dominates in percentage terms. Its initial level of 1.7bn Euro would drop by -71% or -1.2bn Euro under the WTO scenario and exports would be more than halved under a DCFTA (-55% or -1.0bn Euro).

Figure 2 Changes in Sectoral Trade Effects, UK Exports to Germany, Top 10 Sectors, in bn Euro

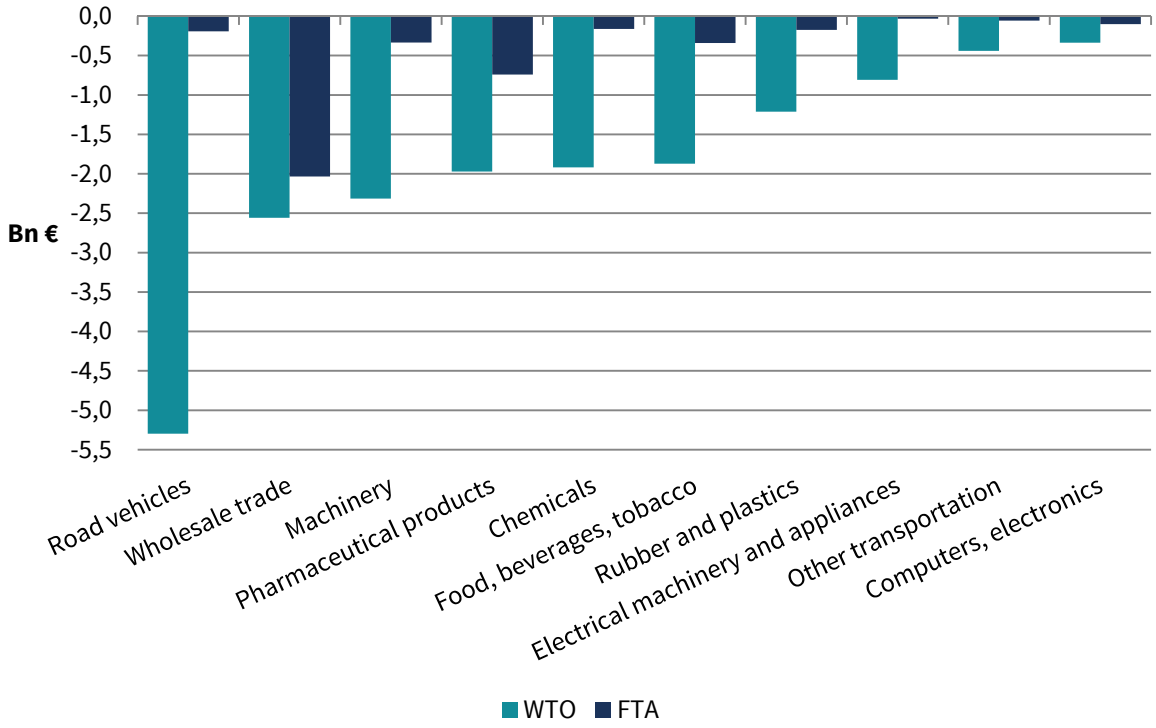


Source: Felbermayr et al., 2017c. The figure shows the ten worst hit UK sectors.

In Figure 3, German wholesale trade involves the largest trade effects in percentage changes; both the WTO and the DCFTA scenario show losses of more than 50% or more than -2bn Euro for German exports to the UK. Apart from that goods sectors are the most affected. Among these, German pharmaceutical products (4.4bn Euro), machinery (7.1bn Euro) and road vehicles (18.9bn Euro) exhibit relatively high export volumes to the UK. Pharmaceutical products are the worst hit industry with a drop of 17% (-0.7bn Euro) in the case of a DCFTA. Contrasting this, road vehicles show nearly no effect (-1% or -0.2bn Euro). In case of a hard Brexit, road vehicles exports lose the highest amounts (-5.3bn Euro) followed by wholesale trade (-2.6bn Euro) and machinery (-2.3bn Euro).

[8] We show the DCFTA and the WTO scenario, as the latter and the Global Britain scenario typically show rather similar trade effects for the German-UK trade pair.

Figure 3 Changes in Sectoral Trade Effects, German Exports to UK, Top 10 Sectors, in bn Euro



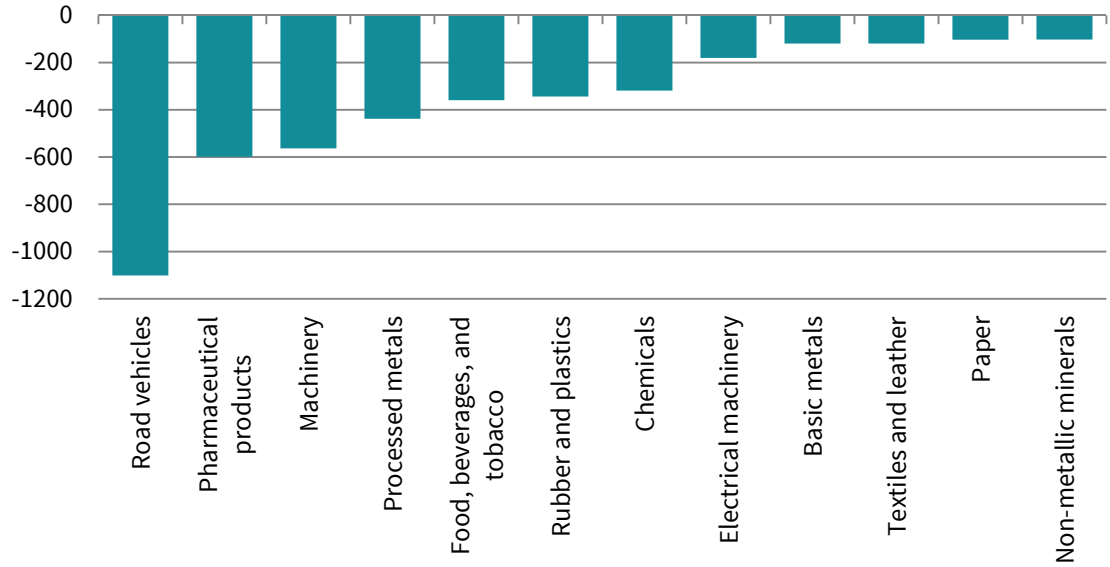
Source: Felbermayr et al., 2017c. The figure shows the ten worst hit German sectors.

Sectoral Value Added Effects

We now examine value added effects for the most affected German industries under the WTO scenario. Simulated losses amount to 4.5bn Euro for the 22 goods sectors; services sectors add another 1.6bn Euro. Hence, three-quarters of German economic losses stem from manufacturing industries. Overall, goods sectors lose value added, except for other transport equipment (shipbuilding, aircraft construction, railway technology) and mining and quarrying, which gain marginally. Services provide mixed results.

Figure 4 shows value added effects for the 12 worst hit German industries under the WTO scenario. We also provide information on econometrically estimated trade cost savings of EU integration, which would be reversed with Brexit, and MFN tariffs, which would be introduced between the EU27 and the UK. Results again reveal that EU27 countries have benefitted more from EU membership than the UK. Reductions in NTBs are typically higher for the EU27 countries, but most UK sectors also show double-digit NTB reductions. German road vehicles record the largest losses with 1.1bn Euro, which accounts for one sixth of the overall economic cost of Brexit. Pharmaceutical products lose 600 million Euro in value added, machinery drops by 560 million Euro. Value added effects in subsequent sectors fall rapidly.

Figure 4 Value Added Effects on Top Manufacturing Sectors in Germany WTO Scenario, in million Euro, NTB Changes and Tariff Changes, in %

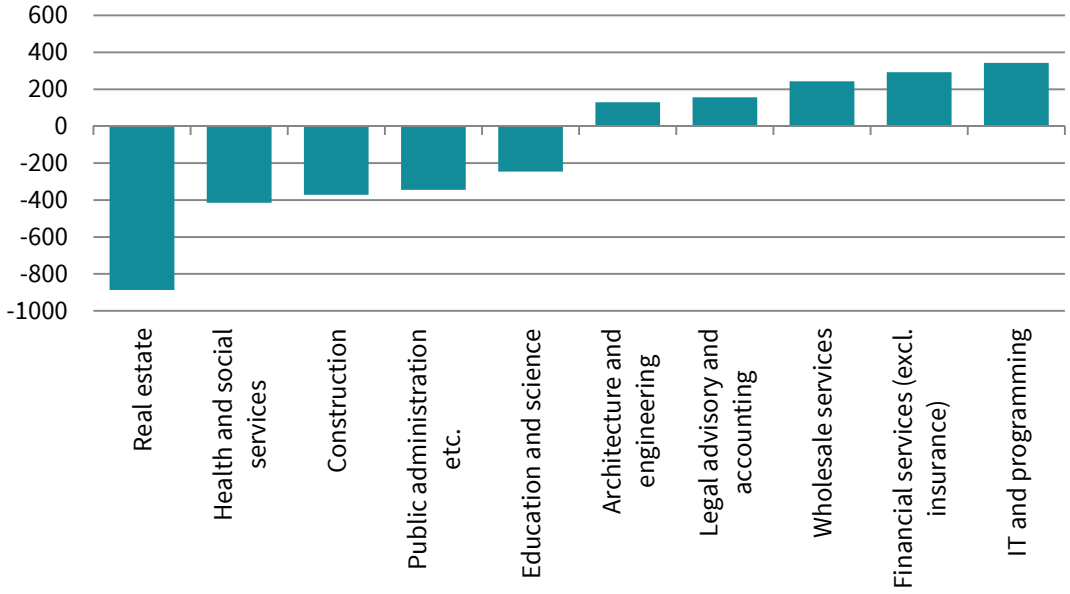


NTBs: EU->UK	22	28	30	33	17	21	19	25	30	8	7	17
NTBs: UK->EU	12	27	19	28	14	17	12	15	30	8	5	14
MFN Tariffs	6	3	3	4	10	6	5	4	3	8	4	6

Source: Felbermayr et al., 2017c. The figure shows the twelve worst hit German manufacturing industries.

Figure 5 depicts the five most profitable and the five worst-performing German service sectors under the WTO scenario. As often emphasized in the debate, Brexit also creates opportunities. Simulations predict that the German financial sector grows by almost 300 million Euro, wholesale services increase by more than 240 million Euro. Among services sectors, consulting industries also benefit; these include IT and programming (340 million Euro), legal advisory and accounting (160 million Euro), and architecture and engineering (130 million Euro). Interestingly, NTBs offset expected additional costs in all aforementioned sectors. On the contrary, German firms could lose up to 890 million Euro in the real estate sector. Furthermore, health and social services, construction, and public administration could also drop by about 400 million Euro each. The latter is not directly negatively affected by new trade barriers, but indirectly through a decline in German economic output.

Figure 5 Value Added Effects on Top Services Sectors in Germany Scenario 1 (WTO), in million Euro, NTB Changes, in %



NTBs: EU->UK	18.6	5.1	18.3	3.6	23.3	17.4	6.6	26.2	29.3	21.1
NTBs: UK->EU	18.6	5.1	18.3	3.6	23.3	16.4	6.6	26.2	10.5	8.5

Source: Felbermayr et al., 2017c. The figure shows the five worst hit and the five best performing German services industries.

Sectoral value added changes in the UK turn out to be quite different from those in Germany under the WTO scenario. Most importantly, simulated losses in UK services sectors amount to 22bn Euro, while UK goods sectors bear a loss of 6.3bn Euro. Hence, services are at least three times more important for the Brexit costs of the UK than goods sectors. The often discussed financial services sector holds value added losses of 850 million Euro. Yet, these do not dominate economic costs as NTB reductions in financial services due to the UK's EU membership are not estimated to be particularly large. This is aggravated by the fact that the UK has a very strong comparative advantage in the finance sector. The considerably smaller insurance industry could face value added losses of 660 million Euro. Other services sectors add significantly to overall costs, such as wholesale (-4.4bn Euro), architecture and engineering (-2.7bn Euro), or legal advisory and accounting (-1.2bn Euro). Our simulation exercises suggest that specific transport sectors could benefit from Brexit, but gains are rather small.

The most negatively affected goods sectors are electronic equipment (-1.6bn Euro), chemicals (-1.4bn Euro), other transportation (-1.2bn Euro), basic metals and machinery (-1bn Euro each), as well as road vehicles (-850 million Euro). Winners include food, beverages and tobacco with gains of 1.4bn Euro, mining and quarrying with increases of 950 million Euro, agriculture and forestry.

Aggregated positive or negative sectoral effects always imply the existence of firms within an industry that show particular negative or positive effects from Brexit. Thus, export-oriented beverage producers (e.g., whiskey) may lose out, while the food sector as a whole gains from Brexit as the UK needs to replace imports with own produce after Brexit.

Effects on Real GDP per Capita

The simulation exercises calculate long-run effects and can be interpreted as a deviation of the growth path of GDP without Brexit relative to the growth path of GDP with Brexit. Note that the two paths are parallel: there are no effects on growth rates in the static model, only the level of GDP falls due to Brexit. The adjustment is carried out continuously over a period of several years. How long the adjustment lasts depends on regulations defined within a Brexit agreement.

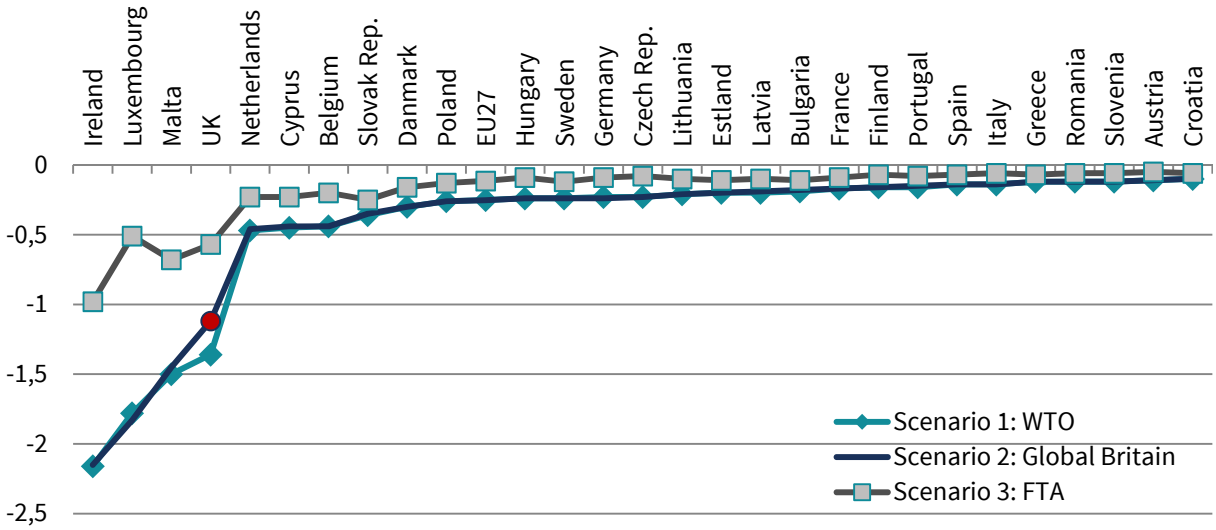
Figure 6 shows the effects of the different Brexit scenarios on real GDP per capita in EU countries (and a EU27 aggregate) in percent relative to the status quo in the year 2014. Brexit is definitely more expensive for the UK than for the average EU27 country. In the worst-case scenario (WTO), the UK would lose 1.4% of GDP per capita, the EU27 average 0.25%. The Netherlands are the country with the fifth largest loss, which amounts to about a third of that of the UK. Germany loses 0.23% of per capita income, France 0.17% and Spain 0.14%. Benelux and Scandinavia as well as Poland and Hungary are more negatively affected. While South-Eastern European countries experience smaller cuts.

Global Britain, involving an ambitious FTA with the U.S., Japan and Canada, leads to slightly smaller losses for the UK of 1.1% relative to the status quo. But, the idea that a few new FTAs could compensate the losses from an EU withdrawal of the UK seems to be a blind alley. In separate calculations, we found that an even more aggressive FTA policy with countries outside the EU cannot compensate for the losses of Brexit. The problem is that trade with geographically and culturally distant countries involves significantly higher trade costs than with nearby European partners. Only Ireland, Luxembourg and Malta are more strongly affected than the UK itself. The reason is the importance of the UK as a sales or sourcing market for these countries in sectors with high value added and strong Brexit effects. This concerns mostly agri-food – particularly relevant for Ireland – but also services such as finance or water transport.

An ambitious free trade agreement would help to reduce the losses from Brexit dramatically for all European parties involved. In the case of a DCFTA, like the EU-Korea FTA, real per capita GDP in the UK decreases by 0.6% and in the EU27 average by 0.11%. Particularly Luxembourg could significantly reduce its losses due to smaller frictions in relevant service sectors. Ireland would still lose more than the UK but far less than under the WTO or Global Britain scenarios. The German loss would fall to 0.1%. The real household income in EU states falls between 0.1% and 1.6%. The latter differs from real GDP, as it does not take tariff income into account. In the hard Brexit scenarios, the relative loss of the UK is at least five times the EU average; in the soft Brexit scenarios it is at least four times as high. As the EU is by far the most important trade partner for the UK, an – even partial – isolation of the economy will have negative effects. Conversely, the details on the design of future trade relations will have a major impact on the UK economy. For all

other EU27 members, a soft Brexit (DCFTA) has only minor impacts. None of the involved EU states can benefit from Brexit – neither hard nor soft.

Figure 6 Effects on Real per Capita GDP (in %)



Source: Felbermayr et al., 2017c. Own representation. Relative to the status quo in 2014. These effects do not include net transfers to the EU.

5. Fiscal Effects: Divorce Bill and EU Budget after Brexit

This section focuses on budgetary aspects of Brexit; that is the issue of disentangling the UK financially from the EU and the question of how the EU budget will change after the exit of the UK. Negotiations between the UK and the EU about the EU budget involve two different but interrelated deals. First, a one-time divorce bill or Brexit bill settlement. Second, possible future contributions and EU expenditures in the UK after Brexit.[9] With the one-off exit bill, the UK is expected to pay off its share of financial obligations to the EU.

The other key issue is how the EU budget will adjust. Since the UK is a net contributor, the EU will have to cut spending, increase contributions from the remaining member states, or do a combination of both. In this chapter we first discuss the Brexit bill and then consider options for the EU budget adjustments.

The Divorce Bill

The issue of the divorce bill promises to be one of the first sticking points in the upcoming Brexit negotiations. EU and member state officials have recently suggested that outstanding liabilities could be as high as 60bn Euro for the UK. The figure has awakened fierce opposition among British

[9] It may be the case that a transitional phase after 2019 will follow the official Brexit, which is likely to happen in 2019. In this transitional phase, Britain could negotiate its new status and adjust smoothly to Brexit and, most importantly, the details of the long-term relationship with the EU. There may be budgetary implications for this transitional phase as well.

negotiation leaders who have repeatedly claimed that the EU cash call is unfair and not legally well grounded.

What is the size of a fair Brexit bill? Darvas et al. (2017) distinguish between the divorce approach and the club membership approach. The divorce approach would be to establish the EU's assets and liabilities and let the UK receive or pay its share, which may differ across different types of assets and liabilities. The club membership approach would imply that members who leave would just stop paying membership fees and no attempt would be made to determine assets or liabilities of the club.

The European Commission seems to prefer the divorce approach. What would this imply for the bill presented to the UK? In its most recent consolidated accounts, published in July 2016 for the financial year 2015, the EU reports assets of 154bn Euro and liabilities of 226bn Euro. According to this balance sheet the net liabilities of 72bn Euro will have to be covered through future budgets. On this basis one could argue that the Brexit bill should be equal to Britain's share of the net liabilities. Assuming that Britain's share is around 12% – its average contribution to the EU's revenues after the UK rebate – this would lead to a divorce bill of 8.64bn Euro. However, these net liabilities include elements which change from year to year and, more important, some potentially relevant items are missing in this balance sheet.

The first budget without Britain will be the EU budget for 2019, given that the UK will cease to be an EU member in March 2019. As recently pointed out by Barker (2017), the following types of liabilities can be lined up for the Brexit bill:

1. Reste a liquider (RAL): This is the sum of outstanding commitments for EU spending agreed to but that have not yet translated into payments. The RAL amounts to 241bn Euro by the end of 2018.
2. Promises made jointly by the member states to fund EU spending of 143bn Euro in 2019 and 2020, mostly in the form of structural and regional policies. This spending is part of the EU budget but it is covered by a special regulation (Regulation No 1303/2013).
3. Additional EU spending agreed on as part of the multiannual financial framework 2014-2020 - one could argue that the UK has made a not legally but politically binding commitment.
4. Pensions of EU employees: EU employees receive generous pensions. These pensions are unfunded. Current pension liabilities are estimated to be 63.8bn Euro.
5. Additional obligations could follow from contingent liabilities the EU has incurred during UK's EU membership. These include 23.1bn Euro in guarantees and provisions, e.g., granted by the European Investment Bank (EIB) or under the Horizon 2020 initiative; others are loans to various countries including Ireland, Portugal and the Ukraine, totalling 56bn Euro. To the extent that debt has been issued to finance loans in this context, this is a liability of the EU. In addition, there are the contingent liabilities implied by the guarantees.
6. Finally, the EU has assets including property, financial assets and the loans mentioned under 5 above. The Brexit bill would be reduced by the share of the UK in these assets. In addition, the UK share of the spending implied by the RAL (1.) as well as other spending commitments (2. and 3.) could be knocked off the Brexit bill.

Table 2 below summarizes estimates of the different assets and liabilities described above from the studies by Barker (2017) and Darvas et al. (2017). It shows that the divorce approach, despite its systematic approach based on the division of assets and liabilities, leads to a wide range of possible results. First, some of the largest items in these calculations are controversial. In particular, net contributors including the Netherlands, Germany and Sweden have repeatedly rejected the view that the RAL is a liability of the member states. Moreover, requiring the UK to contribute to the EU budget as if it continued to be a member until 2020 is problematic because these contributions have to be seen in the context of the rights of member states to have access to benefits, including access to the EU's internal market. These rights can be interpreted as assets departing members give up. If the UK loses this access, it is difficult to justify continued contributions.

But in addition, the approach as such can be questioned. Countries joining the EU do not pay for assets of the EU nor do they get reimbursed for liabilities of the EU. Joining the EU very much follows the club membership logic, not the divorce (or marriage) logic. The calculation of a Brexit bill on the basis of the club membership approach would boil down to determining what exactly belongs to club membership (e.g., the EIB may be seen as a separate club) and for how long the membership fees are due.

Table 2 Possible liabilities, commitments and offsetting assets by end-2018, in bn Euro

	Barker (2017)	**Darvas et al. (2017)**
Reste à liquider (RAL)	241	248.8
Significant legal commitments (SLC)	143.4	148.7
Other planned commitments (OPC)	29 (Incl. Connecting Europe Facility: 10.1, Copernicus: 2.9 and EU Fund for Strategic Inv.: 16)	182.5 (E.g. Common Agricultural Policy (CAP) payments and administrative expenditure)
Pensions	63.8	63.8
Contingent liabilities	Guarantees: 23.1 EU loans: 56.1	Guarantees: 27.6 EU loans: 52.7
EU Assets	Properties: 8.6 Assets available for sale: 13.9	Cash: 21.7 Properties: 8.7 Fin. assets av. for sale: 9.6 Other assets: 1.0
Possible range for UK liabilities (excluding upfront payments for guarantees and loans)	24.5-60.9	25.4-65.8

Overall, these considerations show that the Brexit bill is ultimately a matter of political negotiations, not just an accounting exercise. London and Brussels should be able to compromise on the Brexit bill. Prime Minister Theresa May has dismissed the 60bn Euro bill for now but recognizes the risks of too harsh a stance in the ongoing negotiations at the costs of future relations.

Economically the Brexit bill issue itself is only a distributive issue, a zero sum game. However, it is relevant for the costs of Brexit as a failure to agree on the Brexit bill would almost certainly undermine talks about the future EU-UK trade relations. Put differently, in a positive scenario the Brexit Bill negotiations offer the opportunity to pave the way for cooperative negotiations about a free trade agreement between the EU and the UK and, in addition, cooperation in many other policy fields.

The Impact of Brexit on the Budget of the EU27

The EU27 will need to decide how to adjust the EU budget after Brexit. Since the UK is a significant net contributor, the EU27 will either need to cut spending, increase contributions or do a combination of both.[10] According to estimates of the Office for Budgetary Responsibility (OBR), an independent public finance watchdog in the UK, the British net contribution is projected to be between 8.5bn Pound and 9.5bn Pound until 2019, already taking into account the UK rebate. Estimates of the annual funding gap for the EU budget are in the range of 7bn Euro, an amount which corresponds to the UK's net contribution in 2014, the smallest since 2010, and 10bn Euro, reflecting the average net contribution between 2010 and 2015.

Most studies expect the EU to cut expenditures by the amount that would have gone to the UK otherwise and distribute the Brexit-Gap, the UK's annual net contribution to the EU budget, to the remaining 27 member states, assuming that they increase their contributions to the EU budget accordingly.

But this is only one possible scenario among many, in fact a rather extreme one, as it would imply that EU spending in the remaining 27 member states remains unchanged although a large net contributor has left the club. Other options are, for instance, to cut spending in the EU27 by the amount of the UK net contribution or to keep the level of the EU budget as a percentage of the EU27 Gross National Income (GNI) at the current level.

The budget of the EU is financed by three different sources. Traditional own resources – from levying customs duties and sugar levies – and VAT-based own resources – a standard percentage levied on the harmonized VAT base. Both account for slightly more than 18bn Euro each – together around a quarter of the total EU budget in 2015. The largest share is provided through a uniform percentage on each country's GNI that closes the gap between the agreed budget and the other two financing sources. Although designed simply as a balancing system, this has become the largest source of revenue with total contributions of more than 100bn Euro per year. There are several other smaller revenue sources. These include financing from non-member states that participate in certain EU programs (e.g., Norway and Switzerland), or fines on companies for breaching competition laws; they are only a small fraction of the total budget, usually below 5%.

It is important to note that, despite the relative dominance of GNI-based contributions to the total budget, there is hardly any proportionality between each country's GNI and its contributions due

[10] There would be good reasons to use the opportunity offered by Brexit for a fundamental reform of the EU budget but discussing this in greater detail is beyond the scope of this summarizing report. We highlight a few aspects at the end of this article.

to the existence of several rebate and national compensation schemes, most prominently the UK rebate from 1984. The British rebate has undergone several modifications during the last three decades but still allows the UK to keep two thirds of its annual net contribution. It is financed by the other 27 member states, but Austria, Germany, the Netherlands and Sweden pay only a quarter of their normal share.[11]

The long-term Brexit-Gap would be smaller if the UK continued to make significant contributions after leaving the EU. This could happen if the country retained its membership in the EU's Single Market and the Customs Union, along the lines of the frequently cited Norway model. Currently, such a scenario seems very unlikely as the UK government has ruled out both making large contributions to the EU budget after Brexit and jurisdiction of the ECJ in the UK. But since it cannot be excluded that this position changes it is worth considering the implications for the EU budget.

Norway participates in several EU policies, including programs such as Horizon 2020 and Erasmus+, and the country contributes to the EU budget. This includes financial grants to the 15 least prosperous EU member states in exchange for access to the EU Single Market. Total gross contributions of Norway to the EU budget via several channels amounted to 869 million Euro in 2015, corresponding to roughly 0.25% of the Norwegian GDP of that year.[12] Official figures about the net contributions for Norway and the other member states of the EEA are not publicly available. The available information suggests that Norwegian researchers have received an amount of more than 700 million Euro in science and research grants over the period from 2007 to 2013 – slightly more than half of what Norway contributed to the fund.[13] Simply extrapolating the contribution-receipt-ratio to the other spending areas yields a net payment of Norway of around 104 Euro per capita which translates into 3.8bn Euro for the UK in aggregate terms.[14] Taking a different approach, other studies assume the EU expenses on research grants for Norway to be the only receipts which would lead to a substantially higher net contribution. For example, the results of a study of the Center for European Reform (2014), a London-based think tank, suggest that net contributions of the UK to the EU budget would shrink by only 9% per year – roughly 6.4bn Euro in 2014 EU budget numbers for the UK. Large uncertainty about the actual net payments of Norway –

[11] In addition to the UK, several other member states who are net contributors to the EU budget have made the case that their contributions represent an excessive budgetary burden in relation to their wealth and negotiated correction mechanisms of their own. These include a reduced VAT contribution for Germany, the Netherlands and Sweden which will be fixed at 0.15% for 2014-20 while all other member states have a rate of call of 0.3%. Moreover, Austria, Denmark, the Netherlands and Sweden will benefit from gross lump sum reductions in their annual GNI contributions.

[12] See a report of the Scientific Service of the German Parliament (2016): https://www.bundestag.de/blob/438416/4c9d2ef5283c89e3f8d3743d32de4f6e/wd-4-075-16-pdf-data.pdf (in German).

[13] See the communication of the EU Commission: http://europa.eu/rapid/press-release_IP-14-566_en.htm?locale=en (accessed: October, 12, 2017)

[14] The estimates of the Institute for Public Finance report (2016) are given in British Pound and are transferred into Euros according to the prevailing exchange rate (March 2017).

and any inference about possible UK contributions – allow for very rough estimates only, but it is clear that the net contributions of the UK would be substantial.[15]

As mentioned before, the UK government has for the time being ruled out anything resembling the Norway model. Instead it wants to end "vast contributions to the EU budget"[16] and take Britain completely out of the EU Single Market while maintaining free trade with Europe through a comprehensive free trade agreement. Although the UK does not "seek to adopt a model already enjoyed by other countries", future relations could resemble the relationship between Switzerland and the EU with its roughly 120 sectoral-differentiated bilateral trade agreements.[17] Similar as in the case of Norway, Switzerland participated in the creation of the European Free Trade Association (EFTA) with access to the Single Market in exchange for making contributions to the EU budget and accepting EU regulations as well as its four freedoms of movement for capital, goods, capital, and people. Of course, the freedom for movement of people would be a critical issue, as it is for Switzerland.

The 12-point plan of the UK Ministry that governs the Brexit negotiations is not specific about the participation of the UK in future EU programs. It mentions, however, that "there may be European programs in which we [the UK] might want to participate. If so it is reasonable that we should make an appropriate contribution." As in the case of Norway, reliable numbers of the net contribution to the EU budget of Switzerland are not available except for a positive net receipt from research funding that amounted to 200 million Swiss Francs over the period from 2007 to 2013. Smaller payments to poorer member states as well as "greater success at winning research money" leads the authors of a study from the Institute of Public Finance (2016) to conclude that "Switzerland's net contribution is almost certainly significantly lower than Norway's" (p.15) – without giving a precise number. Estimates of the previously mentioned Center for European Reform analysis suggest that if the UK were successful in negotiating an agreement like Switzerland, its net contribution would fall by 55%. Other scenarios, including looser arrangements such as those agreed with Canada or Turkey could allow the UK to avoid paying into the EU budget at all but would entail more limited access to the EU's markets.

In the following, we assess the impact of the Brexit-Gap on the size and the composition of contributions from the other EU member states on the basis of the EU budget in 2015. EU revenues, amounting to a total of 146bn Euro in 2015, were composed of 21bn Euro from the UK in the form of gross payments (already taking into account the UK rebate of 6bn Euro), 116bn Euro from the other member states (incl. the contributions to finance the UK rebate) and around 9bn Euro from surpluses from previous years as well as other smaller financing sources. Depending on the assumptions made about how to deal with the EU expenses that were previously assigned to

[15] Ferrer and Rinaldi (2016) assume the UK net contribution would shrink to 3.5bn Euro while Haas and Rubio (2016) assume 4.6bn Euro per year instead.

[16] See the accompanying policy paper of the Department for Exiting the EU and David Davis (2017), in particular, see paragraph 8.51 for the details about future EU budget contributions.

[17] See, e.g., Cameron (2017) for a discussion of the different trade agreements.

the UK (around 7bn Euro in 2015) and the amount of future net contributions of the UK to the EU budget – through participation in certain EU programs or via tariff payments – it is a relatively straightforward mechanical exercise to determine the extra burden for the other member states.

In the following calculations we take the size of the EU budget, VAT and GNI contributions as well as traditional own resources for each country as given and redistribute the Brexit-Gap as well as the sum of previous contributions for the funding of the UK rebate according to the GNI of the EU27. Existing rebates, specifically the reduced VAT contributions for some countries, are kept to allow for comparability with the status quo. We focus on the changes in gross and net contributions of the individual member states.[18]

Whether the existing GNI-contributions of each country are understood as the outcome of a political process and are left as they were in 2015 or whether the sum of all GNI-contributions and the Brexit-Gap is re-divided according to GNI-shares can make a substantial difference for some countries: The GNI-contribution of the Netherlands, for example, accounted to 0.72% of their national GNI in 2015, while the average among all EU27 countries was only 0.66%. Austria contributed 0.61% of its national GNI, which means that re-distributing the sum of all GNI-contributions according to each country's GNI would make Austria worse off as compared to the Netherlands. Such differences in the country-specific GNI-contribution can be due to ex-post revisions in the underlying statistical data for specific countries or when contributions from previous years that were unused are returned to the member states.[19] Contrary to other studies, in particular Ferrer and Rinaldi (2016), GNI contributions as they materialized in 2015 are not re-distributed in our simulations since we consider those to be country-specific payments.

In Table 3, we describe two key scenarios together with the corresponding change in the financial burden for each country.[20] We stick to the EU budget figures of 2015 as these are the most recent data available, taking into account, however, that the total net contribution of the UK is slightly above average compared to the previous years (14bn Euro in 2015 vs. 8.5bn Euro on average over the period from 2010 to 2014). Note also that we define the Brexit-Gap as the difference between the total UK contributions and the receipts, to get a complete picture of the UK net payments to the EU. This is different than the Operating budgetary balance of each country which is defined as the difference between allocated operating expenditure (i.e., excluding administration) and own

[18] Net contributions are often criticized for being a poor indicator of benefits member states get from either EU membership or the EU budget, see e.g. High Level Group on Own resources (2016). But at least given expenditures changes in net contributions are an appropriate indicator for the distribution of the financial burden implied by Brexit as far as it affects the EU budget.

[19] The year 2014 was particular in this respect when countries changed their national statistical accounting rules to the new European System of Accounts (ESA 2010) which resulted in upward revisions of their national GNI figures, at least for some countries. Following an agreement, member states were allowed to delay additional payments of its net adjustment amount until September of the following year or to settle their contributions in the same year. See the corresponding communication of the European Commission:

http://ec.europa.eu/eurostat/documents/1015035/2041357/Statistical-recording-EU-budgetary-contributions.pdf/a948e3e7-36bb-4ef8-bc56-dbf6763f78a4 (accessed: October, 12, 2017).

[20] We do not take into account exchange rate movements and inflation rate dynamics in the calculations.

resources payments (i.e., excluding customs duties and sugar levies collected by the member states on behalf of the European Union).[21] In 2015, the operating budgetary balance of the UK with the EU accounted to 11.52bn Euro, or 0.46% of its GNI.

The simplest case is to take the contributions as well as the receipts of the UK out of the current (2015) budget and to fill the resulting gap via higher GNI contributions from the remaining EU27 member states. All countries will face an increase in their contributions within the range of 8% to 10% relative to their previous gross contributions in 2015. Germany, the Netherlands, Austria and Sweden face relatively larger increases of up to 18%, which reflect previous rebates on their respective UK rebate contributions that we expect to expire after Brexit. It is noteworthy that the relative increase in gross payments to the EU budget is comparably moderate in relative and absolute terms for most countries. In contrast, the increase in Germany is among the highest with more than 4bn Euros in terms of extra gross payments which would let its total net contribution rise to more than 21bn Euro per year. Leaving expenditures untapped would imply that the EU budget's total size would rise substantially from less than 1% without hypothetical Brexit in 2015 to 1.15% given that the second-largest economy in terms of GNI is leaving the EU.

The right-hand side of Table 3 illustrates an alternative scenario in which EU spending would be reduced by the same amount as the net contributions of the UK. The Brexit-Gap and off-setting expenditure cuts cancel each other out such that changes in gross payments are reflecting differences in previous contributions to the funding of the UK rebate: As mentioned before, Austria, Germany, the Netherlands and Sweden have benefited from a reduction in their contributions to the financing of the UK rebate compared to the other countries of the EU27. With respect to net contributions, budget cuts will have very different impacts across countries, making net recipients of EU funds worse off while net contributors would improve their net payment balance. For example, Germany pays 26 cents of every marginal Euro spent by the EU according to its GNI-share among the remaining EU27 but receives only 12 cents in return, averaging over all payments from EU funds between 2007 and 2013. Cutting EU expenses by one Euro would therefore reduce Germany's net contribution by roughly 14 cents; cutting annual expenses by 14bn Euro, possibly the most natural response to a structural Brexit-Gap of the same size, would reduce the extra burden from Brexit by almost 2bn Euro with a new annual net contribution of around 19.8bn Euro.

On the contrary, other countries, especially Poland, Portugal and Greece, would see their net payment balance worsening substantially as they benefit most from EU funds under the current system. Gross contributions of Poland would be reduced by 87 million Euros but together with the cuts in receipts from EU programs the overall net contributions would rise by 1.5bn Euro. Despite some substantial worsening of its net payment balance, it would still be the greatest beneficiary of the EU, followed by the Czech Republic (net receipts of 5.1bn Euro) and Romania (4.7bn Euro). Budget cuts of the amount of 14bn Euro annually is an interesting scenario to take note of since

[21] Technically, it is the difference between each member states' share in total national contributions (VAT and GNI-based resources) paid to the EU and their share in the operating expenditure (thus excluding institutions' administrative expenditure) allocated to EU countries, multiplied by the total amount of the latter.

the total EU budget would be shrunk to close to 1% of the EU-wide GNI, as it is sometimes called for by some member states.

Table 4 illustrates the effects for each member state that would materialize under a slightly refined financing scheme: VAT contributions are fully replaced by GNI-based payments and any kind of rebate on GNI-contributions or lump-sum transfers is dismissed. These financing schemes are sometimes claimed to increase transparency and tangibility of the EU budget financing. For a recent proposal of this type see Büttner et al. (2017).

Table 3 Change in contributions with and without expenditure cuts, in million Euros

	Brexit Gap: 14bn, No expenditure cuts			**Brexit Gap: 14bn, Expenditure cuts: 14bn**			
	Change in gross/net contr.	% change in gross contr.	New net contr.	Change in gross contr.	% change in gross contr.	Change in net contr.	New net contr.
Belgium	+ 391	+ 7.1%	- 1 090	- 89	- 1.6%	+ 202	- 1 280
Bulgaria	+ 39	+ 8.1%	- 2 206	- 10	- 2.1%	+ 152	- 2 093
Czech Republic	+ 143	+ 9.2%	- 5 390	- 32	- 2.1%	+ 419	- 5 113
Denmark	+ 265	+ 10.5%	1 257	- 50	- 2.0%	+ 144	1 137
Germany	+ 4 634	+ 16.5%	21 746	+ 1 069	+ 3.8%	+ 2 715	19 827
Estonia	+ 18	+ 8.7%	- 214	- 5	- 2.3%	+ 87	- 146
Ireland	+ 178	+ 9.7%	9	- 32	- 1.7%	+ 222	53
Greece	+ 167	+ 12.5%	- 4 699	- 36	- 2.7%	+ 911	- 3 956
Spain	+ 996	+ 9.9%	- 2 610	- 250	- 2.5%	+ 1 541	- 2 065
France	+ 2 102	+ 10.2%	8 240	- 465	- 2.3%	+ 1 358	7 496
Croatia	+ 44	+ 11.2%	- 163	- 6	- 1.5%	+ 10	- 197
Italy	+ 1 515	+ 9.5%	5 097	- 369	- 2.3%	+ 1 048	4 630
Cyprus	+ 14	+ 6.3%	41	- 6	- 2.5%	+ 16	43
Latvia	+ 23	+ 10.0%	- 723	- 5	- 1.9%	+ 113	- 633
Lithuania	+ 32	+ 8.2%	- 455	- 9	- 2.3%	+ 205	- 282
Luxemburg	+ 40	+ 10.8%	- 1 243	0	0.0%	+ 29	- 1 254
Hungary	+ 97	+ 9.1%	- 4 458	- 25	- 2.3%	+ 507	- 4 049
Malta	+ 7	+ 7.2%	- 23	- 2	- 2.3%	+ 12	- 18
Netherlands	+ 1 009	+ 12.7%	6 597	+ 227	+ 2.9%	+ 504	6 092
Austria	+ 505	+ 18.5%	1 444	+ 119	+ 4.4%	+ 364	1 303
Poland	+ 388	+ 9.2%	- 8 734	- 87	- 2.0%	+ 1 545	- 7 577
Portugal	+ 162	+ 9.9%	- 787	- 40	- 2.4%	+ 623	- 326
Romania	+ 146	+ 10.1%	- 4 945	- 35	- 2.4%	+ 369	- 4 723
Slovenia	+ 36	+ 8.9%	- 501	- 8	- 2.1%	+ 85	- 451
Slovakia	+ 73	+ 10.5%	- 2 965	- 14	- 2.1%	+ 212	- 2 826
Finland	+ 204	+ 11.0%	728	- 38	- 2.0%	+ 144	668
Sweden	+ 685	+ 17.0%	3 236	+ 160	+ 4.0%	+ 378	2 929
Budget (% GNI)		1.15%			1.03%		

Table 4 Change in net contribution under different scenarios within the refined financing system of the EU, in million Euros

	Brexit Gap: 14bn, No expenditure cuts			Brexit Gap: 14bn, Expenditure cuts: 14bn			
	Change in gross/net contr.	% change in gross contr.	New net contr.	Change in gross contr.	% change in gross contr.	Change in net contr.	New net contr.
Belgium	+ 299	+ 5.5%	- 1 182	- 180	- 3.3%	+ 110	- 1371
Bulgaria	+ 29	+ 6.0%	- 2 217	- 21	- 4.2%	+ 142	- 2 104
Czech Republic	+ 116	+ 7.5%	- 5 416	- 59	- 3.8%	+ 393	- 5 140
Denmark	+ 294	+ 11.6%	1 286	- 21	- 0.8%	+ 174	1 166
Germany	+ 4 627	+ 16.5%	21 739	+ 1 062	+ 3.8%	+ 2 708	19 820
Estonia	+ 13	+ 6.1%	- 220	- 10	- 4.9%	+ 82	- 151
Ireland	+ 172	+ 9.4%	3	- 38	- 2.1%	+ 216	47
Greece	+ 206	+ 15.3%	- 4 661	+ 2	+ 0.2%	+ 949	- 3 918
Spain	+ 1 022	+ 10.1%	- 2 584	- 224	- 2.2%	+ 1 567	- 2 039
France	+ 1 893	+ 9.2%	8 031	- 674	- 3.3%	+ 1 149	7 287
Croatia	+ 35	+ 8.8%	- 173	- 15	- 3.9%	+ 1	- 207
Italy	+ 1 966	+ 12.4%	5 548	+ 82	+ 0.5%	+ 1 499	5 081
Cyprus	0	- 0.2%	27	- 21	- 8.9%	+ 2	28
Latvia	+ 24	+ 10.1%	- 722	- 4	- 1.8%	+ 113	- 633
Lithuania	+ 32	+ 8.1%	- 456	- 10	- 2.5%	+ 205	- 283
Luxemburg	+ 20	+ 5.5%	- 1 262	- 19	- 5.3%	+ 9	- 1 274
Hungary	+ 89	+ 8.3%	- 4 467	- 33	- 3.1%	+ 498	- 4 057
Malta	+ 2	+ 2.0%	- 28	- 8	- 7.5%	+ 7	- 23
Netherlands	+ 1 043	+ 13.1%	6 631	+ 261	+ 3.3%	+ 538	6 126
Austria	+ 457	+ 16.8%	1 396	+ 71	+ 2.6%	+ 317	1 255
Poland	+ 333	+ 7.9%	- 8 788	- 141	- 3.3%	+ 1 490	- 7 631
Portugal	+ 116	+ 7.1%	- 833	- 86	- 5.2%	+ 577	- 372
Romania	+ 180	+ 12.4%	- 4 912	- 2	- 0.1%	+ 402	- 4 689
Slovenia	+ 24	+ 6.0%	- 512	- 20	- 4.9%	+ 74	- 463
Slovakia	+ 79	+ 11.3%	- 2 959	- 9	- 1.3%	+ 217	- 2 821
Finland	+ 187	+ 10.1%	711	- 55	- 3.0%	+ 127	651
Sweden	+ 658	+ 16.4%	3 210	+ 134	+ 3.3%	+ 351	2 903
Budget (% GNI)	1.15%			1.03%			

Without reviewing the numbers again in detail, we see that all columns are very closely replicating the results that the Brexit-Gap would bring under the current financing system of the EU as depicted in Table 3. Slight deviations from the previous results are mirroring differences across countries in their VAT contributions relative to their national GNI. The VAT contributions of Cyprus and Malta amounted to 0.20% and 0.18% of their GNI in 2015, respectively, while the average among the remaining EU countries was only 0.12%. Redistributing the aggregate VAT contributions according to each country's GNI would therefore ease the burden on these two countries and reduce their gross contributions accordingly – the reverse is true for countries with below-average VAT contributions as Italy and the Netherlands.

Overall, the results in Table 3 and Table 4 show that the distribution of gains and losses in terms of net contributions is highly sensitive to the way in which the EU budget will be adjusted in response to the exit of the UK. While the magnitude of the financial burden that needs to be absorbed seems manageable relative to the size of the public sector in the EU, it is still significant as a share of the EU budget and the absolute change in net contributions can be considerable.

In addition, in some scenarios and depending on the imposed assumptions about the distribution of the Brexit-Gap, the change in the financial burden with the corresponding adjustments of the EU budget seems relatively unfair with the bulk of the burden carried by some countries only. It is therefore likely that new systems of rebates will need to be introduced to achieve consensus about the burden distribution. As in the case of the Brexit bill, it is likely that the negotiations about the distribution of the burden among the member states will be linked to other issues, in particular the future trade and migration regimes between the UK and the EU where the member states have different interests.

One possible source of additional revenues for the EU budget would be tariffs levied on products imported from the UK.[22] Of course, whether or not there will be tariff revenues will depend on future trade relations between the UK and the EU. If there will be revenues from tariffs on goods imported from the UK, EU companies exporting to the UK will have to pay tariffs, too. The economic burden of these tariffs will partly fall on companies and partly on consumers. Whatever the final outcome will look like, economically tariff revenues will be no compensation for the disappearing net contribution of the UK to the EU budget.

Given that Brexit will lead to significant financial pressure on the EU budget, this may be the right moment to think about a more extensive reform of the EU's finances in order to improve its effectiveness on the expenditure side as well transparency and perceived fairness on the revenue side. The current system, as it is often claimed, has created a vicious circle where beneficiaries and contributors are often pitched against each other in what people have increasingly perceived as a zero-sum game: one member state's gain is another member state's loss while being neglectful about the true value of being part of the EU. If citizens were able to see the link between the

[22] Ferrer and Rinaldi (2016) quantify revenues for the EU in the hard Brexit scenario as 4.6bn Euro per year – but in the form of tariffs.

resources made available to the EU and its progress on the most challenging issues in the EU, it is hoped, it would reinforce the legitimacy of and political support for the EU budgetary spending.

A comprehensive report commissioned by the European Commission, the European Parliament and member states, chaired by Mario Monti, the former Italian prime minister, has made a number of proposals for the reform of the EU budget. Regarding future expenditures, the report emphasizes that "[i]n times of scarce public resources but growing financial needs, the EU budget needs to focus on areas bringing the highest European added value, or on European public goods for which action at EU level is not only relevant, but indispensable, or where national financing possibilities are insufficient for achieving our European goals." The report mentions examples of projects with more potential for European added value, including internal and external security and the fight against climate change.

Taking Stock: The Fiscal Implications of Brexit

The analysis in this section has focused on the divorce bill and the impact of Brexit on the future budget of the EU27. Since there are no established rules and procedures for disentangling a member country financially from the EU, the bill will essentially be the result of political negotiations, reflecting not just budgetary issues but wider aspects of Brexit including future trade relations. For the UK and the EU27 taken together, the Brexit bill is not a cost, it is a distributional issue. If difficulties in finding an agreement on the size of the bill undermine efforts to maintain free trade, it would create economic costs for both the EU and the UK.

It is unavoidable that the departure of a large net contributor like the UK will give rise to financial pressure on the EU budget. How the EU will respond to this and how much will be absorbed by spending cuts as opposed to higher contributions from the remaining member states is again a political question, as is the distribution of the financial burden among the member states. It would be highly desirable though to consider this financial pressure as an opportunity to achieve a reform of EU spending towards a greater weight on policies where EU involvement generates added value. If the EU budget was spent more wisely, the benefits would easily over-compensate the unavoidable cost to the EU 27 of losing the UK net contribution.

Another fiscal issue not discussed here is the impact of Brexit on fiscal competition. One concern voiced by high tax countries in the EU like Germany or France is that the UK might try to become a tax haven and lure investment and jobs away from other countries. As a matter of fact, EU membership does not prevent countries from cutting corporate tax rates or other taxes to very low levels. The UK corporate tax rate is already the lowest in the G7 and one of the lowest in the EU. It is probably more relevant that the UK, after leaving the EU, will no longer be subject to European state aid rules. Currently the EU uses the instrument of state aid control to crack down on tax rules which allow multinational companies to avoid paying taxes in the EU. The case of Apple in Ireland is the most striking example. Therefore, rather than cutting headline tax rate, the UK might become a place for special tax regimes tailored to the needs of multinational companies, intensifying international competition for tax bases and book profits. Those who dislike tax competition will consider this as an additional cost of Brexit while those who welcome tax competition as a means of limiting the taxing powers of states will see it as a benefit.

Adding up Income Effects and Fiscal Redistribution

We now bring income effects and the impact of financial redistribution together. Table 5 provides Brexit effects on real gross income in billion Euros and adds potential maximum fiscal costs, as outlined in Table 3, first column. The EU27 losses amount to 29.6bn Euro in real gross income per year in the WTO scenario. The costs for the UK total 30.2bn Euro. In absolute terms, the UK loses slightly more than the EU27 altogether. As discussed above, fiscal costs are at present hard to quantify as they are subject to negotiations. In 2015, the UK total net contribution to the EU budget amounts to 14bn Euro. Even if the UK reduces these costs completely, Brexit would not turn out to be a positive case, not even under an ambitious FTA with the EU. On the contrary, precisely in this scenario the UK would have to expect further transfers to Brussels. Fiscal costs for EU27 countries would increase with Brexit. Assuming no adjustment in the European expenditure structure and that the fiscal gap in the EU budget is filled proportional to GNI, Germany would have to contribute an additional 4.6bn Euro and France an additional 2.1bn Euro to the EU budget. Net recipients would receive lower transfers. In Poland this would amount to 0.1% of GDP. The consideration of fiscal costs leaves the UK slightly better but the EU27 worse off. In the unlikely event of no more UK net payments to the EU budget, the EU as a whole reports a net loss of 43.5bn Euro in the WTO scenario, 11.3bn Euro of which are allotted to Germany alone.

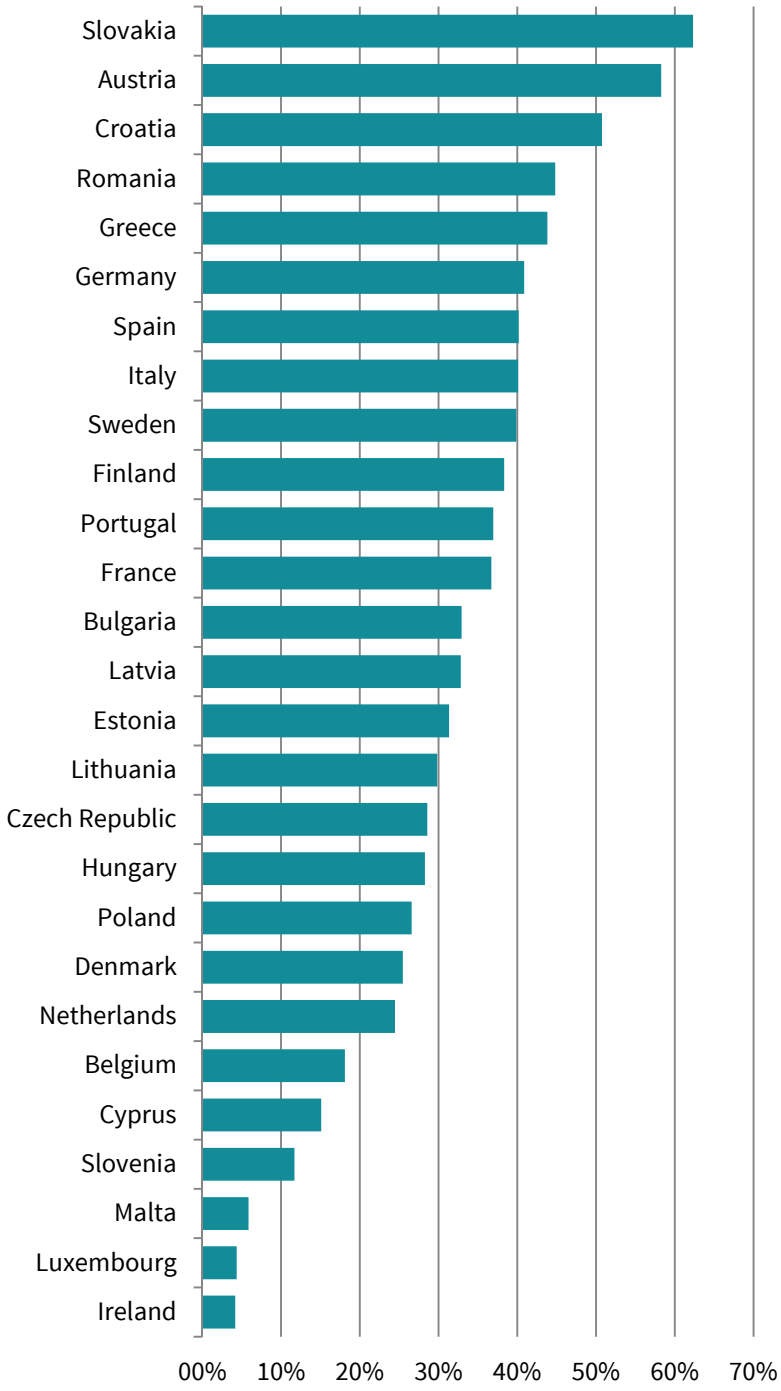
The maximum fiscal costs of Brexit for the EU amount to 32% of maximum total effects. However, we find a high degree of heterogeneity among EU members.

Table 5 Effects on Gross Real Income and Maximum Fiscal Costs, in bn Euro

	Real Gross Incomes			
	1: WTO	2: Global Britain	3: FTA	Maximum fiscal costs
Austria	0.36	0.36	0.16	0.51
Belgium	1.77	1.77	0.80	0.39
Bulgaria	0.08	0.08	0.05	0.04
Croatia	0.04	0.04	0.03	0.04
Cyprus	0.08	0.08	0.04	0.01
Czech Republic	0.36	0.36	0.12	0.14
Denmark	0.77	0.77	0.41	0.26
Estonia	0.04	0.04	0.02	0.02
EU27	**29.56**	**29.76**	**13.49**	**14.00**
Finland	0.33	0.33	0.14	0.20
France	3.63	3.63	1.92	2.10
Germany	**6.71**	**7.00**	**2.62**	**4.63**
Greece	0.21	0.21	0.13	0.17
Hungary	0.25	0.25	0.09	0.10
Ireland	4.08	4.06	1.85	0.18
Italy	2.26	2.26	0.97	1.52
Latvia	0.05	0.05	0.02	0.02
Lithuania	0.08	0.08	0.04	0.03
Luxembourg	0.87	0.90	0.25	0.04
Malta	0.12	0.12	0.05	0.01
Netherlands	3.12	3.05	1.52	1.01
Poland	1.07	1.07	0.54	0.39
Portugal	0.28	0.26	0.14	0.16
Romania	0.18	0.18	0.09	0.15
Slovakia	0.04	0.04	0.02	0.07
Slovenia	0.27	0.26	0.19	0.04
Spain	1.48	1.48	0.74	1.00
Sweden	1.03	1.03	0.52	0.68
United Kingdom	**30.21**	**24.88**	**12.66**	**-14.00**

Source: Income effects from Felbermayr et al., 2017c. Maximum fiscal costs include rebates of net contribution to the EU budget onto EU member states according to GNI shares (see Table 3, first column).

Figure 7 Share of Fiscal Effects in Total Net Income Effects of Brexit, WTO Scenario and Maximum Fiscal Costs, in %



Source: Felbermayr et al., 2017c and Table 3, first column; own calculations.
Notes: The figure shows the share of maximum fiscal costs in maximum total losses (value added effects in the WTO scenario plus maximum fiscal costs) in percent.

Figure 7 illustrates the share of fiscal costs in maximum total cost of Brexit under the WTO scenario for the EU27 countries. For Slovakia, fiscal costs account for 62.3% of the simulated total Brexit costs. Austria, Croatia and Romania show a share of more than 45% in total net income effects. Ireland, Luxembourg and Malta exhibit the lowest shares with less than 6%. This demonstrates clearly that EU members have quite diverging incentives to focus either on a rapid conclusion of a comprehensive FTA or on continuing high fiscal transfers of the UK to the EU budget in the Brexit negotiations.

Conclusions

The decision of the United Kingdom to leave the European Union has been a watershed moment for the European integration project. In this note, we wish to provide some empirical foundations for the political process by quantifying potential economic consequences of Brexit in various counterfactual scenarios.

The ex-post analysis of trade integration shows that the EU membership effect for the UK is asymmetric. While imports of the EU27 from the UK increased by 64.7% (88.1%) for goods (services), UK imports from other EU27 states were pushed only by 18.2% (59.7%) for goods (services). This illustrates that reductions in tariffs and the harmonization of standards by the EU have had a clear positive impact on trade relations. These benefits from European integration – on both the UK and the EU side – are now at risk due to Brexit.

The ex-ante analysis of potential consequences of various future arrangements between the EU and the UK finds that Brexit would in fact lead to a considerable decline of goods and services trade between the UK and the EU27 countries. Under a hard (soft) Brexit, UK exports to Germany drop by 50% (24%), with comparable trade effects for other EU27 countries. German exports to the UK fall by 33% (9%). Overall, services exports are the most pronounced. UK wholesale trade and road vehicles suffer the strongest drop in exports to Germany in values from a hard Brexit, while the financial services sector dominates in percentage terms. German wholesale trade to the UK involves the largest trade effects in percentage changes, but road vehicles exports lose the highest amounts followed by machinery and pharmaceuticals. When looking at value added effects from Brexit, we find that three-quarters of German economic losses stem from manufacturing industries.

The effects on real GDP per capita show that Brexit is definitely more expensive for the UK than for the average EU27 country. In the WTO (Global Britain; DCFTA) scenario, the UK would lose 1.4% (1.1%; 0.6%) of GDP per capita in the year 2014, the EU27 average is -0.25% (-0.25%; -0.11%). This clearly visualizes that the idea that a few new FTAs could compensate the losses from leaving the EU is far-fetched, while an ambitious FTA between the UK and the EU would help to reduce the losses from Brexit dramatically for all countries involved.

The analysis of the one off divorce bill and of the impact of Brexit on the future EU27 budget indicates that the outcome will essentially be a result of political negotiations, which reflect not just budgetary issues but wider aspects of Brexit including future trade relations. The response of the EU to spending cuts caused by Brexit as opposed to higher contributions from remaining members is a political question to be solved. Nevertheless, we suggest that it would be a good

opportunity to achieve a reform of EU spending towards a greater weight on policies where EU involvement generates added value.

The consideration of fiscal costs compared to income losses from Brexit leaves the UK slightly better but EU27 member states worse off. Even if the UK was able to reduce its net contribution to the EU budget to zero, which is unlikely, given that the UK will want to participate in future EU policy initiatives, Brexit would still give rise to high economic costs for the UK. For the EU27, we find a high degree of heterogeneity when combining income and fiscal costs. This is an important finding for the Brexit negotiations. The EU member states have diverging incentives to focus negotiations either on a rapid FTA conclusion with the UK or on continuing high fiscal transfers of the UK to the EU27 budget – particularly under a comprehensive trade agreement.

An important practical issue is that there is little time left for the Brexit negotiations. Since there will be a ratification process after the end of the negotiations, the main elements of the Brexit agreement will need to be completed no later than in autumn 2018. Given this, a pragmatic solution would be to agree on a phase of transition after March 2019. During this transition phase the UK would no longer be a member of the EU but the existing rules about trade and other aspects of the internal market would be preserved. This would buy time to avoid a disruptive Brexit, something that would lead to considerable costs on both side of the Channel.

The outcome of the Brexit negotiations will shape the relationship between the EU and the UK for many years to come. Even though the UK leaves the EU, a lot of potential for future cooperation still exists, not only in trade relations but also in areas like science, education, culture as well as foreign and security policy. Avoiding a failure of the negotiations and minimizing the costs of Brexit is a key responsibility of policy makers on both sides.

Literature

Aichele, R., Felbermayr, G. and I. Heiland, 2014. Going Deep: The Trade and Wefare Effects of TTIP. CESifo Working Paper 5150.

Baldwin, R., DiNino, V., Fontagné, L., De Santis, R. and D. Taglioni, 2008. Study on the Impact of the Euro on Trade and Foreign Direct Investment. Tech. rep., Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Baldwin, R. and D. Taglioni, 2007. Trade Effects of the Euro: A Comparison of Estimators. Journal of Economic Integration 22 (4), 780–818.

Battisti, M., G. Felbermayr, G. Peri and P. Poutvaara. 2017. Immigration, Search and Redistribution: A Quantitative Assessment of Native Welfare. Journal of the European Economic Association (conditionally accepted).

Barker, A., 2017. The €60 billion Brexit bill: How to Disentangle Britain from the EU Budget. Centre for European Reform.

Berger, H. and V. Nitsch , 2008. Zooming Out: The Trade Effect of the Euro in Historical Perspective. Journal of International Money and Finance 27 (8), 1244–1260.

Bergin, P. and C. Lin, 2012. The Dynamic Effects of a Currency Union on Trade. Journal of International Economics 87 (2), 191–204.

Bergstrand, J., Larch, M. and Y. Yotov, 2015. Economic Integration Agreements, Border Effects, and Distance Elasticities in the Gravity Equation. European Economic Review 78, 307-327.

Bun, M. and F. Klaassen, 2007. The Euro Effect on Trade is not as Large as Commonly Thought. Oxford Bulletin of Economics and Statistics 69 (4), 473–496.

Büttner, T., Broer, M. and C. Fuest, 2017. The future of EU finances: New Way of Financing and Distribution? ifo Schnelldienst 70 (06).

Caliendo, L. and F. Parro, 2015. Estimates of the Trade and Welfare Effects of NAFTA. Review of Economic Studies 82 (1), 1-44.

Cameron, D., 2017. Theresa May Clarifies what Brexit Means – Free Trade Agreement and a Hard Exit (accessed March, 2017, via the link: http://europeanstudies.macmillan.yale.edu/news/commentary-theresa-may-clarifies-what-brexit-means-free-trade-agreement-and-hard-exit).

Camarero, M., Gómez, E. and C. Tamarit, 2014. Is the Euro Effect on Trade So Small After All? New Evidence Using Gravity Equations with Panel Cointegration Techniques. Economics Letters 124 (1), 140–142.

Center for European Reform, 2014. The Economic Consequences of Leaving the EU.

Dai, M., Yoto, Y. and T. Zylkin, 2014. On the Trade-Diversion Effects of Free Trade Agreements. Economics Letters 122, 321-325.

Darvas, Z., Efstathiou, K. and I. Gonzalves Raposo, 2017. Divorce Settlement or Leaving the Club? A Breakdown of the Brexit Bill. Bruegel Working Paper.

Department for Exiting the European Union and D. Davis, 2017. The United Kingdom's Exit from and new Partnership with the European Union White Paper February 2017.

Di Giovanni, J., A. Levchenko and F. Ortega, 2015. A Global View of Cross-Border Migration. Journal of the European Economic Association 13(1): 168-202.

Egger, P. H., Larch, M. and K. Staub, 2012. Trade Preferences and Bilateral Trade in Goods and Services: A Structural Approach. CEPR Discussion Paper No. DP9051.

Felbermayr, G., V. Grosmann and W. Kohler, 2015. Migration, International Trade, and Capital Formation: Cause or Effect?, in: Barry Chiswick, Paul W. Miller (eds.): Handbook of the Economics of International Migration 1B, 914 – 1025 (Elsevier).

Felbermayr, G., Gröschl, J. and I. Heiland, 2017a. Undoing Europe in a New Quantitative Trade Model. Mimeo: ifo institute.

Felbermayr, G., Gröschl, J. and M. Steininger, 2017b. Britain Voted to Leave the EU: Brexit through the Lens of New Quantitative Trade Theory. Mimeo: ifo institute.

Felbermayr, G., Gröschl, J., Heiland, I., Braml, M. and M. Steininger, 2017c. Ökonomische Effekte eines Brexit auf die Deutsche und Europäische Wirtschaft. ifo Forschungsberichte 72, ifo Institut

Felbermayr, G., Gröschl, J. and T. Steinwachs, 2017d. The Trade Effects of Border Controls: Evidence from the European Schengen Agreement. Journal of Common Market Studies, forthcoming.

Ferrer, J. and D. Rinaldi, 2016. The impact of Brexit on the EU Budget: A Non-Catastrophic Event. Centre for European Policy Studies Policy Brief 347.

Flam, H., und H. Nordström, 2006. Trade Volume Effects of the Euro: Aggregate and Sector Estimates. Institute for International Economic Studies Seminar Paper No. 746.

Haas, J. and E. Rubio, 2017. Brexit and the EU Budget: Threat or Opportunity? Jacques Delors Institute Policy Paper 183.

Head, K. and T. Mayer, 2014. Gravity Equations: Workhorse, Toolkit, and Cookbook. in G. Gopinath, E. Helpman and K. Rogoff (eds.), Handbook of International Economics Vol. 4, 131–195.

High Level Group on Own Resources, 2016. Future Financing of the EU.

Institute for Public Finance, 2016. Brexit and the UK's Public Finances. IFS Report 116.

Micco, A., Stein, E. and G. Ordoñez, 2003. The Currency Union Effect on Trade: Early Evidence from EMU. Economic Policy 18 (37), 315–356.

Sampson, T., 2016. Dynamic Selection: An Idea Flows Theory of Entry, Trade and Growth. Quarterly Journal of Economics, 2016, 131 (1): 315-380.

Santos Silva, J. and S. Tenreyro, 2006. The Log of Gravity. Review of Economics and Statistics 88(4), 641–658.

Timmer, M., Dietzenbacher, E., Los, B., Stehrer, R. and G. Vries, 2015. An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production. Review of International Economics 23 (3), 575–605.

Wang, Z., S.-J. Wei and K. Zhu (2013). Quantifying International Production Sharing at the Bilateral and Sector Levels. NBER Working Paper 19677.

Wissenschaftliche Dienste des Deutschen Bundestags, 2016. Finanzielle Leistungen Norwegens Zugunsten der EU.

Appendix: Detailed Statistics

Table A1 Export and Import Shares with UK and Top 3 Sectors, 2014

Country	Goods		Services		Top 3 Export		Top 3 Import	
	Export in %	Import in %	Export in %	Import in %	Sector	in bn Euro	Sector	in bn Euro
AUT	1.67	0.72	0.24	0.32	Motor	0.56	Wholesale	0.33
					Machinery	0.48	Motor	0.26
					Chemicals	0.27	Chemicals	0.21
BEL	5.94	3.08	1.15	1.54	Motor	2.47	Wholesale	1.79
					Food	2.17	Admin	1.34
					Petrol	2.12	Petrol	1.32
BGR	0.86	0.73	0.49	0.51	Admin	0.05	Wholesale	0.08
					Textiles	0.03	Electronics	0.05
					Air Transport	0.03	Food	0.04
CYP	1.09	3.54	0.85	2.27	Insurance	0.05	Wholesale	0.12
					Financial	0.05	Financial	0.08
					Other Services	0.03	Motor	0.08
CZE	2.73	0.96	0.38	0.44	Motor	1.24	Wholesale	0.35
					Electronics	0.91	Electronics	0.19
					Machinery	0.42	Chemicals	0.19
DEU	3.37	1.48	0.42	0.50	Motor	18.90	Wholesale	5.09
					Machinery	7.10	Motor	3.07
					Chemicals	5.41	Chemicals	2.97
DNK	4.23	2.18	0.98	1.08	Food	1.19	Admin	1.00
					Admin	0.92	Wholesale	0.72
					Pharma	0.67	Petrol	0.47
ESP	2.24	1.19	0.24	0.21	Motor	3.83	Wholesale	1.55
					Food	1.41	Motor	1.22
					Transport Equip	1.15	Mining	1.07
EST	1.46	1.29	0.55	0.61	Wood	0.07	Food	0.06
					Electronics	0.04	Wholesale	0.05
					Admin	0.03	Motor	0.02
FIN	2.24	1.24	0.17	0.54	Petrol	0.80	Wholesale	0.32
					Paper	0.70	Motor	0.22
					Machinery	0.24	Chemicals	0.17
FRA	3.07	1.56	0.67	0.73	Admin	8.28	Admin	9.23
					Wholesale	4.26	Wholesale	3.75
					Transport Equip	3.36	Food	1.45
GRC	0.57	0.89	0.44	0.56	Water Transport	0.66	Wholesale	0.28
					Pharma	0.07	Transport Services	0.26
					Basic Metals	0.07	Pharma	0.13
HRV	0.70	0.49	0.50	0.56	Other Services	0.13	Insurance	0.05
					Metal	0.03	Wholesale	0.04
					Business Services	0.03	Business Services	0.02
HUN	2.56	0.86	0.79	0.71	Motor	0.64	Wholesale	0.21
					Electronics	0.52	Business Services	0.21
					Machinery	0.28	Machinery	0.13
IRL	18.64	20.59	2.94	4.67	Food	9.13	Business Services	4.42
					Crops	3.96	Wholesale	3.33

Country	Goods		Services		Top 3 Export		Top 3 Import	
					Pharma	2.21	Food	2.99
ITA	1.95	0.77	0.32	0.45	Machinery	2.50	Wholesale	2.00
					Textiles	2.48	Admin	1.74
					Food	2.27	Insurance	0.96
LTU	3.43	0.94	0.14	0.37	Petrol	0.45	Wholesale	0.08
					Chemicals	0.10	Electronics	0.03
					Other Manuf	0.10	Chemicals	0.03
LUX	2.08	2.11	1.47	13.43	Financial	1.25	Insurance	9.34
					Admin	0.16	Business Services	2.97
					Telecom	0.15	Admin	2.35
LVA	2.37	1.22	0.63	0.50	Wood	0.19	Food	0.07
					Land Transport	0.10	Wholesale	0.06
					Transport Services	0.02	Admin	0.04
MLT	2.33	4.36	15.00	7.37	Other Services	1.35	Legal	0.45
					Financial	1.27	Business Services	0.36
					Air Transport	0.04	Financial	0.11
NLD	5.34	2.62	1.55	1.05	Chemicals	3.39	Wholesale	2.54
					Wholesale	3.39	Chemicals	1.57
					Food	2.89	Legal	1.54
POL	2.28	0.94	0.67	0.47	Motor	1.06	Wholesale	0.79
					Food	0.99	Pharma	0.40
					Electronics	0.84	Chemicals	0.39
PRT	2.13	0.99	0.41	0.59	Motor	0.38	Wholesale	0.30
					Textiles	0.35	Admin	0.14
					Air Transport	0.30	Motor	0.14
ROU	0.98	0.51	0.31	0.32	Motor	0.23	Wholesale	0.19
					Textiles	0.16	Chemicals	0.08
					Accommodation	0.12	Machinery	0.08
SVK	2.36	0.47	1.71	0.27	Real Estate	1.07	Wholesale	0.09
					Motor	0.77	Basic Metals	0.05
					Electronics	0.41	Chemicals	0.04
SVN	1.14	0.61	0.26	0.34	Pharma	0.04	Wholesale	0.04
					Metal	0.04	Basic Metals	0.03
					Electrical	0.04	Electronics	0.03
SWE	3.48	2.42	0.37	0.77	Petrol	2.33	Wholesale	1.03
					Paper	0.75	Mining	0.83
					Motor	0.61	Motor	0.68

Source: World Input Output Tables Release 2016, own calculations. **Notes:** Top sectors correspond to Agri: Crop and animal production, hunting and related service activities; Food: Manufacture of food products, beverages and tobacco products; Mining: Mining and quarrying; Textiles: Manufacture of textiles, wearing apparel and leather products; Wood: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; Paper: Manufacture of paper and paper products; Petrol: Manufacture of coke and refined petroleum products; Chemicals: Manufacture of chemicals and chemical products; Pharma: Manufacture of basic pharmaceutical products and pharmaceutical preparations; Basic Metals: Manufacture of basic metals; Metal: Manufacture of fabricated metal products, except machinery and equipment; Electronics: Manufacture of computer, electronic and optical products; Electrical: Manufacture of electrical equipment; Machinery: Manufacture of machinery and equipment; Motor: Manufacture of motor vehicles, trailers and semi-trailers; Transport Equip: Manufacture of other transport equipment; Other Manuf: Manufacture of furniture; other manufacturing; Wholesale: Wholesale and retail trade and repair of motor vehicles and motorcycles; Land Transport: Land transport and transport via pipelines; Water Transport: Water Transport; Air Transport: Air Transport; Transport Services: Warehousing and support activities for transportation; Accommodation: Accommodation and food service activities; Telecom: Telecommunications; Financial Services: Financial service activities, except insurance and pension funding; Insurance: Insurance, reinsurance and pension funding, except compulsory social security; Real Estate: Real estate activities; Legal: Legal and accounting activities; activities of head offices; management consultancy activities; Business Services: Business Services; Admin: Administrative and support service activities; Other Services: Other services activities; Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; Activities of extraterritorial organizations and bodies.

Data

Our most important data source is that of Timmer et al. (2015), the World Input-Output Database (WIOD). It provides sectoral production values, sectoral value-added information, and bilateral final and intermediate trade with producer and consumer prices, including services. This allows us to construct bilateral input-output tables and value-added levels. The data covers 43 countries and the rest of the world (RoW) as an aggregate for the years 2000 to 2014. WIOD distinguishes 56 sectors. In order to carry out the counterfactual simulations, we aggregate sectors into 50 industries. The aggregation mainly affects services sectors. The sectoral level of detail is maintained in the agricultural and manufacturing sectors. The current WIOD data set provides the latest data, which is available in a harmonized form for goods and services transactions and which are compatible with the input-output tables of different countries.

Information on free trade agreements comes from the WTO. The data on the successive accession of the countries to the Schengen Agreement stems from the European Commission, as does the accession data on the EU or the Eurozone. We combine GIS data with information from Google Maps to count the number of Schengen-internal border crossings. The often bemoaned geometry of Europe is an advantage for econometric identification. It allows us to identify the various effects of the EU, the Eurozone, membership in the Schengen area and other trade agreements (e.g., EU-Korea). This is important in order to understand the effect of the EU in detail. Moreover, not all EU members are members of the Schengen area or the Eurozone. In addition, not all members of the Eurozone are part of the Schengen Agreement and vice versa, and they have ratified the agreement at different times. In particular, the UK is a member of the EU, but not of the Eurozone or the Schengen Agreement. If the effects were not separated from one another, the effect of the UK's withdrawal from the EU Single Market and Customs Union would be blended with that of the Eurozone and the Schengen area. In this case, we would overestimate the effect of Brexit.

Bilateral customs data stem from the World Integrated Trade Solutions (WITS-TRAINS) as well as the integrated database (IDB) of the WTO. We estimate the elasticities for agricultural industries and manufacturing sectors in Felbermayr et al. (2017a). For services, we use a consistent external estimator of the elasticity of -5.959 by Egger et al. (2012). All further data required for the simulation are derived from the estimates of the gravity model.

EconPol Europe

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1) sustainable growth and 'best practice',

2) reform of EU policies and the EU budget,

3) capital markets and the regulation of the financial sector and

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