Impact of the EU-UK future trade relationship on the European pharmaceutical industry

July 2020

Colophon

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1 Introduction

The pharmaceutical sector in Europe has a complex web of regulatory and supply linkages which will be disrupted by the UK leaving the EU. This report provides a quantitative estimate of Brexit's impact on the sector, considering value-added linkages across countries. The report looks at the current sectoral linkages across countries and how these are estimated to change under three different scenarios after the end of the Transition Period on 31 December 2020. This is followed by a discussion about the quantitative impact of the three scenarios on GDP, sectoral output and exports. The export and output (production) effects are annual effects, compared to a baseline situation without Brexit (i.e. the counterfactual).

For the estimation of the effects of different scenarios of Brexit we use a computable general equilibrium (CGE) model of the world economy. While the model contains data on applied tariffs, to be able to estimate the impact of reductions in non-tariff measures (NTMs) like regulatory divergences, customs barriers or other non-price, non-quantity related barriers, we supplement the analysis of tariffs with estimates of potential non-tariff trade cost reductions in the pharmaceutical sector. The most important set of NTMs in practice relates to the degree of regulatory cooperation between the EU and UK. We also take advantage of the detailed world input-output tables incorporated in the data, to describe the pre-, and post-Brexit value added linkages of the pharmaceutical sector.

We assume three scenarios. The first scenario is a No Deal, whereby UK exits the EU on WTO terms. Under the second scenario, a simple FTA is assumed, with tariff reductions on goods trade across all sectors. The most ambitious third scenario includes the simple FTA but in addition has a scope beyond tariffs to also cover NTMs in the regulatory cooperation, focusing on a Mutual Recognition Agreement (MRA) for Good Manufacturing Practice (GMP) and batch testing.

This report is structured as follows. In the next Section (Section 2) we provide an overview of the modelling framework, underlying data, and the definition of the associated experiments. This is followed by an overview of the current (i.e. pre-Brexit) value-added linkages between regions in the pharmaceutical sector and the estimated changes in Section 3. Then in the Section 4 we discuss the estimated impact on the sector in terms of GDP, production and exports. A final overview is provided in the concluding section. A technical description of the methodology and further background details are provided in the Annexes to the report.

2 Description of the scenarios, data and methodology

2.1 Modelled scenarios

Three scenarios are assumed for quantifying the impact of potential outcomes of Brexit on the pharmaceutical sector. The three scenarios assume three different level of depth of trade relations between the EU and the UK in the future that would come into effect after the end of the Transition Period on 31 December 2020:

- The No Deal scenario assumes that no agreement is reached between the UK and the EU in 2020 and therefore trade will be conducted on WTO membership terms after 31 December 2020, with no preferential access to each other's markets.
- The next scenario assumes that a trade agreement is reached that covers the removal of all tariffs on goods trade for all sectors. This mirrors the EU ex-ante modelling tariff approach for trade agreements, even though in reality tariffs on a limited number of sensitive products may remain or may only be reduced gradually over time. Since the EU and UK already enjoy two-way tariff-free access, this is a realistic scenario.
- The final scenario assumes that a deeper agreement can be concluded, not only on remaining tariffs, but also non-tariff measures (NTMs). In practice this is the simulation of including regulatory cooperation between the EU and UK on top of the tariff agreement. Regulatory cooperation can consist of an MRA on GMP inspections and batch testing (which also mitigates supply disruptions). More specifically, we assume that NTMs are reduced by 50% relative to the No Deal scenario, combined with full tariff elimination as per the previous scenario. This estimate is based on Ecorys (2009) who estimate NTMs at sectoral level for the pharmaceutical industry and discussions with experts on the relative weight of the MRA on GMP inspections and batch testing versus other NTMs that could emerge post-Brexit like divergence in regulatory databases (e.g. falsified medicines, pharmacovigilance), worker mobility, and other types of regulatory issues (e.g. clinical trial requirements and requirements for life-cycle management).

We note that other considerations like additional costs for both EU and UK regulators stemming from additional inspections and additional negative effects in the form of delays to access of medicines that not only have a human but also an economic cost are not modelled. This implies that the estimated results are based on a large but not complete trade cost picture. All three scenarios depart from the same baseline, which is the current economic and trade policy situation (more specifically with GTAP data being projected to the latest possible year, which is 2018).

Table 1 Summary of scenarios

Scenarios	Scenario Description
No Deal	EU and UK fail to agree to a deal; the two parties trade on WTO terms from 2021.
Simple FTA	EU and UK agree a limited Free Trade Agreement (FTA) covering all tariffs across sectors from 2021.
FTA with MRA	A deeper FTA with zero tariffs and NTMs at 50% of No Deal levels on pharmaceutical trade between the EU and UK, notably via a Mutual Recognition Agreement on pharmaceutical GMP inspections and batch testing (GMP MRA)

2.2 The CGE model

We use a computable general equilibrium (CGE) model of global world trade to estimate the effects of Brexit on the pharmaceutical sector.[1] The CGE model is a large-scale economic model that translates the expected trade costs changes (i.e. tariffs, costs related to non-tariff measures, and quotas) into economic effects at the national and global levels. The estimated economic effects include detailed information regarding changes in values, quantities and input costs for domestic activities and associated trade flows. Given the general equilibrium nature of these models (meaning that sectors interact through both supply linkages and factor markets), complex interactions are captured in the model. In particular, the model simulates the changes in specific economic activities (sectors) that result from Brexit. This is important, as the combined impact of all policy will not be the same as if we examined each set of sectoral policies in isolation.

In general, a CGE model consists of three main elements. The underlying general equilibrium economic model, the multi-regional input-output data, and a set of exogenous parameters and variables (i.e. elasticities that determine the endogenous reactions, as well as policy variables). The combination of these three elements yields a general equilibrium (calibrated) baseline in which all the accounting and market clearing conditions are met. Policy experiments consist of a shock to one or more exogenous variables (e.g. tariffs, quotas or NTMs or a combination of them) that generate changes in the endogenous variables such that a new general equilibrium is reached (the counterfactual scenario). The behavioural equations in the economic model determine how the endogenous variables react, while the underlying baseline data and the exogenous parameters (i.e. the various elasticities in the model) determine the size and scope of the adjustments. To evaluate policy changes, such as the implementation of Brexit, the baseline (business as usual) scenario with no policy effects is compared to the counterfactual scenario that includes the changes in policy. The effect of the policy change is then quantified as the difference between the two.

For the CGE modelling framework to allow for economy-wide analysis across all sectors, it employs a balanced and internally consistent global database (in this case GTAP version 10 database) of all trade and production across countries and industries, including trade in intermediate goods. The GTAP database is a global multi-regional input-output (GMRIO) database that has extensive and comprehensive economic data for 140 countries/regions and 65 production sectors. The GTAP database provides disaggregated data for sectoral production, consumption, taxes and subsidies, trade, government finances, labour variables for different skill levels, and data on other production factors. For documentation on the current version of the database see Aguiar *et al*. (2019). These data feed into the computational model that describes the economic activity for the sectors and agents in the dataset.

Our model has a micro-founded theoretical trade model based on the Eaton and Kortum (2002) model. It is a structurally estimated model, which means the trade elasticities and non-tariff measures are taken from econometric estimations based on the underlying data that are later used in the model.[2]

[1] See the Annex for more technical and a detailed description of the CGE model employed in the study.

[2] For further technical details regarding the CGE model and the structural estimation of trade elasticities and NTMs, see Annex I.

2.3 Measuring resource flows embodied in global value chains (GVCs)

In recent decades, firms have developed increasingly complex supply chains that cross international borders. In the case of the pharmaceutical industry, the global shift from strictly national suppliers to a mix of regional and global production networks means that production and consumption both embody resources that were extracted in other countries, while value added used to produce intermediate and final goods abroad are also embodied in the production of other countries' firms and the consumption basket of its consumers. At the same time, firms and consumers abroad use both intermediate and final goods and services produced in foreign countries. The fact that a significant part of pharmaceutical production involves supply networks that cross borders means that when we quantify the impact of Brexit on the sector, we need to take these linkages into account. Typically, this involves either firm level detailed supply chain analysis, or industry level analysis with what are called multi-region input-output (MRIO) data. MRIO analysis employs data on how, for example, German pharmaceutical production uses pharmaceutical parts from the UK made with inputs from Poland. The advantage of MRIO analysis is that the methodology avoids double counting of resource flows, while also following the stream of resources through complex value chains (across industries and borders) to final production and consumption.

In this study, we use the MRIO method to evaluate the impact of Brexit on the pharmaceutical sector, taking into account the complex linkages of the sector across countries. The methods employed in MRIO analysis ensure that this is done without double counting. MRIO accounting is based on the same data and consistent with the CGE analysis used to assess the impact of the different Brexit scenarios.

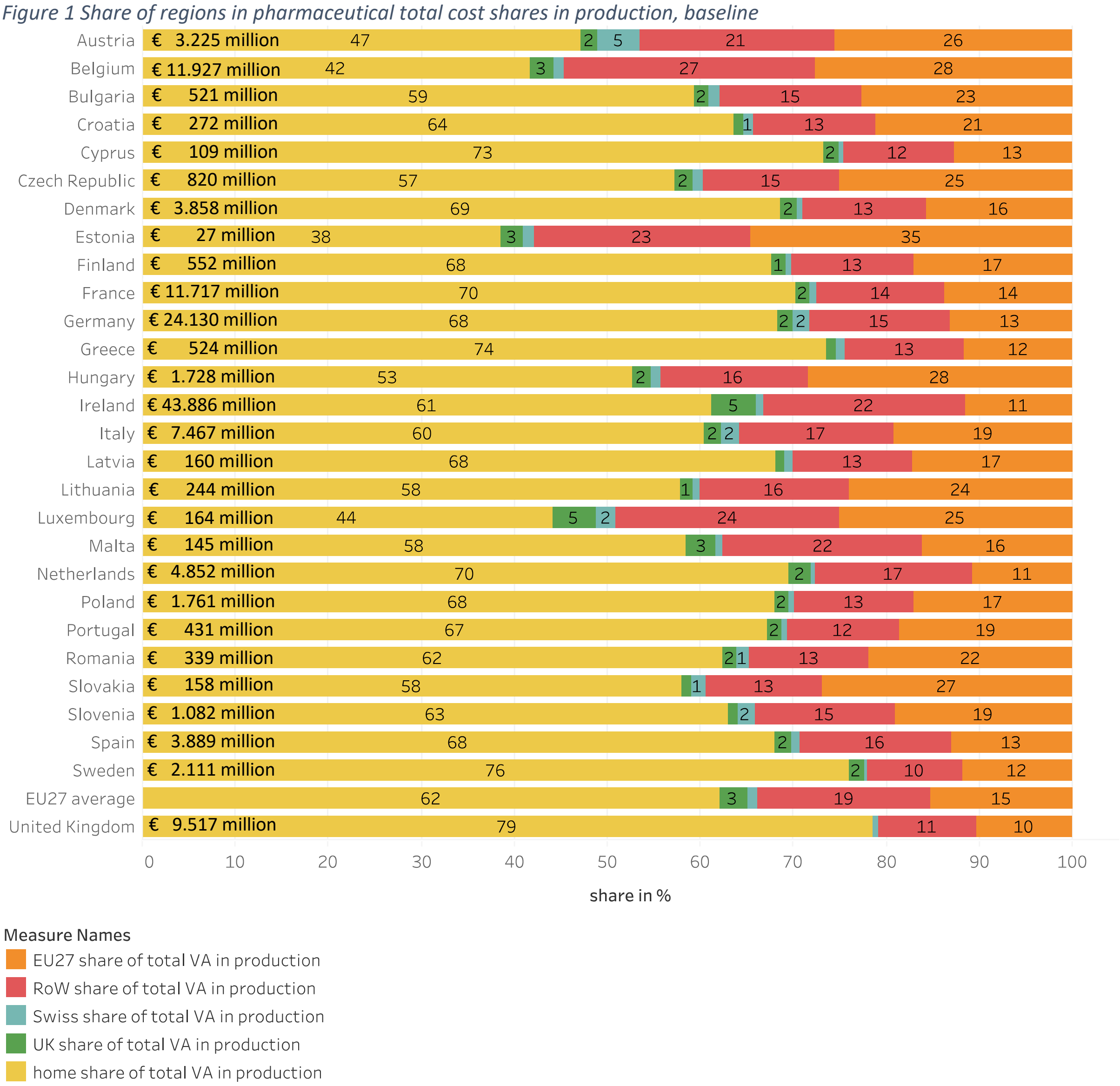
3 Estimated impact on value-added linkages

In this chapter we provide a discussion on how value chains in the pharmaceutical industry will be impacted under the three different Brexit scenarios.

3.1 Shares in total cost in production

Figure 1 shows **the value contribution of other regions in a country's total cost of production for the pharmaceutical industry**. This provides an overview of the industry linkages across countries. For most countries, **the input shares originating from the UK are around 2%** (dark green). So, for example for Austria, the share of total costs of production for the pharmaceutical industry coming from the UK is 2%. 47% of the costs come from Austria itself, while 5% come from Switzerland, 21% from the rest of the world and 26% from the rest of the EU. **Countries where inputs from the UK are relatively more important are Luxembourg, Ireland (about 5% shares); and Belgium, Estonia, and Malta** where the UK's input share is about 3%.

Figure 1 Share of regions in pharmaceutical total cost shares in production, baseline



Source: own calculations based on GTAP and OECD TiVA database

There are important differences between countries in terms of where inputs are coming from. The country with the lowest home share in pharmaceutical production is Estonia, where only 38% of costs are made in-country for pharmaceutical production, while the country with the highest share is the UK. Home inputs constitute 79% of the value of final production – this is in part due to the size of the UK economy combined with the large size of the UK pharmaceutical industry. The importance of sourcing from other EU countries compared to sourcing from the rest of the world also varies between countries; with other EU countries having the highest importance in Estonia (with 35%), and the lowest in the UK (10%), followed by Ireland (10%) and Netherlands (10%).

There are changes under our modelled scenarios in the share of inputs from different locations (see Annex II). There is no significant change in the share of home inputs in any of the countries. For the EU countries, there are minor changes in sourcing inputs from other EU countries. **For most EU countries sourced inputs shift to the rest of the world and not to the EU, to replace the now relatively more costly UK inputs. The share of the rest of the world increases from 18.6% to 19.2-19.3% under the different Brexit scenarios**, while on average, EU input shares decrease marginally or remain unchanged. In the case of the UK, there is a slight increase in home inputs usage in production, but more importantly, **the reduced share of EU inputs (going down from 10.2% to 7.9-8.3% depending on the scenario) get replaced mostly by inputs from the rest of the world (going from 11.8% - 12.3%)**. In other words, EU producers increase sourcing from third countries to make up for what are now more expensive UK inputs under the scenarios modelled.

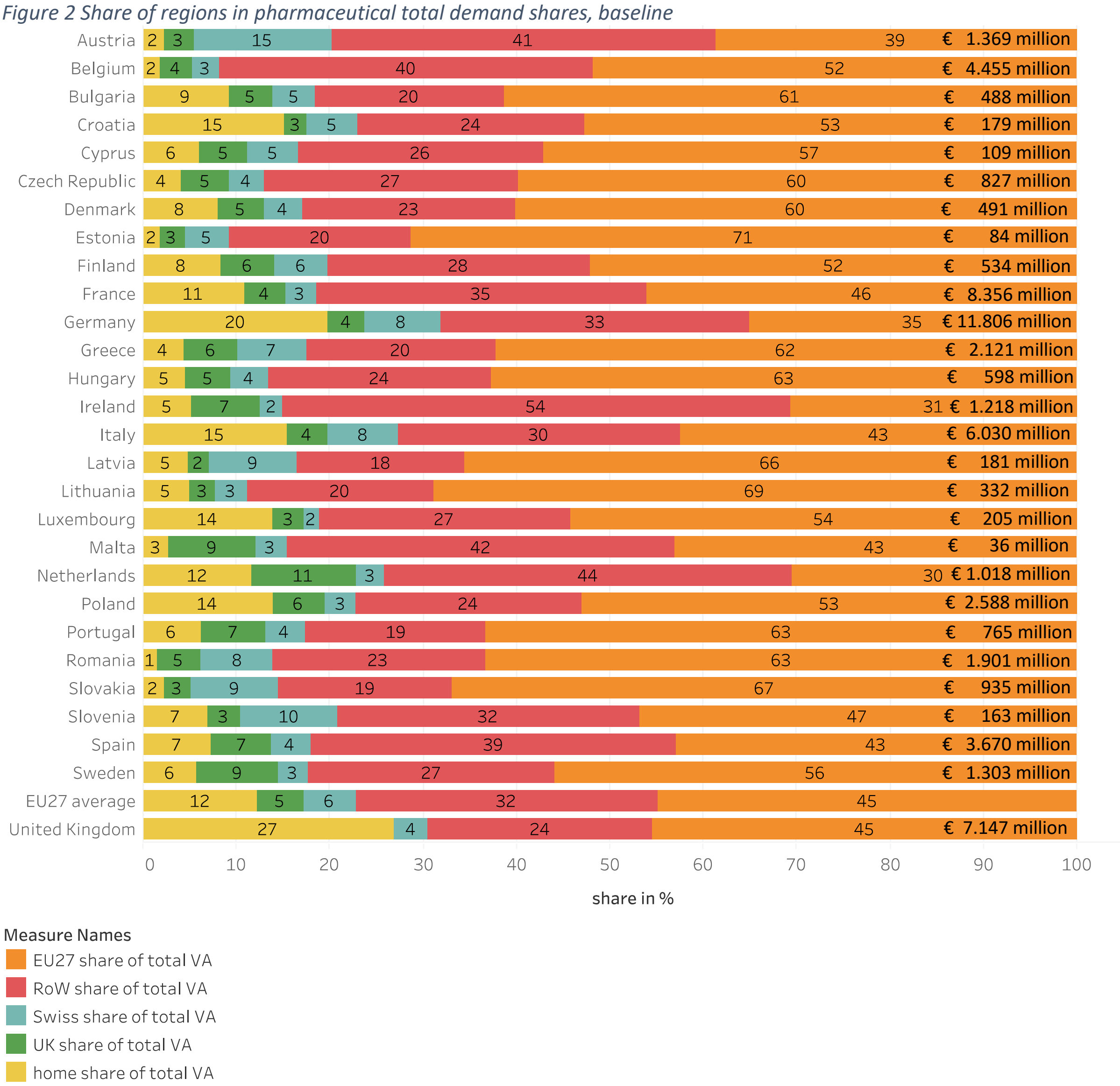
3.2 Value added shares in final medicines domestic demand

Next, we look at the value-added contribution of different regions from a different angle, namely **where value added comes from in pharmaceutical products sold in each country** before Brexit took place (**Figure 2**). **For most EU countries, the share of inputs or value added in goods sold in their countries comes predominantly from other EU countries (i.e. the EU Internal Market)** and from home production. Nevertheless there is some variation, and in some countries rest of the world (RoW) countries also have a very important share, such as in the case of Ireland, where 54% of value added in total demand in pharmaceutical goods originates from the rest of the world.

For the EU27 average, about 32% comes from the rest of the world, with the **UK contributing around 5%**, which is in importance close to Switzerland which contributes around 6%). The UK has the highest share of home production in total demand shares, amounting to 27%. The importance of value added in products sold in the UK market from other EU countries is around the EU average, amounting to 45%.

Next, we look at how these shares are expected to change with the three potential Brexit outcomes. In other words, we look at what portion of total demand in the pharmaceutical sector originates from which region after Brexit. **Figure 3** depicts the outcome of the three different scenarios. As Brexit takes place, **the share of the UK value added in goods sold in EU countries goes down under all scenarios**, due to increased trading costs between the two markets. At the EU average, the **UK's share goes down from 5% to about 3% both under No Deal and the simple FTA scenarios**. With a lower increase in bilateral trade costs, **under the scenario of FTA with MRA, the share remains a bit higher, at 4%**. In all EU27 countries home shares remain almost unchanged. While in some countries only minor changes are expected to occur in the share in total demand of other regions, in about half of the EU countries with declining UK shares **the importance of the rest of the world increases, replacing inputs from the UK. The share of the rest of the world in total demand for medicines goes up from 32% to 35.2% under No Deal and simple FTA, while to 34.9% under an FTA with MRA**. Again, we have a shift in demand to third country suppliers.

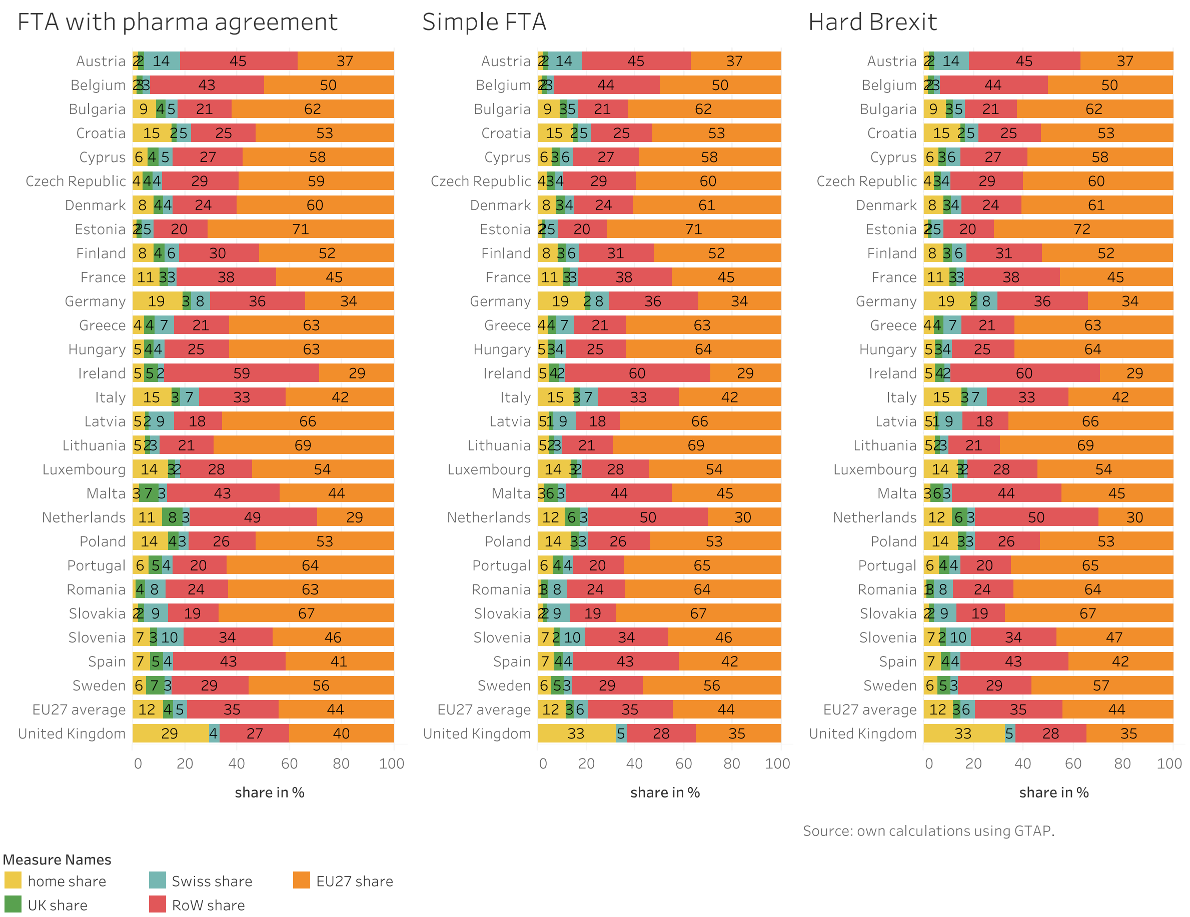
Figure 2 Share of regions in pharmaceutical total demand shares, baseline



Source: own calculations based on GTAP and OECD TiVA database

Estimated changes in the UK mirror these changes, with significantly greater magnitudes given the asymmetry between the two markets. As trade costs increase for the pharmaceutical sector between the EU and the UK, the **EU's share in total UK demand drops from 45.4% to 34.6% under No Deal and a simple FTA, and less, to 39.8% under and FTA with MRA**. Some of the EU value added is being replaced by increased home production in the UK (moving from 26.9% to 32.6%/29.3% depending on the scenarios) as well as by value added from the rest of the world (increasing from 32.3% to 35.2%/34.9%). In addition, Switzerland's share in the UK's total demand will increase, from about 3.7% to 4.5% under No Deal and a simple FTA, while only a rather small increase would take place in case of and EU-UK FTA with MRA (increasing to 4%).

Figure 3 Share of regions in pharmaceutical total demand shares after different FTA scenarios



Source: own calculations using GTAP.

4 Estimated macro-economic impact

4.1 Overview

As trade costs increase when exporting towards the EU after Brexit, exports of pharmaceutical products are expected drop in the UK. Similarly, some EU countries also experience a reduction in their pharmaceutical exports to the UK. Because the UK provides intermediate inputs for exports of all EU Member States – but to some more than to others (see Chapter 3), an increase in more expensive inputs will negatively affect competitiveness of some EU Member State exports. More specifically, pharmaceutical exports are estimated to decrease under all scenarios in Ireland, Belgium, Estonia, and Malta. This is partly driven by some of these countries having stronger supply linkages with the UK and also experiencing higher shifts away from UK inputs in their production. There are also countries which experience increases in exports because they replace the exports of the UK when the latter loses competitiveness due to Brexit, especially compared to the EU internal market.

As explained before, the trade barrier increase is largest under a No Deal scenario, marginally lower under a Simple FTA scenario because of tariff reductions and significantly lower under an FTA with MRA. The reason a No Deal and Simple FTA are similar for the pharmaceutical industry lies in the fact that tariff liberalisation only (i.e. the difference between a No Deal and the Simple FTA scenario) will not do much to EU-UK tariffs because most medicines already trade under the WTO Zero-for-Zero Pharmaceutical Annex (with zero tariffs for most medicines and intermediates). The reason for the significant economic differences between the No Deal and Simple FTA scenarios on the one hand and the FTA with MRA on the other lies in the much more relevant trade cost reductions for the pharmaceutical industry (and regulators and patients even if these indirect effects are not econometrically included) due to the MRA. Notwithstanding the WTO Zero-for-Zero Pharmaceutical Annex, changes in tariffs for chemicals (which include important inputs to the pharmaceutical sector) also contribute to the overall pattern of results.

In the discussion below of potential effects of the three scenarios, we focus mainly on how each of the three scenarios compares to the other two, rather than comparing them to a 'perfect world of no Brexit' that does not exist. The reason for this is that it is important to appreciate the political reality of 2020 – the future EU-UK relationship will either see a No Deal, a Simple FTA, or (when a Simple FTA is a possibility) a more comprehensive FTA with MRA. One of these three options is basically how the future EU-UK relationship will come to look like. Comparing these potential outcomes to the UK remaining in the EU internal market, an EEA type of agreement or even a customs union, is no longer relevant.

4.2 Impact on nominal GDP

The effects of changes in tariffs and regulatory alignment have a direct impact on nominal GDP levels of the EU27, UK and third countries. In **Table 2**, the long-run results are presented for each of the scenarios. When comparing these scenarios three findings stand out:

- First, with the exception of China (where negative income effects in the European market on demand for Chinese goods dominate) third countries (i.e. the US, Switzerland, Japan, and Turkey) generally benefit from the EU27 – UK disintegration. US GDP could be Euro 2.9 billion higher each year in case of a No Deal and Euro 2.0 billion in case of an FTA with MRA (not reported in the Table). This is due to the loss of global competitiveness of both the

EU27 and UK because of Brexit. The loss of global competitiveness of the EU27 and UK, which is the reason third countries benefit, is due to the fact that because of Brexit the EU27 and UK both have to resource inputs elsewhere because of higher barriers, which will increase their costs and thus a loss in relative competitiveness vis-à-vis global competitors.

- Second, for the EU27 the Simple FTA and FTA with MRA are better for its nominal GDP than a No Deal scenario by Euro 6.6 billion and Euro 7.9 billion respectively each year. In the deeper integration scenario, both the EU27 and UK will see smaller cost increases and they lose out less competitively relative to a No Deal scenario.
- Third, when looking at the effects of the FTA with MRA on nominal GDP compared to a No Deal for individual EU Member States, it is clear that except for Luxemburg and Slovenia (who experience a negligible GDP decline) all EU Member States gain from the FTA with MRA. Largest annual gains accrue to Belgium (Euro 926 million), Czech Republic (Euro 188 million), France (Euro 667 million), Germany (Euro 1.8 billion), Italy (Euro 543 million), Netherlands (Euro 765 million), Poland (Euro 323 million), Romania (Euro 104 million), Spain (Euro 348 million), and Sweden (Euro 237 million).
- Fourth, the difference of Euro 1.3 billion annually between the Simple FTA and the FTA with MRA for the EU27 can be attributed to the pharmaceutical annex, i.e. the inclusion of an MRA in addition to the Simple FTA. So, it is in both the EU27s and UK's economic self-interest to agree on an FTA with MRA. The deeper the agreement between the EU27 and UK, the less third countries will benefit and the stronger European resilience in pharmaceuticals will be.
- Fifth, for the UK the Simple FTA leads to nominal GDP being Euro 5.0 billion higher each year compared to a No Deal and the FTA with MRA adds another Euro 2.5 billion annually. From this perspective there is a strong incentive for the UK to focus on an FTA with MRA compared to a No Deal.

Table 2 Changes in nominal GDP compared to baseline and relative comparison to No Deal %, value – Euro million)

Countries	No Deal (%)	Simple FTA (%)	FTA with MRA (%)	Extra GDP Simple FTA compared to No Deal (€)	Extra GDP FTA with MRA compared to Simple FTA (€)	Extra GDP FTA with MRA compared to No Deal (€)
Austria	-0.33	-0.30	-0.30	99	4	103
Belgium	-2.06	-1.90	-1.87	774	152	926
Bulgaria	-0.62	-0.59	-0.58	18	4	22
Croatia	-0.20	-0.19	-0.19	4	1	4
Cyprus	-1.00	-0.97	-0.97	6	1	7
Czech Republic	-0.99	-0.89	-0.89	175	13	188
Denmark	-0.48	-0.46	-0.45	63	6	69
Estonia	-0.67	-0.64	-0.64	6	0	6
Finland	-0.38	-0.35	-0.35	57	7	64
France	-0.35	-0.33	-0.33	564	103	667
Germany	-0.46	-0.42	-0.41	1.541	245	1.786
Greece	-0.45	-0.44	-0.43	36	19	55
Hungary	-0.58	-0.54	-0.53	59	9	68
Ireland	-5.36	-5.08	-4.97	977	357	1.334
Italy	-0.33	-0.30	-0.30	465	78	543
Latvia	-1.04	-0.97	-0.97	20	0	20
Lithuania	-1.04	-0.97	-0.96	32	1	33

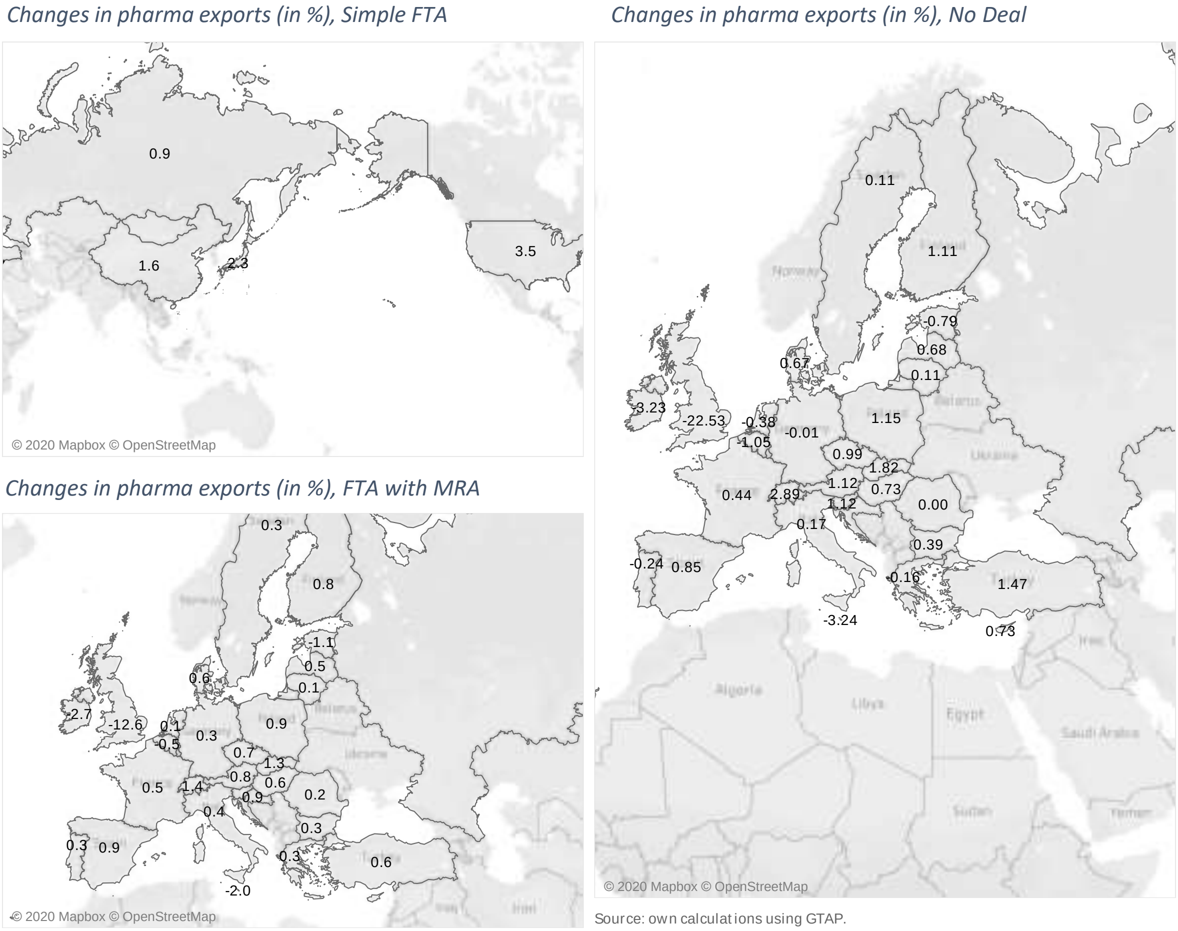
Countries	No Deal (%)	Simple FTA (%)	FTA with MRA (%)	Extra GDP Simple FTA compared to No Deal (€)	Extra GDP FTA with MRA compared to Simple FTA (€)	Extra GDP FTA with MRA compared to No Deal (€)
Luxembourg	-1.94	-1.88	-1.88	34	-1	34
Malta	-2.84	-2.75	-2.69	8	6	15
Netherlands	-1.08	-1.00	-0.98	622	143	765
Poland	-0.70	-0.64	-0.64	304	20	323
Portugal	-0.47	-0.44	-0.44	60	17	77
Romania	-0.52	-0.47	-0.46	93	11	104
Slovakia	-0.64	-0.55	-0.55	76	0	76
Slovenia	-0.31	-0.29	-0.29	9	-2	7
Spain	-0.35	-0.33	-0.33	261	87	348
Sweden	-0.59	-0.55	-0.55	196	41	237
EU27	-0.66	-0.61	-0.60	6.604	1.336	7.939
UK	-4.19	-3.99	-3.89	4.969	2.472	7.441
US	0.02	0.01	0.01	-362	-542	-904
Switzerland	0.05	0.00	0.03	-278	161	-117
Japan	0.06	0.05	0.05	-369	-82	-452
China	-0.08	-0.08	-0.07	595	1.071	1.666
Turkey	0.25	0.21	0.21	-263	0	-263

Source: author's calculations using GTAP. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

4.3 Impact on pharmaceutical exports

The effects of changes in tariffs and regulatory alignment depend on two economic transmission mechanisms that occur in parallel. First, because of an increase in trade costs (because of tariffs and/or lower levels of regulatory alignment) inputs for UK production from the EU become more expensive and inputs for EU production from the UK become more expensive. This trade cost increase will be lowest under the FTA with MRA scenario and highest in the No Deal scenario. Therefore, countries most exposed to each other will see the largest benefits from an FTA with MRA compared to a No Deal – as ties are not severed completely. Second, some EU Member States are competing in third markets (both inside the EU and outside) with the UK. The harder the Brexit, the more they benefit from a weaker UK competitive position. They benefit from a No Deal and continue to benefit from an FTA with MRA also, but to a lesser degree, because the UK's level of competitiveness is not negatively impacted as much (see **Figure 4**).

Figure 4 Changes in pharmaceutical exports in Europe under the different scenarios



Source: own calculations using GTAP.

Estimated changes in exports in the rest of the world, together with the average figures for EU27 countries are shown in Table 3. Exports to third countries go up as a result of EU27 and UK producers becoming less efficient and more expensive. The bigger the disruption to EU-UK pharmaceutical trade (i.e. Brexit/Simple FTA), the more the rest of the world benefits.

Table 3 Changes in pharmaceutical exports compared to baseline (in %), rest of the world

Countries (EU27 and Rest of the World)	No Deal (%)	Simple FTA (%)	FTA with MRA (%)
EU27	-1.22	-1.20	-0.85
UK	-22.53	-22.08	-12.58
US	3.46	3.48	1.45
Switzerland	2.89	0.24	1.38
China	1.65	1.64	0.85
Russia	0.98	0.93	0.65
Turkey	1.47	1.53	0.65

Source: author's calculations using GTAP. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

For the UK, all three scenarios lead to significant reductions in exports as in any of these possible futures, access to the EU internal market is severely reduced. The negative impact on pharmaceutical exports of 22.5%, however, can be reduced by 44% to a decrease of 12.6% in case of a future relationship that is based on an FTA with MRA.

Table 4 shows the long-term effects of the three scenarios on EU Member States, the UK and selected third country pharmaceutical exports for each of the scenarios.

- First, some EU Member State pharmaceutical exports are very negatively impacted by Brexit (e.g. Ireland, Belgium, The Netherlands (under No Deal and a Simple FTA), Germany (under a Simple FTA only) and Malta).

Table 4 Changes in pharmaceutical exports compared to baseline, and relative comparison to No Deal (in values, Euro million)

Scenarios	No Deal (€)	Simple FTA (€)	FTA with MRA (€)	Extra exports Simple FTA compared to No Deal (€)	Extra exports FTA with MRA compared to No Deal (€)
Austria	96	89	67	-7	-29
Belgium	-349	-362	-158	-13	191
Denmark	70	62	58	-8	-12
Finland	15	13	11	-1	-4
France	121	87	149	-35	28
Germany	-5	-94	191	-89	196
Hungary	26	23	20	-3	-5
Ireland	-4.123	-3.858	-3.407	265	716
Italy	30	14	61	-16	31
Malta	-12	-12	-8	0	5
The Netherlands	-48	-57	18	-10	65
Poland	31	27	25	-3	-6
Slovenia	26	25	18	-1	-9
Spain	85	68	94	-17	9
Sweden	7	1	19	-5	13
EU27	-3.992	-3.940	-2.803	52	1.189
UK	-4.132	-4.050	-2.308	82	1.824
Switzerland	1.160	96	555	-1.064	-605
United States	2.406	2.422	1.012	17	-1.394
Japan	103	105	48	3	-55
China	210	209	108	-1	-102

Source: author's calculations using GTAP; Countries with all effects below Euro 10 million have not been reported. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

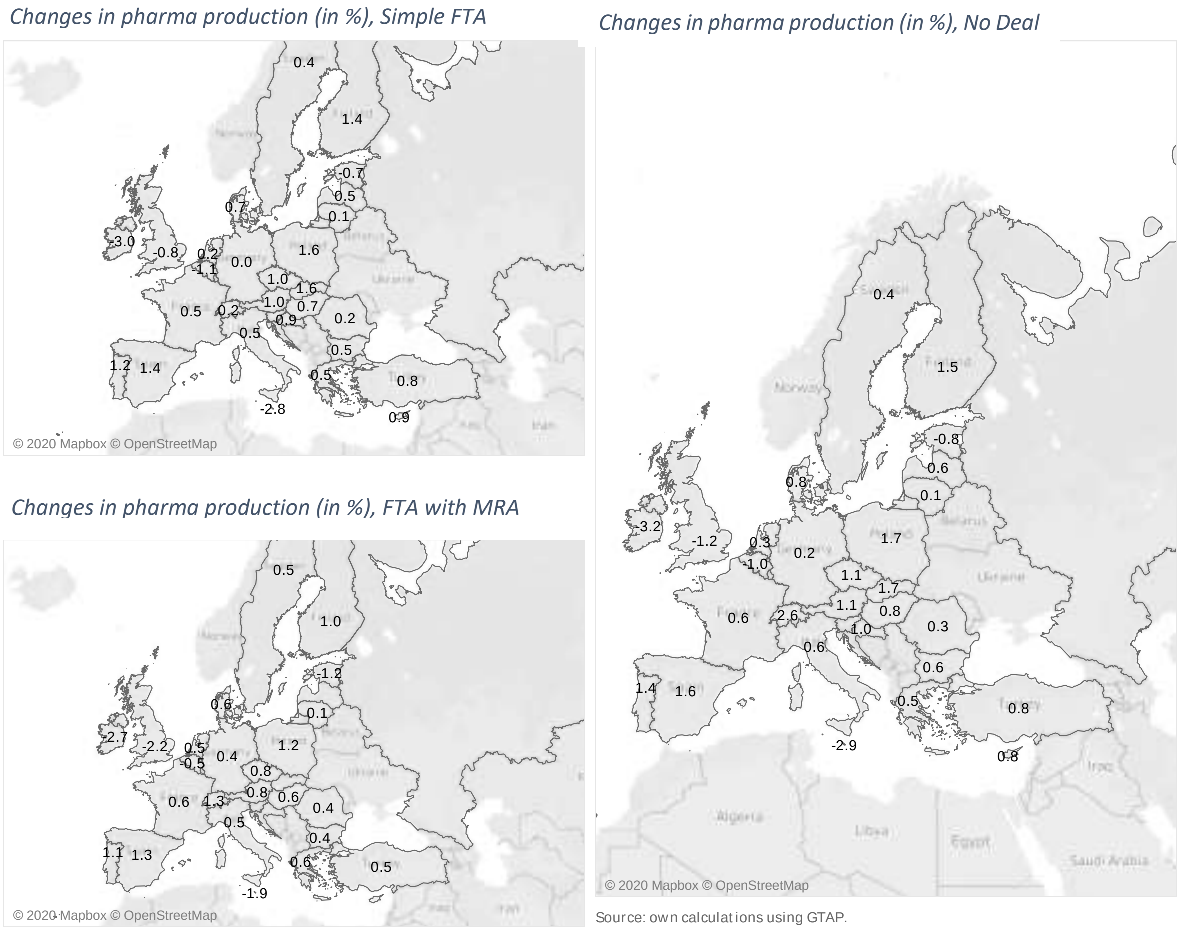
- Second, the rest of the world pharmaceutical exports (e.g. the US, Switzerland, and China) benefit from the EU27 – UK disintegration: rest of world pharmaceutical exports consistently go up to replace EU27 and UK exports globally. They benefit much less (i.e. improve much less their relative competitiveness vis-à-vis the EU27 and UK) in the case of an FTA with MRA.
- Third, for most EU Member States, a Simple FTA does not make a major difference to annual pharmaceutical exports compared to a No Deal scenario. Exceptions here are Ireland where a Simple FTA lessens the reduction of exports by Euro 265 million compared to a No Deal, and Germany where a Simple FTA actually leads to additional export losses compared to a No Deal of Euro 89 million annually). For both Ireland and Germany, an FTA with MRA is dramatically better than the other scenarios.

- Fourth, the FTA with MRA leads to higher European exports compared to a No Deal or Simple FTA scenario: EU27 exports are Euro 1.2 billion higher each year than under a No Deal.
- Fifth, for many EU Member States, exports are decidedly larger each year in the case of an FTA with MRA than under a No Deal or Simple FTA: Euro 716 million for Ireland, Euro 196 million for Germany, Euro 191 million for Belgium, Euro 65 million for The Netherlands, Euro 31 million for Italy, Euro 28 million for France, Euro 13 million for Sweden and Euro 9 million for Spain.
- Sixth, for the UK, though exports drop significantly under any scenario, an FTA with MRA leads to Euro 1.8 billion more exports annually than under a No Deal outcome.

4.4 Impact on pharmaceutical production

The estimated impact of Brexit on pharmaceutical output in Europe can be seen in **Figure 5**.

Figure 5 Changes in pharmaceutical output in Europe under the different scenarios



Source: own calculations using GTAP.

Countries which are estimated to experience a reduction in their exports also see declining levels of pharmaceutical production. However, unlike in the case of exports where the highest exports reductions take place under a No Deal, with output, the pattern is slightly more complex. For the EU27 as a whole, output drops by Euro 4.6 billion annually in case of a No Deal and by Euro 3.5 billion annually in case of an FTA with MRA. Clearly the FTA with MRA leads to higher EU pharmaceutical production than a No Deal. At a disaggregated level, the picture is more complex. For countries like Ireland, Belgium, and Malta, changes in output of the pharma sector follow the same pattern as exports: they decline as exports drop. Compared to a Simple FTA, there is a significant increase in pharmaceutical production via an FTA with MRA for six EU Member States (including France, Germany and Italy). In three EU Member States, there would be a production increase in a Simple FTA, compared to an FTA with MRA.

The effect is more complex for the UK. UK output in the sector is estimated to shrink under all three scenarios because of the loss of the current level of access to the EU (i.e. the EU Internal Market), but production declines a bit less under a simple FTA than under an FTA with MRA. This is driven by other EU countries' better access to the UK market under such agreement compared to a No Deal, resulting in competitive pressure on the industry in the UK, pushing out less efficient production, and thus a slight reduction in output of about 2.2% under such scenario. It is also supported by an increase in costs for inputs for production. Table 5 shows the long-term effects of the three scenarios on EU Member States, the UK and selected third country production (output) for each of the scenarios.

Table 5 Changes in pharmaceutical production compared to baseline, and relative comparison to No Deal (in Euro million)

Scenarios	No Deal (€)	Simple FTA (€)	FTA with MRA (€)	Extra output Simple FTA compared to No Deal (€)	Extra output FTA with MRA compared to No Deal (€)
Austria	101	94	70	-7	-31
Belgium	-353	-366	-164	-13	190
Czech Republic	24	22	17	-2	-7
Denmark	82	74	66	-9	-17
Finland	24	22	16	-2	-8
France	190	152	195	-39	4
Germany	112	17	264	-95	152
Hungary	31	28	23	-3	-8
Ireland	-4.139	-3.870	-3.431	270	708
Italy	125	106	120	-19	-6
Malta	-12	-11	-8	0	4
The Netherlands	40	29	67	-10	28
Poland	69	65	47	-4	-22
Portugal	21	19	17	-2	-4
Slovenia	28	26	18	-1	-9
Spain	211	190	175	-21	-36
Sweden	30	24	32	-6	3
EU27	-4.600	-4.456	-3.521	145	1.080
UK	-354	-236	-621	118	-268
Switzerland	1.465	115	735	-1.351	-730
United States	3.146	3.127	1.639	-20	-1.507
Japan	144	154	70	10	-74
China	210	220	61	10	-150

Source: author's calculations using GTAP; Countries with all effects below Euro 10 million have not been reported. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

- First, from the EU Member States Ireland, Belgium, Malta and Estonia are negatively impacted by Brexit. In Ireland output is Euro 4.1 billion lower annually and in Belgium this is Euro 353 million annually in case of a No Deal.
- Second, pharmaceutical production in other EU Member States benefits from Brexit in terms of production, because to lesser and larger degrees they take over production from the UK. Especially France and Spain, followed by Italy, Germany, Austria, and Denmark, are set to benefit. The gains are much larger under an FTA with MRA than under a No Deal scenario.
- Third, pharmaceutical producers in rest of the world countries like the US, Switzerland, and China benefit from the EU27 – UK disintegration. Production in the selected countries goes up to replace EU27 and UK production as both become less competitive globally. These third countries benefit less (i.e. improve much less their relative competitiveness vis-à-vis the EU27 and UK) in case of an FTA with MRA.
- Fourth, a Simple FTA does not make much difference in terms of production compared to a No Deal (except for Ireland where a Simple FTA leads to additional production worth Euro 270 million annually and for Germany where a Simple FTA leads to additional production losses compared to a No Deal of Euro 95 million each year).
- Fifth, the FTA with MRA leads to much higher levels of production in the EU27 compared to a No Deal or Simple FTA scenario. EU27 production will be Euro 1.1 billion higher each year than under a No Deal. Especially for Ireland, Germany, Belgium and The Netherlands, having an FTA with MRA is important for their domestic pharmaceutical industries.
- Sixth, for the UK, all three scenarios lead to less production in the UK. An FTA with MRA leads to Euro 268 million less production in the UK than under a No Deal. The reason for this result is that in the case of a No Deal, the UK economy will have to produce more domestically (and source more from outside the EU) to offset the decreased trade with the EU – leading to a more autonomous UK economy but cost pressures, via increased costs of inputs, will increase too; by 12.1% in the long run under a No Deal and by 6.1% in case of an FTA with MRA. The input costs for a No Deal are Euro 2.2 billion compared to a No Deal.

Table 6 Changes in pharmaceutical output compared to the baseline (in %), rest of the world

Countries (EU27 and Rest of the World)	FTA with MRA (%)	Simple FTA (%)	No Deal (%)
EU27	-0.99	-1.25	-1.29
UK	-2.15	-0.82	-1.23
US	0.99	1.90	1.91
Switzerland	1.29	0.20	2.57
China	0.02	0.07	0.07
Russia	0.49	0.61	0.63
Turkey	0.47	0.84	0.83

Source: author's calculations using GTAP. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

In the rest of the world, developments in pharmaceutical output (see Table 6) follow similar trends to those seen in the case of exports. Output increases in all other regions, again with a bigger rise taking place under scenarios that see a greater increase in trading costs between the UK and the EU (i.e. a No Deal).

4.5 Impact on costs of inputs

The UK's departure from the EU leads to weaker links between the EU27 and the UK. This is because of higher trade costs between the two blocks as a result of tariff and regulatory divergence. Part of the total cost increases in barriers are offset by sourcing inputs elsewhere (e.g. the rest of the world), but the costs of inputs will still rise in both the UK and the EU27. This increase in input costs mean a loss of competitiveness for the pharmaceutical sector in the EU and UK.

The effect on input costs for pharmaceuticals differs between the EU and UK, but also between EU Member States. The input cost increases are reported in **Table 8**. The largest estimated increase in input costs takes place in the UK, as the UK is the country most affected by increased trade barriers (in terms of trade shares). In the most extreme case, costs for inputs could rise by 12.1% under a No Deal, with about half that increase taking place under the scenario where an FTA with MRA is implemented. The benefit of an FTA with MRA compared to a No Deal from the perspective of limiting the input cost increases is significant and would amount to Euro 2.2 billion for the UK.

With increased trade costs, also in the EU27 input costs are estimated to increase, although to a lesser extent than the UK; with an average estimated rise of 0.5% - 0.8%. Somewhat higher increases are estimated to take place in those countries where final goods contain higher value-added shares from UK inputs (see Chapter 3). For example, in the Netherlands, with the highest share of UK value added in final of pharmaceutical goods, amounting to about 11% pre-Brexit (see **Figure 2**), input costs are estimated to increase by 2.4%. We also see that costs for inputs go up more than the EU average in Malta (+2.0%), Sweden (+1.8%), Ireland (+1.5%), Portugal (+1.3%), Spain (+1.3%), Greece (1.0%) and Finland (1.0%) in a No Deal scenario. These cost increases are roughly 40% lower in the case of an FTA with MRA. The benefit of an FTA with MRA from the perspective of limiting input cost increases amount to Euro 560 million annually. Especially for Belgium, France, Germany, Italy, Ireland, The Netherlands, Spain and Sweden the input cost increases (and thus negative competitive effects) are significant.

Table 8 Changes in input costs for pharmaceuticals (in %) and cost savings compared to No Deal (Euro, million per year)

Countries	No Deal (%)	Simple FTA (%)	FTA with pharma agreement (%)	Input cost savings Simple FTA compared to No Deal (€)	Input cost savings FTA with MRA compared to No Deal (€)
Austria	0,46	0,45	0,30	0,3	8,9
Belgium	0,61	0,58	0,49	8,7	32,3
Bulgaria	0,73	0,73	0,42	-0,1	3,2
Croatia	0,27	0,28	0,15	-0,1	1,0
Cyprus	0,93	0,93	0,51	0,0	0,9
Czech Republic	0,86	0,86	0,52	0,0	12,0
Denmark	0,86	0,85	0,56	0,5	12,1
Estonia	0,30	0,31	0,18	0,0	0,4
Finland	1,02	1,02	0,58	0,0	10,2
France	0,70	0,69	0,47	3,0	64,2
Germany	0,58	0,58	0,37	0,8	88,2
Greece	1,03	1,02	0,62	0,2	13,1
Hungary	0,75	0,76	0,43	-0,2	9,2

Countries	No Deal (%)	Simple FTA (%)	FTA with pharma agreement (%)	Input cost savings Simple FTA compared to No Deal (€)	Input cost savings FTA with MRA compared to No Deal (€)
Ireland	1,45	1,44	0,87	0,3	12,6
Italy	0,69	0,68	0,43	1,1	57,8
Latvia	0,17	0,18	0,10	-0,1	0,4
Lithuania	0,27	0,28	0,15	-0,1	0,9
Luxembourg	0,15	0,15	0,10	0,0	0,2
Malta	2,02	2,00	1,15	0,0	1,4
Netherlands	2,36	2,34	1,36	1,2	75,5
Poland	0,98	0,98	0,58	0,1	24,8
Portugal	1,32	1,31	0,80	0,4	16,5
Romania	0,77	0,77	0,46	0,0	9,0
Slovakia	0,27	0,28	0,15	-0,2	1,7
Slovenia	0,50	0,50	0,31	0,0	1,6
Spain	1,25	1,23	0,76	2,1	76,7
Sweden	1,77	1,76	1,03	0,4	29,5
EU27	0,82	0,82	0,52	18,4	564,4
United Kingdom	12,12	12,01	6,14	39,1	2.202,5
Switzerland	0,26	0,01	0,21	28,7	5,4
US	0,36	0,33	0,30	47,9	108,6
Japan	0,15	0,13	0,11	12,1	22,8
Turkey	0,26	0,24	0,20	0,9	2,5
China	0,10	0,09	0,08	26,9	39,2
Russia	0,18	0,18	0,14	0,4	7,9

Source: author's calculations using GTAP. Colour codes: the darker orange/red, the more negative the effects; the darker green, the more positive the effects; grey areas reflect no significant effects.

5 Overall conclusions

Using Multi-Region Input Output (MRIO) analysis and a Computable General Equilibrium (CGE) model (as the European Commission uses for evaluating trade agreements), quantitative estimates are provided in this report of the impact of Brexit on the EU27, UK and third countries with respect to scenarios for the pharmaceutical industry. Three scenarios were explored, with different depths of trade agreement between the EU and the UK.

Table 9 Summary of scenarios

Scenarios	Scenario Description
No Deal	EU and UK fail to agree to a deal; the two parties trade on WTO terms from 2021.
Simple FTA	EU and UK agree a limited Free Trade Agreement (FTA) covering all tariffs across sectors from 2021.
FTA with MRA	A deeper FTA with zero tariffs and NTMs at 50% of No Deal levels on pharmaceutical trade between the EU and UK, notably via a Mutual Recognition Agreement on pharmaceutical GMP inspections and batch testing (GMP MRA).

All three scenarios depart from the same baseline, the current economic and trade policy situation (2018 data) and show long-term impact (2030 and beyond) per year.

5.1 Overall conclusions

Given the size asymmetry between the UK and the EU markets, and the relative importance in terms of sourcing and supplying inputs and final goods for each other's markets, the UK is impacted more strongly by Brexit than the EU, also in the most ambitious cooperation scenario (the FTA with MRA). The UK pharmaceutical sector is estimated to be impacted more significantly than the EU one, on average, but there is substantial heterogeneity between EU countries, with some countries' pharma sectors, such as Ireland, Belgium, Germany or Malta, being impacted more negatively by Brexit.

Value-added links between economies

- For every unit of medicine sold in the UK, 45% of the value is created in the EU. This would drop to 35% in a No Deal, and to 40% in an FTA with MRA.
- For every unit of medicine sold in the EU, 5% of the value is created in the UK, ranging from 2% in Latvia to 11% in The Netherlands, 9% in Malta and Sweden, and 7% in Ireland, Spain and Portugal. The UK value-added share in the EU would drop from 5% to 3% in a No Deal, but to 4% with an FTA with MRA.
- Value-added for both EU and UK will shift to the rest of the world (increasing from 18.6% to 19.3% for the EU and from 11.8% to 12.3% for the UK).

Macro-economic effects

- An FTA with MRA is the most beneficial scenario for both the UK and the EU. The report shows a significant difference in reducing the negative impact on GDP, exports and production for the EU and UK compared to the other scenarios.
- Without the FTA with MRA, the EU and UK will be less competitive relative to the US, Japan, Switzerland, and China. Third countries benefit most from a No Deal scenario. Europe (EU and UK) will increasingly source from these countries benefitting global competitors in GDP, exports and production.

- Weaker economic ties between the EU and UK will lead to higher costs for both as they will no longer source products as efficiently from each other or from third countries.
- The Simple FTA matters. In the long-term, the EU would be €6.6 billion better off each year than in a No Deal, while the UK would be €5.0 billion better off than in a No Deal. However, for the pharmaceutical industry a Simple FTA does not significantly differ from a No Deal in terms of exports or production as medicines are already traded almost tariff-free. EU exports will be €1.1 billion higher annually in an FTA with MRA compared to a Simple FTA, and EU pharmaceutical production will be almost €1.0 billion higher annually.

5.2 Conclusions for the European Union

- EU nominal GDP will be €1.3 billion higher annually in an FTA with MRA, compared to a No Deal.
- EU pharmaceutical exports are expected to drop by 1.2% in case of a No Deal, and by 0.9% in case of an FTA with MRA. This is a difference of €1.2 billion annually.
- Exports from Ireland, Germany, Belgium are hit hardest under a No Deal or a Simple FTA. Irish medicines exports would be €716 million lower annually compared with an FTA with MRA; German pharma exports €196 million; Belgian exports €191 million; and Dutch exports €65 million lower.
- For other EU Member States like France, Italy, Spain and Sweden, an FTA with MRA is also more positive for these countries' annual exports than a No Deal.
- Pharmaceutical production in the EU27 would be negatively impacted by a No Deal to an amount of €4.6 billion per year (especially in Ireland and Belgium). But the EU would be €1.1 billion per year less worse off in case of an FTA with MRA. EU Member States whose pharma production would be better off under an FTA with MRA than a No Deal include Belgium, France, Germany, Ireland, Malta, The Netherlands, Romania, and Sweden.
- In terms of GDP, exports and production, the FTA with MRA is economically a significantly better outcome than other scenarios for the EU and hurts EU global competitiveness less. The EU is impacted less in absolute and relative terms than the UK.

5.3 Conclusions for the United Kingdom

- For the UK, the difference between a No Deal and an FTA with MRA is significant.
- UK nominal GDP will be €2.5 billion per year less worse off annually in an FTA with MRA compared to a No Deal.
- UK pharmaceutical exports are expected to drop by 12.6% in an FTA with MRA, while for a No Deal scenario this would be almost doubled to 22.5%. This is a difference of €1.8 billion annually.
- In all three scenarios, the UK will experience losses in production in the UK (-1.2%, -0.8% and -2.2% for No Deal, Simple FTA and FTA with MRA respectively). This amounts to losses between €236 million to €621 million per year.

5.4 Conclusions for the third countries

- Third countries benefit most from a loss in EU and UK competitiveness due to negative cost developments in the No Deal scenario.
- The US, Switzerland, Japan, and Turkey benefit in terms of nominal GDP from a No Deal, but less from an EU–UK FTA with MRA, as their relative competitive advantage will not be as large.

- US pharmaceutical exports go up by 3.5% (€2.4 billion) in case of a No Deal / Simple FTA but by much less – 1.5% (€1.0 billion) – in an EU-UK FTA with MRA. Similar relative export boosts happen for Switzerland and (+2.9%), for China (+1.7%) and Turkey (+1.5%).
- Pharmaceutical production in third countries will go up to replace EU and UK production, as both become less competitive globally. For example, for Switzerland, production goes up by €1.5 billion (+2.6%) under a No Deal and US production rises by €3.1 billion (+1.9%). Under an FTA with MRA, Swiss and US production will only increase by half that amount. Also, Japan, Turkey, China, and Russia benefit.
- In terms of GDP, exports, and production, third countries benefit significantly from the loss of competitiveness of both EU and UK. They will to some extent replace the EU and UK on global markets and become more important suppliers for Europe. In the FTA with MRA scenario the relative loss of European competitiveness and hence third country benefits, are much smaller.

This study finds there is a significant long-term economic rationale for the EU and UK to agree to an FTA with MRA compared to the No Deal and Simple FTA scenarios when looking at exports, production and global competitiveness. Without an FTA and MRA, both the EU and UK become less competitive compared to global competitors.

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7 Annex I.: Overview on technical aspects of the modelling

7.1 Overview of the economic modelling

Our quantitative strategy to estimate the economic effects of Brexit involves the use of a computable general equilibrium (CGE). This model, in turn, is calibrated using the GTAP database3, and an integrated assessment that builds on an econometric estimation of trade elasticities that determine the trade volume effects of the trade cost in Brexit. In particular, we measure three different types of trade costs: preferential tariffs and non-tariff measures (NTMs). The resulting structurally estimated general equilibrium model (SEGE model) ensures consistency between the empirically based estimates of the effects of trade agreements, and the subsequent modelling of those agreements.

7.2 The CGE model of global production and trade

We employ a computable general equilibrium (CGE) model with multiple countries, multiple sectors, intermediate linkages and multiple factors of production, as developed in Bekkers and Francois (2018) and Bekkers et al. (2018). Trade is modelled as in Eaton and Kortum (2002) with the remaining structure of the model largely following the standard GTAP model (Corong et al. 2017). The main difference from GTAP is the incorporation of the Eaton and Kortum demand structure, where we derive the gravity equation for our structural estimation of the trade elasticities and changes in trade costs, as discussed above, from this same model. The model set-up and calibration combine features of the older computable general equilibrium (CGE) models (cf. Dixon and Jorgenson, 2013), with the micro-foundations of the more recent quantitative trade models (see Costinot and Rodríguez-Clare, 2014, for an overview). This means that analytically we model trade linkages with the improved micro-founded Eaton and Kortum (2002) structure, while at the same time we have structurally estimated the trade parameters and relevant trade cost changes employing a gravity model derived from the same structural general equilibrium model. Thus, we employ a state-of-the-art CGE model that deals with recent academic criticism of standard CGE models –i.e. that models should be micro-founded based on recent trade theory and the main parameters of the model should be structurally estimated using the same underlying data (cf. Costinot and Rodríguez-Clare, 2014; Bekkers, Francois, and Rojas-Romagosa 2018).

Model simulations are based on a multi-region, multi-sector model of the world economy. Sectors are linked through intermediate input coefficients (based on national input-output and social accounting data) as well as competition in primary factor markets. On the policy side, it offers the option to implement tariff reductions, export tax and subsidy reduction, trade quota expansion, input subsidies, output subsidies, and reductions in NTM related trade costs. International trade costs include shipping and logistic services (the source of FOB-CIF margins) but can also be modelled as Samuelson-type deadweight (iceberg) trade costs. These deadweight costs can be used to capture higher costs when producing for export markets due to regulatory barriers or NTBs that raise costs.

In the model, there is a single representative composite household in each region, with expenditures allocated over personal consumption and savings. The composite household

[3] Version 10 with base year 2014. See Aguiar *et al.* (2019).

owns endowments of the factors of production and receives income by selling these factors to firms. It also receives income from tariff revenue and rents accruing from import/export quota licenses. Part of the income is distributed as subsidy payments to some sectors, primarily in agriculture.

The initial condition of any CGE model is that supply and demand are in balance at some equilibrium set of prices and quantities where workers are satisfied with their wages and employment, consumers are satisfied with their basket of goods, producers are satisfied with their input and output quantities and savings are fully expended on investments. Adjustment to a new equilibrium, governed by behavioural equations and parameters in the model, are largely driven by price equations that link all economic activity in the market. For any perturbation to the initial equilibrium, all endogenous variables (i.e. prices and quantities) adjust simultaneously until the economy reaches a new equilibrium. Constraints on the adjustment to a new equilibrium include a suit of accounting relationships that dictate that in aggregate, the supply of goods equals the demand for goods, total exports equal total imports, all (available) workers and capital stock is employed, and global savings equals global investment. Economic behaviour drives the adjustment of quantities and prices given that consumers maximise utility given the price of goods and consumers' budget constraints, and producers minimise costs, given input prices, the level of output and production technology.

In the structural general equilibrium model, the "whole" economy for the relevant aggregation of economic agents is specified as a set of simultaneous equations. This means that the entire economy is classified into production and consumption sectors. These sectors are then modelled collectively. Production sectors are explicitly linked together in value-added chains from primary goods, through higher stages of processing, to the final assembly of consumption goods for households and governments. These links span borders as well as industries. The link between sectors is both direct, such as the input of steel into the production of transport equipment, and also indirect, as with the link between chemicals and agriculture through the production of fertilizers and pesticides. Sectors are also linked through their competition for resources in primary factor markets (capital, labour, and land). The general conceptual structure of a regional economy in our structural general equilibrium model is detailed in Figure I.1 and Figure I.2.

On the production side, firms produce output, employing land, labour, capital, and natural resources and combine these with intermediate inputs, within each region/country. In technical terms, we model a combination of value added and intermediate inputs, where intermediates (both imported and domestic) are combined in fixed proportions along with value added (known as a Leontief function). Value added itself (e.g. labour and capital) involves what is known as a CES functional form. Firm output is then purchased by consumers, government, the investment sector, and by other firms, and detailed in Figure I.2. Firm output can be and is also sold for export. In the model, arable land is only employed in the agricultural sectors, while capital and labour (both skilled and unskilled) are mobile between all production sectors. While capital is assumed to be fully mobile within regions, land, labour and natural resources are not.

In the experiments themselves, we follow the literature and employ recursive dynamics to link changes in investment expenditure to changes in capital stocks. This involves a fixed savings rate, with changes in savings following from changes in income levels. This change is then transmitted into investment and hence into changes in capital stocks (see Francois, McDonald, and Nordstrom, 1996; as well as Bekkers, et al., 2018; for technical discussions).

Figure I.1 Production Structure in the CGE model

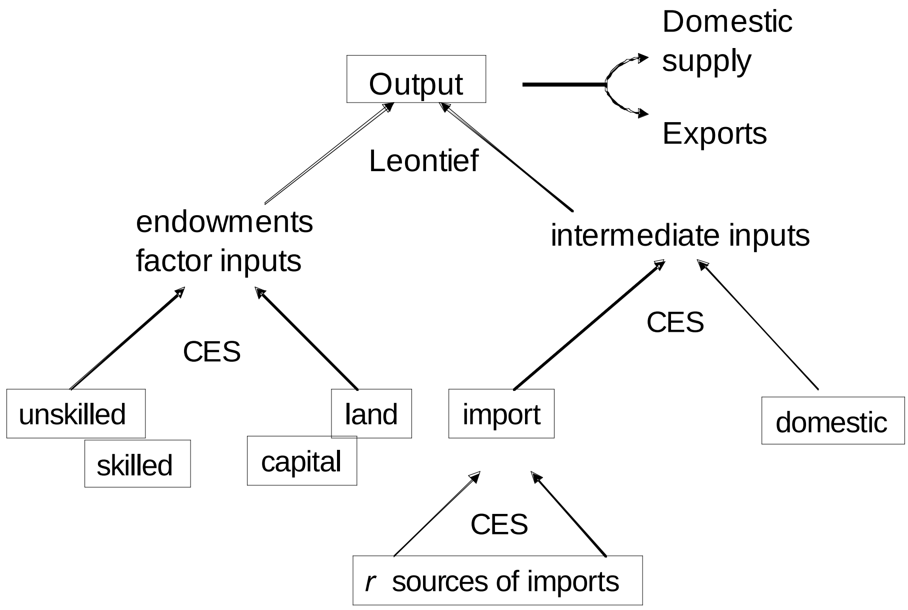
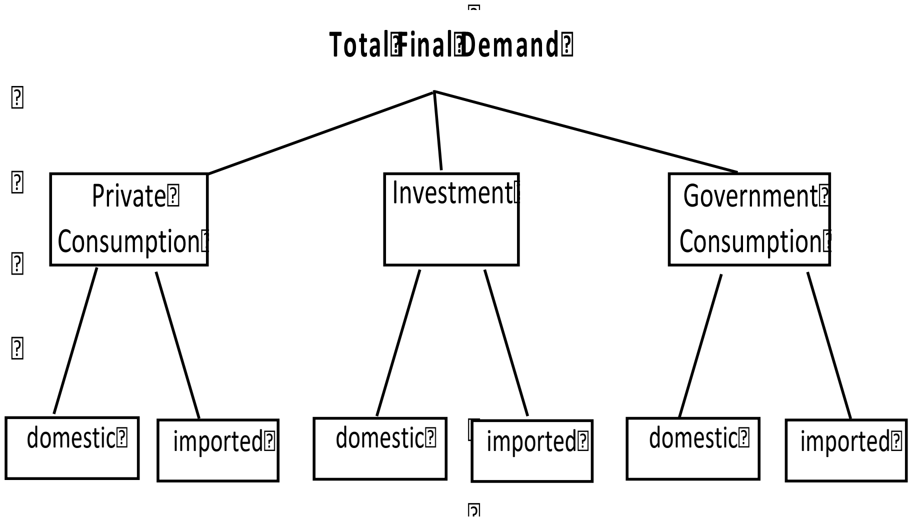


Figure I.2 Consumption Structure in the CGE model



For the purpose of defining the scenarios, trading costs are modelled as in ECORYS (2009), CEPR (2012), and Egger, et al. (2015), meaning iceberg trade cost reductions. In the case of goods, benchmark values for trade cost reductions are based on gravity-based estimates of the trade cost from ECORYS (2009), except where estimates are unavailable. Where unavailable from the ECORYS/CEPR studies, we use estimates from Egger et al. (2015). To fit our global data to the theoretical model, following Egger and Nigai (2015) and Bekkers and Francois (2018), total trade costs and technology parameters are fit from actual import shares (calibration), imposing an exact fit.

Taxes are included at several levels in the modelling. Production taxes are placed on intermediate or primary inputs, or on output. Tariffs are levied at the border. Additional internal taxes are placed on domestic or imported intermediate inputs and may be applied at differential rates that discriminate against imports. Where relevant, taxes are also placed on exports, and on primary factor income. Finally, where relevant (as indicated by social accounting data) taxes are placed on final consumption and can be applied differentially to consumption of domestic and imported goods.

On the production side, in all sectors, firms employ domestic production factors (capital, labour and land) and intermediate inputs from domestic and foreign sources to produce outputs in the most cost-efficient way that technology allow. Perfect competition is assumed in all sectors, but products from different regions are assumed to be imperfect substitutes.

In the standard GTAP model, tariffs and tariff revenues are explicit in the GTAP database, and therefore in the core model. However, NTMs affecting goods and services trade, as well as cost savings linked to trade facilitation, are not explicit in the database and hence a technical coefficient must be introduced to capture these effects. For this, we instead model NTMs as a mix of dead weight or iceberg costs, and rents generated by these NTMs. In formal terms, dead-weights costs capture the impact of non-tariff measures on the price of imports from a particular exporter due to destination-specific changes in costs for production and delivery.

7.3 Underlying data

The model employs version 10 of the GTAP database, which is benchmarked to the year 2014 (Aguiar et al. 2019). The GTAP database is a global multi-regional input-output (GMRIO) database that has extensive and comprehensive economic data for 141 countries/regions and 67 production sectors. This database provides disaggregated data for sectoral production, consumption, taxes and subsidies, trade, government finances, labour variables for different skill levels, and data on other production factors.

Tariffs reflect the most recent applied rates, as incorporated in the GTAP database, as of 2014. We update this information by incorporating implemented FTAs as of today. Since FTA usually create structural effects in the economies involved, CGE analyses are usually medium to long-term economic assessments. In this regard, we employ the most recent GTAP database (version 10 with base year 2014) as our main data source, and project this database to 2018 using OECD and UN macroeconomic and population projections, respectively. These projections to 2018 constitute our "baseline" scenario, which is a business-as-usual scenario without trade policy effects. We then define the Brexit scenario and simulate the trade policy changes expected from the agreement. Then, the economic effects of Brexit are the quantified differences between the “baseline” equilibrium (before the policy change) and the “scenario” equilibrium after the policy change.

7.4 Structural gravity estimates of NTMs and trade elasticities

For the purpose of defining scenarios, trading costs associated with NTMs are modelled by extension of the gravity modelling in ECORYS (2009), CEPR (2012), and Egger et al. (2015), meaning iceberg trade cost reductions. In the case of both goods and services, benchmark values for trade costs and for cost reductions are based on gravity-based estimates of the trade cost reductions realized under different types of PTAs, as classified by level of ambition. For this purpose, our gravity model data includes a version of the DESTA database indicators of PTA depth (Dür et al. 2014). Algebraically, our estimator is a two-stage Poisson, where the first stage is used to control for endogeneity of PTAs, as developed in Egger et al. (2015). Actual trade elasticity estimates are based on the data used in our computable model (the most recent are GTAP10, benchmarked to 2014), at the full level of sector aggregation for tradable sectors (56 sectors), and for all regions. We use tariff data to estimate trade price elasticities for goods, and World Bank STRI-based data for services to obtain price elasticities for services (where we also work, in some specifications, with trade cost estimates from Jafari and Tarr , 2015). We should stress that in general, we find that existing PTAs with services components offer minimal effective market access concessions in services (apart from the EU itself). This is consistent with the general "sense of the literature" in this regard.

Technically, the gravity model of trade can be generalized for a broad class of trade models as follows (see Head and Mayer, 2015):

$$v_{k,i,j} = A_{l,i} B_{k,i,j} C_{k,j} D_{k,j}$$

where $v_{k,i,j}$ is the value of trade in sector k originating in source country i and sold to destination country j. The terms $A_{k,i}$, $B_{k,i,j}$, $C_{k,j}$ and $D_{k,j}$ are source country, pairwise, and destination country determinants of trade flows. Frequently, the source and destination county effects are controlled for with importer and exporter fixed effects, with emphasis then placed on the pairwise role of factors like distance, tariffs, and trade agreements. We distinguish between terms $C_{k,j}$ and $D_{k,j}$ because it is sometimes useful to separate destination demand effects from other destination related variables. The table below maps the general equation (1) to specific standard empirical trade models.

Pairwise gravity specifications in standard empirical models

	B_{ij}
Armington	services $(\tau_{ij} S_{ij})^{1-\sigma}$ goods $(T_{m,ij} T_{x,ij} \tau_{ij} S_{ij})^{1-\sigma}$
Krugman-Ethier	services $(\tau_{ij} S_{ij})^{1-\sigma}$ goods $(T_{m,ij} T_{x,ij} \tau_{ij} S_{ij})^{1-\sigma}$
Melitz	services $(\tau_{ij} S_{ij})^{-\theta} f_{ij}^{1-\frac{\theta}{(\sigma-1)}}$ goods $(\tau_{ij} T_{x,ij} S_{ij})^{-\theta} f_{ij}^{1-\frac{\theta}{(\sigma-1)}} T_{m,ij}^{1-\sigma\frac{\theta}{(\sigma-1)}}$
Eaton-Kortum	services $(\tau_{ij} S_{ij})^{1-\sigma}$ goods $(T_{m,ij} T_{x,ij} \tau_{ij} S_{ij})^{1-\sigma}$
$T_{m,ij}$	bilateral import tariff multiplier $T_{m,ij} = (1 + t_{m,ij})$
	where $t_{m,ij}$ is the import tax rate
$T_{x,ij}$	bilateral export tax multiplier $T_{x,ij} = (1 + t_{x,ij})$
	where $t_{x,ij}$ is the export tax rate
S_{ij}	bilateral distance cost multiplier $S_{ij} = (1 + s_{ij})$
	where s_{ij} is the shipping rate
σ	elasticity of substitution in demand
f_{ij}	firm fixed cost parameter entering j from i in Melitz model
τ_{ij}	actual iceberg costs between i and j
θ	Pareto shape parameter in Melitz model

Note that with an assumption of granularity, meaning $\theta = (\sigma - 1)$, the tariff elasticity and iceberg (NTM) elasticities in Melitz collapse to the otherwise common parameterization of the Armington, Krugman-Ethier, and Eaton-Kortum models.

In computable models such as the GTAP model and recent structural gravity models, a version of equation (1) is explicitly incorporated in log or proportional change form:

$$\widehat{v_{i,s,d}} = \widehat{A_i} + \widehat{B_{ij}} + \widehat{C_j}$$

where $\hat{y} = \frac{dy}{y} = d \ln y$. In estimating trade elasticities and the role of NTBs, we expand the term B_{ij} as follows:

$$B_{k,ij} = \sum_z \beta_{k,z} x_{k,i,j}$$

where the terms β_k are coefficients to be estimated, and x_{ij} are pairwise explanatory variables.

In formal terms, we follow Santos Silva and Teneyro (2006), and Egger et al. (2011, 2015) in employing a generalized-linear exponential-family model for estimating gravity models. One merit of such models is that, unlike ordinary least squares on the log-transformed model, they obtain consistent parameters in the presence of heteroskedasticity even if it is unknown whether the disturbance term is log-additive or level-additive. Furthermore, in line with Terza (1998, 2009), Greene (2002, 2012), Terza et al. (2008), and Egger et al. (2011, 2015) we apply a control-function approach, which is capable of absorbing the endogeneity problem and obtaining consistent parameter estimates, including the partial treatment effects of interest.

Formally, in estimating equation (1) we represent $v_{k,i,j}$ as the dependent variable and specify it as an exponential function of a linear index of the form:

$$v_{k,ij} = \exp\left(\sum_z \beta_{k,z} x_{z,k,i,j} + a_{k,i} + c_{k,j} + c(z_{k,ij})\right) u_{k,ij}$$

where $x_{k,z,ij}$ is a vector of observable (log) pairwise trade-cost measures z (such as log distance, tariffs, and others) at industry level, β_k is a conformable parameter vector, $\{a_{k,i}, c_{k,j}\}$ catch-all measures of exporter- and importer-specific factors (estimated as parameters on i-specific and j-specific binary indicator variables, respectively). Moreover,

$$c(z_{k,ij}) = h_{k,ij} a_h = (h_{1,k,ij}, \ldots, h_{Dk,,ij}) a_h,$$

is a control function used to control for endogeneity if trade agreement depth, which is derived from the assumption of multivariate normality of the disturbances between the processes of selecting into depth and the stochastic term about $v_{k,i,j}$.

Critically, we also include trade with self (domestic shipments) in our regressions. This allows us to identify home market effects (including various interactions with home trade). Because we work with our structural model data (the GTAP database) we have values for trade with self at the same level of aggregation as trade with other countries. A similar approach is also followed in recent applications based on the WIOD database. Note that because we control for destination and pairwise effects in our regression analysis, the exporter fixed effect terms provide, on the basis of trading partner demand, an estimate of the reduced form supply factors determining demand for products indexed i,k. For services, we combine STRI data from the World Bank and Francois et al. (2015a), alongside trade cost estimates from Jafari and Tarr (2015) in lieu of tariff data to estimate price elasticities for services (see Egger et al., 2019).

We use the estimated trade equations to predict home market demand in the absence of pairwise trade costs (tariffs) and controlling for other pairwise differences $\beta_k x_{ij}$, but without the home trade effect. The result is a predicted value for home trade $\widetilde{v_{k,JJ}}$ which can be compared to the actual value of home trade v_{idd} to obtain an estimate of MFN-based trade costs (those not controlled for with pairwise variables) in our regressions based on estimated home bias. Taking the estimated price elasticity from out tariff coefficient, $\beta_{k,T}$, the MFN level trade cost $\gamma_{k,j}$ is:

$$\gamma_{k,j} = \left(e^{\left(\frac{\widetilde{v_{k,JJ}}}{v_{k,jj}} \beta_{k,T}{}^{-1} \right)} - 1 \right) \times 100.$$

Similarly, comparison of predicted pairwise MFN trade and actual trade from the stage two estimation of equation (4) provides a basis for mapping pairwise trade cost reductions at sector and country level to depth of existing PTAs.

Importantly, the trade elasticities, which are one of the most important parameters in the model, are estimated econometrically from the same underlying trade data used in the model. In addition, other parameters (e.g. share terms) are also fitted from the actual model data, and some elasticities (specifically substitution in value added) taken for the literature. Following Egger and Nigai (2015) and Bekkers et al. (2018), total trade costs and technology parameters are calibrated using actual import shares, imposing an exact fit. Changes in trade costs (the structural general equilibrium experiments themselves) follow from our gravity-based estimates of trade costs as discussed above.

8 Annex II. Results tables

Table II.1 EU28 basic pharmaceutical total cost shares in production (TiVA basis)

	home share of total VA in production				EU27 share of total VA in production				UK share of total VA in production				Swiss share of total VA in production				RoW share of total VA in production			
	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA
Austria	47.1	47.4	47.4	47.4	25.6	25.2	25.2	25.2	1.7	1.2	1.2	1.3	4.6	4.4	4.4	4.3	20.9	21.8	21.8	21.8
Belgium	41.7	41.9	41.9	41.9	27.6	27.0	27.0	27.0	2.5	1.7	1.8	1.8	1.2	1.1	1.1	1.1	27.0	28.3	28.2	28.2
Bulgaria	59.3	59.3	59.3	59.3	22.7	23.1	23.1	22.9	1.6	1.0	1.1	1.2	1.1	1.1	1.1	1.1	15.3	15.5	15.5	15.5
Croatia	63.5	63.6	63.6	63.6	21.1	21.3	21.3	21.2	1.1	0.8	0.8	0.8	1.1	1.1	1.1	1.1	13.1	13.3	13.3	13.3
Cyprus	73.2	73.3	73.3	73.3	12.7	13.1	13.0	13.0	1.7	1.1	1.1	1.2	0.5	0.6	0.6	0.5	11.8	12.0	12.0	12.0
Czech Republic	57.3	57.3	57.3	57.3	25.0	25.3	25.2	25.1	2.0	1.3	1.3	1.4	1.0	1.0	1.0	1.0	14.7	15.1	15.1	15.1
Denmark	68.6	68.6	68.6	68.6	15.7	16.1	16.1	16.1	1.9	1.3	1.3	1.4	0.5	0.5	0.5	0.5	13.3	13.5	13.5	13.5
Estonia	38.5	38.3	38.3	38.3	34.6	35.6	35.5	35.5	2.5	1.2	1.3	1.3	1.1	1.1	1.1	1.1	23.3	23.8	23.8	23.8
Finland	67.7	67.7	67.7	67.7	17.1	17.5	17.5	17.4	1.5	0.9	0.9	1.0	0.6	0.6	0.6	0.6	13.1	13.3	13.3	13.3
France	70.2	70.4	70.4	70.4	13.8	13.7	13.7	13.7	1.5	0.9	1.0	1.0	0.8	0.8	0.8	0.8	13.7	14.2	14.2	14.1
Germany	68.2	68.4	68.4	68.4	13.1	13.0	13.0	12.9	1.7	1.2	1.2	1.3	1.9	1.8	1.8	1.8	15.2	15.6	15.6	15.6
Greece	73.6	73.6	73.5	73.6	11.7	11.9	11.9	11.8	1.1	0.7	0.8	0.8	0.8	0.9	0.9	0.8	12.8	13.0	13.0	12.9
Hungary	52.7	52.7	52.7	52.7	28.5	29.0	28.9	28.8	2.0	1.3	1.3	1.5	1.0	1.0	1.0	1.0	15.8	16.0	16.0	16.0
Ireland	61.1	61.4	61.3	61.3	11.5	11.8	11.8	11.8	4.9	3.5	3.6	3.7	0.7	0.7	0.7	0.7	21.8	22.6	22.6	22.5
Italy	60.4	60.5	60.5	60.6	19.2	19.2	19.2	19.1	1.8	1.1	1.1	1.2	2.0	1.9	1.9	1.9	16.6	17.2	17.2	17.1
Latvia	68.2	68.2	68.2	68.2	17.2	17.4	17.4	17.4	1.0	0.6	0.7	0.7	0.9	0.9	0.9	0.9	12.8	12.9	12.9	12.9
Lithuania	57.9	57.9	57.9	57.9	24.0	24.2	24.2	24.1	1.3	0.8	0.9	0.9	0.9	0.9	0.9	0.8	16.0	16.2	16.2	16.2
Luxembourg	44.2	44.2	44.2	44.2	25.0	25.2	25.2	25.2	4.6	4.1	4.2	4.2	2.2	2.2	2.2	2.2	24.1	24.3	24.3	24.3
Malta	58.4	58.2	58.2	58.2	16.1	16.9	16.9	16.8	3.3	2.0	2.1	2.2	0.7	0.7	0.7	0.7	21.6	22.2	22.2	22.1
Netherlands	69.5	69.6	69.6	69.7	10.8	10.9	10.8	10.8	2.4	1.5	1.5	1.7	0.5	0.5	0.5	0.5	16.8	17.5	17.5	17.4
Poland	67.9	68.0	67.9	68.0	17.1	17.3	17.3	17.2	1.5	1.0	1.0	1.1	0.6	0.6	0.6	0.6	12.8	13.1	13.1	13.1
Portugal	67.2	67.2	67.2	67.2	18.6	19.0	18.9	18.9	1.5	0.9	1.0	1.1	0.6	0.6	0.6	0.6	12.1	12.2	12.2	12.2
Romania	62.4	62.4	62.4	62.4	21.8	22.1	22.1	22.0	1.5	1.0	1.0	1.1	1.4	1.4	1.4	1.4	12.9	13.1	13.1	13.0
Slovakia	58.0	58.0	58.0	58.0	26.9	27.1	27.1	27.1	1.1	0.8	0.8	0.8	1.4	1.4	1.4	1.4	12.6	12.7	12.7	12.7
Slovenia	63.0	63.0	63.0	63.0	19.0	19.1	19.1	19.1	1.2	0.8	0.8	0.9	1.7	1.7	1.7	1.7	15.1	15.4	15.4	15.4
Spain	67.9	68.1	68.1	68.1	12.9	12.8	12.8	12.8	1.9	1.2	1.3	1.4	0.9	0.9	0.9	0.9	16.4	16.9	16.9	16.9
Sweden	76.0	76.0	76.0	76.0	11.8	12.1	12.1	12.0	1.7	1.1	1.1	1.2	0.4	0.4	0.4	0.4	10.1	10.4	10.4	10.4
United Kingdom	78.6	79.1	78.9	79.3	10.2	7.9	8.2	8.3					0.6	0.8	0.8	0.6	10.6	12.2	12.1	11.7
EU27 average	**62.1**	**62.3**	**62.3**	**62.3**	**15.2**	**15.2**	**15.2**	**15.2**	**2.9**	**2.0**	**2.1**	**2.2**	**1.2**	**1.1**	**1.1**	**1.1**	**18.6**	**19.3**	**19.3**	**19.2**

Table II.2 EU28 basic pharmaceutical imported cost shares in production (TiVA basis)

	EU27 share of imported VA in production				UK share of total VA in production				Swiss share of total VA in production				RoW share of total VA in production			
	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA
Austria	48.4	48.0	47.9	47.9	3.3	2.3	2.3	2.5	8.8	8.3	8.3	8.3	39.5	41.5	41.5	41.4
Belgium	47.4	46.5	46.4	46.4	4.3	2.9	3.0	3.1	2.0	1.9	1.9	1.9	46.3	48.6	48.6	48.5
Bulgaria	55.7	56.7	56.6	56.4	4.0	2.6	2.6	2.9	2.6	2.7	2.7	2.7	37.6	38.1	38.1	38.0
Croatia	57.9	58.4	58.3	58.3	3.0	2.1	2.1	2.2	3.1	3.1	3.1	3.0	36.0	36.5	36.5	36.4
Cyprus	47.6	48.9	48.8	48.6	6.2	4.2	4.3	4.5	2.0	2.1	2.1	2.1	44.2	44.9	44.8	44.8
Czech Republic	58.5	59.2	59.1	58.9	4.7	3.0	3.1	3.4	2.5	2.5	2.5	2.4	34.3	35.4	35.4	35.3
Denmark	50.0	51.3	51.2	51.1	6.0	4.1	4.2	4.3	1.7	1.7	1.7	1.7	42.3	42.9	42.9	42.9
Estonia	56.2	57.7	57.5	57.5	4.1	1.9	2.1	2.1	1.8	1.8	1.8	1.8	37.9	38.6	38.6	38.6
Finland	52.9	54.1	54.0	53.9	4.6	2.7	2.8	2.9	1.8	1.9	1.9	1.8	40.6	41.3	41.3	41.3
France	46.2	46.4	46.3	46.2	5.1	3.1	3.3	3.5	2.6	2.6	2.6	2.6	46.1	47.8	47.8	47.7
Germany	41.1	41.1	41.0	40.9	5.3	3.7	3.8	4.0	5.8	5.7	5.7	5.7	47.7	49.6	49.5	49.4
Greece	44.1	45.0	44.9	44.7	4.2	2.8	2.9	3.2	3.2	3.2	3.2	3.2	48.5	49.0	49.0	49.0
Hungary	60.2	61.2	61.2	61.0	4.2	2.8	2.8	3.1	2.2	2.2	2.2	2.2	33.4	33.8	33.8	33.7
Ireland	29.5	30.6	30.5	30.4	12.6	9.0	9.3	9.5	1.8	1.9	1.9	1.9	56.0	58.5	58.4	58.2
Italy	48.6	48.8	48.7	48.5	4.4	2.8	2.9	3.1	5.0	4.9	4.9	4.9	41.9	43.5	43.5	43.4
Latvia	54.0	54.7	54.6	54.6	3.0	2.0	2.1	2.1	2.7	2.7	2.7	2.7	40.3	40.6	40.6	40.6
Lithuania	57.0	57.5	57.4	57.3	3.1	2.0	2.0	2.2	2.0	2.0	2.0	2.0	38.0	38.5	38.5	38.5
Luxembourg	44.8	45.1	45.1	45.1	8.2	7.4	7.5	7.5	3.9	3.9	3.9	3.9	43.1	43.6	43.6	43.6
Malta	38.7	40.5	40.3	40.2	7.8	4.8	5.0	5.3	1.6	1.6	1.6	1.6	51.9	53.1	53.1	52.9
Netherlands	35.4	35.8	35.7	35.5	8.0	5.0	5.1	5.7	1.6	1.6	1.6	1.6	55.1	57.7	57.6	57.2
Poland	53.2	54.1	54.0	53.8	4.8	3.0	3.2	3.4	2.0	2.0	2.0	2.0	40.0	40.8	40.8	40.8
Portugal	56.6	57.9	57.8	57.6	4.7	2.9	3.0	3.3	1.8	1.9	1.9	1.9	36.9	37.4	37.4	37.3
Romania	58.0	58.8	58.8	58.6	4.1	2.7	2.8	3.0	3.7	3.7	3.7	3.7	34.2	34.7	34.8	34.7
Slovakia	64.0	64.7	64.6	64.5	2.6	1.8	1.9	1.9	3.4	3.4	3.4	3.4	30.0	30.2	30.2	30.2
Slovenia	51.3	51.7	51.6	51.6	3.1	2.2	2.2	2.4	4.7	4.6	4.6	4.6	40.9	41.5	41.5	41.5
Spain	40.3	40.3	40.2	40.0	5.9	3.8	4.0	4.3	2.7	2.7	2.7	2.7	51.1	53.2	53.1	53.0
Sweden	49.2	50.5	50.4	50.1	7.0	4.6	4.7	5.1	1.6	1.6	1.6	1.6	42.2	43.3	43.3	43.2
United Kingdom	47.9	37.9	38.8	40.2					2.7	3.6	3.6	3.1	49.5	58.5	57.6	56.6
EU27 average	**40.1**	**40.5**	**40.4**	**40.3**	**7.7**	**5.3**	**5.5**	**5.7**	**3.1**	**3.0**	**3.0**	**3.0**	**49.1**	**51.2**	**51.1**	**51.0**

Table II.3 EU28 basic pharmaceutical total demand shares (TiVA basis)

	home share of total VA in production				EU27 share of total VA in production				UK share of total VA in production				Swiss share of total VA in production				RoW share of total VA in production			
	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA
Austria	2.3	2.2	2.2	2.2	38.6	36.7	36.7	36.6	3.1	2.0	2.0	2.3	14.9	14.0	14.0	13.9	41.1	45.1	45.1	44.9
Belgium	1.8	1.8	1.8	1.8	51.8	49.7	49.7	49.6	3.5	2.3	2.4	2.5	2.8	2.6	2.6	2.6	40.1	43.5	43.5	43.4
Bulgaria	9.2	9.2	9.2	9.2	61.3	62.4	62.3	61.9	4.7	2.9	2.9	3.5	4.6	4.6	4.6	4.6	20.3	20.9	20.9	20.8
Croatia	15.1	15.0	15.0	15.0	52.7	52.8	52.7	52.6	2.5	1.6	1.6	1.9	5.4	5.4	5.4	5.4	24.3	25.2	25.2	25.2
Cyprus	6.0	6.1	6.1	6.1	57.1	58.1	58.1	57.6	5.2	3.1	3.1	3.9	5.4	5.5	5.5	5.5	26.3	27.1	27.1	26.9
Czech Republic	4.1	4.1	4.1	4.1	59.8	59.8	59.8	59.3	5.1	3.1	3.1	3.8	3.8	3.8	3.8	3.7	27.2	29.3	29.3	29.1
Denmark	8.0	8.1	8.1	8.0	60.1	60.7	60.7	60.3	5.0	3.1	3.2	3.8	4.0	4.0	4.0	4.0	22.8	24.0	24.0	23.9
Estonia	1.9	1.8	1.8	1.8	71.3	71.5	71.5	71.3	2.6	1.6	1.7	1.9	4.7	4.7	4.7	4.7	19.5	20.3	20.3	20.3
Finland	8.4	8.3	8.3	8.2	52.1	52.1	52.1	51.6	5.7	3.4	3.4	4.3	5.7	5.6	5.6	5.6	28.2	30.6	30.6	30.3
France	10.9	10.8	10.8	10.7	46.1	45.0	45.0	44.8	4.4	2.7	2.7	3.2	3.2	3.1	3.1	3.1	35.4	38.5	38.4	38.2
Germany	19.9	19.5	19.5	19.4	35.0	34.0	34.0	33.9	3.9	2.4	2.5	2.9	8.0	7.8	7.8	7.7	33.2	36.3	36.3	36.1
Greece	4.3	4.4	4.4	4.4	62.2	63.4	63.3	62.8	5.8	3.6	3.6	4.4	7.4	7.5	7.5	7.4	20.2	21.2	21.2	21.0
Hungary	4.6	4.6	4.6	4.6	62.6	63.6	63.5	63.1	4.8	2.9	3.0	3.6	4.1	4.1	4.1	4.1	23.9	24.8	24.8	24.7
Ireland	5.2	4.9	4.9	4.8	30.6	29.0	29.0	28.7	7.3	4.0	4.0	5.2	2.5	2.3	2.3	2.3	54.4	59.8	59.8	59.0
Italy	15.4	15.2	15.2	15.2	42.5	41.8	41.8	41.5	4.4	2.7	2.7	3.2	7.6	7.4	7.4	7.4	30.1	32.9	32.9	32.7
Latvia	4.9	4.9	4.9	4.9	65.5	65.8	65.8	65.7	2.2	1.5	1.5	1.6	9.4	9.3	9.3	9.3	18.0	18.4	18.4	18.4
Lithuania	5.0	5.0	5.0	5.0	68.8	69.1	69.1	68.9	2.7	1.7	1.7	2.0	3.4	3.4	3.4	3.4	20.0	20.8	20.8	20.7
Luxembourg	13.9	13.8	13.8	13.8	54.2	54.1	54.1	54.0	3.4	2.6	2.6	2.7	1.7	1.6	1.6	1.6	26.8	27.9	27.9	27.8
Malta	2.7	2.8	2.8	2.7	43.0	44.6	44.6	43.8	9.5	5.6	5.6	7.3	3.2	3.3	3.3	3.3	41.7	43.7	43.7	42.9
Netherlands	11.7	11.5	11.5	11.3	30.4	29.8	29.8	29.2	11.2	6.2	6.2	8.1	2.9	2.9	2.9	2.8	43.8	49.6	49.6	48.6
Poland	13.8	14.0	14.0	13.9	53.1	53.5	53.4	53.0	5.6	3.4	3.4	4.2	3.3	3.3	3.3	3.3	24.1	25.9	25.9	25.7
Portugal	6.2	6.4	6.4	6.3	63.3	64.7	64.7	64.0	7.0	4.2	4.3	5.3	4.1	4.2	4.2	4.1	19.4	20.5	20.5	20.3
Romania	1.5	1.5	1.5	1.5	63.3	63.9	63.9	63.5	4.7	2.9	3.0	3.6	7.8	7.8	7.8	7.7	22.7	23.9	23.9	23.7
Slovakia	2.2	2.3	2.3	2.3	66.9	67.4	67.4	67.2	2.8	1.8	1.9	2.1	9.4	9.3	9.3	9.3	18.6	19.1	19.1	19.1
Slovenia	7.0	6.9	6.9	6.9	46.8	46.5	46.5	46.3	3.4	2.2	2.2	2.6	10.5	10.4	10.4	10.3	32.3	34.0	34.0	33.9
Spain	7.2	7.1	7.1	7.0	42.9	41.7	41.7	41.3	6.6	3.8	3.9	4.8	4.1	4.0	4.0	3.9	39.2	43.4	43.4	43.0
Sweden	5.7	5.8	5.8	5.7	55.8	56.5	56.5	55.6	8.9	5.2	5.2	6.6	3.1	3.1	3.1	3.0	26.6	29.5	29.5	29.1
United Kingdom	26.9	32.6	32.6	29.3	45.4	34.6	34.7	39.8					3.7	4.5	4.5	4.0	24.0	28.2	28.1	26.9
EU27 average	**12.2**	**12.0**	**12.0**	**11.9**	**44.8**	**44.3**	**44.2**	**43.9**	**5.0**	**3.0**	**3.1**	**3.7**	**5.7**	**5.5**	**5.5**	**5.5**	**32.3**	**35.2**	**35.2**	**34.9**

Table II.4 EU28 basic pharmaceutical imported demand shares (TiVA basis)

	EU27 share of imported VA in production				UK share of total VA in production				Swiss share of total VA in production				RoW share of total VA in production			
	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA	benchmark	hard Brexit	FTA	FTA with MRA
Austria	39.5	37.6	37.5	37.4	3.2	2.0	2.1	2.4	15.2	14.3	14.3	14.2	42.1	46.1	46.1	46.0
Belgium	52.8	50.6	50.6	50.5	3.6	2.4	2.4	2.6	2.8	2.7	2.7	2.7	40.8	44.3	44.3	44.2
Bulgaria	67.5	68.7	68.7	68.2	5.1	3.2	3.2	3.9	5.0	5.1	5.1	5.0	22.3	23.0	23.0	22.9
Croatia	62.0	62.1	62.0	61.9	3.0	1.9	1.9	2.2	6.4	6.3	6.3	6.3	28.6	29.7	29.7	29.6
Cyprus	60.7	61.9	61.9	61.3	5.5	3.3	3.3	4.2	5.8	5.9	5.9	5.8	28.0	28.9	28.9	28.7
Czech Republic	62.3	62.4	62.3	61.9	5.3	3.2	3.2	4.0	4.0	3.9	3.9	3.9	28.4	30.5	30.5	30.3
Denmark	65.4	66.1	66.0	65.6	5.5	3.4	3.5	4.1	4.4	4.4	4.4	4.4	24.8	26.1	26.1	25.9
Estonia	72.6	72.9	72.8	72.6	2.7	1.7	1.7	2.0	4.8	4.8	4.8	4.8	19.9	20.7	20.7	20.6
Finland	56.8	56.8	56.8	56.2	6.3	3.7	3.7	4.6	6.2	6.1	6.1	6.1	30.7	33.3	33.3	33.0
France	51.8	50.4	50.4	50.1	4.9	3.0	3.0	3.6	3.6	3.5	3.5	3.5	39.7	43.1	43.1	42.8
Germany	43.7	42.3	42.2	42.0	4.9	3.0	3.0	3.6	10.0	9.7	9.7	9.6	41.4	45.1	45.1	44.8
Greece	65.0	66.3	66.2	65.7	6.1	3.7	3.8	4.6	7.7	7.8	7.8	7.8	21.1	22.1	22.1	22.0
Hungary	65.6	66.6	66.6	66.1	5.0	3.1	3.1	3.8	4.3	4.3	4.3	4.3	25.1	26.0	26.0	25.8
Ireland	32.3	30.5	30.5	30.1	7.7	4.2	4.2	5.4	2.6	2.4	2.4	2.4	57.4	62.8	62.8	62.0
Italy	50.3	49.3	49.3	49.0	5.2	3.1	3.2	3.8	9.0	8.8	8.8	8.7	35.6	38.8	38.8	38.6
Latvia	68.9	69.2	69.2	69.1	2.3	1.5	1.6	1.7	9.8	9.8	9.8	9.8	19.0	19.4	19.4	19.4
Lithuania	72.5	72.8	72.7	72.5	2.9	1.8	1.8	2.1	3.6	3.6	3.6	3.6	21.1	21.9	21.9	21.8
Luxembourg	63.0	62.8	62.7	62.7	3.9	3.0	3.0	3.2	1.9	1.9	1.9	1.9	31.2	32.4	32.3	32.3
Malta	44.2	45.9	45.9	45.0	9.7	5.8	5.8	7.5	3.3	3.4	3.4	3.4	42.8	44.9	44.9	44.1
Netherlands	34.5	33.7	33.6	32.9	12.6	7.0	7.0	9.1	3.3	3.3	3.3	3.2	49.6	56.1	56.1	54.8
Poland	61.6	62.2	62.1	61.5	6.5	3.9	4.0	4.8	3.9	3.9	3.9	3.8	28.0	30.1	30.1	29.8
Portugal	67.4	69.1	69.1	68.3	7.5	4.5	4.6	5.6	4.4	4.5	4.5	4.4	20.7	21.9	21.8	21.7
Romania	64.3	64.9	64.9	64.4	4.8	3.0	3.0	3.6	7.9	7.9	7.9	7.9	23.0	24.2	24.2	24.1
Slovakia	68.5	69.0	68.9	68.8	2.9	1.9	1.9	2.2	9.6	9.6	9.6	9.5	19.0	19.6	19.6	19.5
Slovenia	50.3	50.0	50.0	49.8	3.7	2.3	2.4	2.8	11.3	11.1	11.1	11.1	34.8	36.5	36.5	36.4
Spain	46.3	44.9	44.9	44.4	7.1	4.1	4.2	5.2	4.4	4.3	4.3	4.2	42.2	46.7	46.7	46.2
Sweden	59.2	60.0	59.9	59.0	9.4	5.5	5.5	7.0	3.2	3.3	3.3	3.2	28.2	31.3	31.3	30.8
United Kingdom	62.1	51.4	51.5	56.3					5.1	6.7	6.7	5.7	32.8	41.9	41.8	38.0
EU27 average	**51.0**	**50.3**	**50.3**	**49.9**	**5.7**	**3.4**	**3.5**	**4.2**	**6.4**	**6.3**	**6.3**	**6.2**	**36.8**	**40.0**	**40.0**	**39.7**

Table II.5 EU28 basic pharmaceutical production, percent change in output

	hard Brexit	simple FTA	FTA with pharma sector agreement
Austria	1.12	1.04	0.78
Belgium	-1.02	-1.06	-0.47
Bulgaria	0.56	0.54	0.36
Croatia	0.96	0.90	0.69
Cyprus	0.85	0.85	0.70
Czech Republic	1.09	1.00	0.76
Denmark	0.76	0.68	0.60
Estonia	-0.83	-0.74	-1.17
Finland	1.46	1.37	0.97
France	0.62	0.50	0.64
Germany	0.18	0.03	0.41
Greece	0.48	0.45	0.58
Hungary	0.82	0.75	0.61
Ireland	-3.23	-3.02	-2.67
Italy	0.56	0.47	0.53
Latvia	0.56	0.52	0.36
Lithuania	0.13	0.12	0.06
Luxembourg	1.18	1.17	0.57
Malta	-2.93	-2.83	-1.87
Netherlands	0.29	0.21	0.49
Poland	1.71	1.61	1.18
Portugal	1.37	1.25	1.12
Romania	0.31	0.25	0.36
Slovakia	1.67	1.57	1.15
Slovenia	1.13	1.08	0.75
Spain	1.56	1.40	1.29
Sweden	0.45	0.36	0.49
EU27	**-1.29**	**-1.25**	**-0.99**
United Kingdom	-1.23	-0.82	-2.15
Switzerland	2.57	0.20	1.29
US	1.91	1.90	0.99
Japan	0.27	0.29	0.13
Turkey	0.83	0.84	0.47
China	0.07	0.07	0.02
Russia	0.63	0.61	0.49
ROW	0.72	0.71	0.43

note: EU27 value is weighted by value added, not gross output.

Table II.6 EU28 basic pharmaceutical production, percent change in exports

	hard Brexit	simple FTA	FTA with pharma sector agreement
Austria	1.12	1.04	0.78
Belgium	-1.05	-1.09	-0.48
Bulgaria	0.39	0.36	0.31
Croatia	1.08	1.00	0.85
Cyprus	0.73	0.74	0.68
Czech Republic	0.99	0.90	0.73
Denmark	0.67	0.59	0.56
Estonia	-0.79	-0.71	-1.14
Finland	1.11	1.00	0.81
France	0.44	0.32	0.54
Germany	-0.01	-0.17	0.34
Greece	-0.16	-0.18	0.28
Hungary	0.73	0.65	0.58
Ireland	-3.23	-3.02	-2.67
Italy	0.17	0.08	0.36
Latvia	0.68	0.63	0.48
Lithuania	0.11	0.09	0.09
Luxembourg	2.44	2.40	1.50
Malta	-3.24	-3.13	-2.00
Netherlands	-0.38	-0.46	0.14
Poland	1.15	1.03	0.94
Portugal	-0.24	-0.36	0.32
Romania	0.00	-0.07	0.22
Slovakia	1.82	1.70	1.27
Slovenia	1.12	1.06	0.75
Spain	0.85	0.68	0.94
Sweden	0.11	0.02	0.31
EU27	**-1.22**	**-1.20**	**-0.85**
United Kingdom	-22.53	-22.08	-12.58
Switzerland	2.89	0.24	1.38
US	3.46	3.48	1.45
Japan	2.25	2.31	1.04
Turkey	1.47	1.53	0.65
China	1.65	1.64	0.85
Russia	0.98	0.93	0.65
ROW	1.80	1.78	1.00

Table II.7 EU28 basic pharmaceutical goods, percent change in input costs (%)

	hard Brexit	simple FTA	FTA with pharma sector agreement
Austria	0.46	0.45	0.30
Belgium	0.61	0.58	0.49
Bulgaria	0.73	0.73	0.42
Croatia	0.27	0.28	0.15
Cyprus	0.93	0.93	0.51
Czech Republic	0.86	0.86	0.52
Denmark	0.86	0.85	0.56
Estonia	0.30	0.31	0.18
Finland	1.02	1.02	0.58
France	0.70	0.69	0.47
Germany	0.58	0.58	0.37
Greece	1.03	1.02	0.62
Hungary	0.75	0.76	0.43
Ireland	1.45	1.44	0.87
Italy	0.69	0.68	0.43
Latvia	0.17	0.18	0.10
Lithuania	0.27	0.28	0.15
Luxembourg	0.15	0.15	0.10
Malta	2.02	2.00	1.15
Netherlands	2.36	2.34	1.36
Poland	0.98	0.98	0.58
Portugal	1.32	1.31	0.80
Romania	0.77	0.77	0.46
Slovakia	0.27	0.28	0.15
Slovenia	0.50	0.50	0.31
Spain	1.25	1.23	0.76
Sweden	1.77	1.76	1.03
EU27	**0.82**	**0.82**	**0.52**
United Kingdom	12.12	12.01	6.14
Switzerland	0.26	0.01	0.21
US	0.36	0.33	0.30
Japan	0.15	0.13	0.11
Turkey	0.26	0.24	0.20
China	0.10	0.09	0.08
Russia	0.18	0.18	0.14
ROW	0.15	0.14	0.11

Table II.8 EU28 GDP changes, percent

	hard Brexit	simple FTA	FTA with pharma sector agreement
Austria	-0.33	-0.30	-0.30
Belgium	-2.06	-1.90	-1.87
Bulgaria	-0.62	-0.59	-0.58
Croatia	-0.20	-0.19	-0.19
Cyprus	-1.00	-0.97	-0.97
Czech Republic	-0.99	-0.89	-0.89
Denmark	-0.48	-0.46	-0.45
Estonia	-0.67	-0.64	-0.64
Finland	-0.38	-0.35	-0.35
France	-0.35	-0.33	-0.33
Germany	-0.46	-0.42	-0.41
Greece	-0.45	-0.44	-0.43
Hungary	-0.58	-0.54	-0.53
Ireland	-5.36	-5.08	-4.97
Italy	-0.33	-0.30	-0.30
Latvia	-1.04	-0.97	-0.97
Lithuania	-1.04	-0.97	-0.96
Luxembourg	-1.94	-1.88	-1.88
Malta	-2.84	-2.75	-2.69
Netherlands	-1.08	-1.00	-0.98
Poland	-0.70	-0.64	-0.64
Portugal	-0.47	-0.44	-0.44
Romania	-0.52	-0.47	-0.46
Slovakia	-0.64	-0.55	-0.55
Slovenia	-0.31	-0.29	-0.29
Spain	-0.35	-0.33	-0.33
Sweden	-0.59	-0.55	-0.55
EU27	**-0.66**	**-0.61**	**-0.60**
United Kingdom	-4.19	-3.99	-3.89
Switzerland	0.05	0.00	0.03
US	0.02	0.01	0.01
Japan	0.06	0.05	0.05
Turkey	0.25	0.21	0.21
China	-0.08	-0.08	-0.07
Russia	0.00	0.00	0.00
ROW	0.03	0.02	0.02