CGE meets gravity: Brexit implications for Central and Eastern Europe's trade

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Abstract:
In this paper we analyze the implications of Brexit for exports of the selected four Central and Eastern Europe (CEE) countries. We apply a global computable general equilibrium model to simulate these implications. The scenario is based on the results of the Brexit agreement, i.e. a Free Trade Area (FTA) and exit from the Single European Market (SEM). The shocks analyzed include increase of border costs and of non-tariff measures (NTMs) in bilateral trade flows. The changes in the NTMs are estimated using gravity models for both merchandise trade and services. Our simulation results demonstrate that the drop of CEE exports to UK are in a range of 14-18%. However, some sectors may experience more significant drops in exports; in particular, the food and some manufacturing export-oriented sectors. The latter results are confirmed by partial equilibrium simulations.
Additionally, we confront the results of GTAP simulations with the changes in actual exports of the EU countries to UK after the Brexit. Structural gravity estimates allow us to distinguish between the effects of the COVID-19 pandemics and Brexit, and show a similar magnitude of changes of EU exports to UK to those shown by our simulations.

Keywords: CGE modelling, international trade, Brexit, trade policy, gravity model

JEL codes: F13, F14, F15, F17.

1 Introduction

Following the referendum on 23 June 2016, the United Kingdom (UK) voted to leave the European Union (EU). The United Kingdom left the European Union on 31 January 2020 with a transition period, which lasted until 31 December 2020. On 24 December 2020, the new Trade and Cooperation Agreement (TCA, so called Brexit Agreement – BA) was reached on 30 December 2020. It was provisionally applied from 1 January 2021 and it has entered into force on 1st of May 2021. Therefore, it is too early to provide detailed ex-post evaluation of the trade changes resulting from Brexit. However, since the beginning EU-UK negotiations in June 2017 several authors employed partial and general equilibrium (GE) models to evaluate *ex-ante* the economic consequences of Brexit[1].

The new Trade and Cooperation Agreement sets up the free trade area (FTA) between the EU and the UK. It means that all goods traded between the EU and UK are not subject to the tariffs or import quotas. However, there is no specific agreement on non-tariff measures (NTMs). The EU and British entities face additional regulatory requirements that will make exports of goods more costly and burdensome. In particular there are new rules of origin. The EU and UK firms have to certify the origin of their exports to qualify for tariff-free access to the other market. There are limits on what proportion of goods can be assembled from parts and components made in the third countries to qualify for tariff-free access[2]. There are also additional testing and certification requirements. Moreover, there is no automatic mutual recognition, which means that UK and the EU regulatory bodies will not be able to certify products for sale in the EU and the UK, which is potentially an important cost and big obstacle to bilateral trade.

Even in the case of the most liberal FTA, trade relations will be different compared to the frictionless trade within the EU's Single European Market (SEM). In the FTA rules of origin and customs formalities will apply; all imports will need to comply with the rules of the importing party and will be subject to regulatory checks and controls for safety, health and other public policy purposes[3]. Leaving the SEM increases the border costs as well. Thus, despite the FTA agreement the level of NTMs will be increased in trade relations between the EU and UK.

Brexit is likely to have significant economic implications for both UK and EU economies, in the short and long run. The UK was the second largest economy in the EU, as measured by the level of GDP. It has

[1] Intensive research related to the economic effects of Brexit has already started in 2012. A brief review of the most important findings in the field is presented by Hagemejer et al. (2021).

[2] More on rules of origin in preferential trade agreements see e.g. Garay and Estevadeordal (1996), Falvey and Reed (1998), Estevadeordal (1999), OECD (2010, 2015), Fulponi et al. (2011) or Thompson-Lipponen and Greenville (2019).

[3] More details are provided in the document of European Commission: Questions & Answers on the draft negotiating directives for a new partnership with the United Kingdom, Brussels, 3 February 2020.

very intense trade relations with the rest of the EU27, and is main extra-EU trading partners[4]. Specifically, the implications of Brexit will be important for many "old" EU members from Western Europe (we will refer to those as EU-14). The economic and financial relations with UK are crucial for Ireland as well as other states such as the Netherlands, Germany, France or the Nordic countries.

The potential importance of Brexit for the New Member States (NMS) of the EU varies a lot and for some countries the expected effects of Brexit are quite significant. We focus our attention on 4 Visegrad countries (V4: Czechia, Hungary, Poland and Slovakia). For example, for Poland, the British economy is the third main trade partner. Polish exports to the UK are concentrated in some industrial sectors, such as wood products and paper products, metals, electronic equipment as well as transport equipment. The British market is also very important for Polish exports of processed food, beverages and tobacco. Moreover, UK market is also important for Poland's exports of business, communication and transport services. Finally, British market attracted about 1.5 million of workers from Poland. On the other hand, Poland is an important market for British exporters of beverages and tobacco, motor cars, processed food and machinery. In some sectors both countries intensively participate in the same global value chains. Thus, Brexit, by increasing the trading costs between UK and other CEE EU members can encounter substantial negative consequences for both United Kingdom and EU members.

The goal of this paper is to analyse possible trade, production and welfare implications of Brexit agreement on the NMS economies with a focus on Poland. We employ a global computable general equilibrium model (GTAP) in both short and long-run setting to analyse the scenarios covering both tariff and non-tariff barriers. This scenario is based on the outcome of the Brexit agreement. We analyse the implications of increase of border costs and of non-tariff measures in bilateral trade flows. The detailed analysis of changes in the level of NTMs is based on own estimation of non-tariff barriers. Lastly, we compare the results of the CGE simulations to the early estimates of a structural gravity model capturing the first-year of the post-Brexit trade.

This paper is organized as follows. Section two covers some descriptive statistics of the EU-UK international trade in goods and services. Section three surveys the up-to-date literature on the outcomes of Brexit focusing on the analysed scenarios and the range of results. Section four presents our methodology: the model, the method of estimation of non-trade barriers and our simulation scenarios

[4] Intensive trade flows between UK and EU27 are in line with predictions of gravity models.

and the method of estimation of the structural gravity model. Section five presents the results of the simulations and the regression results. Last section concludes.

2 UK – EU trade profile

Before we turn to the simulation analysis of the Brexit, we look at the structure of UK-EU trade, which has an impact on the structure of the response of the analysed economies. Table 1 presents the pre-Brexit (and pre-COVID-19) shares of total UK merchandise and services trade with the particular EU members and shares of the EU members with the UK. In bilateral EU-UK relations, the EU is significantly more important for the UK than vice versa (see Table 1). The UK-EU trade represents about 50% of total UK merchandise trade and over 40% of total UK trade in services. UK's major trade partners are: Germany, Netherlands, France and Ireland. The contribution of NMS (including Poland) is small. As far as merchandise trade is concerned, UK is a destination for 6.7 percent of EU's exports, while only 2.4 EU's imports come from the UK. In trade in services this pattern is reversed, i.e. UK is an important exporter of services to the EU (7% of overall EU service imports) and relatively less important destination of EU services. Looking at individual countries, Ireland stands out as an important UK's partner, both in goods and services, while France, Germany and the Netherlands are also highly dependent on imports of services from the UK. As far as the NMS are concerned, the bilateral trade of the NMS in goods and services is lower than in the EU-14, with Poland having the highest merchandise export shares (6.3%).

Table 1 **Importance (in %) of trade relations between UK and EU, 2019 (Merchandise trade), 2018 (Services)**

	UK trade with EU countries		EU countries trade with UK	
	Merchandise trade			
Country	Share of imports	Share of exports	Share of imports	Share of exports
Poland	2.2	1.5	1.2	6.3
Czechia	1.2	0.9	1.0	4.6
Slovakia	0.5	0.3	0.6	3.8
Hungary	0.6	0.5	0.9	3.2
rNMS	1.1	1.3	2.1	3.4
Ireland	2.8	5.1	10.5	9.4
France	5.6	5.7	1.9	6.5
Netherlands	8.5	6.7	2.9	11.2
Germany	14.1	9.1	1.6	6.5
rEU14	17.6	16.1	3.4	6.4
Overall	54.1	47.1	2.4	6.7
	Services			
Country	Share of imports	Share of exports	Share of imports	Share of exports
Poland	1.4	0.8	7.6	5.3

Czechia	0.4	0.3	5.0	3.7
Slovakia	0.2	0.1	3.7	4.1
Hungary	0.4	0.2	4.7	3.6
rNMS	1.6	0.8	0.9	0.8
Ireland	4.2	4.8	8.7	5.0
France	8.1	5.9	8.8	7.1
Netherlands	3.8	6.0	9.7	4.0
Germany	5.9	6.8	7.4	4.4
rEU14	21.0	14.1	8.0	6.3
Overall	47.1	40.0	7.0	4.6

Source: UN Comtrade trade database; OECD Trade in services by partner economy data (EBOPS 2010); UK trade: EU country/region share in total UK trade; EU trade: UK share in total trade;

The sectoral importance of bilateral trade can be measured by the revealed comparative advantage indices (RCA's). In Table 2, we present the RCA's of the EU countries/regions in their exports to the UK. As far as the NMS is concerned, Poland has more sectors with RCAs than the remaining NMS, which is a consequence of larger size, lower level of trade openness and more diversified structure of exports. Sectors in which Poland has comparative advantages are: food and beverages, wood and paper, minerals, metals, electronic equipment (manufacturing sectors) and construction, trade, accommodation and food service, land transport (part of transport nec), real estate, (services sectors). Other V-4 show RCAs in motor vehicles and metal products as well as electronic equipment, while the structure of service export RCAs overlaps to a large extent with that of Poland. On the other hand, there are only a few manufacturing sectors where the UK has RCA's in exports to EU countries. These industries are: food, beverages and tobacco, paper products, chemicals and motor vehicles. UK has RCA's in the following sectors of services: communication, financial and business services.

Table 2 **Revealed comparative advantage indices of EU countries in trade to UK**

	RCAs of EU countries in trade to UK									
Sector	POL	CZE	SVK	HUN	rNMS	IRL	FRA	NLD	DEU	rEU14
Agriculture	0.6	0.0	0.0	0.1	1.8	2.0	0.9	1.9	0.3	1.1
Fishing	0.3	0.1	0.0	0.0	3.5	1.9	0.3	1.2	0.1	1.8
Mining	0.0	0.1	0.0	0.0	0.1	0.6	0.1	2.0	0.2	1.8
Food	1.7	0.2	0.3	0.7	0.6	3.3	1.1	1.1	0.6	0.9
Bvrges & Tobacco	1.2	0.1	0.0	0.6	0.6	1.3	2.8	0.7	0.4	1.1
Textiles	0.7	0.6	0.4	0.5	1.6	0.5	0.8	1.1	0.7	1.5
Wearing apparel	0.5	0.5	0.0	0.1	3.6	0.4	1.4	0.8	0.6	1.4
Leather	0.4	0.7	0.1	0.1	0.2	0.2	1.9	1.1	0.6	1.3
Wood	3.6	0.5	1.4	0.6	7.6	1.0	0.4	0.2	0.6	1.3
Paper, Publishing	1.1	0.7	1.0	0.7	0.3	0.6	0.8	0.6	0.8	1.5
Fuels	0.4	0.0	0.0	0.0	0.9	0.8	0.7	2.4	0.1	1.4

Chemicals	0.1	0.3	0.1	0.6	0.5	1.2	1.5	1.2	1.0	0.9
Pharmaceuticals	0.7	0.2	0.1	0.5	0.5	2.2	0.8	1.8	0.7	1.0
Rubber & Plastics	1.4	1.5	1.6	1.8	1.2	0.9	1.0	0.5	1.3	0.9
Non-metalic minerals	1.4	1.2	1.0	1.6	1.5	1.2	1.3	0.5	0.9	1.1
Steel	0.5	1.6	0.4	0.1	0.8	0.5	0.9	0.9	0.7	1.5
Metals nec.	1.7	0.1	0.1	1.1	0.6	0.4	0.7	0.3	1.6	1.0
Metal products	1.1	1.2	1.7	0.4	1.0	0.6	0.6	0.4	1.0	1.5
Motor vehicles & parts	0.8	1.2	2.3	1.0	0.7	0.1	0.7	0.3	1.7	1.0
Transport Eq. n.e.c.	0.4	0.5	0.0	0.2	0.3	0.1	2.3	0.5	1.5	0.8
Electronics & opticals	1.6	3.1	2.4	3.5	0.5	1.0	0.6	2.3	0.5	0.4
Electrical Equipment	2.0	1.8	1.3	2.1	2.5	0.8	0.9	0.6	1.6	0.9
Machinery and eq. Nec	1.0	1.4	0.9	1.7	1.3	0.7	0.9	0.8	1.2	0.9
Mnfcs nec	0.8	2.1	0.1	0.3	0.3	0.6	3.1	0.4	0.7	1.0
Energy	0.1	0.5	0.6	0.4	1.3	0.2	5.1	1.7	0.1	0.4
Construction	2.1	0.3	0.7	0.4	0.7	0.1	1.6	2.1	1.6	0.7
Trade	1.1	0.9	0.9	1.0	1.1	0.5	1.6	0.7	0.5	1.2
Accommodation &Food	1.1	1.0	0.9	1.0	1.1	0.4	1.6	0.6	0.5	1.2
Transport nec	1.9	1.6	1.7	0.9	1.9	0.4	1.6	0.8	0.3	1.2
Water transport	0.4	0.0	0.1	0.1	2.0	0.2	1.6	1.0	0.3	1.3
Air transport	0.5	0.7	0.6	1.5	1.1	1.3	0.9	0.9	1.4	0.8
Warehousing and support	1.4	1.1	1.1	1.1	1.6	0.6	1.2	0.7	0.8	1.1
Communication	1.1	1.6	1.4	1.0	1.2	1.1	0.9	1.4	1.1	0.9
Financial services nec	0.5	0.3	0.5	0.4	0.4	1.4	0.3	0.2	1.0	1.3
Insurance	0.5	0.6	0.5	0.4	0.4	2.5	1.4	0.5	1.0	0.7
Real estate activities	1.5	3.8	1.9	0.8	0.7	0.8	1.5	1.0	0.7	1.0
Business services nec	1.1	0.9	1.0	1.0	0.7	1.5	0.6	1.5	1.3	0.8
Recreational and oth.	1.1	1.4	1.7	2.3	1.0	0.2	1.6	0.8	0.5	1.1
Public administration	0.8	0.5	0.7	0.7	0.7	0.4	1.0	1.0	1.3	1.0
Education	0.6	0.4	0.7	0.6	0.7	0.4	0.8	1.0	1.5	1.0
Human health, social work	1.1	0.9	1.0	1.2	1.1	0.5	1.8	0.6	0.6	1.1

Source: own calculation using UN Comtrade trade database (2018) for merchandise trade and GTAP database (2014) for services.
EU RCAs are relative to total EU27 exports to UK.

3 Review of literature

There have been many ex-ante studies related to the trade and welfare effects of Brexit. Indeed, majority of them analyzed various scenarios of Brexit, which can by classified in a simplified way as Hard and Soft Brexit. Hard, No Deal Brexit or WTO options assume that both parties would apply MFN tariffs to each other. In slightly softer option it can also be combined with trade liberalization with the third countries (Felbermayr *et al.* 2018; Brakman *et al.* 2017 or HM Treasury 2018), ie:

- the so called Global Britain policy option, envisaged closer trade relations, such as FTAs with other English-speaking countries, including the US, Canada, Australia and New Zealand;

- Unilateral Free Trade solution assumed that UK unilaterally abolishes all tariffs on imported goods (from the EU and all other countries), whilst it will face EU MFN tariffs for goods sold to the EU;

Several Soft Brexit FTA scenarios have been analyzed. They implie that both parties conclude a trade agrement, which reduces tariffs on goods exchanged between the UK and EU well below EU's current MFN rates. These include as follows:

- a free trade deal between the EU and three of the European Free Trade Association (EFTA) members (Norway, Iceland and Lichtenstein, Switzerland decided to stay out) allowing for tariff-free access to the EU's Single Market and gives right to control own external trade policy;
- a free trade agreement (FTA) with the EU similar to the agreement with Switzerland;
- a customs union with the EU outside the framework of the EU treaties and institutions called as Turkish solution;
- A comprehensive/deep FTA.

The ex-ante studies on Brexit generally used four broad classes of quantitative trade models (Bekkers 2017): Computational General Equilibrium (CGE) models, Gravity models (GM), Global Econometric models (GEM) as well as Hybrid models (HM), where the latter combines elements of the first three models. These models differ in their structure and assumptions, ie. CGE models rely on a complex structure of international and intersectoral linkages together with a large set of elasticities; the gravity models are simpler in their behavioral assumptions but usually rely largely on panel data, while GEM models focus more on time series dynamics, using mostly aggregated macroeconomic data.

We focus our attention on Soft Brexit studies, which are based on assumptions which are close to the provisions of the final Withdrawal Agreement. In the case of Brexit trade implications in almost all simulations assume increase of border costs and NTMs, but the different models arrived at range of findings. According to the majority of simulations Soft Brexit will harm the UK's economy, but there are visible differences in the expected impact. For example, using GEM approach the most pessimistic results concerning UK exports to the EU (Hantzsche, A. et al. 2018) predict its drop, between 22% to 38% depending on which estimates is considered. Ebel and Warren (2016) forecast a drop of UK exports to the EU by 10.5% to 17.5%. The studies using gravity models anticipate usually slightly lower decreses of trade flows. For example Oberhofer and Pfaffermayr (2017) envisage that UK export to the EU will drop by 13-16%, Felbermayr et all. (2015) a drop by 4-6% and Ottaviano et all. a decrease by 9%.

Furthermore, simulations in general show that an increase in border costs and NTBs will decrease trade flows and can lead to a reduction of GDP and welfare. The CGE models anlyzing Soft Brexit scenario predict the UK GDP level can decrease from 0.5% (PWC (2016), through 1% (Ciuriak et al. 2017) to 1,24%

(CEPR 2013). In only one case, under very specific scenarios, that include the arrangements with the EU concerning FTAs and with third countries, the UK economy may see a rise of GDP, by 0.75% of GDP in a study by Booth et al. 2015.

The level of the EU GDP can also drop as a result of Brexit. The cost of Brexit could range from 0.029% (Booth et al. 2015) through 0.8% (Rojas-Romagosa 2016) to 1.3% of GDP (Dinghra et all (2017)). In the last study Dinghra et al. (2017) predict that the most affected country would be Ireland; 1.3% decline in the case of soft scenario. The percentage declines for other EU members would be much smaller. The relevant figures for Hard Brexit range between 0.7 to 0.25 in the case of hard Brexit and the most affected countries are: Netherlands, Belgium, Denmark, Hungary, Czech Republic, Sweden, Germany and Poland.

Detailed analyses of the trade effects of Brexit for Poland or the Central and Eastern European Countries in general (CEECs)[5] are not available, but some simulations of macro effects are. According to Rojas-Romagosa(2016) the level of Poland's GDP could be lower by 0.4% to 0.6% in 2030. Further, Hungary could face the highest reduction of the level of GDP amounts to 0.6% in soft Brexit scenario. An adverse impact of Brexit on CEECs is simulated by Felbermayr, G. *et al.* (2015). They predict a drop of the GDP of CEECs up to 1.82% till 2025 in the case of hard Brexit. According to this study, of the analyzed CEECs the Czech Republic is affected to a largest extent with a change in real income ranging equals to -0.12% in case of the soft option. Two other analyses (Ciuriak, G. *et al.* 2017 and Booth, S. *et al.* 2015) show in this context more optimistic predictions, though still negative, proving that the costs of the Brexit for the CEECs range between -0.089 and -0.23 of GDP in the long run.

All trade-related scenarios assume changes in non-tariff barriers (NTBs) to trade in goods and services as resulting from Brexit. There are several approaches to the treatment of NTBs. They can, however, be classified into two specific categories by virtue of the quantitative approach applied (Francois 2013). The one defined as a bottom-up, is based on data which are attributable to percentages (based on micro-data) of estimated changes in NTBs level, while the second refers to the empirical evidence of different FTAs in the past (e.g. EU-Norway, EU-Turkey or other).

Hence, the bottom-up approach assumes that trade of the UK with the EU, when considering its trade with the EU after Brexit–can be subject to some fraction or percentage of the reducible NTBs, that is the fraction of the trade cost that could in principle be eliminated (or increased) by policy action of the

[5] The block of the Central and Eastern European Countries is understood here as a bloc of seven countries consisted of Poland, Czechia, Slovakia, Hungary, Lithuania, Latvia and Estonia.

referenced state (such as the third countries outside the EU, for example the US). In the case of Brexit, some studies suggest that the costs of NTBs can rise by 25% and 75% of the reducible costs faced by the USA in trade relation with the EU (Dinghra *et al.* 2017) or by ¼ and ⅔ of NTBs between the EU-US as well as 45% of the rate of EU-US trade (Erken *et al.* 2016).

The top-down approach implies that the *ad valorem* equivalent of increasing NTBs can be inferred from gravity estimations as applied for example by Hantzsche *et al.* (2018), or Rojas-Romagosa (2016). Thus, Hantzsche *et al.* (2018) assume that Brexit will create NTBs, the opposite effect to the European integration process. According to this study, the potential elevated level of the post-Brexit NTBs mirrors, in general, the scope of their decline during the period of UK's membership in the EU. At the same time, it is expected that these post-Brexit NTBs can be higher than they are currently between the EU and Norway or between the EU and Switzerland. According to Rojas-Romagosa (2016) *ad valorem* equivalents of the post-Brexit NTBs amount 6.4 for both types of trade, in the case of FTA agrement with the EU. We follow the same methdology, using gravity equation, in estmiating the the EU tariff equvalants of NTBs.

4 Methodology

4.1 CGE simulation model

The core tool we use to evaluate the effects of trade liberalization is the GTAP global computable general equilibrium model and a global database developed by the Global Trade Analysis Project. We employ version 10 of the GTAP database released in late 2019 with the latest base year of 2014. This version of the has information on 65 sectors in 141 regions (with 121 individual country data). The data includes information on the production volume, sales both domestic and international, intermediate use and primary factor use. It also contains information about bilateral trade between countries in both goods and services. For the purpose of this paper, we have created an aggregated database covering 21 countries/regions and 40 sectors (we merge the very detailed agricultural and food sectors as well as created the country/regional division with a focus on Europe and its major trading partners).

The GTAP framework is a commonly used framework for trade policy analysis. The structure of the model is relatively simple and follows the logic of a neo-classical static computable general equilibrium model with perfect competition while allowing for a large range of policy related simulations; it includes a variety of taxes, subsidies and other policy instruments[6].

[6]For a complete description of the model consult Hertel, Tsigas (1997).

The central economic agent in the GTAP model is the regional household that maximizes the regional utility subject to regional income constraints. This regional household takes all the expenditure decisions within the region's economy, by is choosing the levels of private consumption, government expenditures and savings. The decision-making process of the household is multi-level, ie. it involves maximization of a nested utility structure. In the top nest the private consumption, public consumption and overall regional savings are aggregated using a Cobb-Douglas function leading to constant shares of consumption and spending in total expenditure. Private consumption demand is governed by a Constant Difference of Elasticity preferences to account for the non-homothetic nature of consumption demand. Government consumption is, on the other hand, a Cobb-Douglas composite. For each consumption type, domestically produced variety of goods is an imperfect substitute to imports and imports are differentiated by the source of origin, i.e., the so-called Armington's assumption (Armington, 1969). The allocation of expenditure across domestic/imported goods and across sources of imports follows the constant elasticity of substitution aggregator.

Firms produce using intermediate goods and primary factors purchased from the regional household. The sources of primary factors are purely domestic – it is assumed that the factors are strictly immobile internationally and mobile within a region (with exception of land and natural resources). The intermediate goods can be either domestically produced and imported. Factor markets are perfectly competitive.

4.2 Gravity model analysis

On top of the performing ex-ante CGE simulations that show medium and long-run effects of Brexit, we make use of the fact that the trade data for 2021–the first whole year under new trading arrangement– are available. Therefore, we use the gravity framework to look into the change in the trade pattern and volume. Of course, the challenge in estimating ex-post effects of Brexit lie in the fact that since early 2020, the world has been subjected to the effects of the COVID-19 pandemics and has suffered considerable trade distortions. In order to identify these two coinciding trade disruptions, we make use of the fact that Brexit is a bilateral phenomenon for the UK, while COVID-19 is the multilateral one, i.e., we separate changes in trade across all directions from the drop in trade with the EU members.

Formally, we employ a structural gravity model in the form of a Poisson Pseudo Maximum Likelyhood (PPML) as proposed by Silva and Tenreyro (2006) to account for heteroskedasticity related to non-linearities in the gravity model and in particular the problem of zero-trade flows. Moreover, we follow the state-of-the-art described, among others, in Yotov et al. (2016) and include both pair-specific (importer-

exporter pair) fixed effects and time-varying fixed effects to account for multilateral resistance terms as well as other, potentially omitted, variables both at the country and country-pair levels. This means that only bilateral time varying variables can be included on the right hand side of the equation and these include the dummy variables controlling for preferential trade agreements, EU membership as well as two Brexit variables, which are dummy variables that takes on the value of 1 for the UK and other EU member states. The two variants of the variable correspond to the UK being respectively an importer or exporter to account for possible differences in Brexit effects for these two trade directions.

Formally the estimated equation is:

$$imports_{ijt} = \exp\left(Fe_{it} + Fe^{s}_{jt} + Fe_{ij} + \beta_1 FTA_{ijt} + \beta_2 EU_{ijt} + \beta_3 COVID_{ijt} + \beta_4 Brexitimports_{ijt} + \beta_5 Brexitexports\right) \times u_{ijt}$$

Alternatively, we also perform alternative estimations in a PPML framework with bilateral and country-specific fixed effects without time varying fixed effects, where we include the prevalence of the COVID-19 pandemic measures: importer-specific and exporter-specific number of cases per million of population or the number of deaths per million of population. However, this measure is obviously only available in 2020 and 2021 and takes zero in other years.

The data for the estimations are primarily based on the CEPII gravity database, that contains trade flows for the period of 1948 to 2020. We update this database with the missing trade flows for 2021 from COMTRADE WITS and base our estimations on the post-2000 period. Our data on COVID-19 death and cases comes from Our World in Data database[7] and the daily data has been averaged out to annual measures. The macro data (GDP and population) come from the CEPII dataset (original source is World Development Indicators). For the 2001 we use the numbers from the IMF WEO dataset which includes some actual data and some IMF estimates.

4.3 Non-tariff barriers

Our GTAP simulation scenario involves increases in non-tariff barriers. The NTBs estimates are available both for goods and services in several papers including (Dean et al. (2009), Berden et al. (2009, 2013),

[7] https://ourworldindata.org/coronavirus

Fontagne et al. (2013), Egger et al. (2015), they are scattered, ie. are done for outdated data, different time periods, different sectoral classification. We decided to provide our own estimates using a gravity framework to provide full compatibility with the GTAP framework.

We use GTAP data as a source of bilateral trade data for a panel of two time periods, ie. 2011 and 2014. Data on standard gravity macro variables (ie. GDP and population) come from World Development Indicators and the time-invariant gravity variables (ie. distances, contiguity, common language, colonial ties) comes from CEPII geo-dist database.

We loosely follow Fontagne, Guillin and Mitaritonna (2011) and obtain tariff equivalents of NTBs from a gravity model of the form:

$$\log\left(imports_{ijt}^{s}\right) = a_0^s + a_1^s \log\left(GDP_{it}\right) + a_2^s \log\left(GDP_{jt}\right) + a_3^s \log\left(POP_{it}\right) + a_4^s \log\left(POP_{jt}\right) + a_5^s \log\left(DIST_{ij}\right) + a_6^s CONT_{ij} + a_7^s LANG_{ij} + a_8^s COL_{ij} + a_9^s EU_{ijt} + Fe_i^s + Fe_j^s + u_{ijt}^s$$

where i refers to the reporter country, j refers to partner country, t is the time period and s is the good/service category of the GTAP classification, *imports* refers to bilateral imports, *GDP* to gross domestic product in partner and reporter country in current USD, *POP* to level of population, *DIST* to distance between capitals, *CONT* – contiguity, *LANG* – common language, *COL – common colonial past*. In the above equation EU_{ijt} is a dummy variable that takes a value of 1 when both countries are members of the EU and zero otherwise and *Fe* refer to reporter and partner fixed effects. The last term in the above equation is the error term.

The estimates of reporter-level fixed effects provide an average level of imports of a particular reporter when all the other gravity variables are accounted for. Therefore, a difference between country *i* fixed effect and some reference country fixed effect provide *caeteris paribus* an approximate percentage deviation in trade between that country and a reference country. One could choose the reference country to be the most liberal country in the sample, ie. having the highest reporter-level fixed effect.

Given that the time-invariant Armington's elasticity provides a link between a percentage change in price of a particular variety and a change in import demand, the deviation of trade between a country *i* and a reference country is linked to a level of hypothetical equivalent of tariff that would restrict the level of trade through the following equation:

$$-\sigma^s \ln t_i^s = Fe_i^s - Fe_{ref}^s$$

We obtain the average fixed effects for all countries, select the reference country for each sector and compute the average differences between the reporter fixed effects of the EU countries and those of the reference country. Then, using GTAP sectoral Armington's elasticity, we recover the t_i^s – the tariff equivalent of NTBs. While this tariff equivalent refers to the tariff equivalent of NTBs in trade of the EU with the third countries, we still need to obtain the level of NTBs in the SEM. This is obtained by the use of the EU dummy which provides the average boost in trade that is due to both reporter and partner taking part in the SEM, and therefore through the use of the Armington's elasticity, we obtain the percentage difference between the internal and external EU NTBs. If the EU average reporter fixed effect plus the EU dummy is larger than the initial reference country reporter fixed effect, therefore the internal EU NTBs are lower than that of the reference country and therefore EU becomes the reference country with zero NTBs. The estimated NTBs along with the applied and MFN external tariffs for the EU are given in Table 3.

Table 3 EU external tariff and estimated tariff equivalents of NTBs, in percent

	NTB Intra EU	NTB Extra EU
Agriculture	0.0	26.9
Fishing	20.5	43.5
Mining	6.1	11.7
Food	0.0	19.9
Beverages & Tobacco	0.0	31.2
Textiles	1.1	8.8
Wearing Apparel	0.0	15.3
Leather	0.0	13.8
Wood	1.0	10.7
Paper, Publishing	6.9	18.7
Fuels	19.2	27.1
Chemicals	7.7	19.0
Pharmaceuticals	0.0	13.8
Rubber & Plastics	8.2	16.3
Non-metalic minerals	6.5	12.7
Steel	33.8	47.8
Metals nec	32.1	44.9
Metal products	8.0	11.5
Electronics and opticals	8.1	14.3
Electrical equipment	8.5	11.1
Machinery and equipment nec	14.6	15.5
Motor vehicles and parts	0.0	11.4
Transport equipment nec	8.8	6.3
Manufactures nec	9.6	15.3
Energy	0.4	7.5
Construction	29.0	37.1
Trade	32.9	39.0
Accommodation and Food	34.9	39.2
Transport nec	36.8	44.4

Water transport	9.7	10.6
Air transport	6.4	11.2
Warehousing and support	32.2	37.1
Communication	25.5	31.2
Financial services nec	46.2	55.0
Insurance	58.1	65.8
Real estate activities	28.5	33.6
Business services nec	21.8	26.7
Recreational and oth.	30.5	32.9
Public Administration	25.4	34.5
Education	15.0	22.2
Human health, social work	10.8	16.9

Tariffs are tariffs weighted averaged across all extra-EU partners for 2014. NTBs from gravity model estimations.

4.4 Simulation scenarios

In our study we analyze soft short run (SR) Brexit scenario reflecting – in our opinion- quite closely the outcome of Brexit negotiations. We assume that there is FTA agreement between the EU and UK covering all tradable goods, but the UK quits SEM. The UK external tariffs remain unchanged towards the rest of the world (RoW). In particular, we assume that the external trade relations of the UK remain unchanged, i.e., we do not analyze possible future FTA agreements to be concluded by the UK with other countries. In this scenario we assume, that UK applies external MFN tariffs to all other countries with which the EU has preferential trade agreements[8].

We assume that the UK exit from the SEM increases bilateral border costs by 2.5%[9], resulting from the additional burden related to border controls, customs administration, controls of sanitary requirements and other costs of non-participation in the EEA. Leaving the SEM will also increase the level of NTMs. In particular, we assume that the level of tariff equivalents, estimated using the gravity model and presented in Table 2, will increase by 25%. This assumption reflects first of possible gradual divergence of technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) standards and regulations and other NTMs, which exist in international trade flows between the EU and RoW (US). The assumption of 25% increase has been analyzed by other economists studying the Brexit implications (e.g., PWC, 2016, Ottaviano et all., 2014).

We also assumed that the tariff equivalents of NTBs will increase by 25% in the case of services, since we believe that service sectors will be burdened by some barriers, even under the FTA agreement equivalent to the case of soft Brexit. These NTBs will significantly increase since the scope of WTO services' liberalization (within the GATS) is fairly limited.

Thus, in our simulations based on GTAP model the tariff shocks are not analyzed. The shocks to NTBs are imposed through the trade shift parameter corresponding to the iceberg cost of trade in the GTAP model (ie. an increase in price and a corresponding decrease of the delivered quantity of the

[8] This assumption means that the UK tariffs increase in relations with other countries, which can be questionable in terms of the WTO commitments (Article II and XXIV).

[9] The border costs will increase by 5% in the case of animal products.

imported goods). We perform the baseline simulations for the short run (SR) period. We extend our baseline analysis for the long run (LR) scenario in which we allow changes in the capital accumulation, that affect the level of investment, production and GDPs.

5 Results of simulations

We begin with aggregated macro results reflecting the overall scale of effects of different scenarios and the likely distribution of the effects across the analysed countries. In Table 4 we present the short run soft Brexit (SB(SR)) scenario, close to the provisions of WA. The baseline simulation leads to mild macroeconomic effects of a drop in GDPs of analysed countries of 0.1-0.2 percent of GDP in the majority of the EU members. The notable exceptions are Ireland and the UK, where simulated drops of GDP are equal to 1.3% and 0.9% respectively. The changes of equivalent variations are of similar magnitude. Among the NMS Czechia stands out with a larger drop in GDP than in the case of Poland, which is due mainly to higher export intensity and smaller size of this economy.

Table 4 Simulated changes in GDP in the short run (SR) and long run (LR) in percent

	Real GDP		Equivalent Variation (% of GDP)	
Country/scenario	SB (SR)	SB (LR)	SB(SR)	SB (LR)
Poland	-0.1	-0.4	-0.2	-0.4
Czechia	-0.2	-0.5	-0.2	-0.4
Slovakia	-0.1	-0.3	-0.1	-0.2
Hungary	-0.1	-0.3	-0.1	-0.3
Germany	-0.1	-0.3	-0.1	-0.2
France	-0.1	-0.2	-0.2	-0.2
Netherlands	-0.2	-0.7	-0.3	-0.6
Ireland	-1.3	-7.2	-1.4	-4.5
Rest of NMS	-0.1	-0.4	-0.2	-0.3
Rest of EU-14	-0.1	-0.3	-0.2	-0.3
UK	-0.9	-1.8	-1.5	-1.9

Source: own simulation

The results of long run simulations (SB(LR), including investment and production reallocations reveal much bigger changes, roughly twice as large in the short run. The GDP of NMS can drop by 0.3-0.5 %, with the largest decrease of 0.5% in the case of Czechia. The moderate macroeconomic effects stem from relatively mild effects on the overall exports ranging from -0.1 to 0.5 in the NMS and slightly larger in the EU countries as it reflects moderate shares of the UK in bilateral trade of those economies as well as trade redirection towards the existing EU members. Among the old 15 EU members the largest drops are simulated in the Netherlands (0.7%) and Ireland (7.2%)[10] i.e., in the countries having the closest economic relations with the United Kingdom. The GDP of UK can drop by 1.8 %, a large number, but much smaller in comparison to the simulations reflecting hard Brexit scenarios. It indicates that the FTA concluded with the EU significantly reduced negative implications of possible hard Brexit, with no agreement.

[10] Such a large drop of Ireland's GDP, shown also in some other studies, requires a separate analysis.

The Brexit increases NTMs (trade costs) and therefore reduces significantly the bilateral trade flows between the EU and the UK. It will also have implications for overall structure of exports and imports through trade creation and diversion effects. The simulated changes in overall trade flows are presented in Tables 5 and 6.

Table 5. The percent changes in the structure of bilateral exports of NMS in the short (SR) and log run (LR) scenarios

Exports Scenario	Source Destination	POL	CZE	SVK	HUN	rest NMS	UK
SB SR	EU	1.5	1.1	1.0	0.9	1.0	-15.6
	ROW	1.7	1.4	1.1	1.1	1.1	13.3
	UK	-25.9	-23.8	-23.3	-23.5	-23.9	17.9
	Total	-0.1	0.0	0.0	0.0	0.0	0.0
SB LR	EU	1.2	0.8	0.8	0.7	0.7	-19.9
	ROW	1.2	0.8	0.7	0.7	0.8	8.0
	UK	-25.5	-23.3	-22.8	-22.9	-23.4	14.2
	Total	-0.4	-0.4	-0.2	-0.2	-0.3	-4.8

Source: own simulation

Table 6. The percent changes in the structure of bilateral imports of NMS in the short (SR) and long run (LR) scenarios

Imports Scenario	Source Destination	POL	CZE	SVK	HUN	rest NMS	UK
SB SR	EU	1.3	1.2	0.8	1.1	1.3	-23.4
	ROW	-1.0	-1.1	-1.0	-1.0	-0.9	11.5
	UK	-19.1	-18.2	-17.8	-15.0	-16.1	17.9
	Total	-0.2	0.0	0.0	0.1	-0.1	-6.3
SB LR	EU	0.9	0.8	0.5	0.8	0.9	-23.2
	ROW	-0.7	-0.7	-0.7	-0.6	-0.6	12.5
	UK	-23.2	-22.5	-21.8	-19.2	-20.2	14.2
	Total	-0.5	-0.4	-0.2	-0.2	-0.3	-5.7

Source: own simulation

Table 5 shows that exports of NMS to the UK can drop by 23-26%. The largest drops are forecasted for Poland (25.9%), which has the largest share of UK in overall exports (6.3%). This drastic decrease of bilateral exports is compensated by increase of exports to the other EU members (0.9-1.5%) and to third (RoW) countries (1.1-1.7%). These changes reflect static (SR) effects of relative internal trade creation and external trade diversion. The overall changes in exports in the long run (LR) are quite similar.

The analysis of simulated changes in overall imports reveals a similar pattern, although the changes are less drastic, since the UK share in imports of NMS is visibly smaller (about 1/3) in comparison to exports (see Table 1). The significant drop of imports of NMS from the UK (15.0-19.1%) is partially offset by

increased imports (0.8-1.3%) from other EU members. Here also the largest geographical shifts are predicted for Poland. The overall changes in exports in the long run (LR) are quite similar.

The detailed simulated changes in sectoral exports and imports of NMS to the UK in the short run (SR) are presented in **Table A.1** of the Appendix. The pattern of changes in the long run is very much the same. The pattern of the simulated changes is very similar among all NMS. The largest percentage drops in merchandise exports of Poland to UK, exceeding 30%, are predicted in the case of agricultural products (-44.1), Fishing (-40.2), Mining (-45.0), Food (-37.0), Textiles (-35.9), Wearing Apparel (-55.4%), Leather (-52.1), Metals (48.7%), and Electronic and optical instruments (32.1). The pattern of exports changes among other analysed NMS is very similar. In these mostly labour-intensive sectors, the NMS reveal fairly strong RCAs and the tariff equivalents of NTMs are relatively high. The predicted drops in Poland's exports of services are most pronounced (over 15%) in construction (20.2), trade (17.7), financial services (17.7) and insurance (16.0%). Here also the pattern of exports changes among other NMS is very similar. We have to take into account that the level of NMS exports of financial and insurance services to UK is relatively small.

The predicted changes in NMS imports from the UK are somewhat smaller, but the pattern of changes is also very similar among analyzed NMS. The largest drops of Poland's merchandise imports, exceeding 30%, are predicted for Agricultural products (-44.4), Food (-40.1), Wearing apparel (-37.9), Leather (-41.0), Pharmaceuticals (32.4), Steel (33.2), Metal nec (42.1) and Motor vehicles (28.7%). The most important changes in terms of values are predicted in the case of Steel, Pharmaceuticals and Motor vehicles sectors. The decrease of NMS imports of services from UK is much more limited. The most important drops are predicted for Financial (-6.5) and Insurance services (-6.4).

The changes in trade flows between NMS and UK and other EU members can reshuffle the production structure in the analyzed NMS. The predicted changes of production structure are presented in Table 7.

Table 7:The predicted percentage changes in the pattern of sectoral production of NMS resulting from Brexit in the short run.

POL	CZE	SVK	HUN	rest NMS
Wearing apparel (+1.0)	Wearing apparel (-1.8)	Wearing apparel (+1.5)	Wearing apparel (-0.9)	Wearing apparel (-2.2)
Other transport equipment (+1.1)	Leather (-2.8)	Leather (+1.1)	Leather (+0.9)	Leather (+1.1)
Non-Ferrous Metals (-1.4)	Chemicals (+0.8)	Chemicals (+1.1)	Chemicals (+0.5)	Chemicals (+0.5)
Pharmaceuticals (+1.1)	Pharmaceuticals (+1.0)	Pharmaceuticals (+1.0)	Non-Ferrous Metals (-0.7)	Steel(+0.9)
Electronics (-0.8)	Electronics (-1.1)	Electronics (-1.0)	Electronics (-1.1)	Electronics (0.7)
Motor vehicles (+0.9)	Motor vehicles (+0.9)	Steel(+0.7)	Motor vehicles (+1.0)	Motor vehicles (+1.0)
Food (-0.5)	Furniture (-0.3)	Food (-0.5)	Food (-0.5)	Wood (-0.9)

Source: own simulation

The simulations indicate that the percent changes in the value of production are rather limited, and rarely exceed (wearing apparel) one percent of the value of production. The pattern of production of changes among NMS is differentiated but there are also some clear similarities. The most important losses, close to 1 percent of the production are forecasted in the case of electronic products and food products in Poland Slovakia and Hungary. The largest possible gains in production are forecasted for Pharmaceutical products and Motor vehicles (close to 1% in three NMS). The possible gains in the Motor vehicles sector result mostly from predicted decreases of imports from the UK to the EU countries.

The simulations based on Computable General Equilibrium models (GTAP) have many advantages and show the complexity of trade and production relations among all countries. On the other hand, the ex-post verification of predicted results is very difficult. We do not have a good measure of counterfactual world. Analyzing the implications of Brexit, we should be able to distinguish between effect of Brexit and those of pandemic. The analysis based on data for 2022 will be even more difficult since the trade flows are strongly affected by the war in Ukraine.

Being aware of all these limitations we run structural gravity estimates which in principle should allow us to distinguish between the effects of the COVID-19 pandemics and Brexit. As mentioned before, we perform a structural gravity model estimation using PPML in a setting including both exporter and importer-specific time varying fixed effects as well as pair-specific fixed effects which takes care of all time-invariant pair-specific heterogeneity as well as all country-specific macro developments as well as global trends. This specification is central to the analysis as it is able to control for a great deal of unobservables including the COVID-19 unilateral effects. The results of such regressions are shown in column 1 of table Table 8. They show considerable effects of Brexit both on the EU exports' and imports' side of the order of 20 percent. In order to explore differences between the NMS and the remaining EU member states, we also run a similar regression with an additional Brexit dummy variables for the NMS measuring the additional effect of Brexit for those countries. The results show, that while these dummies are insignificant on the 10 percent level, their estimates point to a slightly higher effect of Brexit on NMS imports from the UK and milder effect on NMS exports.

Table 8 Gravity model estimation results

VARIABLES	(1)	(2)	(4)	(6)
GDP (exporter)			0.536***	0.540***
			(0.0139)	(0.0138)
GDP (importer)			0.543***	0.546***
			(0.0131)	(0.0130)
Population (exporter)			-0.230***	-0.217***
			(0.0463)	(0.0464)
Population (importer)			0.0746**	0.0858***
			(0.0321)	(0.0324)
EU	0.0936***	0.0937***	0.250***	0.245***
	(0.0193)	(0.0193)	(0.0147)	(0.0147)
RTA	0.0859***	0.0859***	0.0653***	0.0680***
	(0.00989)	(0.00989)	(0.0117)	(0.0116)
Brexit (imports)	-0.232**	-0.223*	-0.433***	-0.374***
	(0.118)	(0.119)	(0.0642)	(0.0625)
Brexit NMS (imports)	-0.234***	-0.240***	-0.317***	-0.269***
	(0.0659)	(0.0669)	(0.0493)	(0.0419)
Brexit (exports)		-0.123		
		(0.0817)		
Brexit NMS (exports)		0.0540		
		(0.0439)		
COVID cases (exporter)			0.237**	
			(0.114)	
COVID cases (importer)			0.173*	
			(0.101)	
COVID deaths (exporter)				25.05***
				(6.068)
COVID deaths (importer)				17.65***
				(6.002)
Constant	16.47***	16.47***	-4.625***	-5.030***
	(0.00681)	(0.00681)	(0.512)	(0.513)
Time varying FE	Yes	Yes	No	No
Pair FE	Yes	Yes	Yes	Yes
Importer- and Exporter-FE	No	No	Yes	Yes
Time effects	No	No	Yes	Yes
Observations	607,606	607,606	407,003	407,003

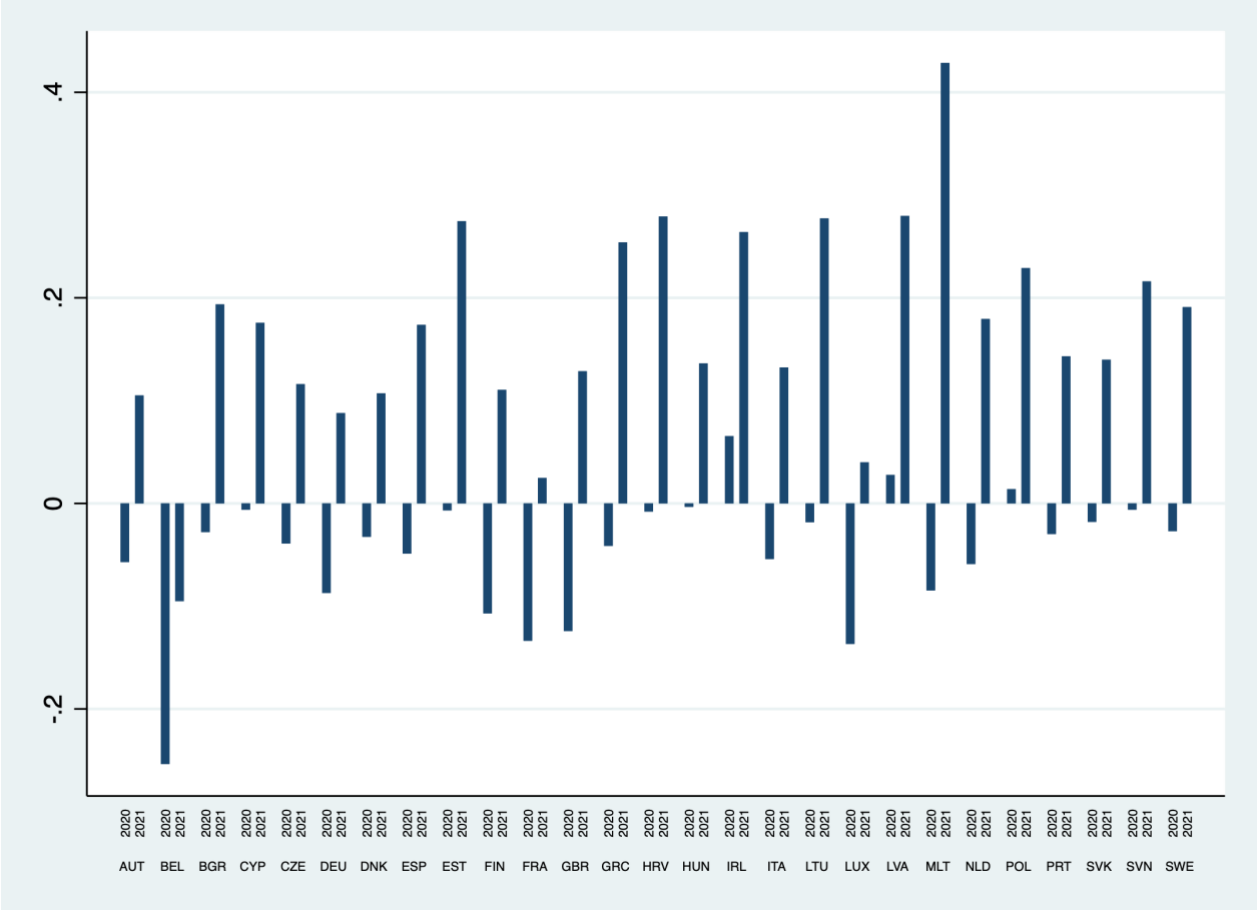
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Additionally, instead of time-varying fixed effects, we include the standard unilateral gravity variables in the regressions and importer- and exporter-specific fixed effects, pair effects and time effects. In order to control for COVID-19 effects post 2020, we include the level of COVID-19 cases (and deaths) alternatively as control variables in the regression with an unexpected results, i.e., both cases and deaths has proven to be positively related to trade which suggests unclear causation patterns (i.e. more open countries more

exposed to COVID, or having better testing procedures etc.). We also attempted creating a bilateral measure of COVID (i.e., a product of cases of trading countries) with similar results. It has to be noted that in regressions without time-varying fixed effects, the estimates of Brexit are considerably higher, suggesting that the Brexit dummy is capturing some of the COVID-19 effects.

We also explore the unilateral COVID-19 effects by extracting the time varying exporter and importer fixed effects. They show a considerable drop in trade in 2020 relative to 2019 and a subsequent rebound in 2021. Figure A.1 in the appendix shows a corresponding table for importer effects showing considerably lower initial effects of COVID-19 on imports in 2020 (and a less pronounced rebound in 2021).

Figure 1 Time-varying exporter effects



Source: own estimations. Numbers relative to 2019

6 Conclusions

In this paper we analyze the impact of Brexit on the New Member States (NMS) of the EU, with special attention devoted to Poland and 3 other NMS (Czechia, Hungary and Slovakia). We investigated the Soft

Brexit scenario, with FTA covering all goods and services, which reflect the provisions of Withdrawal Agreement. We used a CGE model (GTAP) and analyzed the shocks resulting from modifications of non-tariff barriers. The benchmark line model was based on the tariff equivalents of non-tariff barriers, which are estimated basing on an econometric gravity model.

Our results show that in spite of the UK being one of the most important trading partners for many of the NMS the short run macroeconomic effects of Soft Brexit are small. The predicted decline in GDPs of analyzed countries is of less than 0.1 percent of GDP in the short run. In the case of NMS there is no major difference between countries. Amongst the NMS, Czechia and Hungary stand out with a roughly 40% larger drop in GDP in comparison to Poland.

As usually found in CGE simulations, increase in trade barriers reduces the economic activity and the return on capital, leading to a to overall drop in investment. The capital stock falls leading to a magnification of the effects of short-term scenario. The simulation of long run scenario roughly double effects of the short run effects.

The increase of NTMs barriers reduces EU27-UK trade flows and will lead to changes in sectoral trade flows and outputs, especially in some export-oriented sectors. Our simulations show that exports of NMS to the UK can drop by 23-26%. The largest drops are forecasted for Poland (25.9%), which has the largest share of UK in overall exports. This drastic decrease of bilateral exports is compensated by increase of exports to the other EU members (0.9-1.5%) and to third (RoW) countries (1.1-1.7%). The analysis of simulated changes in overall imports reveals a similar pattern, although the bilateral changes are less drastic, since the UK share in imports of NMS is visibly smaller (about 1/3) in comparison to exports (see Table 1). The significant drop of imports of NMS from the UK (15.0-19.1%) is partially offset by increased imports (0.8-1.3%) from other EU members.

The simulations indicate that the percent changes in the value of production are rather limited, and rarely exceed one percent of the value of production. The pattern of production of changes among NMS is differentiated but there are also some similarities. The most important losses, close to 1 percent of the production are forecasted in the case of electronic products and food products in Poland, Slovakia and Hungary. The largest possible gains in production are forecasted for pharmaceutical products and motor vehicles (close to 1% in three NMS). The possible gains in the motor vehicles sector result mostly from predicted decrease of imports from the UK to the EU countries.

Our early gravity estimates pointing to the negative effect of Brexit just in 2021 of the order of 20% of the value of bilateral trade between the EU members and the UK. This shows the order of magnitude of this short run effect only slightly lower than the effect shown by the computable general equilibrium model. These results are to some extent surprising, i.e., there has been seemingly very little regulatory divergence so far and the observed effect consumes large part of the expected change. This may be due to at least two reasons, i.e., CGE models are equilibrium models allowing for factor mobility, and in reality, this may be subject to considerably frictions and therefore this initial drop in trade will decrease over time with the adjustments in factor and product markets. However, it may also be the case that the effects of COVID-19 are underestimated and at least some of the observed drop is in fact a repercussion of COVID-19 that is of a bilateral nature (we control only for its unilateral effects).

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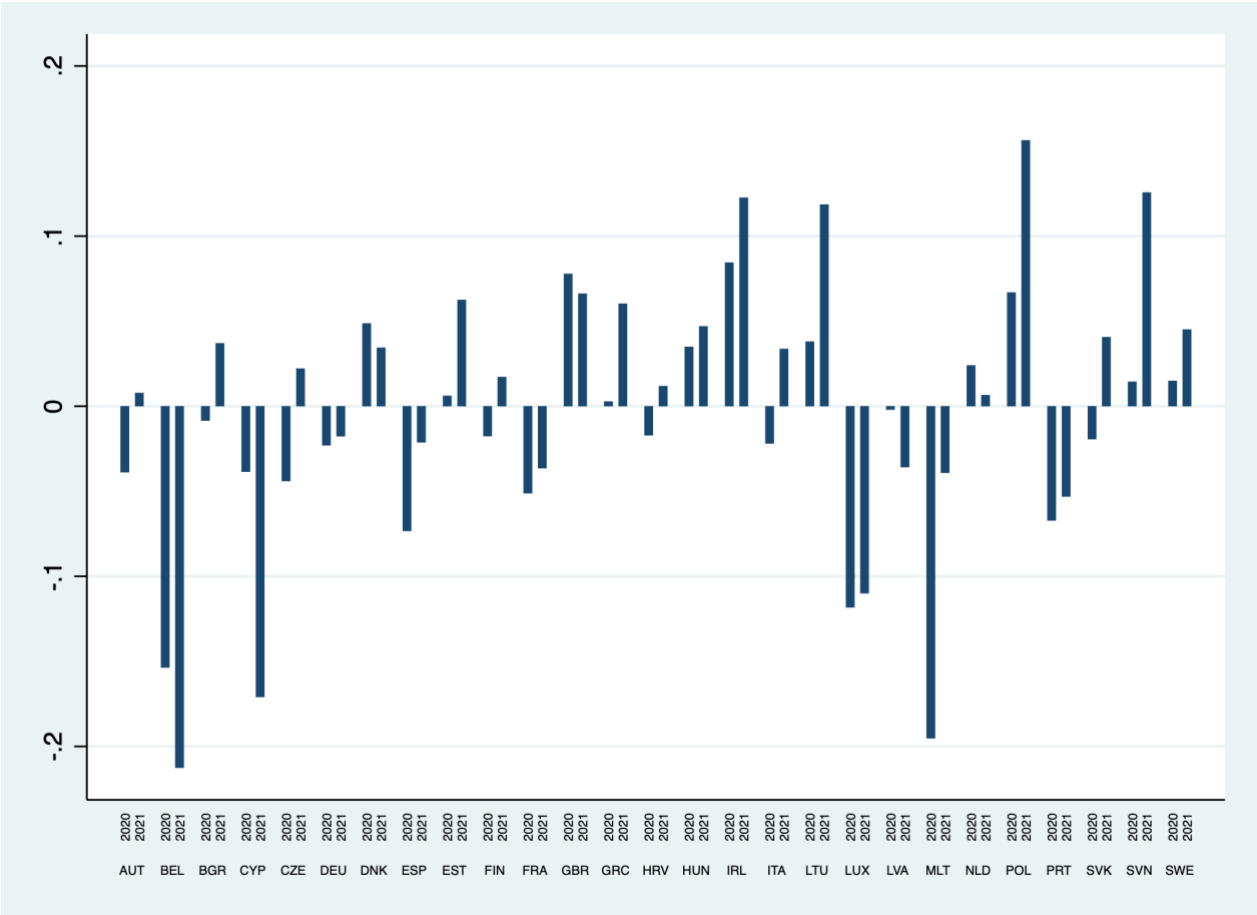
Appendix

Table A 1: Percent changes in exports and imports of NMS to the UK in the short run (SR)

	Exports					Imports				
Sector	POL	CZE	SVK	HUN	rNMS	POL	CZE	SVK	HUN	rNMS
Agriculture	-44.1	-44.6	-44.6	-44.6	-44.8	-44.6	-44.4	-45.3	-44.3	-44.4
Fishing	-40.2	-40.5	-40.5	-40.4	-40.3	-25.1	-26.4	-28.8	-26.6	-28.6
Mining	-45.0	-45.6	-45.5	-45.6	-45.4	-16.8	-16.5	-15.8	-17.6	-17.6
Food	-37.0	-37.3	-37.4	-37.4	-37.4	-40.1	-40.3	-40.8	-40.4	-40.3
Beverages & Tobacco	-12.5	-12.6	-12.7	-12.8	-12.7	-18.7	-19.4	-19.8	-18.7	-18.4
Textiles	-35.9	-36.2	-36.1	-36.3	-36.1	-20.7	-21.2	-22.0	-21.5	-21.1
Wearing Apparel	-55.4	-56.1	-55.7	-55.8	-55.7	-38.8	-37.9	-38.9	-39.3	-39.0
Leather	-52.1	-52.4	-52.3	-52.4	-52.1	-40.5	-41.0	-41.0	-40.7	-41.0
Wood	-29.2	-29.5	-29.7	-29.8	-29.7	-27.5	-27.4	-28.2	-27.2	-27.8
Paper, Publishing	-26.6	-26.7	-27.1	-26.9	-27.0	-24.9	-25.0	-25.6	-25.1	-25.0
Fuels	-19.8	-19.8	-19.8	-19.8	-19.8	-13.9	-13.7	-13.8	-13.8	-13.8
Chemicals	-25.8	-26.2	-26.1	-26.3	-26.1	-30.0	-30.2	-30.8	-30.4	-30.6
Pharmaceuticals	-23.3	-23.8	-23.7	-23.9	-23.8	-32.4	-32.6	-33.7	-32.9	-33.2
Rubber & Plastics	-26.9	-27.3	-27.3	-27.3	-27.3	-20.6	-20.5	-21.3	-20.8	-20.9
Non-metalic minerals	-21.8	-22.1	-22.5	-22.3	-22.5	-15.1	-15.1	-15.4	-14.8	-15.2
Steel	-26.1	-26.4	-26.5	-26.5	-26.3	-33.2	-33.4	-33.5	-33.3	-33.2
Metals nec	-48.7	-48.9	-49.0	-48.9	-48.9	-42.1	-41.8	-41.9	-42.2	-41.9
Metal products	-22.0	-22.3	-22.6	-22.5	-22.7	-11.8	-11.9	-12.4	-11.8	-12.0
Electronics and opticals	-32.1	-32.4	-32.5	-32.9	-32.2	-21.8	-21.9	-22.6	-22.1	-21.7
Electrical equipment	-22.4	-22.9	-23.1	-23.0	-22.8	-12.3	-12.1	-12.6	-12.0	-12.6
Machinery and equipment nec	-15.6	-16.0	-16.3	-16.2	-16.0	-4.7	-4.3	-4.8	-4.4	-4.8
Motor vehicles and parts	-14.4	-14.7	-14.8	-14.8	-14.6	-28.7	-28.9	-29.1	-28.8	-28.7
Transport equipment nec	-11.7	-12.3	-12.2	-12.2	-12.1	9.1	8.2	7.6	8.5	8.9
Manufactures nec	-29.0	-29.5	-29.5	-29.5	-29.2	-17.8	-17.7	-18.2	-17.7	-17.9
Energy	-3.5	-3.8	-4.1	-4.0	-4.1	21.5	21.0	21.0	21.3	21.6
Construction	-20.2	-20.4	-20.6	-20.6	-20.6	-8.2	-8.0	-8.0	-7.8	-7.9
Trade	-15.4	-15.8	-16.0	-15.9	-15.9	-4.3	-4.4	-4.5	-4.3	-4.2
Accommodation and Food	-13.0	-13.2	-13.4	-13.4	-13.4	-4.8	-5.0	-5.1	-4.9	-5.0
Transport nec	-13.3	-13.6	-13.8	-14.0	-13.7	-7.8	-7.6	-7.8	-7.7	-7.9
Water transport	-6.9	-7.7	-7.7	-8.0	-7.8	-1.5	-1.3	-1.2	-1.3	-1.3
Air transport	-13.0	-13.2	-13.3	-13.4	-13.4	-4.4	-4.4	-4.3	-4.2	-4.3
Warehousing and support	-8.8	-9.2	-9.4	-9.3	-9.3	-3.0	-3.0	-3.3	-3.3	-3.0
Communication	-14.9	-15.1	-15.3	-15.2	-15.3	-3.7	-3.5	-3.7	-3.4	-3.4
Financial services nec	-17.7	-17.9	-18.4	-18.1	-18.1	-6.5	-6.3	-5.9	-6.2	-6.3
Insurance	-16.0	-16.3	-16.6	-16.4	-16.3	-6.4	-6.1	-5.8	-5.8	-6.0
Real estate activities	-12.7	-13.0	-13.3	-13.1	-13.2	-1.8	-1.8	-1.9	-1.7	-1.6
Business services nec	-13.6	-13.8	-14.1	-14.0	-14.1	-2.5	-2.4	-2.6	-2.3	-2.3
Recreational and oth.	-11.7	-12.1	-12.3	-12.1	-12.2	1.7	1.8	1.6	1.8	1.8
Public Administration	-19.1	-19.3	-19.6	-19.4	-19.5	-8.3	-8.6	-8.6	-8.6	-8.1
Education	-16.2	-16.5	-16.8	-16.5	-16.5	-5.1	-5.2	-5.1	-4.9	-4.7
Human health, social work	-14.9	-15.4	-15.4	-15.4	-15.3	-6.4	-6.2	-6.5	-6.2	-6.1

Figure A.1 Time-varying importer effects



Source: own estimations. Numbers relative to 2019