19-5 Brexit: Everyone Loses, but Britain Loses the Most

María C. Latorre, Zoryana Olekseyuk, Hidemichi Yonezawa, and Sherman Robinson
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Abstract

This paper examines 12 economic simulation models that estimate the impact of Brexit. We provide their range of results and explain their associated assumptions and methodologies (macroeconometric models, computable general equilibrium [CGE] models, or mixed approaches). CGE models simulate the operation of market economies, solving for changes in equilibrium prices and quantities (production, employment, demand, and international trade) for all sectors in the economy. Macroeconometric models focus on economic aggregates and macro shocks, such as interest rates, the exchange rate, inflation, risk, uncertainty, and government expenditure/revenue. Most of the studies find adverse effects for the UK and the EU-27. The UK's GDP losses from a hard Brexit (reversion to World Trade Organization rules due to a lack of UK-EU agreement) range from –1.2 to –4.5 percent in most of the models analyzed. A soft Brexit (e.g., Norway arrangement, which seems in line with the nonbinding text of the political declaration of November 14, 2018 on the future EU-UK relationship) has about half the negative impact of a hard Brexit. Only two of the models derive gains for the UK after Brexit because they are based on unrealistic assumptions. We analyze more deeply a CGE model that includes productivity and firms' selection effects within manufacturing sectors à la Melitz (2003) and the operations of foreign multinationals in services. Based on this latest model, we provide a complete overview and explanation of the likely economic impact of Brexit on a wide range of macro-economic variables, namely GDP, wages, private consumption, capital remuneration, aggregate exports, aggregate imports, and the consumer price index.

María C. Latorre is assistant professor at the Faculty of Statistical Studies of the Universidad Complutense de Madrid (Spain). Her research focuses on the impact of trade, foreign direct investment, and multinationals' operations. For more information, see www.ucm.es/deaeh/latorremc. **Zoryana Olekseyuk** is a senior researcher at the German Development Institute (Deutsches Institut für Entwicklungspolitik [DIE]). Her research areas include international trade, economic integration/disintegration, and trade and investment facilitation with a particular focus on developing countries. **Hidemichi Yonezawa** is researcher in the Division for Energy and Environmental Economics at the Research Department at Statistics Norway. His research focuses on analyzing the role of public policy by employing both theoretical framework and numerical simulation models. **Sherman Robinson** is nonresident senior fellow at the Peterson Institute for International Economics. He is a leading expert on computable general equilibrium simulation models, which have become a standard tool of analysis of trade and fiscal policy reform, regional integration, structural adjustment, and development strategies.

INTRODUCTION

In June 2016, the United Kingdom (UK) voted by a narrow margin in favor of leaving the European Union (EU). Then home secretary Theresa May became prime minister and took on the onerous task of putting together a divorce deal. Brexit was set in motion when the UK formally triggered Article 50 of the Lisbon Treaty on March 29, 2017, to leave the EU and begin negotiations with Brussels. On November 14, 2018, EU and UK negotiators reached a draft withdrawal agreement and outlined a draft political declaration on the future UK-EU relationship once the Brexit transition period ends. EU leaders endorsed that withdrawal agreement on November 25 but the UK Parliament rejected it in January 2019. Since then, the political situation surrounding the exit deal has been unclear and in flux.

At the time of publication of this paper, the UK was set to officially exit the EU, with or without a deal, on March 29, 2019, and enter a transition period, which, in principle, would end on December 31, 2020 (with a possible extension once), and a new economic and political relationship between the UK and the EU would begin. According to the draft withdrawal agreement of November 14, 2018, during the transition period "the UK will continue to participate in the EU Customs Union and the Single Market (with all four freedoms) and all Union policies" (European Commission 2018a). For the situation after the transition, there was only a nonbinding political declaration (European Commission 2018b), which suggests that the intention is to keep barriers low (e.g., to trade and foreign direct investment [FDI]) between the Brexit partners. To begin with, the political declaration talks about a future "economic partnership," which implies close economic ties. In the case of goods, it says, "Comprehensive arrangements creating a free trade area combining deep regulatory and customs coopera-tion…; zero tariffs, no fees, charges or quantitative restrictions across all goods sectors, with ambitious customs arrangements that build on the single customs territory provided for in the withdrawal agreement, respecting the Parties' legal orders" (European Commission 2018b, 2).

Although the devil is in the details, to an important extent, all this sounds like a deal avoiding barriers in goods. With respect to services, the declaration says, "Ambitious, comprehensive and balanced arrangements on trade in services and investment, delivering a level of liberalization in trade in services well beyond the Parties' WTO commitments, and in line with Article V of the General Agreement on Trade in Services, with substantial sectoral coverage, covering all modes of supply and providing for the absence of substantially all discrimination in the covered sectors, with exceptions and limitations as appropriate" (European Commission 2018b, 3). Interestingly, Article V mentions possible special treatment to deal with services among countries that are involved in a wider process of economic integration, which is the case between the EU and UK. However, the text on services also mentions the idea of "preserving regulatory autonomy," which leaves the door open to the emergence of barriers.

Unless both UK and EU lawmakers agree upon and approve an exit deal, the UK will leave the EU without any agreement and become a normal member of the World Trade Organization (WTO). This scenario looks very likely given the uncertainty prevailing in the UK Parliament at the time of publication of this paper. But all scenarios seem possible at the moment. The good news is that we do have estimates of the economic impact for all of them. There is now a wide range of predictions of the economic consequences for both the UK and the remaining 27 EU members (EU-27). Most of the models studied in this paper consider medium- to long-run

impacts of Brexit. A no-deal "crash out" on March 29 would have serious negative short-run impacts on the UK, which are essentially impossible to model. See HM Government (2019) for some possible shock effects.

The EU is the world's most deeply integrated economic area. The EU project is much more favorable to trade than the North American Free Trade Agreement (NAFTA), for example (Krugman 2018). It is impossible that any other EU-UK agreement can replicate their current integration. In other words, all alternatives imply cost increases in transactions (trade, investment, capital, and people's movement) with the EU. So, there can be little doubt that Brexit represents changes in the EU and UK economies, with a variety of potential negative shocks as the most likely outcome. But how big these shocks are depends on various scenarios, which are being determined by negotiators.

An examination of 12 studies of the potential economic impacts of the Brexit decision yields a number of conclusions, almost all of them adverse for both sides. All these studies use economic simulation models to consider the different scenarios. Only two studies find that the UK gains from Brexit. We explain that they rely on unrealistic assumptions, as others have already noted (Krugman 2018, Wolf 2018, Sampson et al. 2016). The rest of studies indicate that Brexit will damage economic growth in both the UK and EU-27. The UK losses are much greater than EU-27 losses, however. The evidence thus supports the well-known comment of European Commission President Jean Claude Juncker: "There is no good Brexit."

The losses inflicted by Brexit would be incurred by increased barriers to trade, with higher tariffs, nontariff barriers (NTBs), tighter rules of origin, changes in standards, and increased "frictions" that constrain supply/value chains. There would also be decreases in FDI; sectoral declines in productivity associated with decreased trade; and efficiency losses because of changes in the structure of production. In addition, macro shocks affecting interest rates, the exchange rate, inflation, risk, government expenditure/revenue, and macro balances are expected to generate unemployment and lower GDP on the whole. Finally, Brexit would lead to an exodus of skilled and unskilled workers from the UK. No wonder that the UK's negotiation position set on July 12, 2018, through the so-called Brexit white paper or Chequers proposal, called for a Brexit trying to mitigate the emergence of barriers, particularly in goods and less in services and that the draft for the withdrawal agreement of November 14, 2018, tries to avoid most barriers for the transition period and seems to have the same intention once it has ended.

The larger the barriers to trade and FDI that result from different Brexit scenarios, the more negative the impacts for both partners. The UK's GDP losses from a hard Brexit (reversion to WTO rules due to a lack of UK-EU agreement) range from –1.2 to –4.5 percent in most of the models analyzed here. A soft Brexit (e.g., a post-Brexit arrangement similar to the one that Norway has with the EU and also similar to the political declaration on the future EU-UK relationship of November 14, 2018) would dampen the potential for harm to both regions, cutting the losses roughly by half, making this scenario preferable to a hard Brexit.

Losses for the UK are larger than for the EU-27 because European firms will be able to substitute for reduced trade with the UK through two channels: first, by trading more in the unfettered European Single Market, and second, EU firms find lower barriers than other countries do in third nations. The EU has many trade agreements, which fall short of the European Single Market, but still are some of the most advanced in the world. By contrast, the UK can recover less of the trade it loses with the EU by trading with third nations. The UK loses preferential access to the huge EU market, but also it will no longer be party to EU's trade deals with other nations, which

will have to be revised or renegotiated (Molinonuevo 2017, World Bank 2016). Pro-Brexit economists argue that, once out of the Single Market, the UK will be able to sign many other trade agreements. However, UK trade with the EU accounts for around half of the UK's total trade.[1] The UK will have to strike trade deals with most of the remaining countries of the world to compensate for the lost EU trade. This restructuring will take time, although the UK may be quicker in its negotiations since it does not need the agreement of the remaining EU-27 Parliaments, as happens with EU trade and FDI agreements. But the UK must also consider that it loses leverage in the negotiations and has much less to offer (e.g., a smaller market with fewer potential customers) than the EU.

Pro-Brexit economists also underestimate the presence of NTBs hindering trade and FDI. It has taken decades for the EU to harmonize regulations across its member countries. NTBs are sometimes sheer protectionism, but many protect consumer health and security and the environment (e.g., Sandbu 2018). Deregulation may not be feasible, since it is entrenched in existing regulations and, sometimes, not desirable. In addition, the EU has been a great advocate of trade. There are reasons why the EU does not have trade deals with attractive countries such as China or the United States (US), as we discuss below. It will probably not be that easy for the UK to sign them either.

The simulation models analyzed in this paper vary widely in how many of these shocks they consider, how they are incorporated in the models, and how important they are in scenario results. Computable general equilibrium (CGE) models are the most widely used methodology for analyzing Brexit scenarios.[2] CGE models simulate the operation of market economies, solving for changes in equilibrium prices and quantities (production, employment, demand, and international trade) for many sectors given policy changes under different Brexit scenarios. Other studies use macroeconometric models, focusing on economic aggregates and macro shocks, some linked informally with CGE models. These macro models do not incorporate trade policy changes at the sectoral level. Instead they focus on shocks related to interest rates, the exchange rate, inflation, risk, uncertainty, government expenditure/revenue, and macro balances. These scenarios are more speculative in that they go beyond issues of trade policy and protection that are the main focus of CGE models and assume strong impacts from increasing uncertainty. Indeed, they have probably overestimated the impact of uncertainty, as explained below. However, some of the effects the macroeconometric models analyze would add to the impacts of changes in trade policy due to Brexit since they involve mechanisms that differ from, and are independent of, those in the CGE models. The losses considered by these macroeconometric models range from –3 to –8 percent of GDP.

The rest of this paper is organized as follows. First, it presents detailed data on the UK's strong trade dependency on EU-27 and the much smaller role of the UK in EU-27 trade. Then, it offers an overview and explanation of the likely economic impact of Brexit on a wide range of macroeconomic variables (GDP, wages, private

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1. The UK's exports to (imports from) EU-27 are 43 percent (54 percent) of aggregate exports (imports) in 2016, according to the UK's Office for National Statistics (2017). Asia, the region that is growing the most in the world and will keep doing so, explains only 20 and 18 percent of the UK's exports and imports, respectively. Geographical and cultural (regulations, customs etc.) distance with that region are not to be undervalued, as gravity law suggests (Krugman 2018), even in the digital era. China accounts for 7.6 and 3.1 percent and the US for11.9 and 18.2 percent of the UK's exports and imports, respectively. For an analysis of the main trade and foreign direct investment partners of the UK, see Fernández-Pacheco, Lopez, and Latorre (2018a, 2018b).

2. See Devarajan and Robinson (2005) for a survey of the use of CGE models in policy analysis.

consumption, capital remuneration, the consumer price index [CPI], aggregate exports, and aggregate imports).[3] Next a summary survey of all 12 models is provided, including CGE models and macroeconomic regression models that have been used in "simulation mode" to provide macro projections under different scenarios. Finally, the results from all 12 models are summarized in the conclusion.

UK ECONOMIC RELATIONS WITH EU-27

Table 1 provides figures on projected value added, exports, and imports for the UK from Latorre, Olekseyuk, and Yonezawa (2018). The data in the table are from a reference scenario with the CGE model providing projections for 2020 without Brexit.[4] This scenario provides the benchmark for comparing the impact of Brexit scenarios. The first three columns present the structure of value added and trade in the UK (the shares of all sectors in total value added, aggregate exports, and aggregate imports). They show the strong specialization in services by the UK: Services account for 75.9 percent of total value added. The bulk of trade, however, is concentrated in manufactures, which includes 66.4 and 77.5 percent of UK total exports and imports, respectively.

The next two columns in table 1 present the shares of UK exports going to and imports coming from the EU-27 in each sector. The EU-27 is a crucial trade partner for the UK: 46.9 and 48.4 percent of UK aggregate exports and imports are directed to or coming from the EU-27, respectively. This trade dependency is evident across all sectors. The UK, by contrast, accounts for only 6.3 percent of exports and 5.3 percent of imports for the EU-27 (including intra-EU trade). The last two columns show the shares of exports and imports relative to domestic production in each sector, which indicates sectoral dependence on foreign trade. Exports and imports account for 14.3 and 15.5 percent of total production, respectively. There are important differences between manufactures and services—the latter are much more oriented to the home economy than the former. For services, the home country's regulations are much more important than trade regulations.

This difference may explain why in the "Brexit white paper" Prime Minister Theresa May preserved British autonomy over regulation for many services. However, this puts at risk the UK's prominent role in the financial world. The proposal acknowledges that diverging services rules would mean the UK and the EU will not have the current level of access to each other's markets. This could also have implications for non-EU financial firms (such as Swiss or US firms) carrying out their activities using the UK as a platform for their EU operations. As noted, the political declaration for the future EU-UK relationship also leaves the door open for preserving regulatory autonomy in services.

The figures above indicate that the potential negative effects of erecting barriers to trade in the UK are sizeable. Such barriers will affect half of UK trade. Not all the barriers will appear suddenly after the transition period

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3. CGE models cover a broader set of macro and microeconomic variables than macroeconometric models do. Thus the macroeconomic results we show are provided by the CGE model developed by Latorre, Olekseyuk, and Yonezawa (2018), which includes not only trade but also multinationals and productivity effects as explained below. The code used for these simulations is available at https://piie.com/system/files/documents/wp19-5.zip.

4. Latorre, Olekseyuk, and Yonezawa updated the information from 2011, which is the latest year available in the GTAP9 database (Global Trade Analysis Project, version 9; see Aguiar, Narayanan, and McDougall 2016), using IMF (2016) projections. The implementation of Brexit barriers is expected in 2021, after a negotiated transition period in which the UK will continue to be in the Single Market and the current status will still hold. According to the withdrawal agreement, which still needs to be ratified, this transition period could be extended only once until December 2022.

following Brexit, since many of them are related to regulations. The UK is in compliance with EU regulations at the moment, so barriers will tend to grow as time passes. However, other barriers, such as customs controls, could emerge very soon after Brexit. Given this, Latorre, Olekseyuk, and Yonezawa (2018) assume two scenarios: soft Brexit, in which the barriers to trade and FDI are small, and hard Brexit, where they are large. In this model, "soft" means that the UK achieves a trade relationship with the EU-27 like that of Norway and similar to the "Brexit white paper," while "hard" means moving to WTO status.[5] This latter scenario would arise if no agreement is struck between the UK and the EU.

In the case of hard Brexit, following Dhingra et al. (2017), Latorre, Olekseyuk, and Yonezawa increase import tariffs between the UK and EU-27 to the most favored nation level. They assume that the UK would become a normal WTO member in its relations with the EU. In the hard Brexit scenario, the UK and EU-27 are also assumed to face an increase in their respective bilateral NTBs equivalent to half of the NTBs that the US currently faces in EU markets. Regarding FDI barriers, in the hard Brexit scenario, Latorre, Olekseyuk, and Yonezawa assume an increase in existing FDI barriers between the UK and EU-27 by 50 percent. In the case of soft Brexit, the tariffs remain at zero, but NTBs and FDI barriers are increased by 25 percent.[6]

Other models use different specifications of "hard" and "soft" Brexit scenarios, with somewhat different definitions of "small" and "large" changes in trade barriers. We mention some of the differences in the comparative section below.

The impact of FDI has received less attention in the literature. To the best of our knowledge only Latorre, Olekseyuk, and Yonezawa (2018) and Ciuriak et al. (2015) have disentangled FDI effects from other forces present in their models. Their results are discussed below.

ECONOMIC IMPACT OF BREXIT SCENARIOS: LATORRE, OLEKSEYUK, AND YONEZAWA CGE MODEL

We discuss results from the Latorre, Olekseyuk, and Yonezawa (2018) model because, to the best of our knowledge, it is the only study covering the broadest set of variables and has a number of original features especially relevant for Brexit analysis. It includes 21 sectors in each country and incorporates changes in productivity and firm selection (following Melitz 2003) within and across manufacturing sectors and the effects of changes in foreign direct investment and multinationals in services.[7] The variables that appear in the table include GDP,

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5. The other models, analyzed below, use similar definitions of a "hard" and "soft" Brexit. None of the models considered a "soft" scenario with the UK remaining in the EU Customs Union. In her speech at Mansion House on March 3, 2018, Prime Minister Theresa May confirmed that the UK wanted to leave the Single Market and Customs Union. However, the nonbinding political outline on the future EU-UK relationship of November 2018 leaves this door open.

6. The UK faces fewer barriers (and, therefore, costs) in the European markets than the US does. Therefore, Latorre, Olekseyuk, and Yonezawa assume an increase in UK/EU-27 barriers by a fraction of the total barrier. It is hard to know the exact change in percentage costs, so Latorre, Olekseyuk, and Yonezawa follow the approach of Dhingra et al. (2017), except for the FDI component, which is not included in the Dhingra et al. analysis.

7. Latorre, Olekseyuk, and Yonezawa extend the path-breaking model of Balistreri, Hillbery, and Rutherford (2011), which is the first CGE model that incorporates the full Melitz structure in several sectors and regions. Melitz (2003) specifies that productivity differs across firms within the same sector and that only the most productive firms are able to export. By contrast, the least productive firms sell only domestically. Melitz (2003) can be considered one of the most important contributions in international economics in the last decades. With a Melitz model, such as Latorre, Olekseyuk, and Yonezawa, if barriers to trade increase (e.g., with Brexit), export markets

private consumption, wages, capital remuneration, aggregate exports, and aggregate imports for both the UK and EU-27.[8]

Table 2 presents the Latorre, Olekseyuk, and Yonezawa (2018) model's medium-run impacts of Brexit scenarios on these variables for the UK and EU-27. Most of the effects in the other countries/regions are close to zero—the effects of Brexit are largely confined to Europe when we assume no changes in the trade policy against third countries. In a later paper Latorre, Yonezawa, and Olekseyuk (2018) analyze the joint impact of Brexit and other trade and FDI agreements of both Brexit partners with third regions. We summarize their results below.

Table 2 presents results for a soft (Norway) and a hard (WTO) Brexit, at the left and right of the table, respectively. It presents the separate effects of different "shocks," together with their joint impact, for 2020. For soft Brexit, it includes increases in NTBs and increased barriers to FDI as well as their joint impact. For hard Brexit, the impact of moving to most favored nation tariffs is also included. NTBs and FDI barriers are increased further in the hard Brexit scenario than in the soft one, as explained above.

The negative impacts of the two scenarios are much larger in the UK than in the EU-27 for all macroeconomic variables. GDP in the UK is projected to contract by –1.23 and –2.53 percent under the soft and hard Brexit, respectively. By contrast, for the EU-27 the fall in GDP would be much milder: –0.16 and –0.35 percent after the soft and hard Brexit, respectively.

Reductions in private consumption are more pronounced than the reduction in GDP in both regions. The UK loses more than the EU-27 in absolute terms (billions of dollars, 2020) as well as in percentage change. After the hard Brexit, the consumption loss is –3.17 percent (–62.70 billions of dollars) for the UK versus –0.59 percent (–57.98 billions of dollars) for the EU-27. In the case of the soft Brexit, the consumption loss would be –1.56 percent (–30.82 billions of dollars) in the UK and –0.27 percent (–26.18 billions of dollars) in the EU-27. Changes in NTBs account for the largest share of the total negative impact. The change in FDI also plays a significant role—it explains around one-third of the contraction in GDP and private consumption in the UK and EU-27.

The results for wages and capital remuneration are parallel to the changes in GDP and private consumption. Increases in NTBs induce the largest reduction in factor remuneration, even though reduced FDI also has an important negative contribution. Average wages and capital remuneration in the UK are projected to decline by –2.83 and –3.34 percent in the UK with the hard Brexit, respectively, and by –1.26 and –1.59 percent, respectively, with the soft Brexit. Reductions in wages and capital remuneration are approximately seven times larger in the UK than in the EU-27. Declines in factor prices lead to reductions in the consumer price index (CPI) in the EU-27 (last rows in table 2), but not in the UK, where larger trade barriers applied to half of its trade result in price increases.

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shrink. British high-cost firms are able to enter the domestic market due to reduced competition from abroad. By contrast, productive low-cost firms contract because they export less. Overall, the industrywide average productivity, which also accounts for firms' exit and entry to/from third markets, will decrease. By contrast, productivity effects are not taken into account in most of the models of Brexit.

8. Sectoral results from the Latorre, Olekseyuk, and Yonezawa model are discussed in detail in Latorre, Olekseyuk, and Yonezawa (2018). The model also includes results for the US, China, India, Japan, other advanced economies, South East Asia, Latin America, Middle East, and Sub-Saharan Africa.

The impacts on aggregate UK trade (table 2) in the two scenarios are dramatic. Reductions in exports in the UK would be –16.94 and –7.54 percent after the hard and soft Brexit, respectively, while they would reach only –3.48 and –1.54 percent in the EU-27, respectively. The outcomes are very similar for imports. The drop amounts to –14.42 and –6.44 percent in the UK and –3.82 and –1.69 percent in the EU-27, respectively.

Reductions in foreign trade are much larger in the UK than in the EU-27 because the UK loses preferential access to the huge EU market, which takes around half of its trade. By contrast, the EU-27 loses preferential access to a much smaller UK market and is able to recover an important share of the reduced exports and imports directed to the UK by trading more intensively within the EU-27.

As noted above, firms in the Latorre, Olekseyuk, and Yonezawa model have selection effects and differences in productivity in manufacturing sectors.[9] Our results show that both the UK and EU-27 experience reductions in industrywide average productivity after Brexit. The reductions are much more pronounced in the UK than in the EU-27. In addition, the decrease in average productivity is deeper in the hard Brexit scenario than in the soft one. The differences in these reductions of average productivity in the UK and EU-27 vary across sectors. They range between almost 3 times larger reduction after the hard Brexit in the UK food production sector and 86 times larger reductions in the UK than in the EU-27 in other machinery and equipment.[10] Hereby, the highest reductions of industrywide average productivity occur in case of hard Brexit in food processing, with –2.76 percent in the UK and –1.10 percent in the EU-27.

In a later paper, Latorre, Yonezawa, and Olekseyuk (2018) study different policy alternatives for the UK and EU-27 to counteract the harmful impact of Brexit. They analyze a unilateral tariff elimination in the UK, different FDI agreements between the UK and China, Japan, and India, and a comprehensive trade and FDI agreement with the US (similar to the Transatlantic Trade and Investment Partnership [TTIP]). FDI agreements have a negligible impact on the UK. A UK-US TTIP kind of agreement is insufficient to compensate for the negative impacts of Brexit. By contrast, in most of the possible Brexit and EU-27–US TTIP joint scenarios, such a deal could be useful for the EU-27 to offset the limited negative effects it experiences with Brexit. Interestingly, during his visit to the UK, President Trump was initially upset by the UK's "Brexit white paper" proposal and said the US would not sign any bilateral agreement with the UK if such a soft Brexit took place. He also said he would turn to a bilateral agreement with the EU-27, instead. However, at the end of the trip, Trump changed his mind and said the US would sign a bilateral trade deal with the UK even if the "Brexit white paper" proposal made progress (Wall Street Journal 2018a).

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9. For comprehensive descriptions of these features, see Melitz (2003), Balistreri, Hillberry, and Rutherford (2011), Olekseyuk (2016), Olekseyuk and Balistreri (2018), Latorre, Yonezawa, and Zhou (2017), Latorre and Yonezawa (2018), Latorre (2009), and Tarr (2013).

10. The percentage reduction of the industrywide average productivity in other machinery, used for this calculation, is rather low and amounts to –0.01 and –0.54 percent in the EU-27 and the UK, respectively. Because most countries need to import machinery, barriers to trade in this sector tend to be very low. As a consequence, the emergence of these small barriers has only a limited negative impact on productivity.

COMPARATIVE BREXIT ANALYSIS: 12 SIMULATION MODELS

Tables 3 and 4 provide a summary comparison of currently available studies of the impact of Brexit. Each table focuses on the studies that use one of the two broad methodological approaches: (1) CGE models (table 3) or (2) macroeconometric models (table 4). The difference between the two methodologies is discussed below. Both tables have basically the same structure. The column headings on top report the authors of the papers. The first row reports the economic indicator whose impact is reported in the next row. For the studies that include GDP, we have chosen that variable. For a few studies in table 4, the impact on GDP was not available. In some studies, the results are available only for the UK. Whenever the comparison between the UK and EU-27 is possible, it becomes clear that the impact would be negative for both but much larger for the UK than for the EU-27. In principle, studies covering both regions support comparison of the coherence and consistency of the results compared with studies that consider only the UK. Just below the row offering the impact in tables 3 and 4, other rows offer more details on the methodological approach, including which type of sectoral effects, barriers, and macroeconomic shocks are considered in each study.

The Brexit models follow three different methodologies: (1) seven CGE models, (2) two new econometrically estimated "gravity" models called "new quantitative trade models" (NQTMs), and (3) three mixed models that link with the NiGEM macroeconometric model (a VAR model and a gravity model used by HM Treasury and a CGE model used by the Organization for Economic Cooperation and Development [OECD]). CGE models include many detailed features of the economy including explicit simulation of the operation of supply and demand across product and factor markets, bilateral trade at a disaggregated sector level, sectoral production, and demand for labor, capital, and intermediates, as well as many macroeconomic aggregates like the ones shown in table 2. They are well suited for analysis of medium- to long-run scenarios involving changes in equilibrium market prices and factor returns due to policy changes.

By contrast, modern gravity models include much less detail on the working of the economy. They estimate their main parameters from the same database used for simulation, which supports statistical validation of the model within the domain of the data used for estimation. They can quantify estimation uncertainty and provide confidence intervals for the results, as happens for the hard Brexit scenario in the study of Aichele and Felbermayr (2015) in table 4. Often, NQTMs are one-sector models with one factor of production and operating in perfect competition. However, recent attempts include multiple sectors with one production factor (e.g., Aichele and Felbermayr 2015, Dhingra et al. 2017). That is why these latter studies do not report impacts on wages and capital remuneration.

Macroeconometric models such as NiGEM work with economic aggregates and do not involve sectoral detail that CGE models consider. They focus on relationships at the macro level and are more suitable than CGE or gravity models for simulating Brexit scenarios involving macro "shocks" to the economy (e.g., exchange rate changes, swings in financial capital flows, changes in inflation). The linking of a short-run macroeconometric model with longer-run CGE models is challenging, since they focus on different channels by which policy changes

affect the economy (e.g., market price incentives in CGE models versus changes in aggregate demand and asset markets in macro models).[11]

Two outliers are the only studies that find a positive impact of Brexit. Both are reported in table 3. Booth et al. (2015) (also known as Open Europe study) provides results for soft and hard Brexit scenarios based on projections for 2030 reported in Ciuriak et al. (2015), from whom they were requested. The only difference is that the Booth et al. (2015) report does not use a simulation model but instead subtracts the percentage savings in GDP due to the (partial) elimination of contributions to the EU budget from the CGE results of Brexit. The impact of a hard and soft erosion of preferential access to the EU is still (after subtracting EU budget contributions) clearly negative for the UK. The positive outcomes they derive assume that the UK simultaneously conducts trade liberalization not only with the EU but also with the rest of the world *and* includes assumed gains from a further liberal regulatory strategy in the UK economy. In table 3 we present the scenarios in which they obtain positive outcomes under the heading "FTAEU+ROW+Dereg." This heading, in turn, includes two scenarios. In the first one they derive a 0.6 percent GDP increase, which arises from the UK striking a free trade agreement with the rest of the world (ROW), as well as assumed gains from deregulation and more liberal policies. Importantly, the latter component of deregulation alone would contribute a 0.75 percent GDP increase. In the second scenario they obtain a 1.6 percent GDP increase. In this case, the UK also strikes a free trade agreement with the EU and ROW together and implements an extremely ambitious deregulation, which would now account for a 1.3 percent rise in GDP versus the more modest 0.75 percent they had calculated for the previous scenario. The authors, themselves, regard their most extreme estimations (the 1.6 percent GDP increase in the second FTAEU+ROW+Dereg scenario and –2.23 percent decrease in the hard Brexit scenario) as unrealistic.

According to the OECD (2016), the UK is liberalized by many standards and will not benefit much from further liberalization. PricewaterhouseCoopers (2016) also includes savings related to deregulation and estimates that their impact could be a gain of 0.3 percent of GDP, while the assumptions in Booth et al. (2015) are much larger. The interviews conducted with UK firms for a report of the Harvard Kennedy School (Sands et al. 2017) suggest that UK firms fear a larger regulatory burden after Brexit. Firm managers assert they will still have to comply with all EU regulations to be able to export to the EU, while having to abide by new future regulations in the UK as well. The press has echoed the complaints of many firms that would like a soft Brexit (e.g., Wall Street Journal 2008b). Even in the digital world, regulations (NTBs) do matter, and when they differ across borders they make exporting much more challenging. Even in the presence of e-commerce, a giant like Amazon will have to put different information on the label of its products and use different packaging procedures, depending on whether it sells them in China or in Latin America. If we think about a farmer, he will need to collect different certificates from different agencies to show he is in compliance with health and environmental laws in different parts of the world. The process exporters face is much easier within the European Single Market. The assumptions made by Booth et al. (2015) seem unrealistic. As already noted, not all regulation is protectionist but can be protective and desirable.

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11. See Robinson (1991, 2006) for discussions on linking macro and CGE models.

The second outlier is Minford et al. (2016), who assume that the UK could benefit if it trades with the EU under WTO rules and unilaterally removes all import tariffs globally. These results are based on a scenario with dubious assumptions that have been criticized by Sampson et al. (2016). For example, Minford et al. (2016) make the shaky assumption that the UK's prices of manufactures and agricultural goods will fall by 10 percent after Brexit. They also assume that trade responds dramatically to changes in trade costs. Their model assumes an infinite response elasticity in each industry, which implies that tiny changes in prices lead to dramatic and unrealistic changes in demand. Empirical evidence is that this price response elasticity varies by industry and is certainly far from infinite (e.g., Dhingra et al. 2017, table A.3). In sum, the construction of their model leads to outcomes that are empirically unrealistic. Dhingra et al. (2017), Latorre, Yonezawa, and Olekseyuk (2018), and Ortiz and Latorre (2018a) also estimate the impact of the UK trading under WTO rules and unilaterally removing all import tariffs in a CGE model. In contrast to Minford et al. (2016), they all find that the UK would not be able to compensate for the losses suffered from less trade with the EU with increased trade with other regions.

A note on how to interpret the percentage changes reported in tables 3 and 4 seems in order. In principle, all the studies in the two tables report the short- or medium-run but permanent effects with respect to a benchmark base year (i.e., initial values in the dataset), in which the impact of Brexit has not taken place. In other words, these studies report comparative static effects. A short- or medium-term impact can be around two or three years. However, the economic science is not as precise as physics, and economists often discuss how long it will take for a given shock to generate its effects in the economy. The timing of a similar shock may vary from one country to another and across different time periods for the same economy. What we know is that these models predict that once the effects of Brexit go through, they will remain in the future unless another shock undoes the effects of the primary shock.

Short- or medium-run effects differ, however, from long-run or dynamic effects. The studies whose results, as displayed in tables 3 and 4, are obtained in a dynamic framework are marked with the item "dynamics" at the bottom of the tables. In that case of dynamics the interpretation of the results will be detailed below, since it needs a case by case explanation. In a longer timespan more effects related to a particular shock, e.g., Brexit trade barriers, kick in and a reaction from agents can also be expected. So the long-run impact is likely to be different than the short- or medium-run one. In tables 3 and 4, we have included in most cases the studies and scenarios whose assumptions are more realistic. However, throughout the text we also report the outcomes of the studies in other scenarios not included in the tables and try to illustrate why we believe they are less reliable.

In table 3, the studies of PricewaterhouseCoopers (2016), Ciuriak et al. (2015), and Booth et al. (2015) report long-run dynamic effects. In these latter cases, the percentage contractions reported should be subtracted from different estimations for GDP growth rates per annum till 2030 (in the absence of Brexit effects), to obtain the overall impact on GDP growth of Brexit in 2030. PricewaterhouseCoopers (2016, 5) estimates per annum growth till 2030 would be of 2.3 percent in the absence of Brexit. Thus, the soft Brexit scenario would not lead to a recession in the UK because 2.3 percent minus 1.2 percent is 1.1 percent and, therefore, positive. But the hard Brexit scenario would, because 2.3 percent minus 3.5 percent is −1.2 percent. Ciuriak et al. (2015, 7) and Booth et al. (2015), which use the same model as Ciuriak et al. (2015), assume per annum growth till 2030 of 2.12 percent

for the UK and of 1.56 percent for the EU-27 without Brexit. So, comparing this growth with the numbers in this table, only the hard Brexit could lead to very small contractions in the UK's GDP.

In table 4 the percentage differences in HM Treasury (2016a, 46) are with respect to a dynamic quarter-on-quarter growth path during eight quarters just immediately after the Brexit vote (if the referendum had been in favor of Remain), and they emphasize that in the two scenarios (hard and soft) the UK would have fallen into a recession after a referendum in favor of Brexit. We now know that, although the UK's GDP has slowed its growth with respect to pre-referendum quarterly growth, a recession has not taken place in the first two years after the referendum. The percentage differences in HM Treasury (2016b, 184) reflect the difference with respect to a level of final GDP estimated for the UK in 2030 without the Brexit shock, which is considered the UK's long-run equilibrium (i.e., its steady state). HM Treasury (2016b) does not report what the percentage increase of this final long-run GDP without Brexit in 2030 is with respect to the initial data. We could interpret that, given the strong contractions HM Treasury (2016b) estimates after Brexit, which appear in this table, their results suggest a recession in the UK by 2030. The OECD (2016) study is also based to a great extent on the same model as the one of HM Treasury (2016b), namely, the NiGEM model. The short-run estimations, which appear in table 4, are for 2020. They are derived by introducing the impact on trade from the METRO CGE model into the NiGEM model, together with other macro elements, such as exchange rates, savings and investment, risk, and uncertainty. The OECD (2016) also provides long-run estimations for 2030, which are completely based on NiGEM and very similar to the ones derived by HM Treasury (2016b). It is not known what the growth would have been in 2020 and 2030 without Brexit, while the percentage changes reported in table 4 are relative to the dynamic path till 2020.

The results presented in table 2 for the Latorre, Olekseyuk, and Yonezawa's CGE model project intermediate impacts for Brexit scenarios compared with the rest of the studies in tables 3 and 4. They are in line with the results from NQTMs,[12] with the short-run impact of the OECD study, and with the long-run impact in a dynamic model by Ciuriak et al. (2015).[13] Latorre, Olekseyuk, and Yonezawa results are more negative than the CGE analysis of Ortiz and Latorre (2018a), because the latter results are derived in a climate of perfect competition. However, the Ortiz and Latorre (2018a) model considers the simultaneous impact of trade (tariffs and NTBs) *and* migration. Table 3 presents the results only for trade, since there is a wide range of possible scenarios for migration. The more restrictive the migration policy becomes (i.e., the larger the reduction in immigrants), the more sizeable the losses in terms of GDP for the UK. In addition, even modest reductions in the net inflow

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12. Aichele and Felbermayr (2015) and Dhingra et al. (2017) switch to different models from the ones they had used to derive the short-run impact shown in table 4 in order to offer estimations for the long-run (or dynamic) impact of Brexit. They derive much more negative outcomes for the UK in these long-run estimations, compared with the short-run ones. Dhingra et al. (2017) estimate reductions in GDP per capita in the UK between –6.3 and –9.4 percent. The range of Aichele and Felbermayr (2015) is even more extreme: GDP per capita income could fall between 6 and 26 percent in the UK. However, "we must warn readers here not to take the results too seriously because they always apply the average effect of openness (determined for many countries) to the specific case of a Brexit" (Aichele and Felbermayr 2015, 50).

13. Ciuriak et al. (2015) offer estimations for different years. We report the ones including full development of all Brexit barriers (in 2030) in table 3, which are more comparable to the barriers of the Latorre, Olekseyuk, and Yonezawa model, even though the Latorre, Olekseyuk, and Yonezawa model uses a static framework, while Ciuriak et al. use recursive dynamics.

of migrants (i.e., the OECD's optimistic projected reductions of 42,000 immigrants per year) accumulated through five years could reach nearly a half percentage point reduction in GDP. On the other hand, the scenario results reported by Latorre, Olekseyuk, and Yonezawa are less negative than scenarios considered in the studies that include uncertainty: HM Treasury (2016a, 2016b) in table 4, the short-run impact of OECD (2016), and PricewaterhouseCoopers (2016).[14] Uncertainty has failed to materialize so far, with the intensity these studies suggested, even though it seems there should have been scope for that to happen.

While the majority of studies explicitly consider trade barriers such as tariffs and nontariff barriers, the approach of HM Treasury (2016b) (table 4) estimates the impact of reductions in trade and FDI on productivity and introduces these changes in productivity into the NiGEM macroeconomic model to estimate the effect for UK GDP. HM Treasury (2016a, 2016b), OECD (2016), and PricewaterhouseCoopers (2016) introduce changes in unemployment rates, which tend to generate larger impacts compared with studies that maintain structural unemployment rates fixed.[15] OECD (2016) offers a particularly rich approach to the modelling of value chains in a perfect competition setting, which stands out among the other attempts.

In table 3, Jafari and Britz (2017) are one of the few studies that incorporate sectoral productivity effects (following Melitz 2003), as do Latorre, Olekseyuk, and Yonezawa (2018), together with migration and a proxy for the impact of FDI. They simulate a reduction in the stock of labor and population in the UK equivalent to 1.2 million fewer people, which explains –2.49 percentage points of the total –4.45 percent reduction in GDP they project. Tariffs alone would reduce GDP by –0.38 percent, tariffs together with NTBs yield a –1.17 percent reduction, and their proxy for FDI yields a fall by –0.59 percent in GDP.[16]

Another CGE model including Melitz effects is Hosoe (2018), which does not report total percentage changes of macroeconomic aggregates but rather reports changes in private consumption measured in billions of dollars. Because of lack of comparability, we have not included his results in table 3. His estimations are consistent with Latorre, Olekseyuk, and Yonezawa (2018) in that UK losses in absolute values are greater than EU-27 losses. However, his negative outcomes are smaller than the results in Latorre, Olekseyuk, and Yonezawa due to the different levels of barriers he assumes and to the fact that the model does not include the impact of lower FDI.[17]

14. In table 3 we include the results derived by PricewaterhouseCoopers (2016) for 2030, in which uncertainty has nearly vanished as a determinant of the outcomes and all trade barriers are fully in place. This scenario is again the most comparable to the ones of the Latorre, Olekseyuk, and Yonezawa model. Note that uncertainty is the most negative component in PricewaterhouseCoopers' results for 2020. As a consequence, PricewaterhouseCoopers obtain quite negative outcomes of –3.1 and –5.5 percent reductions in UK GDP under a soft and hard Brexit, respectively.

15. Dealing with unemployment rates in CGE models can be complicated. There are many reasons for maintaining a fixed unemployment rate as a way of capturing a sort of "structural unemployment" in the model, which differs from cyclical unemployment. In general, relaxing the assumption of fixed structural unemployment tends to overestimate adjustments in the model.

16. Their reduction in the stock of population contrasts with the much smaller reductions in the net inflows of migrants from OECD (2016) and seems too big, with the benefit of hindsight, in light of the preagreement of December 8, 2017, and the proposal in the current exit agreement. FDI is modeled as reductions in savings and, thus, in the stock of capital, rather than by the presence of multinational firms operating simultaneously with domestic firms within sectors of the model, as in the Latorre, Olekseyuk, and Yonezawa model. On the other hand, Jafari and Britz apply larger NTBs than do Latorre, Olekseyuk, and Yonezawa, which increases their negative outcomes.

17. Latorre and Hosoe (2016) do include the role of foreign multinationals in a dynamic setting, but this treatment is not included in the Hosoe (2018) model.

Most of the studies considered provide results that are consistent with economic intuition (Hall 2016, Krugman 2018). For trade and FDI, Brexit implies that markets shrink. This implies that firms have access to fewer customers, which leads to a reduction in economies of scale, productivity, and factor remuneration. However, the effects are asymmetric because the UK loses preferential access to its main natural partner and largest market. These effects are less intense for EU-27 firms. There are other elements to be considered such as contributions to the EU budget, migration, or a different regulatory regime.[18] However, the effect of trade and FDI prevail over any changes in the EU budget contributions and potential gains from further deregulation. Once mass deportation has been ruled out, the impact of migration will be smaller but still significant.[19]

On the other hand, the two studies that project a positive response for the UK from Brexit incorporate unrealistic economic mechanisms and policy response scenarios in their models. While economic intuition is often ignored in political debates, it can provide a useful first test for assessing the realism of economic analysis of major changes in policy regimes (Van Reenen 2016).

History provides useful lessons and another test of our economic intuition. In 1961, the UK applied for membership in the European Economic Community (EEC), the precursor of the European Union. The UK realized that its firms were facing rising discrimination and disadvantages in a much larger and faster growing market, the EEC. The UK had encouraged the creation of the European Free Trade Association (EFTA), but that market was not large enough to generate scale effects. EEC firms were benefiting from larger economies of scale, while UK firms had less scope for doing so (Baldwin 2016).

CONCLUSION

The consensus view of the economic studies of Brexit is that it will damage both the UK and the EU and that the damage will be far worse for the UK than for the rest of the EU (EU-27).

Brexit implies a shrinking of the EU market, in which, among other things, each of the partners will have more difficulties to reach the other Brexit partner's customers. Given the much larger size of the EU-27, the process is much more harmful for the UK. In all the scenarios with CGE models, the UK experiences much greater losses in industry productivity, foreign trade, production, wages, private consumption, capital remuneration, and value-added creation than EU-27.

The magnitudes of the UK GDP loss from the hard Brexit scenario (a "no deal" reversion to WTO rules) in the CGE models range from –1.2 to –4.5 percent, depending on the nature of the changes in trade policy. The most optimistic ones assume no sectoral productivity shocks. The Latorre, Olekseyuk, and Yonezawa (2018) model, which includes productivity and multinationals' shocks, apart from trade, but not out-migration effects, projects a GDP loss of –2.53 percent, in the middle of the range for the CGE models. Note that the inclusion of multinationals in services in the Latorre, Olekseyuk, and Yonezawa CGE model provides an additional channel

18. UK contributions to the EU budget have varied across years with a maximum potential net fiscal saving from Brexit of –0.53 percent of UK GDP.

19. Ortiz and Latorre (2018b) explain that according to the text of the "joint agreement" reached by the UK and EU on December 8, 2017, very restrictive policies seem to be ruled out, which has been later confirmed by the November 14, 2018 withdrawal agreement (European Commission 2018a). They also note, however, that after the "Windrush scandal" some doubts about the final implementation of future UK migration policies remain. The authors estimate a rich set of migration scenarios.

for Brexit losses that has often been neglected in other studies.[20] They find that, in Brexit scenarios FDI explains around one-third of the overall fall in GDP and private consumption in the UK and in the EU-27.

Most of the Brexit studies show that, in both hard and soft Brexit scenarios, EU-27 firms are able to recover much of the lost exports to and imports from the UK through increased intra-EU trade and by trading more with third nations. In these scenarios, the UK recovers a much lower share of its lost trade. A soft Brexit scenario is much less damaging than a hard Brexit for both the UK and EU-27. Empirically, a soft Brexit (e.g., Norway arrangement, similar to the political declaration on the future EU-UK relationship of November 14, 2018) has about half the negative impact of a hard Brexit. For political reasons, however, the EU-27 could have pushed for a hard Brexit to deter other nations from following the UK's path. This negotiating position can now be ruled out, given the declaration of November 14, 2018. However, EU negotiators could have decided that protecting the EU project as a whole was more important than minimizing economic losses related to a hard Brexit.

On the other hand, the "no deal" Brexit, which is the scenario that would arise if the withdrawal agreement is not ratified, also has supporters in the UK. They are convinced that further deregulation could increase growth prospects in UK. We have provided evidence that this view is not supported by businesses and that there seems to be little scope for further deregulation in the UK since, by many standards, it is already quite liberal. In addition, signing trade and FDI agreements with third nations may not be such an easy task. The EU has not made much progress with a trade deal with China for decades, nor with an FDI deal, whose negotiations begun in 2013. The EU's TTIP with the US is also on hold. But in case the UK strikes such deals, prospects are not that rosy. We have also shown that an ambitious UK-US trade deal, similar to TTIP, which President Trump and Prime Minister Theresa May recently said was possible, would not compensate for the harm caused by Brexit. By contrast, a TTIP between the EU-27 and US, would, if it is ambitious (Latorre, Yonezawa, and Olekseyuk 2018).

There is still high uncertainty on whether the withdrawal agreement will eventually be implemented. All future scenarios of the relationship between the UK and the EU-27 (i.e., a no-deal Brexit, implementation of the withdrawal agreement with or without an extension of the transition period, a second referendum, etc.) seem possible.

What is clear is that the terms of the final agreement will be crucial to assess its economic damage. In this sense, the British referendum should have been preceded by a discussion of what economic UK-EU relationship would be adopted in the case of Brexit. Some politicians probably thought that the vote would not lead to Brexit, but it did, and now there is no good Brexit.

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Table 1 Trade and GDP structure in the UK in 2020

Sector	Percent share in total			Percent share going to (coming from) EU-27		Percent share of total domestic production	
	Value added	Exports	Imports	Exports	Imports	Exported	Imported
1. Agriculture	1.1	0.8	2.1	71.3	48.7	12.4	30.8
2. Other primary	2.1	3.8	7.0	68.0	11.4	38.0	56.1
3. Food	2.7	4.1	6.1	57.9	74.7	14.5	23.2
4. Textiles	0.9	1.8	5.4	62.3	30.3	23.2	48.7
5. Wood and paper	2.0	2.1	3.5	48.7	62.0	12.0	21.7
6. Chemicals	2.5	18.2	14.8	55.1	57.9	40.7	39.9
7. Metals	1.5	6.5	9.9	40.1	35.2	36.6	51.2
8. Motor vehicles	1.0	7.7	8.4	47.8	84.3	52.2	58.7
9. Other transport	0.9	4.1	2.9	32.7	36.6	44.6	41.0
10. Electronics	0.5	3.1	5.2	58.5	41.5	50.5	66.1
11. Other machinery	2.6	12.3	10.7	35.6	54.7	49.5	50.2
12. Other manufactures	1.2	2.3	3.3	38.0	36.9	19.7	29.6
13. Construction	5.2	0.4	0.3	34.0	37.6	0.9	0.7
14. Water transportation	0.5	0.5	0.6	42.0	56.7	8.8	46.2
15. Air transportation	0.4	3.0	2.7	34.4	51.2	46.5	49.3
16. Communications	3.5	0.7	1.0	72.9	50.0	4.7	7.0
17. Finance	4.3	5.8	2.2	44.2	37.0	23.4	12.3
18. Insurance	1.6	1.5	0.3	16.9	52.6	10.4	3.3
19. Business services	15.6	14.0	5.7	50.7	35.3	16.0	7.6
20. Personal services	3.3	1.7	1.5	44.4	46.6	7.4	8.3
21. Other services	46.6	5.5	6.3	33.4	43.9	2.0	2.8
All manufactures	23.0	66.4	77.5	48.2	49.9	27.8	33.3
All services	75.9	32.8	20.4	43.7	42.7	7.2	5.9
Total	100.0	100.0	100.0	46.9	48.4	14.3	15.5

Source: Authors' estimations based on Aguiar, Narayanan, and McDougall (2016) and on IMF (2016) for the projections.

Table 2 Impact of Brexit on macroeconomic aggregates in 2020
(percent change relative to initial levels)

Item	Soft (Norway case)		Hard (WTO case)	
	EU-27	UK	EU-27	UK
GDP				
Nontariff barriers	–0.10	–0.82	–0.18	–1.47
Foreign direct investment	–0.06	–0.41	–0.12	–0.83
Tariffs			–0.06	–0.39
Total	–0.16	–1.23	–0.35	–2.53
Private consumption (change in billions of dollars)				
Nontariff barriers	–15.616	–18.950	–29.016	–34.741
Foreign direct investment	–10.585	–11.915	–20.309	–23.485
Tariffs			–9.908	–6.527
Total	–26.178	–30.818	–57.977	–62.701
Wages				
Nontariff barriers	–0.12	–0.97	–0.22	–1.75
Foreign direct investment	–0.05	–0.29	–0.09	–0.63
Tariffs			–0.10	–0.88
Total	–0.17	–1.26	–0.39	–2.83
Capital remuneration				
Nontariff barriers	–0.14	–0.98	–0.24	–1.76
Foreign direct investment	–0.07	–0.61	–0.13	–1.11
Tariffs			–0.11	–0.93
Total	–0.21	–1.59	–0.43	–3.34
Aggregate exports				
Nontariff barriers	–1.47	–7.63	–2.52	–12.86
Foreign direct investment	–0.07	0.08	–0.13	0.15
Tariffs			–1.48	–7.98
Total	–1.54	–7.54	–3.48	–16.94
Aggregate imports				
Nontariff barriers	–1.68	–6.23	–2.87	–10.55
Foreign direct investment	–0.01	–0.22	–0.02	–0.37
Tariffs			–1.66	–6.63
Total	–1.69	–6.44	–3.82	–14.42
Consumer price index				
Nontariff barriers	–0.08	0.31	–0.16	0.57
Foreign direct investment	0.02	0.02	0.04	0.08
Tariffs			–0.12	0.89
Total	–0.06	0.33	–0.20	1.14

WTO = World Trade Organization

Note: Shaded cells denote losses.

Source: Latorre, Olekseyuk, and Yonezawa (2018).

Table 3 Comparison of recent computable general equilibrium (CGE) studies on Brexit (percent change relative to no-Brexit scenario)

	Booth et al. (2015) (Open Europe study) Soft UK	Hard UK	FTAEU+ ROW+ Dereg^a UK	FTAEU+ ROW+ Dereg^a UK	Ciuriak et al. (2015) Soft EU-27	Soft UK	Hard EU-27	Hard UK	Jafari and Britz (2017) Hard UK	Minford et al. (2016) UK alone	Latorre, Olekseyuk, and Yonezawa (2018) Soft EU-27	Soft UK	Hard EU-27	Hard UK	Ortiz and Latorre (2018a) Soft EU-27	Soft UK	Hard EU-27	Hard UK	Pricewaterhouse Coopers (2016) Soft UK	Hard UK
Impact on GDP	-0.81	-2.23	0.64	1.55	-0.24	-0.97	-0.65	-2.54	-4.45	4.00	-0.16	-1.23	-0.35	-2.53	-0.07	-0.50	-0.14	-1.15	-1%	-3.5
Sectoral effects considered																				
Sectoral productivity shocks á la Melitz (2003)									√				√							
Imperfect competition and variety effects									√				√							
Perfect competition		√						√		√						√			√	
Value chains		√						√	√	√			√			√			√	
Barriers considered																				
Tariffs		√						√	√	√			√			√				
Nontariff barriers to trade		√						√	√	√			√			√				
Nontariff barriers to foreign direct investment		√						√					√							
Rules of origin		√						√												
Macro shocks																				
Foreign direct investment		√						√	√				√							
Migration									√							√			√	
EU budget		√							√										√	
Exchange rate		√						√											√	
Changes in unemployment rate																			√	
Risk premia/uncertainty																			√	
Dynamics		√						√											√	

a. See text for explanation of this scenario.

Source: Authors' revision.

Table 4 Comparison of recent macroeconometric studies on Brexit (percent change relative to no-Brexit scenario)

	Aichele and Felbermayr (2015)				Dhingra et al. (2017)				HM Treasury (2016a)		HM Treasury (2016b)			OECD (2016)	
	Soft		Hard		Soft		Hard		UK		UK			Hard	
	EU-27	UK	EU-27	UK	EU-27	UK	EU-27	UK	Soft	Hard	EEA	FTA	WTO	EU-27	UK
Impact on	Real income				Private consumption				GDP		GDP			GDP	
	−0.1	−0.64	(−0.36;−0.24)	(−2.8;−1.54)	−0.32	−1.34	−0.82	−2.66	−3.60	−6.00	−3.80	−6.20	−7.50	−1.0	−3.3
Overall approach	New quantitative trade model (NQTM)				NQTM				VAR and NiGEM		Gravity and NiGEM macroeconomic model			CGE and NiGEM	
Sectoral effects considered															
Sectoral productivity shocks á la Melitz (2003)															
Imperfect competition&variety effects															
Perfect competition		√					√		√			√			√
Value chains		√					√								√
Barriers considered															
Tariffs		√					√								√
Nontariff barriers to trade		√					√								√
Nontariff barriers to foreign direct investment															
Rules of origin															√
Macro shocks															
Foreign direct investment												√			
Migration												√			√
EU budget							√		√			√			√
Exchange rate									√			√			√
Changes in unemployment rate									√						√
Risk premia/uncertainty									√			√			√
Dynamics									√			√			

EEA = European Economic Area; FTA = free trade agreement; WTO = World Trade Organization

Source: Authors' revision.