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Brexit Impact on the UK Trade Agreements

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Abstract

The people of Great Britain said their word to leave the European Union. The Brexit consequences impact on international trade is negative and large. In the meantime, the ambition Great Britain post Brexit aims for new trade agreements while not explicit (clear) about the type and with whom these agreements. Meanwhile, we examine the UK options in this study, emphasizing the substance of the Brexit negative trade impact on the UK and other major economic countries, including the EU. After reviewing all the alternative and potential options for UK trade agreements post-Brexit, we find no better substitutions to the EU agreement before Brexit.

Keywords: *Brexit, Gravity model, Trade predictions, Trade Agreement, Economics*

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1. Introduction

The United Kingdom people voted, on June 23, 2016, to leave the European Union, the so-called Brexit. On March 29, 2017, the British Prime Minister informed the European Union of his intention to terminate Great Britain's membership in the European Union. The EU quickly responded on March 31, that this “creates significant uncertainties that are likely to cause disruption, particularly in the United Kingdom as well as in other member states”.¹ Indeed, Brexit creates uncertainty on many fronts, such as political, social and economic. We focus on economic aspects highlighting the consequences of Brexit on trade flows and analysing UK trade options. The UK's choice to leave joining the EU is outstanding as an aspect of international trade. Leaving a large free trade area where the EU is to reduce trade and welfare. Without a new agreement, the trade barriers relative will change by making a trade with the European Union relatively more expensive than trade outside the EU, creating trade with the world outside the EU and diverting trade away from the EU. The equilibrium of these developments is a probable decline in trade and welfare. The trade barriers it's increasing between the United Kingdom and the EU (the largest trading bloc in the world).² All Brexit analyses by economists supported this assessment. Estimates range from a 1.5% to 7% or more drop in GDP, depending on assumptions made about how Brexit will happen (Baldwin, 2016). Only Economists for Brexit provide a positive estimate, while that seems a bit far-fetched. Estimates are available (see Miles, 2016, for an overview).

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¹ See the speech of the British Prime Minister: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/29_03_17_article50.pdf

² The so-called Kemp-Wan theory gives the net effect to be positive: The trade must remain constant after the membership changes. Therefore, trade barriers must adapt in special ways to achieve this (Venstra (2016) for discussion).

The challenge for the UK is to find a new position in the world of trade agreements. The UK Prime Minister's letter (see note 1) notes that the white paper on February 2, 2017 outlined the principles of international trade to Brexit, as states, the UK aims "forge a new strategic partnership with the European Union, including a broad, bold, and ambitious free trade agreement" and that "we will forge ambitious free trade relationships around the world."³. The various comments of the politicians indicate that the negotiations will sometimes become confrontational. The UK links trade negotiations to security issues and Gibraltar, while Donald Tusk (President of the European Union) warned that "cherry picking" on the part of the UK would not be accepted by the EU (see footnote 1).

In this paper, we will not anticipate or anticipate the most likely Brexit negotiations outcome, but instead, analyze the options available to the United Kingdom in terms of international trade. In the white paper, the UK indicated that it would like to "forge new trade agreements". The question we answer in this paper is what trade agreements could be an alternative to the current status quo of UK membership in the European Union. Based on the latest gravity model, we will first estimate in our data—value-added trade data—what the consequences of Brexit will be. Next, we will analyze the UK's options that have been brought up in many policy discussions—including a trade partnership with the US, or with various other parts of the world—and counter those estimates with a (renewed) partnership with the European Union. Our general conclusion is simple: no alternative for the UK only a trade agreement should be signed with the EU unless it is willing to accept a reduction in trade. Given this conclusion, two important and related questions would be why UK citizens voted by a margin of 52-48% for Brexit on June 23, 2016 and why there were distinct regional differences in Brexit voting across the UK. The answers to these questions go beyond the current paper, however, for the regional political and economic aspects of Brexit, we refer the interested reader to Becker *et al.* (2016); Luce *et al.* (2017). The paper is structured as follows. Section 2 describes our methodology and data set. Section 3 presents the results of our estimation. Finally, Section 4 concludes.

2. Methodology

2.1. The Gravity Equation with Counter-Reality Scenarios

A well-known and well-established method for estimating the consequences of Trade Agreements (TAs) is the so-called gravitational equation (for a survey, see Head and Mayer, 2014). This is an accepted method for evaluating the effects of changes in variables that in some way affect barriers to trade between countries. Theories of economic growth and development do not motivate our analysis because such models assume that future levels of post-Brexit investment and innovation are known. Our approach is more modest in the sense that the chosen theoretical framework and analysis yield comparative statics. One of the most important modern formulations of gravity models is the so-called multilateral resistance (MLR) terminology. These terms are related to price indicators and are important for analyzing the effects of, say, technical analysis between two countries on the rest of the trading system. Without these terms, the simulation effects of TA would only affect the two countries involved. With these price index terms in place, the TA changes the MLR terms and thus affects the entire trading system as trading takes place between any pair of countries against the background of changing price indices. We provide some simple nuances of the model, based on monopolistic competition, to show how this works. We follow Baldwin and Taglioni (2007), as summarized in Bergeijk and Brakman (2010) and continued in 6 steps.

Step 1: The first step is an equilibrium equation which says that the value of trade flows from country i to j , $p_{ij}x_{ij}$, should equal the share, s_{ij} , that country i has in the expenditure of j , E_j : $p_{ij}x_{ij} = s_{ij}E_j$, where p_{ij} is the import price from i to j .

Step 2: Assuming the familiar Constant Elasticity of Substitution (CES) demand structure, it is straightforward to derive demand for each product and calculate s_{ij} , explicitly:

$$s_{ij} = (p_{ij} / p_j)^{1-\sigma}, \text{ where } P_j = \left\{ \sum_{i=1 \dots N} n_i (p_{ij})^{1-\sigma} \right\}^{1/(1-\sigma)}$$

where, P_j is the exact price index associated with the CES demand structure; $\sigma > 1$ is the elasticity of substitution between varieties " n_i "; N is the number of countries. The number of varieties is determined by profit maximization (under monopolistic competition) and the zero-profit condition.

Step 3: Trade costs are crucial in gravity models. Let $t_{ij} > 1$ indicates all bilateral trade costs from country i to j (man-made and natural costs), then the price in market $j = p_{ij} = p_i t_{ij}$, where p_i is the so-called mill price of a product in the market of origin, i .

Step 4: The gravity model describes total bilateral trade, T_{ij} , for industries, or countries, so we have to aggregate across varieties (products):

$$T_{ij} = n_i p_{ij} x_{ij} = n_i s_{ij} E_j = n_i (p_i t_{ij})^{1-\sigma} (E_i / p_j^{1-\sigma})$$

where we use $s_{ij} = (p_i / p_j)^{1-\sigma}$, While the price includes transportation costs.

Step 5: We assume that all goods are traded, implying that the total output of a country, j , Y_j equals total sales to all destination countries (including the home country):

$$Y_j = \sum_i T_{ij} = n_i (p_i)^{1-\sigma} \sum_j \left\{ t_{ij}^{1-\sigma} \left(\frac{E_i}{p_j^{1-\sigma}} \right) \right\}$$

where we use the result of step 4. We can re-write this equation as follows:

$$n_i (p_i)^{1-\sigma} = \left(\frac{y_i}{\Pi_i^{1-\sigma}} \right) \text{ where } \Pi_i = \left\{ \sum_j t_{ij}^{1-\sigma} \left(\frac{E_i}{p_j^{1-\sigma}} \right) \right\}^{1/1-\sigma}$$

Step 6: The gravity model [now combining the two steps 4 and 5]:

$$T_{ij} = Y_i E_i \left(\frac{t_{ij}}{p_j \Pi_j} \right)^{1-\sigma} \tag{1}$$

This is the basic formulation (Equation 1) of a modern gravity equation and is the basis of our empirical specification (Section 2.3).

In empirical research, other variables are included that affect trade barriers, such as a common language between i and j , a shared border, similar history (colonies), and most importantly for this paper, being part of a common TA. Note that bilateral trade is not only affected by variables describing the bilateral relation between i and j , but also by Π_i and P_j , the MLR terms. These terms depend on all prices in the system. Changes in trade costs between two countries thus also affect the rest of the trading system. According to the result, of our simulations, there are two effect types: those directly affecting the trading partners themselves as they exit/enter the TA, and effects related to the rest of the world through MLR terms (price index effects).

In practice, it is difficult to estimate Equation (1) because the MLR terms depend on the parameters that need to be estimated. Anderson and Van Wincoop (2003) have a frequency model programmed specifically to find estimates of Equation (1). We follow Anderson *et al.* (2015), with a more explicitly developed estimation method (see also Anderson and Yotov, 2016; Larch and Yotov; 2016). A crucial step in their method is to re-estimate the model as described in steps 1-6, for the alternative policy scenario, the counterfactual model.

First, Equation (1) is estimated to calculate the implied baseline trade costs, $(t_{ij})^{1-\sigma}$. Next, the new policy scenario is evaluated by switching on/off, in our case, a TA dummy. In the Brexit case, the TA dummy that describes the EU membership of the UK becomes zero. Given the estimates, one can calculate the counterfactual implied trade costs and substitute these in the expressions for the MLR terms as defined above. This results in counterfactual MLR terms. By imposing market clearance, one can calculate the new values of Y_i . In this way, we can compare the original (baseline) situation to counterfactual situations and calculate changes in trade flows and income.

Note that we do not differentiate between types of TAs; some TAs are broad and cover a lot of different provisions, while others are narrower. Because it is not clear and unknown how negotiations between the UK with various trading blocs in the world will incorporate various elements, we opt for the simple way to describe a TA, i.e., with a binary dummy.⁴

In this paper, we will focus on the so-called ‘full endowment general equilibrium’ trade effects, i.e., the change in trade once income and expenditure have adjusted to the new MLR terms and counterfactual trade costs (for a detailed discussion, see Larch and Yotov, 2015).

³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/589191_The_United_Kingdoms_exit_from_and_partnership_with_the_EU_Web.pdf

2.2. Data

While traditional estimates of the gravity equation rely on gross trade data, a growing literature has emphasized the importance of using novel measures of Value-Added exports (VAX) data to account for the international fragmentation of production (see, e.g., [Johnson and Noguera, 2012](#); [Koopman et al., 2014](#); [Kaplan et al., 2017](#)). In line with this development, we explicitly use data on trade in value-added (covering both manufacturing and services) instead of gross exports (typically only covering manufacturing). Value-added data are more relevant for exercises as we present in this paper because the value-added trade changes are directly related to the welfare and income of the countries concerned.⁵

Value-added exports are calculated based on the 2016 release of the World Input-Output Database (WIOD), which covers the period 2000-2014.⁶ The 43 countries covered in our analysis account for more than 85% of world GDP. By construction, WIOD provides a Rest-of-the-World (ROW) aggregate to ensure full world coverage of value-added trade. A list of countries is provided in Table 1. For a detailed description of WIOD, its construction and its applications, see [Timmer et al. \(2015, 2016\)](#). Other typical gravity-equation controls (bilateral distance, contiguity and common language) are from CEPII ([Mayer and Zignano, 2011](#)). Similar to [Anderson et al. \(2015\)](#), the bilateral distance between WIOD country i and the ROW is calculated as the average bilateral distance between i and all non-WIOD countries in the CEPII bilateral distance database. Trade agreement data for 2000-2011 are from [Kohl \(2014\)](#) and updated for 2012-2014 using the WTO Regional (Preferential) Trade Agreements Database.

2.3. Empirical Strategy

Taking logs of Equation (1) results in a simple empirical specification of the gravity model. Note that because we estimate the gravity model as a cross-section, Y and E are captured by the fixed effects. Closely following [Anderson et al. \(2015\)](#), we estimate the following equation with PPML in annual cross-sections⁷:

$$VAX_{ij} = \ln(DIST_{ij}) + CNTG_{ij} + BRDR_{ij} + TA_{ij} + F_i + F_j + \varepsilon_{ijt} \quad \dots(2)$$

where VAX represent value-added exports of origin i to destination j at destination prices; $DIST$ is the bilateral distance between the trade partners in kilometers; $CNTG$ is a dummy which is 1 when i and j share a common border and 0 otherwise; $BRDR$ is a binary variable equal to 1 if international trade is involved and 0 if the country is trading with itself (see step 5 in section 2.1); TA is 1 when i and j have a trade agreement and 0 otherwise; F_i and F_j represent origin and destination fixed effects, respectively, and are the MLR terms (after correction for Y and E , see Equation (1)). In the next section, we will present a series of different scenarios the results of that can be calculated with the methodology outlined above. First, we are looking at the event of a hard Brexit, where the UK ends its membership in the European Union and all trade agreements to which the UK belonged as a member and part of the EU.⁸ This scenario comes down to the case where Brexit means that the UK no longer has a Preferential Trade Agreement (PTA) with the EU. In order to calculate the counterfactual trade costs, the binary TA variable will be “switched off”, i.e., from 1 to 0, for all country-pairs involving the UK and another EU member. Note that we do not take the depth of trade agreements into account ([Kohl et al., 2016](#)) and that being part of a trade agreement is simply a binary option, see also [Ebell \(2016\)](#). An alternative option might be a so-called “soft Brexit”, in which the UK leaves the EU and retains its membership in all the EU’s trade agreements with countries such as Canada, Mexico and South Korea, in this case, the UK thus maintains its PTAs with the EU (but without being part of the EU single market as an EU membership).^{9,10}

⁴ [Kohl et al. \(2016\)](#) differentiate between various provisions in trade agreements and in addition, differentiate whether or not a provision is legally enforceable; resulting in 52 different elements in a trade agreement.

⁵ Given data limitations, we can’t estimate the gravity equation on a regional level; this would require a global regional (value-added) trade matrix currently unavailable.

⁶ Our results are qualitatively similar when using gross trade and production data as used in [Anderson and Yotov \(2016\)](#). All results are available from the authors upon request.

⁷ We rely on [Anderson et al. \(2015\)](#)’s method to econometrically perform counterfactual gravity computations in cross-sections. At the time of writing, a panel version was not available. Therefore, to account for possible time trends in our data, we calculate annual effects first, then take the average over the entire sample period, i.e., 2000-2014. Average effects are discussed throughout the main text and reported in Tables 1 and 3. Annual effects for the “Hard Brexit” scenario are presented in Table 2; all other annual effects are available from the authors upon request.

⁸ Note that all EU members’ trade agreements are centralized at the EU level. The UK does not have trade agreements that are independent and separate from the EU.

⁹ For our analysis, it does not matter whether the UK signs a new bilateral agreement with current EU TA partners, or (re)negotiates its membership in existing agreements between the EU and its TA partners.

¹⁰ Some debate as to the merits of a ‘Norway’ construction (i.e., free trade, but no labor mobility), such a scenario cannot be computed with our counterfactual gravity equation setup. The reason is that the TA variable is already 1 for UK-EU members in the baseline, nothing would change in the counterfactual scenario in which an alternative agreement replacing the UK’s current EU membership is activated.

3. Results

A full overview of all results is presented in Table 1 (average percentage change compared to baseline, i.e., pre-Brexit), Table 2 (annual changes for the hard Brexit scenario) and Table 3 (change in absolute values).

Country	Name	Gross Trade	Value-Added Exports						
		Hard Brexit	Hard Brexit	Soft Brexit	UK-US-TA	UK-WORLD-TA	No-NAFTA	No-EU	No-TA
AUS	Australia	0.10	0.19	0.14	0.18	0.93	0.48	1.33	-2.83
AUT	Austria	-0.20	-1.81	-1.91	-1.84	-1.96	-1.64	-25.33	-24.67
BEL	Belgium	-0.53	-4.70	0.53	-4.76	0.50	-4.55	-32.45	-31.80
BGR	Bulgaria	-0.09	-1.11	-1.19	-1.13	-1.20	-0.94	-16.88	-16.53
BRA	Brazil	0.12	0.24	0.19	0.21	1.22	0.71	1.57	0.69
CAN	Canada	0.04	0.15	0.11	0.09	0.74	-25.72	0.89	-26.20
CHE	Switzerland	-0.27	-2.62	0.34	-2.66	0.34	-2.48	-24.02	-25.52
CHN	China	0.08	0.20	0.15	0.18	0.97	0.43	1.42	-3.35
CYP	Cyprus	n/a	-1.21	-1.29	-1.23	-1.33	-0.98	-17.63	-17.14
CZE	Czech Republic	n/a	-1.95	-2.05	-1.97	-2.09	-1.77	-23.73	-23.18
DEU	Germany	-0.48	-3.83	-3.99	-3.88	-4.16	-3.66	-28.07	-27.06
DNK	Denmark	-0.35	-2.37	-2.49	-2.41	-2.57	-2.17	-26.03	-25.35
ESP	Spain	-0.46	-3.32	-3.45	-3.37	-3.57	-2.96	-28.64	-28.33
EST	Estonia	n/a	-0.82	-0.88	-0.84	-0.87	-0.69	-13.09	-12.78
FIN	Finland	-0.26	-1.43	-1.53	-1.46	-1.57	-1.22	-20.49	-19.93
FRA	France	-0.55	-7.06	-7.30	-7.15	-7.57	-6.83	-33.91	-33.39
GBR	United Kingdom	-9.69	-39.35	-31.87	-34.84	-15.91	-39.11	-35.16	-34.74
GRC	Greece	-0.25	-1.86	-1.97	-1.89	-2.03	-1.58	-29.17	-28.72
HRV	Croatia	n/a	-1.11	-1.19	-1.13	-1.20	-0.97	-15.10	-14.72
HUN	Hungary	-0.21	-1.46	-1.55	-1.48	-1.57	-1.29	-21.30	-20.81
IDN	Indonesia	n/a	0.19	0.14	0.18	0.93	0.42	1.37	-6.31
IND	India	n/a	0.30	0.22	0.28	1.38	0.56	2.11	-4.97
IRL	Ireland	-1.22	-4.13	-4.26	-4.19	-4.41	-3.90	-20.78	-20.21
ITA	Italy	-0.36	-2.56	-2.67	-2.59	-2.76	-2.29	-29.78	-29.40
JPN	Japan	0.08	0.17	0.13	0.16	0.89	0.41	1.28	0.02
KOR	South Korea	0.06	-0.02	0.09	-0.03	0.58	0.17	-0.39	-14.33
LTU	Lithuania	n/a	-1.11	-1.19	-1.13	-1.20	-0.95	-15.64	-15.27
LUX	Luxembourg	n/a	-2.34	0.32	-2.37	0.33	-2.22	-21.62	-21.21
LVA	Latvia	n/a	-1.01	-1.08	-1.02	-1.08	-0.86	-13.70	-13.37
MEX	Mexico	-0.09	-1.07	0.11	-1.11	0.05	-16.95	-8.51	-31.78
MLT	Malta	n/a	-1.65	-1.74	-1.68	-1.8	-1.41	-22.12	-21.63
NLD	Netherlands	-0.63	-4.25	-4.42	-4.31	-4.31	-4.1	-30.69	-29.87

Table 1 (Cont.)

Country	Name	Gross Trade	Value-Added Exports						
		Hard Brexit	Hard Brexit	Soft Brexit	UK-US-TA	UK-WORLD-TA	No-NAFTA	No-EU	No-TA
NOR	Norway	-0.39	-1.85	0.24	-1.88	-1.88	0.24	-15.45	-16.7
POL	Poland	-0.26	-1.89	-1.99	-1.92	-1.92	-2.05	-24.71	-24.09
PRT	Porugal	-0.32	-2.63	-2.73	-2.67	-2.67	-2.83	-27.2	-26.7
ROM	Romania	-0.28	-1.3	-1.39	-1.32	-1.32	-1.42	-20.36	-19.89
RUS	Russia	n/a	-1.24	0.19	-1.27	-1.27	0.18	-12.66	-12.15
SVK	Slovakia	n/a	-0.92	-0.99	-0.93	-0.93	-0.99	-19.48	-19.04
SVN	Slovenia	n/a	-1.54	-1.62	-1.56	-1.56	-1.64	-20.7	-20.29
SWE	Sweden	-0.3	-1.78	-1.88	-1.81	-1.81	-1.94	-22.08	-21.43
TUR	Turkey	-0.24	-1.36	0.22	-1.39	-1.39	0.21	-17.14	-17.77
TWN	Taiwan	n/a	0.12	0.09	0.11	0.11	0.64	0.93	1.17
USA	United States	0.21	0.37	0.29	2.08	2.08	1.93	2.31	-14.95
EU	EU 27 (exct. GBR) average	-0.4	-2.27	-2.07	-2.3	-2.13	-2.06	-22.99	-22.47

Table 2: Full Endowment General Equilibrium Effects for “Hard Brexit” on Value-Added Exports (in %, Annual Effects)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average
AUT	-1.70	-1.52	-1.58	-1.60	-2.04	-2.08	-2.08	-2.03	-1.89	-1.87	-1.83	-1.75	-1.75	-1.75	-1.75	-1.81
BEL	-3.94	-3.54	-3.81	-3.86	-4.75	-5.12	-5.32	-5.31	-5.41	-5.05	-5.03	-4.87	-4.93	-4.79	-4.83	-4.70
BGR	-0.98	-0.94	-1.02	-1.04	-1.21	-1.23	-1.22	-1.36	-1.29	-1.25	-1.10	-0.99	-0.99	-1.01	-1.02	-1.11
BRA	0.23	0.20	0.21	0.21	0.25	0.26	0.27	0.28	0.28	0.24	0.25	0.25	0.24	0.25	0.25	0.24
CAN	0.11	0.10	0.12	0.12	0.15	0.16	0.17	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.15
CHE	-2.52	-2.32	-2.44	-2.44	-2.90	-3.00	-2.99	-2.84	-2.67	-2.58	-2.58	-2.49	-2.48	-2.53	-2.56	-2.62
CHN	0.18	0.16	0.18	0.18	0.23	0.22	0.21	0.21	0.20	0.19	0.19	0.20	0.19	0.20	0.19	0.20
CYP	-1.11	-1.01	-1.09	-1.06	-1.44	-1.44	-1.42	-1.43	-1.40	-1.32	-1.22	-1.09	-1.03	-1.02	-1.02	-1.21
CZE	-1.65	-1.52	-1.67	-1.68	-2.17	-2.24	-2.27	-2.29	-2.18	-2.10	-2.06	-1.90	-1.85	-1.83	-1.81	-1.95
DEU	-3.86	-3.31	-3.32	-3.41	-3.96	-4.19	-4.31	-4.12	-4.06	-3.92	-3.99	-3.87	-3.76	-3.71	-3.65	-3.83
DNK	-2.17	-1.92	-2.11	-2.10	-2.60	-2.68	-2.77	-2.82	-2.63	-2.49	-2.37	-2.25	-2.22	-2.22	-2.25	-2.37
ESP	-3.10	-2.76	-3.01	-3.09	-3.84	-4.03	-4.12	-4.11	-3.80	-3.33	-3.20	-2.97	-2.84	-2.79	-2.86	-3.32
EST	-0.71	-0.65	-0.72	-0.74	-0.98	-0.99	-1.02	-1.03	-0.90	-0.86	-0.78	-0.72	-0.72	-0.75	-0.77	-0.82
FIN	-1.31	-1.17	-1.26	-1.30	-1.61	-1.67	-1.64	-1.61	-1.51	-1.52	-1.46	-1.38	-1.35	-1.35	-1.37	-1.43
FRA	-5.63	-5.10	-5.63	-5.81	-7.18	-7.75	-8.08	-8.18	-8.04	-7.71	-7.67	-7.38	-7.35	-7.22	-7.19	-7.06
GBR	-32.36	-29.49	-32.88	-33.37	-41.08	-42.53	-42.98	-43.78	-45.03	-43.83	-43.37	-40.99	-39.44	-40.32	-38.79	-39.35
GRC	-1.96	-1.77	-1.91	-1.91	-2.17	-2.15	-2.18	-2.18	-1.98	-1.90	-1.75	-1.57	-1.48	-1.47	-1.48	-1.86
HRV	0.24	0.23	-1.18	-1.21	-1.53	-1.55	-1.53	-1.54	-1.44	-1.41	-1.27	-1.15	-1.10	-1.13	-1.12	-1.11
HUN	-1.31	-1.20	-1.31	-1.32	-1.81	-1.82	-1.77	-1.72	-1.60	-1.51	-1.43	-1.30	-1.26	-1.28	-1.30	-1.46
IDN	0.14	0.13	0.16	0.16	0.21	0.21	0.22	0.22	0.23	0.19	0.21	0.20	0.21	0.21	0.21	0.19
IND	0.25	0.23	0.25	0.25	0.33	0.34	0.35	0.36	0.34	0.30	0.31	0.31	0.30	0.29	0.29	0.30

Table 2 (Cont.)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average
IRL	-4.14	-3.42	-3.56	-3.69	-4.73	-5.14	-5.27	-5.31	-4.84	-4.17	-3.85	-3.51	-3.33	-3.46	-3.53	-4.13
ITA	-2.43	-2.14	-2.35	-2.37	-2.84	-2.97	-3.05	-2.96	-2.79	-2.63	-2.64	-2.46	-2.28	-2.22	-2.20	-2.56
JPN	0.15	0.14	0.15	0.14	0.18	0.19	0.19	0.18	0.19	0.16	0.15	0.18	0.18	0.19	0.19	0.17
KOR	0.12	0.11	0.14	0.13	0.16	0.17	0.18	0.18	0.17	0.12	0.13	-0.49	-0.46	-0.44	-0.44	-0.02
LTU	-0.90	-0.83	-0.91	-0.94	-1.33	-1.35	-1.36	-1.40	-1.31	-1.20	-1.11	-1.03	-0.98	-1.00	-1.02	-1.11
LUX	-2.02	-1.88	-2.07	-2.13	-2.58	-2.70	-2.59	-2.55	-2.55	-2.46	-2.40	-2.31	-2.36	-2.26	-2.32	-2.34
LVA	-0.78	-0.73	-0.79	-0.80	-1.20	-1.23	-1.30	-1.36	-1.22	-1.10	-0.96	-0.91	-0.90	-0.91	-0.92	-1.01
MEX	-1.05	-0.96	-1.02	-1.02	-1.27	-1.26	-1.23	-1.23	-1.14	-1.05	-1.00	-0.94	-0.91	-0.93	-0.95	-1.07
MLT	-1.62	-1.41	-1.46	-1.47	-2.00	-2.02	-1.97	-1.87	-1.73	-1.77	-1.67	-1.49	-1.45	-1.44	-1.43	-1.65
NLD	-3.84	-3.51	-3.72	-3.76	-4.58	-4.58	-4.97	-5.00	-4.76	-4.45	-4.37	-4.15	-4.08	-3.91	-3.90	-4.25
NOR	-1.66	-1.50	-1.72	-1.73	-2.03	-2.00	-1.99	-2.09	-1.85	-1.98	-1.94	-1.78	-1.76	-1.82	-1.88	-1.85
POL	-1.75	-1.55	-1.64	-1.60	-2.13	-2.17	-2.20	-2.25	-2.17	-1.96	-1.92	-1.80	-1.73	-1.70	-1.74	-1.89
PRT	-2.68	-2.40	-2.58	-2.53	-3.03	-3.10	-3.03	-2.98	-2.85	-2.72	-2.62	-2.35	-2.20	-2.19	-2.22	-2.63
ROM	-1.11	-1.04	-1.10	-1.14	-1.35	-1.41	-1.43	-1.71	-1.58	-1.43	-1.35	-1.24	-1.19	-1.19	-1.21	-1.30
RUS	-0.97	-0.99	-1.08	-1.08	-1.34	-1.35	-1.39	-1.49	-1.38	-1.32	-1.28	-1.22	-1.24	-1.27	-1.25	-1.24
SVK	0.27	0.26	0.30	0.30	-1.42	-1.48	-1.48	-1.47	-1.41	-1.41	-1.36	-1.25	-1.19	-1.20	-1.21	-0.92
SVN	-1.42	-1.27	-1.35	-1.35	-1.78	-1.81	-1.79	-1.80	-1.69	-1.65	-1.57	-1.43	-1.38	-1.37	-1.37	-1.54
SWE	-1.70	-1.50	-1.61	1.62	-1.98	-2.03	-2.01	-2.01	-1.87	-1.82	-1.79	-1.70	-1.66	-1.69	-1.73	-1.78
TUR	-1.44	-1.07	-1.18	-1.26	-1.54	-1.60	-1.59	1.59	-1.43	-1.30	-1.38	-1.32	-1.23	-1.28	-1.26	-1.36
TWN	0.13	0.11	0.11	0.11	0.16	0.15	0.15	0.14	0.14	0.11	0.11	0.11	0.11	0.11	0.10	0.12
USA	0.34	0.34	0.35	0.35	0.45	0.46	0.46	0.45	0.42	0.34	0.35	0.54	0.33	0.33	0.34	0.37
EU	-1.97	-1.76	-1.94	-1.97	-2.53	-2.64	-2.64	-2.68	-2.55	-2.41	2.33	-2.33	-2.12	-2.11	-2.12	-2.27

Table 3: Full Endowment General Equilibrium Effects for Counterfactual Scenarios (in Millions of US\$ - Based on 2000-2014 Averages)

Country	Hard Brexit	Hard Brexit	Soft Brexit	UK-US -TA	UK-WORLD -TA	No-NAFTA	No-EU
AUS	1.395	1.038	1.295	6.833	3.561	9.841	20.905
AUT	-3.791	-3.993	-3.845	-4.09	-3.418	-52.927	-51.553
BEL	-10.818	1.219	-10.947	1.144	-10.456	-74.626	-73.132
BGR	-270	-288	-275	-292	-229	-4.107	-4.023
BRA	2.724	2.102	2.37	13.631	7.933	17.571	7.729
CAN	1.367	1.059	794	6.845	-238.76	8.262	-243.178
CHE	-7.941	1.026	-8.051	1.035	-7.497	-72.704	-77.254
CHN	6.879	5.094	6.37	34.199	14.959	49.945	-117.575
CYP	-163	-175	-167	-181	-132	-2.389	-2.323
CZE	-1.802	-1.893	-1.827	-1.938	-1.639	-21.957	-21.451
DEU	-74.666	-77.814	-75.735	-81.162	-71.318	-547.258	-527.55

Table 3 (Cont.)

Country	Hard Brexit	Hard Brexit	Soft Brexit	UK-US -TA	UK-WORLD -TA	No-NAFTA	No-EU
DNK	-3.85	-4.036	-3.912	-4.167	-3.523	-42.231	-41.124
ESP	-29.942	-31.054	-30.376	-32.144	-26.665	-258.059	-255.203
EST	-79	-84	-80	-83	-66	-1.251	-1.222
FIN	-1.958	-2.083	-1.995	-2.138	-1.664	-27.971	-27.209
FRA	-119.468	-123.541	-120.97	-127.995	-115.482	-573.702	-565.001
GBR	-659.069	-533.769	-583.457	-266.441	-655.121	-588.816	-581.798
GRC	-3.52	-3.724	-3.572	-3.85	-2.988	-55.233	-54.387
HRV	-329	-352	-334	-354	-286	-4.473	-4.361
HUN	-877	-927	-890	-943	-774	-12.772	-12.478
IDN	763	569	706	3.665	1.64	5.379	-24.807
IND	2.966	2.192	2.786	13.544	5.526	20.743	-48.899
IRL	-3.724	-3.842	-3.78	-3.979	-3.519	-18.732	-18.22
ITA	-35.16	-36.764	-35.663	-37.98	-31.531	-409.721	-404.502
JPN	7.044	5.218	6.489	36.933	16.878	53.252	836
KOR	-94	578	-159	3.573	1.033	-2.436	-88.465
LTU	-203	-217	-206	-219	-174	-2.859	-2.791
LUX	-344	46	-347	48	-326	-3.168	-3.108
LVA	-138	-148	-140	-148	-118	-1.879	-1.833
MEX	-8.064	832	-8.372	379	-128.294	-64.38	-240.515
MLT	-61	-65	-62	-67	-52	-821	-803
NLD	-17.369	-18.033	-17.593	-18.708	-16.74	-125.32	-121.942
NOR	-3.801	501	-3.867	497	-3.45	-31.757	-34.32
POL	-4.526	-4.784	-4.599	-4.926	-4.008	-59.267	-57.799
PRT	-3.811	-3.956	-3.873	-4.099	-3.255	-39.407	-38.685
ROM	-1.129	-1.21	-1.149	-1.238	-959	-17.701	-17.296
RUS	-8.974	1.382	-9.158	1.319	-7.341	-91.345	-87.7
SVK	-349	-375	-354	-377	-296	-7.422	-7.252
SVN	-347	-366	-352	-371	-311	-4.685	-4.592
SWE	-4.575	-4.844	-4.657	-4.991	-4.012	-56.741	-55.077
TUR	-5.346	852	-5.448	816	-4.482	-67.163	-69.652
TWN	308	227	288	1.609	692	2.334	2.935
USA	47.59	36.69	264.51	245.03	-2059.53	293.19	1901.52
EU	-323.27	-323.30	-327.70	-335.25	-303.94	-2426.68	-2374.92

3.1. The Great Brexit

The setup for our discussion of the various scenarios is relatively straightforward. Ranked on the horizontal axis by the size of their economy, as measured by $\ln(GDP)$, we show for each country in our sample the effect of the change in the trade agreement status on value-added exports (in %) using the methodology outlined in Section 2. The bubble for each country is proportional to a country’s value-added exports in 2014. These results are the effects of the overall equilibrium of the endowment, which however still could underestimate the impact of Brexit or related scenarios (Dhingra *et al.*, 2016) for mainly two reasons. First, the effects are static means that the dynamic negative impact a decline in trade could have on productivity growth is not taken into account. Second, the analysis is only concerned with trade effects and ignores the changes in international factor mobility that the changes in trade agreements might give rise to. So, Brexit case, the analysis does not deal with the possible effects of changes in labor migration or (re)location decisions of (multinational) firms. Having said so, the first scenario when estimating (2) and “creating” the counterfactual is the “hard Brexit” case where the UK not only leaves the EU but also all other trade agreements it currently has as a European Union member. The results are shown in Figures 1 and 2 below (where Figure 2 is just a blown-up version of Figure 1).

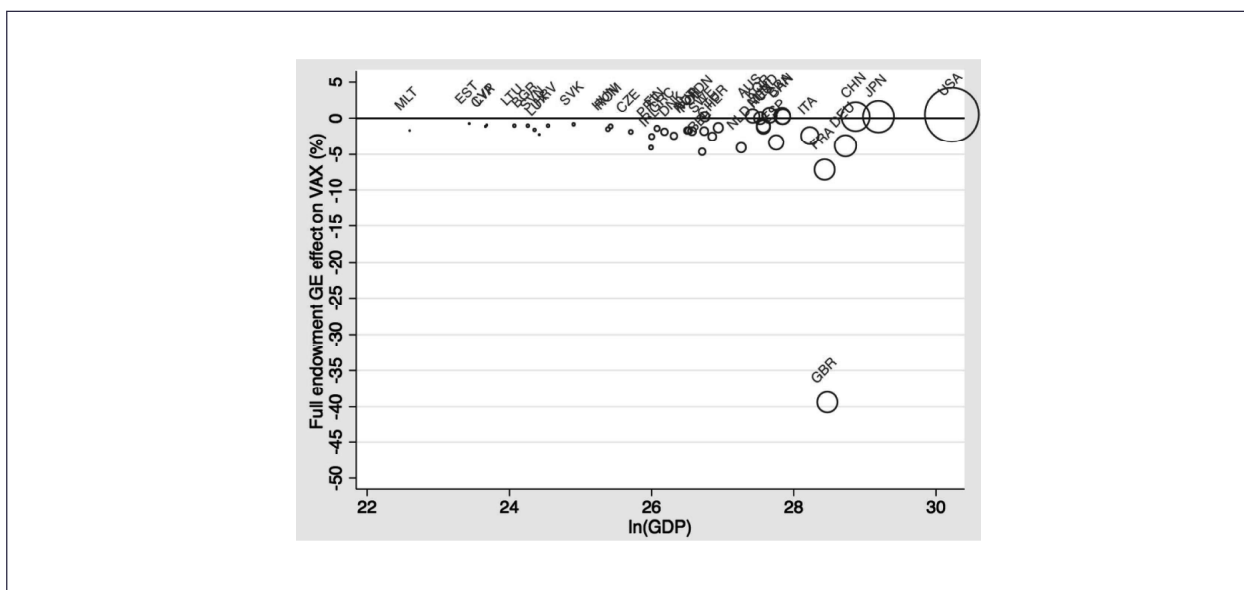


Figure 1: “Hard Brexit” - UK Terminates EU Membership and Membership in all Other EU-Based Trade Agreements

Note: Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014. For a comparison with gross trade, see Figure 9.

As Figure 1 presents, the scenario of “hard Brexit” has a robust negative effect on value-added exports to the UK, falling by 39% Because trading with [all other European Union] becomes more expensive. It shows the disproportionate impact of the hard Brexit, in which, not too surprisingly, exports, and thus the UK economy, will take a much bigger hit than other EU member states or non-EU countries. These countries also experience a trade decline, but to a lesser extent than the UK, because the UK market is smaller than that of the EU. The impact is also stronger if one focuses on VAX, as we do here when compared with the impact of gross trade as can be seen by comparing Figure 1 and the results for gross trade in Figure 9. The main reason for this difference (which holds for all our scenarios) is that the value-added data take the intricate production value chain linkages between, in the case the UK and the other countries of the world, into account whereas the gross trade data do not so. Figure 2 gives a detailed or ‘zoomed-in’ view of the hard Brexit results as shown by Figure 1 to highlight that (mainly) other EU countries are also negatively affected by a hard Brexit in terms of their value-added exports. This holds first and foremost for France, where value exports decrease by about 7%, and countries such as Ireland, Belgium, the Netherlands, and Germany face a decrease in VAX of about 4%. Most other EU countries see their value-added exports drop by 1-2%, with the EU27 (excl. UK) average at -2%. Note that non-European countries are not affected by a hard Brexit.

As a milder version of the hard Brexit scenario, we also looked into a “soft” Brexit option whereby the United Kingdom leaves the European Union but somehow manages to retain all other trade agreements with non-EU countries that it currently enjoys as a European Union member state. Figure 3 shows the results. The main message is that a negative effect of Brexit is only slightly mitigated under this scenario: the UK’s VAX fall by 32% compared to 39% under

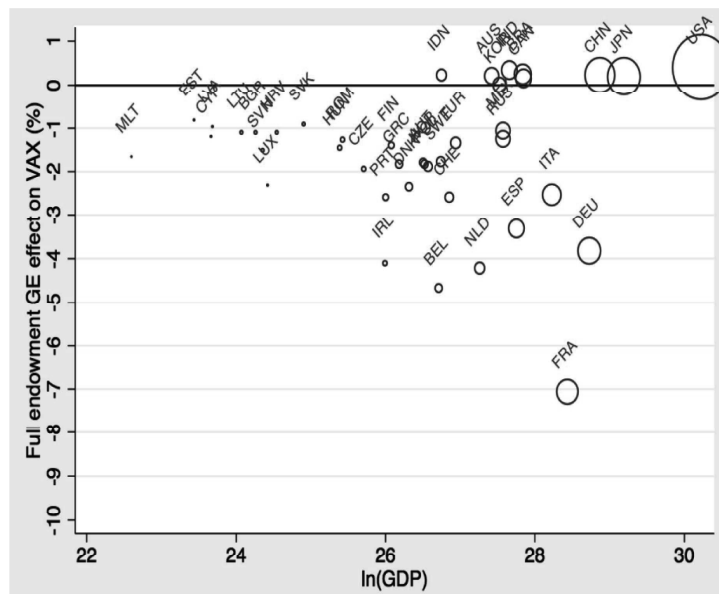


Figure 2: “Hard Brexit” – Detailed View of Figure 1 without the UK

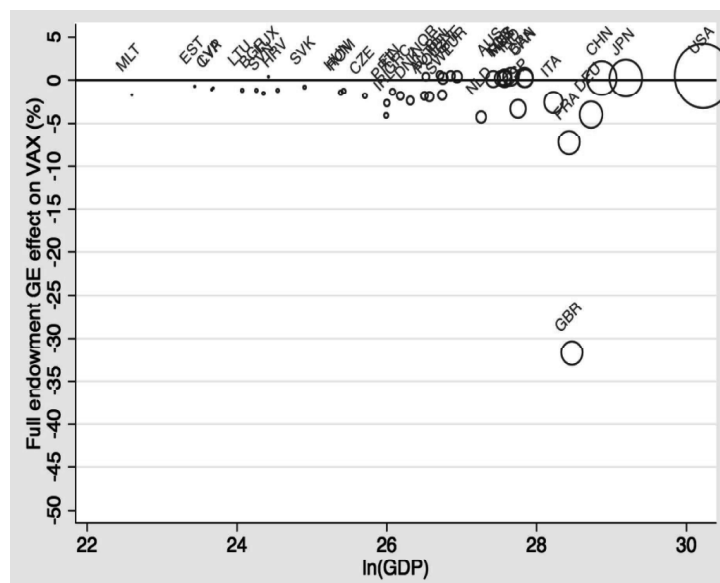


Figure 3: “Soft Brexit” – UK Terminates EU Membership and Retains Membership

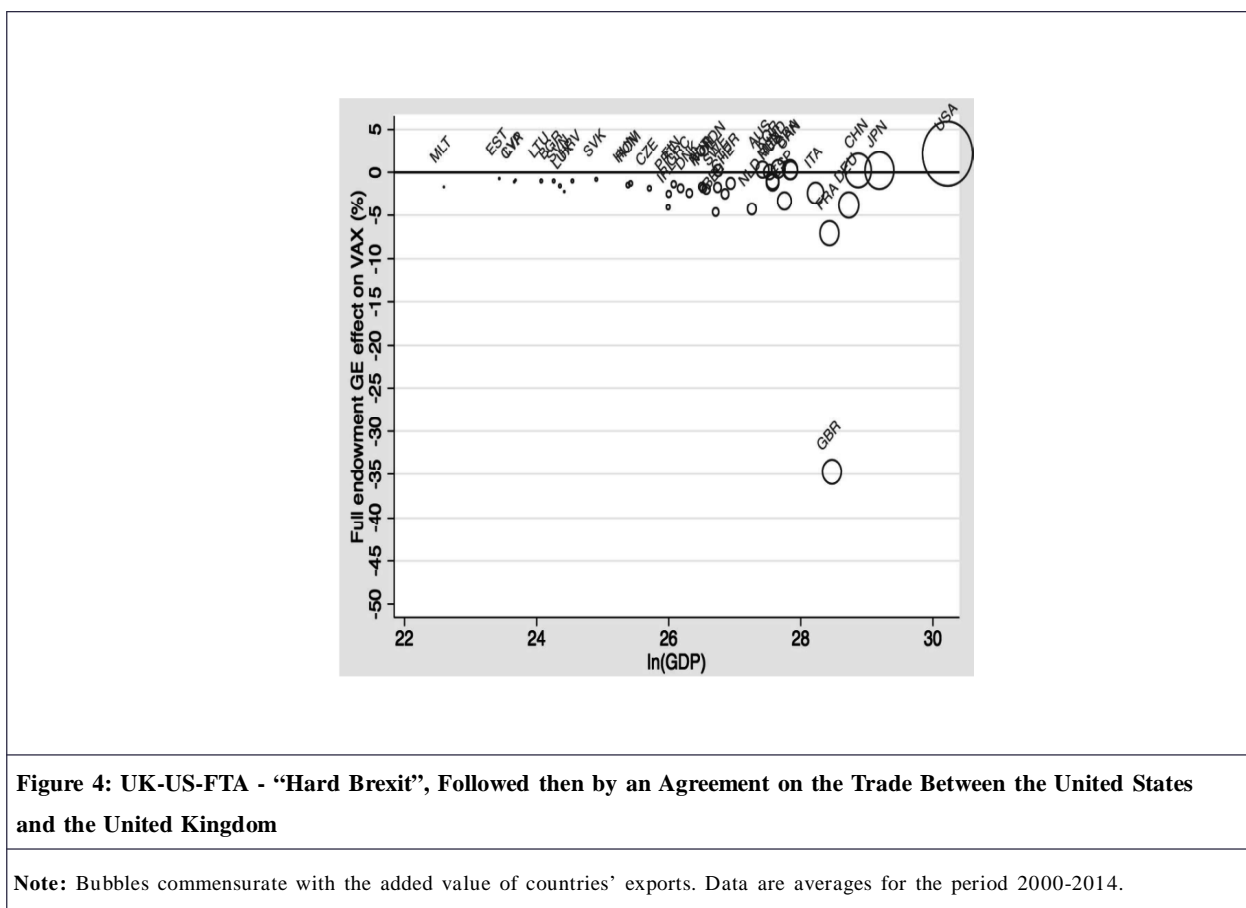
Note: Bubbles commensurate with the added value of countries’ exports. Data are averages for the period 2000-2014.

the scenario of the hard Brexit scenario. The consequences of Brexit are also reversed for the non-EU countries with which the EU has a trade agreement. The effect for other countries is unchanged. The conclusion that arises from Figures 1 and 3 is clear. Brexit will have a robust negative effect on the exports of the value-added of the United Kingdom. If no deal is struck between the UK government and the EU now that the Article 50 procedure has begun, our estimates suggest that the UK will experience a very substantial decline in VAX by almost 40%. The remaining EU countries are also negatively affected in terms of their VAX, with the largest impact occurring for the UK’s main trading partners in the EU. Given these rather bleak long-term trade impacts of Brexit, it is perhaps no wonder that the UK government has

signaled to actively seek to establish other (new) trade agreements with trading partners outside the UK. Headed by Prime Minister Theresa May, the UK government has invoked the idea of “Global Britain” where the UK by inter alia establishing new trade agreements arguably would be able to offset the effects of Brexit on the UK economy. It is in this scenario that we turn next.

3.2. Global Britain with Brexit

In this sub-section, we assume that a hard Brexit has materialized and then look into the effects of alternative trade agreements by the UK on the exports of the value-added for the UK and the other countries in our sample. Inspired by Donald Trump’s vocal support for Brexit and early talks by Trump with May after he became president of the USA, Figure 4 shows the effects of a bilateral agreement of trade between the USA and the UK. Since we assume that this trade agreement was concluded with Brexit in full, one should compare the results in Figure 4 with those in Figure 1. The main effect of the UK-USA trade agreement is that it increases the value of—adding exports to both countries by about 4 and 2 percentage points, respectively, relative to the starting point for Brexit. Regarding the UK, this marks that the negative effect of Brexit is replaced only marginally by the bilateral with the USA trade agreement (compare -39% as marked in Figure 1 and -35% marked in Figure 4); also See Table 1 for minute values. Access to the market of the US is easier to substitute the trade loss to some extent of Brexit, but within the gravity market logic, the US is farther away and therefore less attractive.



A UK-China bilateral trade agreement would have similar effects (not shown here) in the sense that it would marginally raise UK value-added exports, but this again is not enough to offset Brexit. This might lead one to conclude that the global Britain scenario cannot simply offset the negative trade impacts, as measured by the change in exports of the value-added, of Brexit. But this ignores the fact that China and the UK are only two of the non-EU countries with which the UK trades. In order to investigate the maximum trade potential for the Global Britain scenario, we also analyzed what comes if the UK determines to leave the European Union but meantime manages to conclude a trade agreement with all the other countries in our sample outside the EU. As Figure 5 presents, this scenario would provide a boost to exports of the value-added for the UK and other countries involved (see alongside the US and China now also an increase in VAX such as Japan, Russia or Canada). Regarding the UK, remaining the case of a mix of Brexit with the Global Britain scenario remains so negative that exports of the value-added fall by 16%.

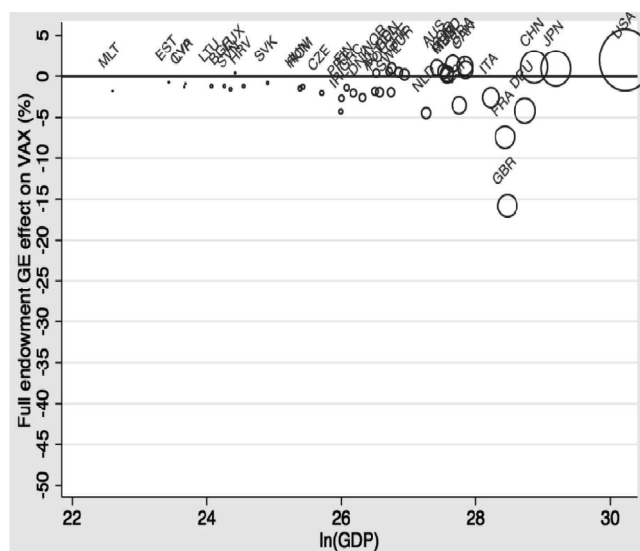


Figure 5: UK-WORLD-TA - “Hard Brexit”, and then the UK Retraction Agreements of the Trade with Other World Countries Except for EU Members

Note: Bubbles commensurate to countries’ exports of the value-added. The data are averages for the period 2000-2014.

All in all, the conclusion from the estimation results in Section 3.1 (Brexit only) and Section 3.2 (Brexit cum Global Britain) must be that not only will Brexit have a strong negative trade impact on the UK, but also that it is rather difficult to see how these negative effects can be more than offset by other trade agreements by the UK. The hard Brexit case as summarized in Figure 1 assumes that the UK will not secure a trade agreement with the European Union before March 2019 (2 years after the Article 50 procedure began) and that all of the UK’s trade and the European Union (and the other countries with which the EU has a trade agreement) will take place under basic WTO rules (Grauwe, 2016). In the current discussion in the UK, the option “better no deal than a bad deal” with the EU is considered to be a possible outcome. When it comes to the UK’s trade, the “no deal” world will look like Figure 1. At the other extreme of the “no deal” option is a variant of a Norway scenario whereby the UK would (continue to have) full access to the EU’s single market but without the free movement of people that applies to Norway. As a non-EU member, Norway effectively takes part in the EU’s single market much like a regular EU member, but it does so with the free movement of people as is required by EU membership which, given the importance of labor migration in the Brexit debate, might limit the likelihood of this scenario for the UK. In terms of our analysis—where, as we stated before, factor mobility is not taken into account—the expected long and difficult negotiations that would result in a Norway-type deal, leaving aside the issue of factor mobility, would to a large extent replicate the current trade agreement between the EU and the UK. Brexit would then lead to a new situation where the UK’s agreement for trade with the EU would essentially copy, from a trade perspective, the current situation where the UK is an EU member (for a different and more pessimistic view, see Baier et al., 2008).

Our final and truly bleak trade scenario is that we estimate the gravity Equation (2) and construct our counterfactual as outlined in Section 2 under the assumption that a “hard Brexit” is accompanied by an all-out global trade war where all existing agreements for a trade would be dissolved. Figure 8 shows the results for this “no trade agreement left” scenario. The main difference between Figure 1 (only hard Brexit) or Figure 7 (hard Brexit and dissolution of EU as a trade agreement) is that now the other world countries, that is to say, the non-EU countries, are also severely affected. This is especially true for countries in our sample that are not only relatively small and open but also relatively heavily dependent on trade in modern global value chains like Mexico or Korea. Under this scenario, unlike most of the other trade agreement scenarios we discussed, there are almost only losers with countries witnessing a fall in their value-added exports, see also Table 3 for the exact values.

3.3. Trumping the Union Jack Flat

In our final set of analyses, we aim to put the possible trade impact of Brexit into some perspective by investigating the trade effects using the same estimation procedure as before of alternative dissolutions of trade agreements. In each of

the examples we consider, the question is: what are the “knock-on” effects of these dissolutions, over and above the effects of a hard Brexit? The first example takes an election promise by Donald Trump to its logical conclusion by looking into the impact on value-added exports that would come from the dissolution of NAFTA, which is an agreement for trade between Canada, Mexico and the USA. From Figure 6 we can see that dissolving NAFTA would have a negative effect on the VAX of the 3 countries that make up NAFTA but it would not, recall again Figure 1, have much of a discernible effect on the exports of the value-added of the other countries in our sample, including the UK.

Perhaps most relevant to our current paper, where we are mainly concerned with the impact of Brexit on the UK and the EU, is the scenario in which one Brexit is followed by another ‘exit’ from the EU with the result that the EU itself is

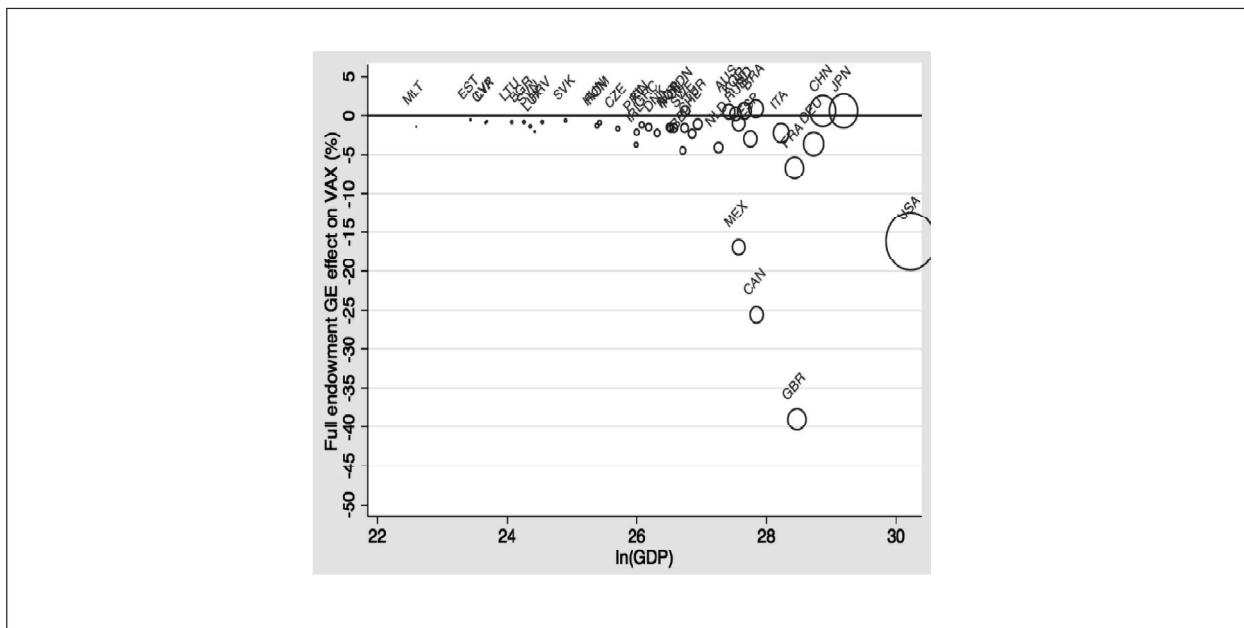


Figure 6: No-NAFTA - “Hard Brexit”, Followed by the US Dissolving NAFTA

Note: Bubbles commensurate to countries’ exports of the value-added. The data are averages for the period 2000-2014.

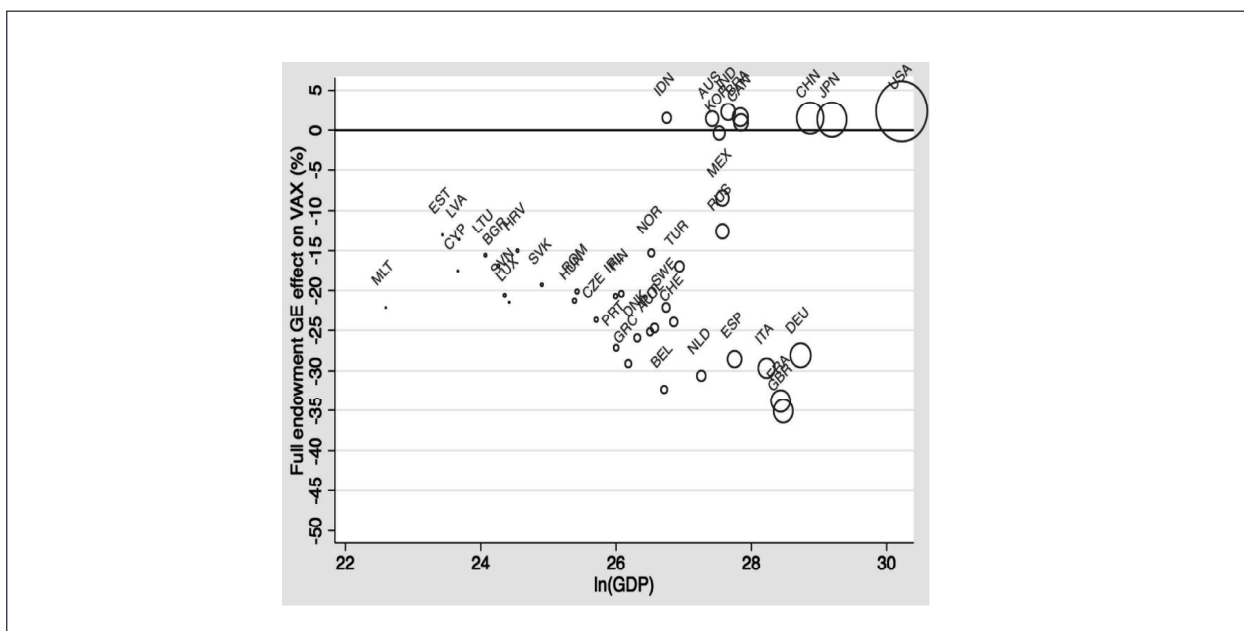


Figure 7: No-EU – “Hard Brexit”, then After the EU Dissolution and Termination of EU Countries’ Membership in EU-Related PTAs

Note: Bubbles commensurate to countries’ exports of the value-added. The data are averages for the period 2000-2014.

thus no longer, there is one market. In our estimates, this means that all EU countries will experience their (hard) exit from the EU, so to speak. As Figure 7 shows, this has strong negative implications for VAX for all (former) EU members; the effect is strongest for major trading countries within the EU such as France, Germany and the Netherlands but also the UK. For these countries, the negative trade impacts are within the scope of what we found for an isolated Brexit in Figure 1 (note, all other non-EU TAs trade agreements remain active).

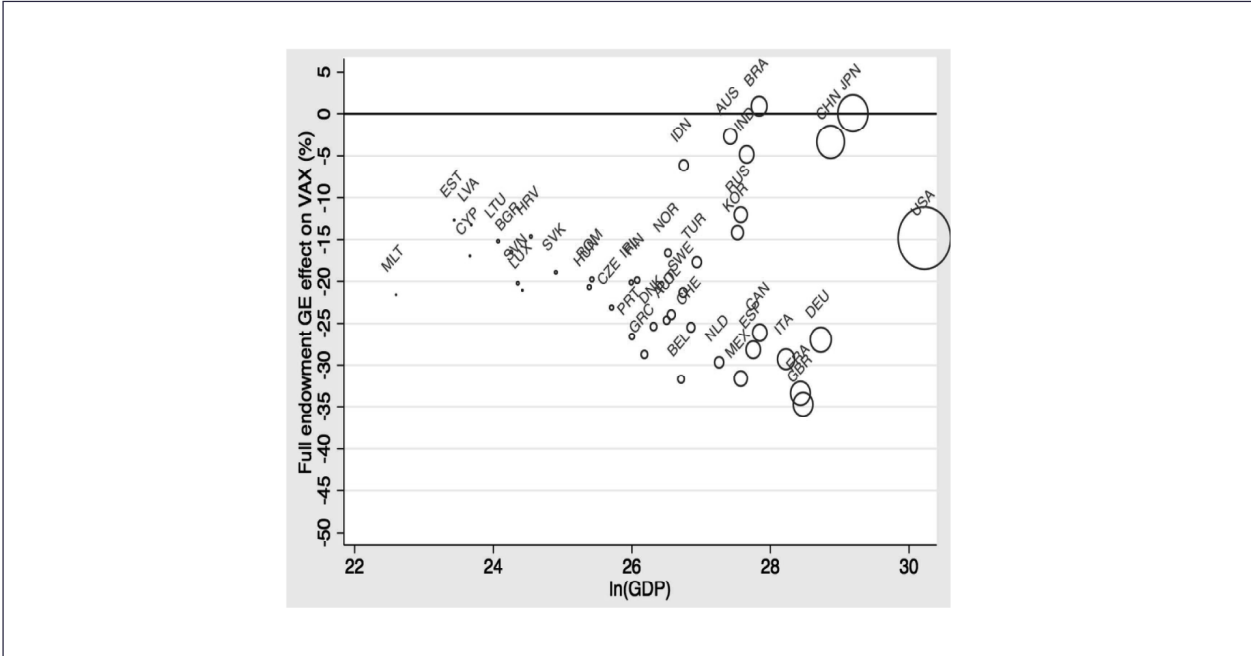


Figure 8: No-TA – “Hard Brexit”, Followed by a Dissolution of all Agreements for Trade Worldwide

Note: Bubbles commensurate to countries’ exports of the value-added. The data are averages for the period 2000-2014

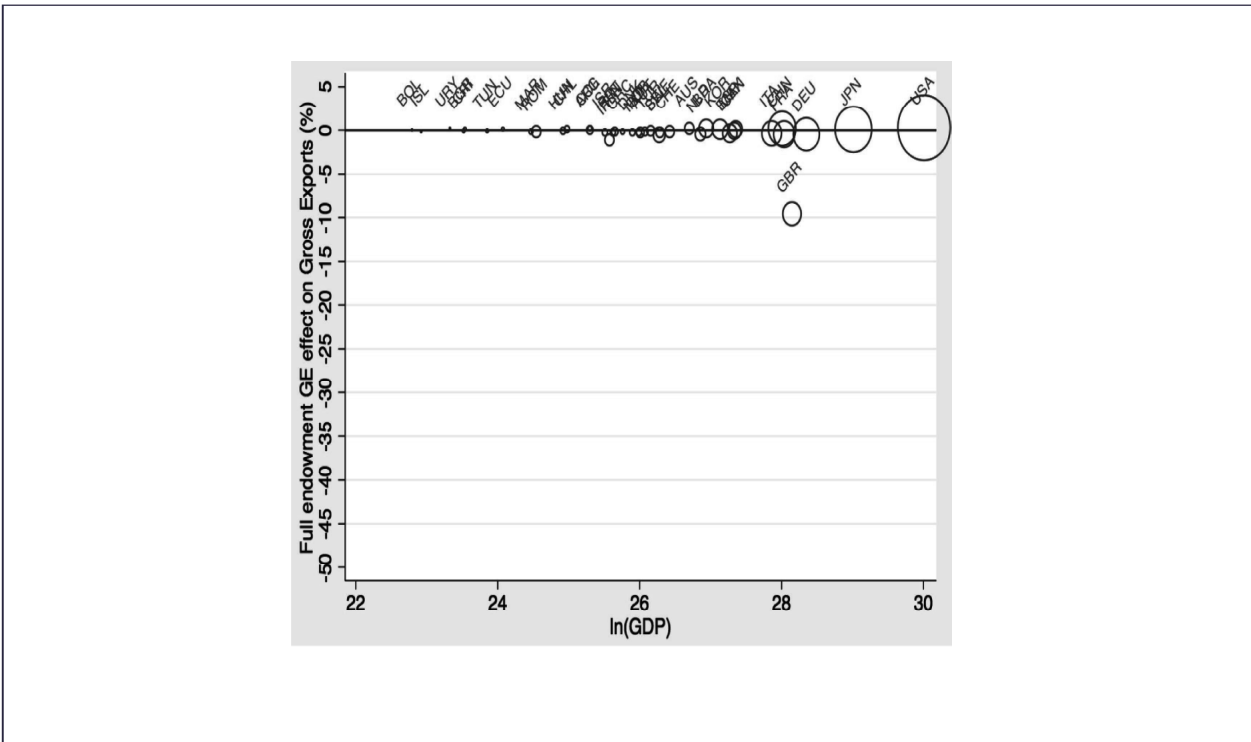


Figure 9: “Hard Brexit” – The United Kingdom Ends the EU Memberships and all Other EU Trade Agreements

Note: Dependent variable: total trade. Baseline total trade and production data generously provided by Mario Larch as used in Anderson *et al.* (2015) and Anderson and Yotov (2016). Bubbles are relative to a country’s total exports.

Our final and truly bleak trade scenario is that we estimate the gravity Equation (2) and construct our counterfactual as outlined in Section 2 under the assumption that a “hard Brexit” is accompanied by an all-out global trade war where all existing agreements for a trade would be dissolved. Figure 8 shows the results for this “no trade agreement left” scenario. The main difference between Figure 1 (only hard Brexit) or Figure 7 (hard Brexit and dissolution of EU as a trade agreement) is that now the other world countries, that is to say, the non-EU countries, are also severely affected. This is especially true for countries in our sample that are not only relatively small and open but also relatively heavily dependent on trade in modern global value chains like Mexico or Korea. Under this scenario, unlike most of the other trade agreement scenarios we discussed, there are almost only losers with countries witnessing a fall in their value-added exports, see also Table 3 for the exact values.

4. Conclusion

Following a referendum in 2016, the UK decided to leave the EU. The negotiations between the UK and EU to determine under what conditions Brexit should take place started in March 2017. Brexit is puzzling from a trade perspective internationally, as almost all studies predict that trade decreases significantly with the EU.

The government of the UK states that it aims to replace the UK’s current EU membership with other large-scale trade agreements. However, at this point, it is unclear what the new trade agreement will be and with any countries can participate in these new agreements.

This paper reviews the alternatives that the UK government has. The central question we are trying to answer is: Does the UK have an alternative to current membership in the EU, an alternative that would offset the significant negative trade of the Brexit shock? In reviewing the options that have emerged in the Brexit discussions, such as a broad deal with the US, China or all countries except the EU, our conclusion is simply: the UK will not have an alternative to boosting trade other than an agreement that mimics, as closely as possible, the situation. Without being officially a member of the European Union. Our analysis has emphasized the trade consequences for the UK economy as a whole vis-à-vis the world economy by focusing on value-added exports. Future research could look into the consequences of Brexit by zooming in on certain sectors or regions in the UK and by also taking the political economy aspects into account (Becker *et al.*, 2016; Los *et al.*, 2017).

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Our heroic staff of the NHS always goes over and beyond their call of duty and is quick in their action and cooperative. God bless you, keep up your spirit.

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