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European agriculture after Brexit:

Does anyone benefit from the divorce?

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Abstract

UK's exit (Brexit) from the EU would entail disturbances in agri-food markets. This study analyzed three different Brexit scenarios with increasing barriers to trade (*EEA+*, *FTA*, *WTO*), employing the EU focused global agricultural sector model CAPRI. In the UK, food prices will increase, making consumers in the UK the biggest losers. However, provided trade costs are kept low, termination of the contribution to the EU Common Agricultural Policy (CAP) and the gains to producers from higher food prices could offset the losses to consumers. In the EU, declining food prices would benefit consumers but reduce farmers' incomes.

1. Introduction

The UK invoked Article 50 of the *Treaty on European Union* after the national referendum held in June 2016 and is due to withdraw from its EU membership (Brexit) in March 2019. Depending on the outcome of current negotiations on a Withdrawal Agreement and future trade relationship, the UK might lose the economic benefits of access to both the EU customs union and the single market. Thus, in a worst case scenario, trade in goods between the UK and the EU will be subject to tariffs and other border measures. Both parties would be exposed to potentially significant impacts on agricultural markets.

Trade policy changes are key factors in determining the economic consequences of Brexit for agricultural markets in Europe. Various outcomes are possible depending on the negotiation results. One option is that the UK pursues a freest possible economic relationship with EU27 as well as regulatory alignment (Soft Brexit) so that it maintains frictionless trade as far as possible after Brexit (HM Government, 2017). However, UK's red lines in Brexit negotiations, e.g. no free movement of labor, independent trade policy, no EU budget contribution, and independence from the European Court of Justice, mean that frictionless-trade cannot be replicated (Gasiorek et al., 2016) (See Table 1).

One of the options for a soft Brexit would be for the UK to agree to stay in the European Economic Area (EEA), which would minimize trade friction after Brexit as well as eliminate tariffs in agriculture (so-called EEA+, where the '+' indicates that agricultural tariffs are also removed unlike in the EEA itself). An alternative soft Brexit option is a free trade agreement (FTA) between the UK and EU27 but without regulatory alignment. It means that the UK leaves the single market, but makes a FTA for goods. This option inevitably entails higher trade facilitation costs than in the EEA+ case because Non-Tariff Barriers (NTBs) in trade increase. Both in EEA+ and FTA, Rules of Origin (RoO) will increase trade costs as NTBs after Brexit, but the impacts of food standards such as Sanitary and Phytosanitary measures (SPS) and Technical Barriers to Trade (TBT) could differ depending on the scope of an FTA agreement between the UK and the EU. Additionally, NTBs in FTA will be affected by transport delays

due to border inspections as well as the need to show compliance with the regulatory standards of the other party.

If neither of those trade deals between the parties is achieved, the UK and the EU would face the Most-Favored-Nation (MFN) tariff rates of the other party, as for any WTO member without a preferential agreement (Hard Brexit). Consequently, those increases in tariffs and NTBs would lead to trade destruction between the UK and the EU and some trade diversion to third countries that would then have relatively more favorable access to both markets.

Table 1 UK red lines and Brexit negotiation options.

		Customs union (Turkey)	EEA (Norway)	FTA	WTO (No deal)
UK defensive objectives	Control over labor mobility	Yes	**No**	Yes	Yes
	Independent trade policy	**No**	Yes	Yes	Yes
	Control over budget	Yes	**No**	Yes	Yes
	Not subject to European Court of Justice	Yes	**No**	Yes	Yes
UK offensive objectives	Access to SM in goods (without tariffs)	Yes	Yes	Yes/**No**	**No**
	Customs NTBs (SPS, TBT)	High	Low	High/Low	High
	Border control NTBs	High	Low	High/Low	High
	Access to SM in services	**No**	Yes	Yes/**No**	**No**

Source: adapted from Gasiorek et al. (2016)

SM: Single Market, SPS: Sanitary and Phytosanitary measures , TBT: Technical Barriers to Trade

The future of current preferential access of third countries to the EU market is also unclear. Current Tariff Rate Quota (TRQ) access to the EU market needs to be re-negotiated with many agricultural trade partners of the EU. Whether this will result in overall increasing preferential access to suppliers of the EU and UK market remains to be seen. Currently, the UK and EU27 agreed on sharing existing

TRQs based on historical consumption shares,[1] but major agricultural exporters such as Canada, the USA, Argentina, Brazil, New Zealand, Thailand, and Uruguay have objected to this (House of Commons, 2018a).

Furthermore, Brexit will impact on government budgets in both the UK and the remaining EU members. The UK is the second largest net contributor to the EU budget (€9.8bn in 2016, House of Commons (2018b)). The UK treasury will benefit financially from Brexit, but the EU will suffer from revenue loss and it will indirectly affect agricultural budget spending in CAP. As of May 2018, the EU Commission proposed a 5% cut in nominal terms (which translates into a 15% cut in real terms) in the CAP budget for the Multi-annual Financial Framework (MFF) (2021-2027) both because of Brexit but also the need to focus budget resources on new priorities [2].

Previous Brexit impact assessments have considered new tariffs in trade, together with changes in trade facilitation costs as NTBs at various ranges (Table 2). In a hard Brexit scenario (*WTO*), such studies found the largest impacts for beef, pig, poultry, and dairy sectors in the UK. Berkum et al. (2016) and Davis et al. (2017) show increases in prices of meat by 7–17 % and of dairy products by 8–30%. Bellora et al. (2017) investigated hard Brexit scenario impacts on EU27 markets and showed that Ireland would experience the strongest impacts (-16.3%) in value-added in agriculture among EU 27 countries followed by the Netherlands (-2.7%) and France (-0.3%), but Brexit would increase UK's agri-food value added by 2.1%. The above-mentioned assessments mainly focused on impacts on the UK due to trade policy change.

In this study, we assess the economic impacts of Brexit, focusing on agricultural markets of both the UK and EU27, as well as changes in UK's CAP budget contribution. We employ the CAPRI (Common Agricultural Policy Regionalized Impact Modelling System) for the analysis in a comparative static

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[1] See Council of the EU (2018), http://www.consilium.europa.eu/en/press/press-releases/2018/06/26/council-authorises-opening-of-negotiations-with-wto-members-on-brexit-related-adjustments/.

[2] The press release by EU commission on 2th May 2018: http://europa.eu/rapid/press-release_IP-18-3570_en.htm, In the proposal, 5% cut mainly comes from the rural development program (Pillar 2 in the CAP) while the basic payment budget (Pillar 1) faces a reduction of less than 4% in nominal terms.

manner (Britz et al., 2014). CAPRI lets us compute Brexit impacts on agricultural supply, prices, and welfare. With the scenario analysis, we aim to identify potentially vulnerable sectors and regions, as well as potential winners of Brexit, taking into account interactions with world markets.

Table 2 Previous Brexit assessments on the agri-food sector/ the whole economy (CGE: Computable General Equilibrium, PE: Partial Equilibrium).

Study	Model (type)	Regional focus	Scenario	Non-Tariff Barriers (NTBs) ranges in AVE	NTBs source
Boulanger et al. (2015a)	MAGNET(CGE)	UK	UK-EU FTA: CAP budget withdrawal and trade costs	2-5%	(Francois et al., 2005; Hornok et al., 2015)
Berkum et al. (2016)	AGEMOD (PE), Farm model	UK	Trade scenarios (FTA, WTO default, UK trade liberalization), UK domestic ag policy (direct paymet cut 100%, 50%, no payment)	5-8%	(Abreu, 2013)
Donnellan et al. (2016)[1]	Own PE model	Ireland	Hard Brexit (MFN tariff)	Not specified	
Rojas-Romagosa (2016)	WorldScan (CGE)	Netherlands	Two trade scenario (FTA, WTO)	Primary agriculture (12-15%), Processed food (33-48%)	(Egger et al., 2015)
Bellora et al. (2017)	MIRAGE (CGE)	UK, EU27	Hard Brexit (MFN tariff)	26% (EU exports to the UK), 23% (UK exports to the EU)	(Kee et al., 2009)
Baker et al. (2017)	Own PE model	UK	Evolution, Unilateral liberalization, Fortress UK	Not specified	
Davis et al. (2017)	FAPRI-UK (PE)	UK	Three trade scenarios (FTA, MFN tariff, UK liberalization)	5-8%	(Abreu, 2013)
Yu et al. (2017)	GTAP (CGE)	Denmark	Two trade scenarios (FTA, WTO)	Primary agriculture (12-15%), Processed food (33-48%)	(Egger et al., 2015)

1) This study used results from gravity trade model in Hufbauer et al. (2009) and Barrett et al. (2015)

2. CAPRI for Brexit assessments

CAPRI is a partial equilibrium (PE) agricultural sector model with a focus on EU agricultural markets and regional agricultural supply. It also considers EU agricultural policy and border policies with the main global trading regions (Britz et al., 2014). Regarding agricultural supply, CAPRI consists of a set of mathematical programming models for about 280 EU regions (including the UK) representing farmers' decisions on agricultural supply, with a detailed representation of domestic agricultural policy measures. The supply module computes optimal farm activities by maximizing farm incomes with given premium, input costs and market prices, subject to increasing marginal costs. The objective function contains econometrically estimated quadratic cost terms in the tradition of positive mathematical programming, as described in Jansson et al. (2011).

The payment scheme of the current CAP framework (2014-2020) is explicitly modeled in the supply module. For pillar 1 payments, the basic payment scheme (BPS) and greening payment schemes are distinguished. Payment entitlements of BPS and greening payments are endogenously determined in CAPRI, considering national payment ceilings. Regarding pillar 2 payments, CAPRI covers only less-favoured area support, Natura 2000 support and agri-environmental schemes.

 The supply module is iteratively connected to a global market model for agri-food products, depicting bilateral trade flows between the EU-27, UK and third countries, with a detailed set of trade policies at the border (*ad valorem* and specific tariffs, TRQs, etc.). The bilateral trade model is based on the Armington assumption (Armington, 1969). It depicts trade preferences among domestic and imported products from different origins, considering price differences.

The CAPRI simulates bilateral trade flows between selected regions and countries globally, which in particular includes the regions "EU-West", "EU-East"[3] and the UK. Within the two EU regions, there

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[3] In CAPRI, EU-West includes EU14 countries without the UK, which are the EU member countries prior to the accession of ten candidate countries on 1 May 2014. EU-East includes the other EU13 countries from Central/Eastern Europe since 2014.

is supply on a sub-regional level (NUTS2[4]), demand and processing on a national level, but no explicit modeling of trade between sub-regions or countries. Agri-food trade impacts will, therefore, affect the aggregate EU trade regions (EU-West and EU-East), but then price impacts transmit proportionally to all regions and farmers in the member countries. For global trade of agricultural goods, we report trade values at an aggregated regional level like North America (NAM), Middle & South America (MSA), Asia, Africa, Australia & New Zealand (ANZ) and Non-EU Europe. Non-EU Europe includes non EU countries in Europe and Russia.

For welfare calculation in this study, we consider consumer surplus, producer income, and tax payer costs. Consumer surplus is calculated as money metric in indirect utility functions. Producer income is defined as gross value added, i.e. revenues minus variable costs, plus subsidies. Fixed costs such as machinery costs, depreciation, labor and taxes are not accounted for in CAPRI. Government revenue consists of revenues from import tariffs, minus direct payment to farmers (CAP budget) and cost of public market interventions such as storage. Importers and exporters are assumed to split any TRQ rents equally.

3. UK agri-food trade with the EU

UK agriculture is highly integrated into the EU single market. Overall, 30% of the food consumed in the UK stems from the other 27 member states of the EU (Defra, 2018). In 2016, UK imported food, drinks, and feed worth £42bn and exported £20bn. EU27 accounts for 65% of the UK's imports and 60% of its exports of agri-food. The UK mainly imports meat (processed and unprocessed), dairy, fruits, and beverages from EU-27 and exports meat and dairy products to EU27. Concerning the main EU trading partners, the Netherlands, Ireland, Germany, and France account for about 60% of the UK's food imports from the EU27. Thus Brexit could imply serious disturbances for agri-food traders (and indirectly producers) not only in the UK but also in a number of EU member countries, with the biggest potential impacts in the meat, dairy and fruits and vegetable sectors. However, the CAPRI database

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[4] NUTS stands for Nomenclature of Territorial Units for Statistics and the hierarchy of NUTS levels indicates a subregional level corresponding to an administrative division in each country.

covers only 55% of exports and 77% of imports in the UK's agri-food trade in terms of gross revenues compared to the UK's official statistics (Defra, 2018). Mainly, beverages and some processed food products are not covered in CAPRI compared to the UK's statistics.
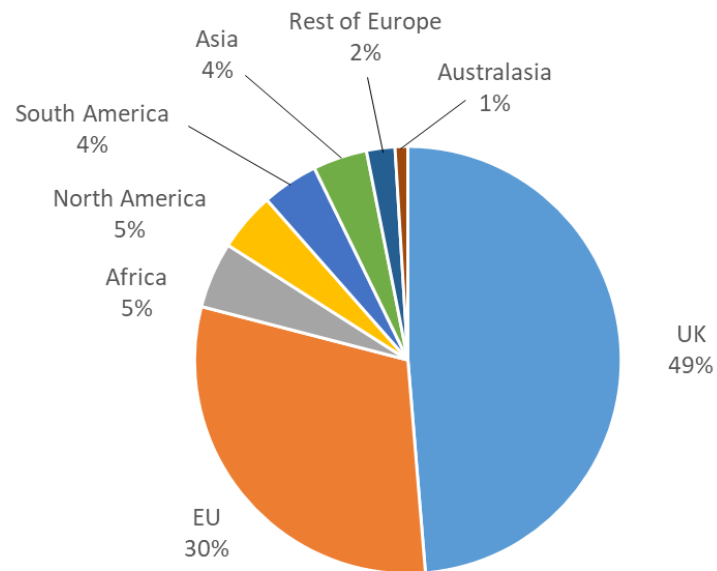

Figure 1 Origins of food consumed in the UK in 2016. The calculation is based on the farm-gate value of raw food (Source: Defra (2018)).

Table 3 Trade of the UK with EU27 in CAPRI database in 2012

Products	UK imports from EU27		UK exports to EU27	
	Import values (mil. euro)	Share (%) of EU27 in total imports	Export values (mil. euro)	Share (%) of EU27 in total exports
Cereals	339.6	59.8	194.1	49.6
Other arable crops	446.0	74.4	177.5	50.0
Oilseeds	85.2	24.2	263.7	96.5
Fruit &Vegetables	4,800.1	53.1	159.7	73.1
Meat	4,022.7	84.4	1,912.6	80.4
Dairy products	2,495.1	89.9	798.7	93.3

Source: CAPRI database.

4. Brexit and UK's net contribution to the CAP

The EU budget is mainly sourced from customs duties on imports, value added tax and a standard percentage of each member state's gross national income. CAP budget accounts for about 40% of EU budget in the MFF of 2014/2020[5]. For considering UK's net contribution to the CAP in welfare analysis, we used results from M'barek et al. (2017) (Table 4). It shows changes in UK's net contribution to CAP and EU CAP budget from 2016 to 2030 without considering Brexit. In this calculation (see details in Boulanger et al. (2015b)), the gross CAP budget contribution from each EU member country in 2030 is simulated, using tariff revenues from all trade and uniform GDP shares in each member country. Here, the share of tariff revenues in CAP budget contribution is determined by gross tariff revenues from imports less the administration costs (25%)[6] multiplied by exogenously given CAP share of the tariff revenue (36 % in 2016, 19% in 2030 in . The remaining CAP budget (EU CAP budget – tariff revenues contribution) is fulfilled by EU-wide uniform percentage share (endogenous variable) of each member's GDP. Finally, UK's net CAP budget contribution is calculated by comparing gross contribution to the CAP, CAP receipt, and UK's rebate attributable to CAP. UK's rebate from CAP is

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[5] Source: European Parliament: Fact Sheets on the European Union-The Common Agricultural Policy figures (http://www.europarl.europa.eu/factsheets/en/sheet/104/the-common-agricultural-policy-in-figures)
[6] As of 26 May 2014 (Council Decision No 2014/335), the collection costs remains in member states are reduced to 20%, the rest is collected for the EU budget.

estimated by deducting 66% of its total net contribution as UK' rebate and additional corrective payment from other member countries.[7]

Accordingly, the UK's net contribution to CAP budget is €1.6bn in 2016 and is expected to decline in 2030 (€1.5bn) in 2016 price. After Brexit, UK's net contribution to CAP would be eliminated in some of the simulated scenarios. It would benefit the UK, but reduce government revenues in the EU. For welfare calculation in the term of government revenue after Brexit, only changes of tariff revenues in agricultural trade are simulated in CAPRI. The correction of government revenues with the change in the EU CAP budget contribution of the UK is done as a post-calculation after the model simulation.

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[7] This is an approximation of a very complex formula. For example, in calculating its share of EU expenditure, the actual rebate formula excludes most EU rural development expenditure in the Member States that joined the EU after 2004.

Table 4 UK' net contribution to the EU CAP budget in 2016 and 2030

Unit: € Mil.		UK			EU		
		2016	2030		2016	2030	
			(2016 prices)	(current price)		(2016 prices)	(current prices)
Gross contribution to the CAP	Total	8,071	7,393	9,622			
	From tariff revenue	1,469	1,279	1,665			
	From GDP	6,602	6,114	7,957			
CAP receipts		-3,727	-3,368	-4,383	53,371	45,475	59,185
UK rebate attributable to CAP		-2,703	-2,521	-3,281			
Net contribution to the CAP	Total	1,640	1,505	1,959	-1,640	-1,505	-1,959
	From tariff revenue	298	260	339	-298	-260	-339
	From GDP	1,342	1,245	1,620	-1,342	-1,245	-1,620

Source: Own compilation based on projections of gross contribution to the CAP, CAP receipts, excess payments over receipt and net contribution in the UK and EU CAP receipt to 2030 in 2016 prices from M'barek et al. (2017). Here, CAP contribution is decomposed by tariff revenue and GDP by using shares provided by the authors and values are calculated in 2030 (current price) by applying an inflation rate 1.9% to be same as CAPRI.

5. Scenarios

5.1 The baseline until 2030

All scenarios are compared to a baseline for 2030 in which the UK remains in the EU. The agri-food sector economic trends for 2030 are based on the EU Commission's agricultural outlook (EC, 2015). It contains specific market projections for EU countries and global market trends from the OECD-FAO market outlook (OECD/FAO, 2015) which makes projections until 2025. The projections are extended to 2030 by extrapolation. The details about the CAPRI calibration to the baseline are given in Himics et al. (2014). CAP measures currently decided upon are continued until 2030. In this baseline, the EU's FTAs with Canada and Korea are not included, but other FTAs such as with Switzerland and Norway, as well as preferential schemes for developing countries are taken into account.

5.2 Brexit scenarios

In order to systematically analyze the impacts of the multitude of changes that are likely to follow from Brexit, we develop scenarios around two main aspects: the outcome of Brexit negotiations and the post-Brexit UK's agricultural policy (See Table 5). For Brexit negotiations, we consider three negotiation scenarios: *EEA+*, *FTA*, and *WTO*. In all scenarios, we assume that the UK roll over all of the EU's preferential trade agreement after Brexit. TRQs are divided between the UK and EU27 based on domestic consumption levels of TRQ products.

Table 5 Brexit scenarios. NTB costs are shown in *ad-valorem* equivalent (AVE) tariff rates.

	Soft Brexit		Hard Brexit (No deal)
	EEA+	**FTA**	**WTO**
NTBs	5.0%	7.9−12.7%	12.6−24.2%
Tariff (UK- EU27)	No tariffs	No tariffs	MFN tariffs
UK's EU budget (CAP) contribution	Yes	No	No
TRQs	historical level TRQs remain in the UK		
UK's trade with the ROW	UK retains EU's FTAs with third countries		

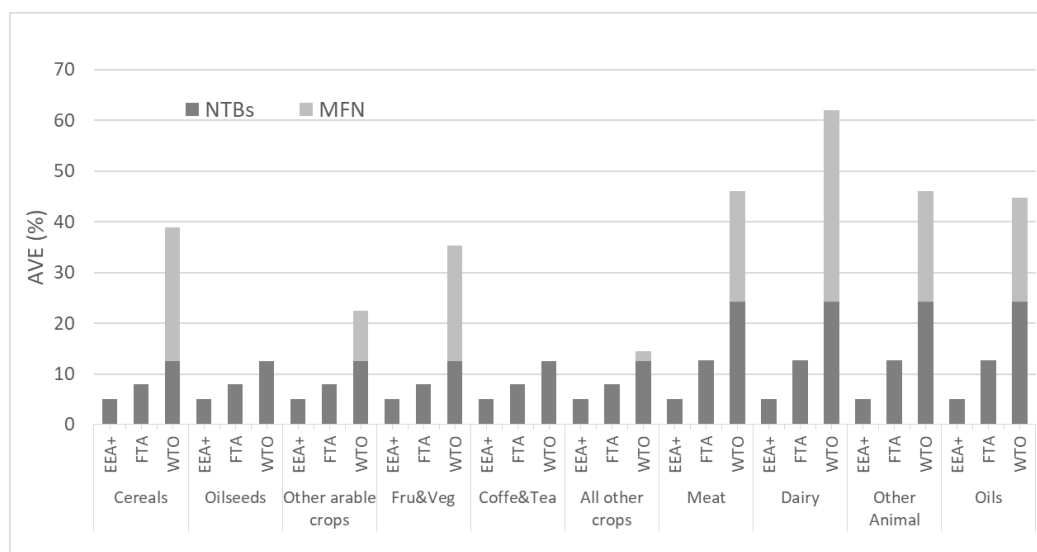Source: Own compilation based on various sources.

Figure 2 Comparison of NTB costs (in *ad-valorem* equivalent (AVE) (%)) in each Brexit negotiation scenario and MFN tariffs. Note: Product specific tariffs are aggregated at product groups. (Other

arable crops: potato, pulses, sugar beet, All other crops: flax, hemp, tobacco, flowers etc.). Source: Own calculations, see text for explanation.

The *EEA+* scenario represents a case in which the UK remains in the single market and concludes a tariff-free FTA with the EU27, but gains sovereignty on trade policy. In addition to the current EEA, a tariff-free trade agreement is made for agricultural products. In this scenario, we assume that NTBs related to sanitary, phytosanitay and technical standards do not increase trade costs and only border-related NTB costs increase by 5%. The overall increase stems from paperwork of rules of origin (RoO) and additional costs from border controls due to inspection and delay (Abreu, 2013). In this scenario, we assume that the UK would continue to make a transfer into the EU budget equivalent to net CAP transfers less third country tariff revenues.[8] For the UK, tariff revenues in agri-food trade are not transferred to the EU.

The *FTA* scenario depicts a case in which the UK leaves the EU single market and only makes an FTA in goods including agricultural products with EU27. Agricultural products are traded with zero tariffs, but NTBs increase more than in the EEA+ scenario (7.9% for primary products and 12.7% for processed products). The NTB costs are derived from Egger et al. (2015), which estimate the potential trade cost saving of a deep FTA between the EU and United States. We assume that greater similarity in regulations between the UK and EU27 before Brexit and mutual recognition arrangements would reduce trade restrictiveness by 50% compared with the values presented by Egger et al. (2015). The UK's net CAP contribution is abolished and it would become a financial gain for the UK and loss for the EU.

In the WTO scenario, no trade deal is agreed in the negotiation and most favored nations (MFN) tariffs are charged on agricultural products according to WTO rules between the UK and EU27. We further assume that the UK will apply the same tariffs towards non-EU countries after Brexit as it does today as an EU Member State. NTB costs increase the largest (12.6% for primary products and 24.2% for

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[8] The contributions made by EEA states and Switzerland in return for access to the single market are not, strictly, paid into the EU budget but are transferred directly to cohesion countries as a form of development aid. We assume that if the UK made this payment under an EEA+ arrangement, the EU would make savings in its own cohesion spending by this amount. In this way, the UK transfer can be seen to benefit the EU budget.

processed products) among the considered scenarios. For NTB costs, we use the results of NTB reduction estimated by Egger et al. (2015) for the case of the EU single market, and again assume that only 50% of NTB costs materialize as trade barrier in the FTA scenario. Thus, we assume that NTB costs in *WTO* become larger that in *FTA* by assuming that a less favorable trade environment is formed between the UK and the EU, and that the UK's food standards and regulations will diverge from the EU to some extent.

6. Results

This section presents the main results of the Brexit negotiation outcome scenarios on the components of the market balances, prices and welfare.

6.1 Impacts on trade

Brexit has a much larger impact on relative trade patterns in the UK compared to the EU27. Imports and exports decrease in both the UK (Figure 3) and EU27 (Figure 4) due to trade frictions in all scenarios. The UK's exports decline more in relative terms (% change on basis of tons) than its imports and meat exports are most affected in all scenarios. Even in the *EEA+* scenario, UK's exports decrease by 10-25% in all product groups due to the additional 5% trade facilitation costs. In the high impact scenario *WTO*, cereals, meat and dairy product exports decline more than 60%. Imports to the UK decline in all product categories except oilseeds. However, imports of oilseeds increase slightly in all

scenarios due to zero tariff rates and since demand for feedstuffs increases. In the *WTO* scenario, dairy imports decline the most (about 50%) among all products.

For the EU27, exports and imports have moderate impacts compared to the UK. Exports of "Fruit&Veg (Fruits and Vegetables)", meat and dairy products are most affected. In *EEA+* and *FTA*, relative changes of exports and imports are less than 3%. In *WTO*, exports of "Fruit&Veg" and dairy decrease by about 8 and 11%, respectively. Overall reductions in cereals, meat, and dairy imports to the EU27, can be mainly attributed to a decrease in imports from the UK.
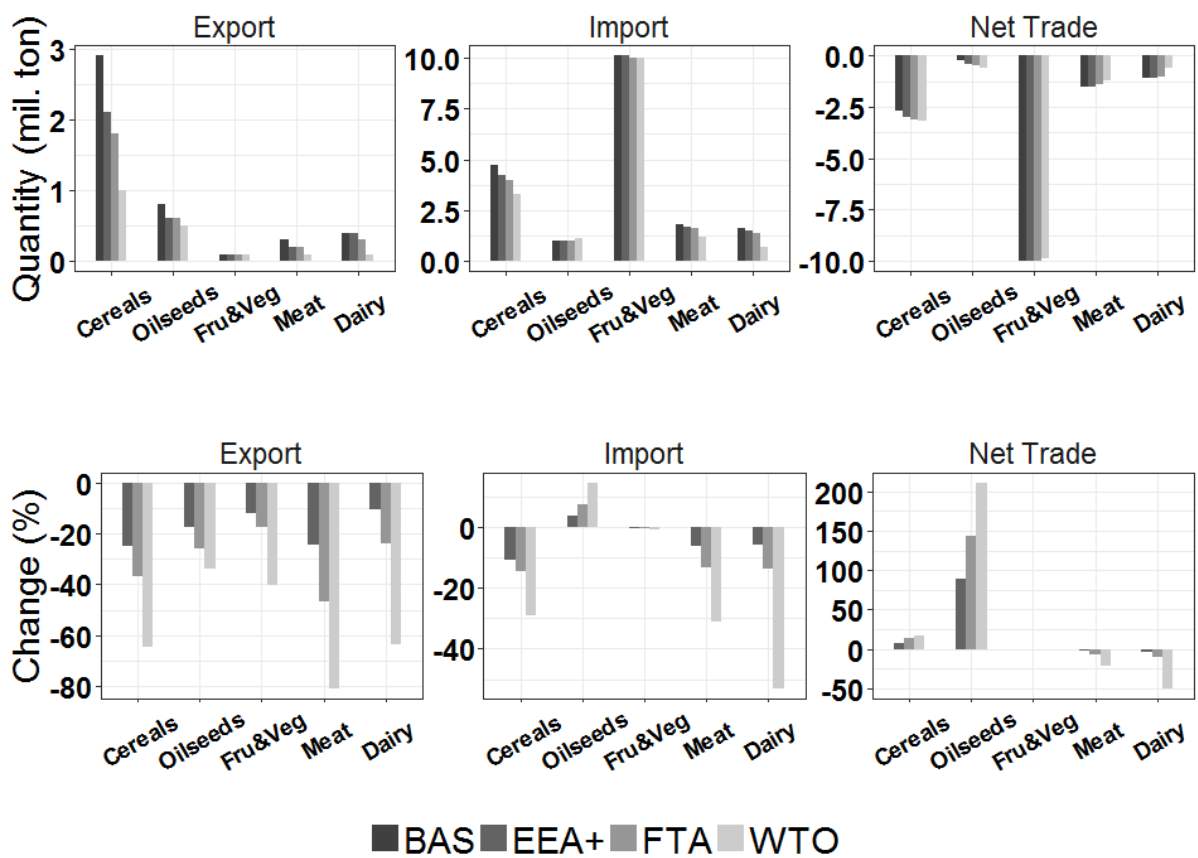

Figure 3 Changes in UK's trade after Brexit negotiation with EU27 and all third countries. Scenario outputs are compared to the baseline (gray bars in the upper figure with the label name of 'REF' in the legend).
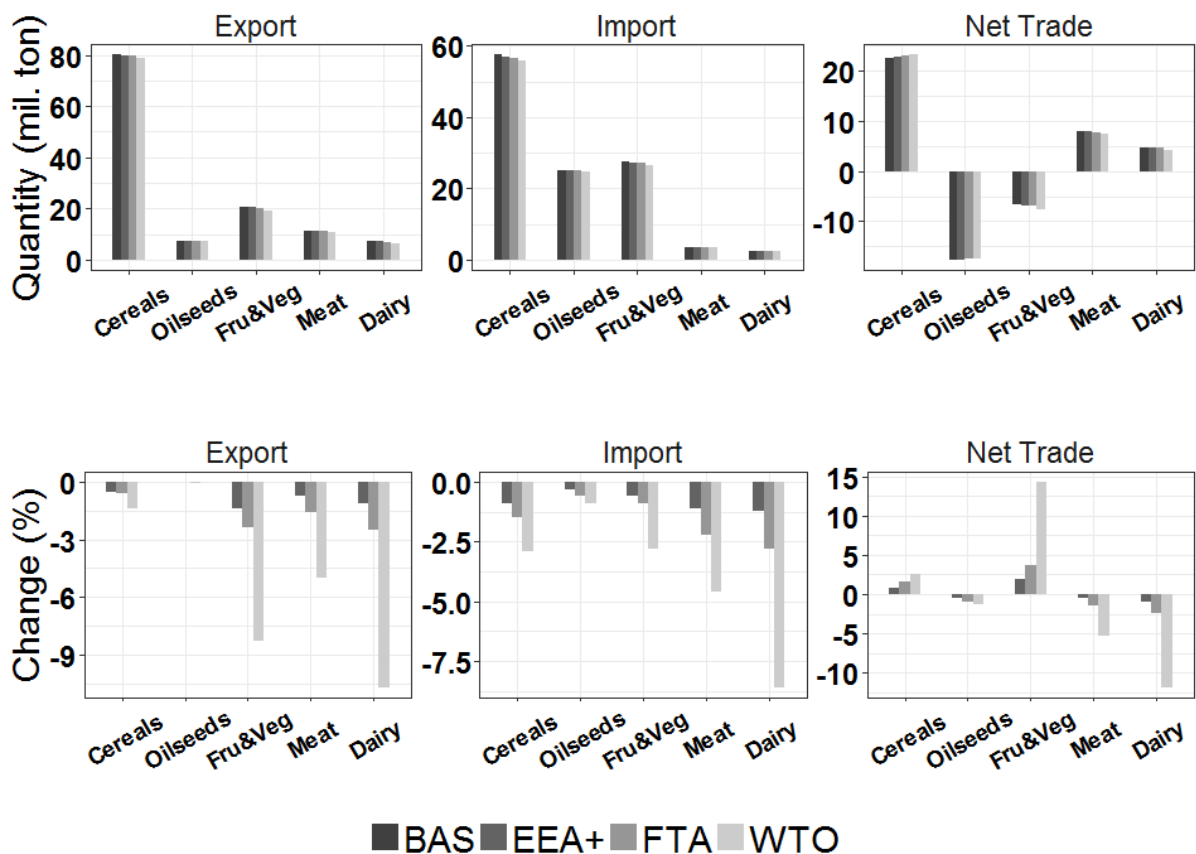
Figure 4 Changes in EU27 trade after Brexit negotiation with the UK and all third countries. Scenario outputs are compared to the baseline (gray bars in the upper figure with the label name of 'REF' in the legend).

6.2 Impacts on prices, production and consumption

Due to a decrease in imports to the UK, producer prices in the UK increase in most products (Figure 5). In *EEA+* and *FTA*, producer price changes are rather small (less than 5%) for all products. Impacts on cereals and dairy products are smaller than for other product groups. The strongest impacts are found in the *WTO* scenario, where producer prices of meat and dairy products increase by 12% and 7.5%, respectively. Only in oilseed markets, producer prices decrease in all scenarios because imports at lower prices increase from the rest of the world (ROW). In addition, production response follows the sign of changes in producer prices. In the UK, production of "Fruit&Veg", meat, and dairy products in the UK increases the most in all scenarios. In the *WTO* scenario, meat and dairy production increases by 12%, 6%, respectively, due to the higher producer prices. Changes in cereal production in the UK partially

depend on feed demand changes in the scenarios. With smaller impacts on trade in *EEA+* and *FTA* scenarios than in the *WTO* scenario, cereals production decreases slightly as net imports of cereals increase. However, in the *WTO* scenario, the increase is caused by larger animal production which in turn induces a rise in feedstuff demand.

For the EU27, producer prices decrease for most products, because exports to the UK decline. Meat producer prices decline by 1.8% in the *WTO* scenario. Producer prices of oilseeds, however, increase slightly because oilseed imports from the UK decrease. Compared to the UK, the relative changes in agricultural production in EU27 are rather small and stay below +/- 1%. Production decreases for all products except for oilseeds for which an increase can be observed due to decreased imports from the UK.

Regarding the consumer side, in the UK, consumer prices[9] increase in all product groups except oilseeds. In the *WTO* scenario, meat and dairy products increase substantially by about 9% and 12%, respectively. Consumption of cereals, meat and dairy products decreases in all scenarios and of "Fruit&Veg" decreases in EEA+ and FTA scenarios. In EU7, consumers in EU27 benefit from a decrease in prices, except cereals and oilseeds.

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[9] Consumer prices in this study refer to the retail prices paid by ultimate food consumers. They are calculated in CAPRI, using average prices of consumed goods domestically (quantity weighted average over domestic and imported product prices) plus a fixed margin (e.g. transport, processing, and other marketing costs). They should not be confused with ex-farm prices paid by first purchasers of farm products.
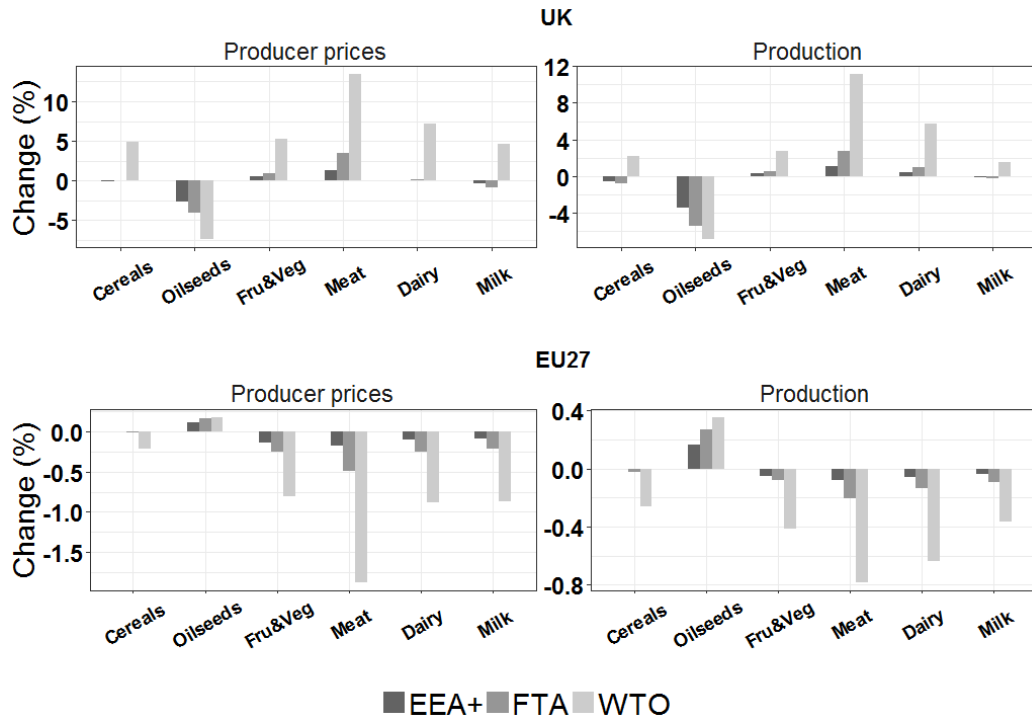
Figure 5 Changes in producer prices (left) and production (right) in the UK (upper) and EU27 (lower) in Brexit scenarios (EEA+, FTA, WTO). Scenario outputs are compared to the reference scenario.
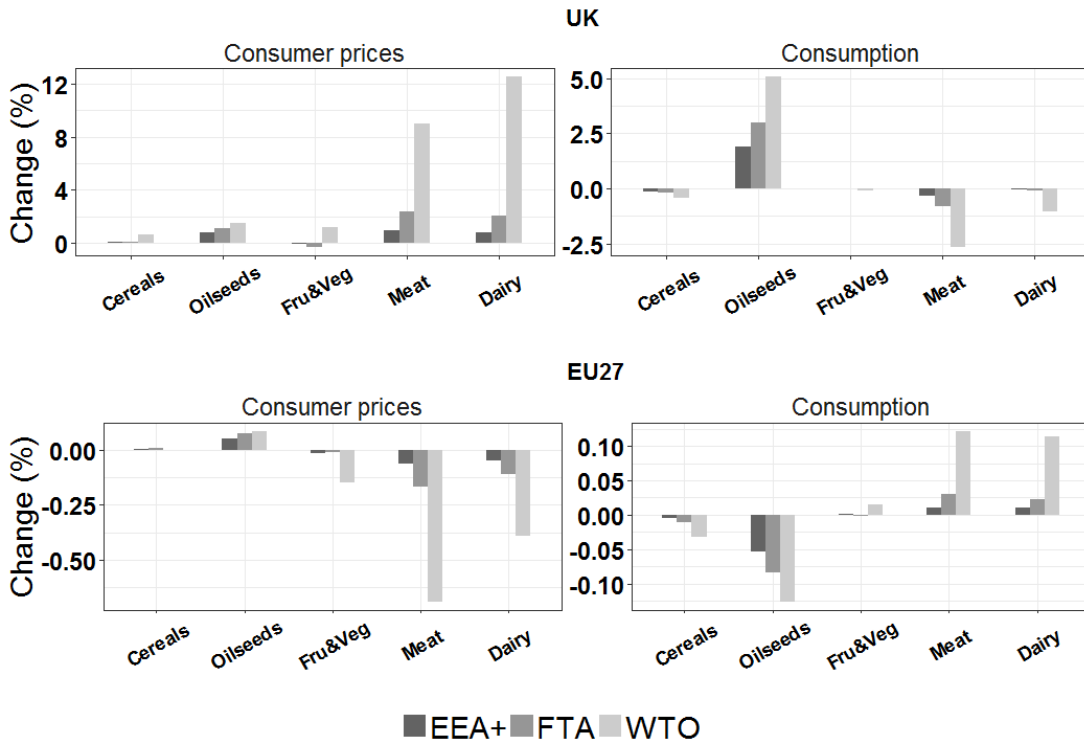

Figure 6 Changes in consumer prices (left) and consumption (right) in the UK (upper) and EU27 (lower) in Brexit scenarios (EEA+, FTA, WTO). Scenario outputs are compared to the reference scenario.

6.2 Impacts on welfare

We compute the *welfare* impacts as changes in consumer surplus, producer income and changes in government revenue. As explained in section 4, we include a change in UK's net contribution to the EU CAP budget from two sources: tariff revenue from agricultural trade and share of GDP. The results are summarized in Table 6. The level of trade barriers assumed in the Brexit scenarios explain the extent of impacts on consumers and producers. The scenario *EEA+* shows the smallest, and the *WTO* the largest impacts, whereas the *FTA* scenario results stay in between. In all scenarios, consumers in the UK (-12 to -125 €/capita) and producers in EU27 (income losses, -0.2 to -2.5%) suffer due to higher food prices and lower producer prices, respectively, than the baseline. In the *WTO* scenario, consumer surplus in the UK amounts to €-8.8bn (-125 €/capita). Producer income, however, increases in the UK by 0.7−17.4% compared to the baseline. Consumers in EU27 benefit from Brexit because food prices decline as exports to the UK decrease. Considering only consumer surplus and producer income, both regions lose, and the UK's loss is larger than EU27's, mainly due to the large decrease in consumer surplus.

However, if we also consider changes in taxpayer welfare including the UK's net contribution to the EU CAP budget, the final welfare level become different. In *FTA* and *WTO* scenarios, the UK gains €2.2 and 2.8bn of government revenues respectively by leaving the EU membership, whereas government revenue losses (€-1.9bn) occur for the EU27. Here, we assumed that the UK's transfer payment associated with an EEA+ membership is the same as before Brexit. Only the UK gains from tariff revenues in agricultural trade. In *EEA+*, the UK and the EU27 experience small welfare losses due to increased trade costs (5% assumed in this scenario). In *WTO*, even with UK's gain in government revenue, the UK welfare loss (€-3.1bn) is larger than the welfare loss for the EU27 (€-2.5bn). However, in *FTA*, the net welfare of the UK become positive (€668bn) because the country's gain from phasing out CAP contributions (€2.2bn) exceed the market loss (€1.6bn).

Table 6 Welfare impacts in the agri-food sector in 2030 (current prices) in Brexit negotiation scenarios. Scenario outputs are compared to the reference scenario (unit: €1 million).

Welfare items		unit	UK			EU27		
			EEA+	**FTA**	**WTO**	**EEA+**	**FTA**	**WTO**
Consumer surplus		mil. euro	-856	-1,974	-8,802	+315	+776	+3,266
		euro/capita	-12	-28	-125	+0.7	+1.7	+7.3
Producer income		mil. euro	115	363	2,923	-372	-884	-3,874
		(%)	0.7	2.2	17.4	-0.2	-0.6	-2.5
Consumer surplus+producer income		mil. euro	-741	-1,611	-5,879	-57	-108	-608
TRQ rent		mil. euro	+1	+1	+25	+1	+3	+54
Government revenue	CAP costs and other costs[a]	mil. euro	+1	+1	-1	-2	-3	-15
	CAP budget — Net tariff revenue	mil. euro	+644	+659	+1,108	-343	-345	-336
	CAP budget — GDP	mil. euro		+1,620	+1,620		-1,620	-1,620
Total		mil.euro	-97	+668	-3,125	-399	-2,071	-2,550

a) 'CAP and other costs' is costs as budget spending. The negative value means gains of government revenue.

b) Tariff revenues in agricultural trade are shown in two rows as the reference and after Brexit to show trade impacts on tariff revenue.

7. Discussion and conclusions

Brexit is expected to cause disturbances in international agri-food trade in various ways. The direction and the extent of impacts will be determined by the outcome of the Brexit negotiations. This study analyzes Brexit scenario impacts not only in the UK, but also in the EU27. The partial equilibrium global agricultural sector model CAPRI is employed to evaluate impacts on trade, prices, production and welfare.

Our results mainly confirm previous studies (Table 1). Brexit causes increases in agricultural prices (mainly meat, dairy products) in the UK agricultural markets. The results are largely driven by our assumptions on NTB costs, which are in the middle of those used in previous studies (Table 2). Additional border control, delay and certificates requirement will inevitably increase trade costs between the UK and the EU27. The extent of NTB costs will depend on how much the UK harmonizes food standards and regulations with the EU27 in the long term. In addition, our study contributes to the literature by clarifying ambiguous effects on the cereal markets in previous studies (Berkum et al., 2016; Davis et al., 2017). Our results show that the livestock sector and feed demand affect the response in the cereal markets. A relatively high increase of livestock production due to reduced imports (Scenario *WTO*) would require higher feed demand and lead to higher cereal production than the reference scenario. But small impacts on the livestock sector demand less feedstuff and cereal production decreases.

Furthermore, this study supplements previous studies with welfare analysis. The largest loss occurs to UK's consumers and taking account of the UK's net contribution to CAP is decisive in affecting the net welfare change for the UK and the EU. UK's gain from the change in net CAP contribution is large enough to lead to an increase of UK's net welfare in the negotiation outcome of *FTA*. Considering UK's large net budget contribution to CAP in agriculture, Brexit and UK's FTA with the EU can be an economically sound choice in the agricultural sector. UK's large net contribution to CAP (€1.6bn) play an important role in the net welfare change for the UK and could justify Brexit for the UK in the agricultural sector.

It should be noted that UK's membership fee for an EEA+ deal could be lower than its current net EU membership contribution, depending on the negotiations. In this study, however, constant payment to the UK is assumed in *EEA+*. Currently, Norway's final contribution to the EU (€890 million) is about two thirds of UK's on basis of per capita[10]. This indicates *EEA+* can lead to net gain for the UK by reducing payments to the EU. In addition, UK's post-Brexit policy would be crucial to mitigate those market impacts after Brexit. Unilateral import tariff abolition for agricultural products can be considered as an option to reduce increases in agricultural prices, but producers would have to increase productivity to cope with decreasing market prices.

For the EU, Brexit would incur relatively small impacts due to its large economic size. Net market impacts (consumer surplus + producer revenue) are expected to be small, but the loss of UK's net contribution to CAP leads to a reduction in the net welfare except in the scenario *EEA+*. Moreover, the withdrawal of the UK as a net contributor to the overall EU budget would put pressure on the CAP budget (as seen in the Commission proposals for the next MFF period). Reductions in CAP spending may further aggravate farm income. This may lead to increased food prices and could offset the benefits of Brexit to consumers in the long run, but this is not considered in this study.

Furthermore, other aspects not considered in the model may question the robustness of the direction and strength of our model results. The expected negative Brexit impact on the exchange rate might directly affect the prices of imported agri-food products (including intermediates) and also the prices of primary inputs for agriculture (e.g. mineral fertilizers). In addition, labor market disturbances (e.g. restricted mobility of seasonal workers from Eastern Europe to the UK) could impact labor-intensive agricultural sectors, such as horticulture in the UK. Negotiation of TRQs for third countries preferential access to the UK would be of importance. Moreover, CAPRI does not cover food markets such as beverage, alcohol and some processed products such as jam, frozen pizza, pet food. Thus, absolute levels of consumer surplus changes could be larger than estimated in CAPRI and our model may thus underestimate welfare impacts in the UK. Moreover, CAPRI uses the Armington approach, which has

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[10] Source: The UK's independent factchecking charity (https://fullfact.org/europe/norway-eu-payments/)

the well-known disadvantage of not capturing emerging trade flows (zero trade problem) and understating trade creation from small trade shares (small share problem) (Kuiper and Tongeren, 2006).

Finally, our study implies that increased market inefficiency arising from trade barriers due to Brexit could lead to welfare losses for the UK and the EU27. In particular, the consumer surplus losses in the UK could be substantial (-125 euro/capita) in the scenario *WTO*. However, net welfare gain could be achieved in the UK due to financial gains in producer income and EU CAP contribution in the scenario *FTA*. For the EU27, net market impacts are small, but loss of CAP contribution from the UK can lead to net welfare loss. For the UK, no deal scenario (*WTO*) would impose strong markets impacts for consumers. It remains to be seen how UK's post-Brexit agricultural and trade policy can mitigate those market impacts. For the EU27, producers would likely face income losses due to lower food prices and a shrinking EU CAP budget.

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