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European Agriculture after Brexit: Does Anyone Benefit from the Divorce?

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Abstract

The UK exited the EU on 31 January 2020, with a transition period agreed as part of the Withdrawal Agreement. During this transition period the UK and the EU will decide on their future trading relationship. No matter what form this relationship takes, there will be disturbances to agri-food markets. This study analyses four different scenarios with increasing barriers to trade, ranging from a very close relationship similar to the European Economic Area to a distant relationship in which the UK and EU trade on Most Favoured Nation terms, using the EU focused global agricultural sector model CAPRI. In the UK, food prices will increase in all scenarios, making consumers in the UK the biggest losers. Only in a free trade agreement scenario does the UK show an unambiguous positive net welfare gain in just the agri-food sector. In the case of the European Economic Area scenario, which assumes continued access to the single market, the net welfare impact would depend on the size of the UK's continued contribution to the EU. In the EU, declining food prices would benefit consumers but the sum of the loss in farmers' incomes and the UK's EU CAP contribution would be much greater than the consumer's gain. These impacts in agricultural markets under different future trade arrangements will also be influenced by the UK's agricultural policy changes in direct payments as well as by possible further UK trade liberalisation after the end of the transition period.

Keywords: *Agricultural policy*; *Brexit*; *CAPRI*; *common agricultural policy*; *economic modelling*; *international trade*; *trade analysis and policy*.

JEL classifications: *C60, F10, P51, Q17.*

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1. Introduction

The UK exited the EU on 31 January 2020 but under the transition period agreed as part of the Withdrawal Agreement it retains the rights and obligations of an EU member state until 31 December 2020 unless the transition period is extended by mutual agreement. During this transition period the UK and the EU will decide on their future trading relationship. The UK has made clear in its negotiating mandate that it is not seeking to remain part of the EU single market nor to be part of a customs union; its preferred model is a comprehensive free trade agreement (FTA) along the lines of similar agreements that the EU has made with other third countries, supplemented by other international agreements covering additional topics (HM Government, 2020). Given the tight negotiating timescale and the well-known differences between the two sides on issues such as the role of the European Court of Justice, level playing field commitments, fisheries, and access for financial services, among others, reaching an FTA by the end of 2020 is not guaranteed. Thus, in a worst case scenario, trade in goods between the UK and the EU could be subject to tariffs and other border measures. In either case, 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 the UK and Europe. Under the UK's preferred option of a free trade agreement (FTA) between the UK and EU27 at the end of the transition period, the UK leaves the single market but there is an FTA for goods. This option inevitably entails higher trade facilitation costs compared to the UK remaining in the EU because non-tariff barriers (NTBs) in trade would increase. These include the costs of customs clearance, and of determining rules of origin, as well as sanitary and phytosanitary (SPS) and technical barriers to trade (TBT) inspections. Additionally, NTBs in an FTA include transport delays due to border inspections as well as the need to show compliance with the regulatory standards of the other party.

Some of these costs could be avoided if the UK opted to stay in the European Economic Area (EEA). European Economic Area countries have an independent trade policy but agree to adopt EU single market legislation which gives their products and services full access to the EU single market. Even though the UK has ruled out this option, we include it in our scenarios as an *EEA+* option (where the '+' indicates that agricultural tariffs are also removed, unlike in the EEA itself) to provide a benchmark against which to measure the additional costs and benefits of the more likely trade relationship outcomes. If an FTA is not agreed between the parties, 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, a scenario often referred to as a hard Brexit. Any 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 favourable access to both markets.

The future access of third countries to the EU and UK markets is also unclear. With the threat of no-deal looming in early 2019 as disagreements continued over the terms of the Withdrawal Agreement, the UK announced a temporary tariff schedule in March 2019 that would apply in the event of no-deal pending discussions on a permanent post-Brexit schedule (DIT, 2019). This tariff schedule envisaged a significant liberalisation as compared to the EU tariff schedule. Eighty-seven per cent of total imports to the UK by value would be eligible for tariff free access. Some products including beef, lamb, pork, poultry and some dairy would continue to be protected by

a mixture of tariffs and quotas although at rates lower than those the UK applied as an EU member. The impact of this tariff schedule is simulated in our *NoDeal_L* scenario. In February 2020, the UK announced it was withdrawing its March 2019 proposed tariff schedule. Instead, it launched a public consultation on a permanent tariff schedule it called the UK Global Tariff (DIT, 2020). This schedule proposed to maintain the current EU MFN tariff but with some simplification, including considering converting the many compound agricultural tariffs into simple percentage tariffs. Although this tariff schedule may be amended following the public consultation, the impact of maintaining the EU's MFN tariff schedule is simulated in our *NoDeal_H* scenario.[1]

In both scenarios, current Tariff Rate Quota (TRQ) access to the EU and UK markets would need to be renegotiated with many agricultural trade partners of the EU. Whether this will result in increased preferential access to suppliers of the EU and UK market remains to be seen. Currently, the UK and EU27 agreed to apportion existing TRQs based on historical consumption shares (EU, 2019), but major agricultural exporters such as Canada, the USA, Argentina, Brazil, New Zealand, Thailand and Uruguay have objected to this (House of Commons, 2018). In addition, the UK plans to 'roll-over' the around 70 FTAs that the EU has with countries around the world before the end of the transition period. Around 7% of UK food exports (2016–2018) in value terms were exported to these markets (AHDB, 2019). By the beginning of February 2019 the UK had agreed 'roll-overs' in 19 cases covering 50 countries.[2]

Brexit will also impact on government budgets in both the UK and the EU27 after the end of the transition period. The UK is the second largest net contributor to the EU budget – €9.8 billion in 2016 (House of Commons, 2018). The UK treasury will benefit financially from Brexit after the end of the transition period, but the EU will suffer from revenue loss and it will indirectly affect agricultural budget spending in CAP post 2020. 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 and also the need to focus budget resources on new priorities.[3]

Previous Brexit impact assessments have considered new tariffs in trade, together with changes in trade facilitation costs as NTBs at various ranges (Table 1). In a hard Brexit scenario, 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 meat prices by 7–17% and of dairy products by 8–30%. Bellora *et al*. (2017) show a hard Brexit would increase UK's agri-food value added by 2.1%. However, a study

[1]The UK announced its final Global Tariff on 19 May 2020, https://www.gov.uk/guidance/uk-tariffs-from-1-january-2021. While simplification has reduced some agricultural tariffs compared to EU levels, it is still broadly similar to *NoDeal_H* scenario simulated here. The AHDB provide a comparison of agricultural tariffs in the UK Global Tariff with the EU TARIC tariff rate at the following website: https://ahdb.org.uk/uk-and-eu-import-tariffs-under-no-deal-brexit.

[2]The list is updated regularly on the UK Department of International Trade website: https://www.gov.uk/guidance/uk-trade-agreements-with-non-eu-countries.

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

Table 1
Previous Brexit assessments on the agri-food sector/ the whole economy

Study	Model (type)	Regional focus	Scenarios	Non-Tariff Barriers (NTBs) ranges in AVE	NTBs source
Boulanger and Philippidis (2015a)	MAGNET(CGE)	UK	UK-EU FTA: CAP budget withdrawal and trade costs	2–5%	Francois *et al.* (2005); Hornok and Koren (2015)
Berkum *et al.* (2016)	AGEMOD (PE), Farm model	UK	Trade scenarios (FTA, WTO default, UK trade liberalisation), UK domestic agri policy (direct payment cut 100%, 50%, no payment)	5–8%	(Abreu, 2013)
Donnellan and Hanrahan (2016)[a]	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 and Swales (2017)	Own PE model	UK	Evolution, Unilateral liberalisation, Fortress UK	Not specified	
Davis *et al.* (2017)	FAPRI-UK (PE)	UK	Three trade scenarios (FTA, MFN tariff, UK liberalisation)	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)
Bradley and Hill (2019)	Gravity trade model, own PE model	UK	Two trade scenario (FTA, WTO UK tariff)	2–4% (crops) 5–8% (livestock products)	Not specified

Notes: CGE: Computable General Equilibrium, PE: Partial Equilibrium.
[a]This study used results from the gravity trade model in Hufbauer and Schott (2009) and Barrett *et al.* (2015).

Table 2
Mapping of product groups and items in CAPRI

Product groups	Items
Cereals	Wheat, rye and meslin, barley, oats, paddy rice, maize, other cereals
Oilseeds	Rape, sunflower, soya, olives, other oilseeds
Fruit and vegetables	Tomatoes, other vegetables, apples and pears and peaches, table grapes, citrus fruits, table olives, wine
Meat	Beef, pork, sheep and goat, poultry
Dairy	Butter, skimmed milk power, cheese, fresh milk products, cream, concentrated milk, whole milk powder, whey powder and casein

(Bradley and Hill, 2019) shows negative impacts on UK farm incomes if its planned direct payment cuts in England are factored in. For EU27, 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 EU27 countries followed by the Netherlands (−2.7%) and France (−0.3%).

In this study, we assess the economic impacts of different future trade relationships for the agri-food sector, focusing on the agricultural markets of both the UK and EU27, as well as changes in the UK's CAP budget contribution. We employ the CAPRI (Common Agricultural Policy Regionalised Impact Modelling System) in a comparative static analysis (Britz and Witzke, 2014). CAPRI lets us compute Brexit impacts on agricultural supply, prices, and welfare. Compared to many previous studies, this study evaluates the impacts on both the UK and the EU27, taking into account also welfare changes including the impact of the loss of the UK net contribution for the EU budget. Bilateral trade modelling is a feature in the CAPRI partial equilibrium model. However, we do not consider any post-Brexit agricultural policy changes in the UK and the EU in the scenarios and only evaluate trade policy impacts. 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. As a partial equilibrium study, our focus is on welfare impacts within the agri-food sector and the study is not a comprehensive analysis of the impact of Brexit on the UK and EU economies as a whole.

2. CAPRI for Brexit Assessment

CAPRI is a partial equilibrium (PE) agricultural sector model with a focus on EU agricultural markets and regional agricultural supply, covering about 50 primary and processed products. It also considers EU agricultural policy and border policies with the main global trading regions (Britz and Witzke, 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 maximising 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 and Heckelei (2011).

Table 3
Trade of the UK with EU27 in CAPRI simulations in 2030

	UK imports from EU27		UK exports to EU27	
Products	Import values (€m)	Share (%) of EU27 in total imports	Export values (€m)	Share (%) of EU27 in total exports
Cereals	708	55	652	41
Oilseeds	105	29	415	50
Fruit and vegetables	3,467	32	56	24
Meat	4,809	89	510	23
Dairy products	4,530	95	1,623	48

Source: CAPRI database.

The supply module generates new levels of output in different trade scenarios as it is linked with a global market model by an iterative procedure to find equilibrium market prices and production. The global market model for agri-food products has bilateral trade flows, with a detailed set of trade policies at the border (*ad valorem* and specific tariffs, TRQs, etc.). In particular, the trade regions include 'EU-West', 'EU-East' and the UK. Within these regions, there is supply on a sub-regional level (NUTS2), and demand and processing on a national level, summed up to enter the market balance of the trade region. The bilateral trade model is based on the Armington assumption (Armington, 1969). It models trade preferences among domestic and imported products from different origins, considering price ratios, working in two tiers. In the first tier, consumers choose between domestic products and imports. In the second tier, importers choose how imports are sourced from different regions of the world. Human final consumption is modelled based on a Generalised Leontief expenditure function (Ryan and Wales, 1999), satisfying the usual micro-economic regularity conditions, featuring income, own and cross price elasticities among commodities, where an aggregate good representing 'all other goods' ensures that all consumer expenditures are accounted for. The demand system is estimated using the projected baseline quantities and prices and an *a priori* matrix of elasticities provided by Muhammad *et al*. (2011).

The previous CAPRI version did not simulate the UK's trade flows independently and they were aggregated as part of 'EU-West'. For this Brexit study, the UK is separated out from the EU trade block 'EU-West' (EU 15 countries) in the market model to simulate independent trade flows and to compare its trade between the pre-Brexit and post-Brexit situations. In this Brexit CAPRI version, trade information such as traded quantities, prices, and TRQs are newly established between the UK and the ROW including EU-West, EU-East and third countries. In the baseline simulation, which mimics the pre-Brexit situation, CAPRI simulates the UK's trade when in the EU single market and customs union. For that purpose, TRQs are already split between the UK and 'EU-West' with an assumption that TRQ imports follow domestic consumption ratios. Finally, in this study, simulation results are reported in selected product groups as shown in Table 2, following the CAPRI commodity definitions.

Table 4
UK net contribution to the EU CAP budget in 2030 assuming it remained an EU member state

	Unit: €m	UK	EU-west	EU-east
Contribution to the CAP budget	Total contribution	8,876	30,415	4,360
	From tariff revenue	1,889	5,789	830
	From GDP	6,987	24,625	3,530
CAP receipts		3,402	29,851	10,396
UK gross contribution		5,474		
UK rebate		3,613		
UK net contribution		1,861		

Notes: Prices are nominal values (current prices) by applying an inflation rate 1.9% in CAPRI.
Source: Own compilation based on projections of CAPRI in this study.

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 comes from the other 27 member states of the EU (Defra, 2018). In 2016, UK imported food, drinks, and feed was worth £42 billion and exports £20 billion. EU27 accounts for 65% of the UK's imports and 60% of its exports of agri-food products. The UK mainly imports meat (processed and unprocessed), dairy, fruits, and beverages from EU27 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 several EU member countries, with the biggest potential impacts in the meat, dairy, and fruits and vegetable sectors. However, the CAPRI database 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. Table 3 shows UK's trade dependence on EU27 simulated in the CAPRI baseline (see details in section 5.1) for 2030. Trade impacts after the UK's new trade arrangements in each scenario are compared to this baseline.

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. The CAP budget accounts for about 40% of the EU budget in the 2014–2020 MFF.[4] To obtain the UK's net contribution to the CAP for the welfare analysis, we develop the following methodology (for an alternative approach, see Boulanger and Philippidis, 2015b). This study assumes that tariff revenues in agricultural trade are allocated to the CAP

[4]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).

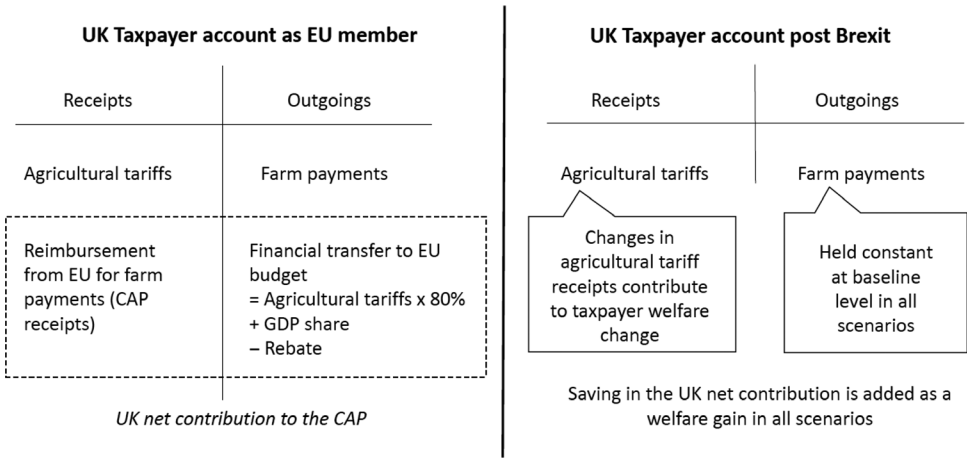

Figure 1. How UK taxpayer welfare changes are calculated *Source*: Own compilation.

budget first and the rest is filled by a GDP-based source.[5] CAPRI baseline simulation results are utilised to estimate expected tariff revenues, agricultural trade and CAP receipts in 2030. The agricultural tariff revenues assigned to the CAP budget are reduced to account for administration costs (20%). Knowing CAP budget expenditure and total tariff revenue receipts in 2030, the balance of the revenue needed to finance the CAP budget is assumed to come from the GDP resource. This in turn is allocated to each member state based on their shares in EU GDP. Each member state's position vis-à-vis the CAP budget can then be calculated by subtracting its CAP receipts. For the UK, this gives rise to an estimated gross contribution to the CAP budget in 2030. The UK receives a rebate on its gross contribution, which is estimated by deducting 66% of its gross contribution.[6] Accordingly, the UK's net contribution to CAP budget is €1.861 billion in 2030 (Table 4). After the end of the transition period, the UK's net contribution to CAP would be eliminated in the simulated scenarios, which benefits the UK but reduces government revenues in the EU.

Figure 1 helps to explain how welfare calculations involving government revenue after Brexit are made. CAPRI only simulates changes of tariff revenues in agricultural trade. The correction of government revenues with the change in the CAP budget contribution of the UK after Brexit is done as a post-calculation after the model simulation. As an EU member, the UK budget makes payments to farmers and a financial transfer to the EU budget, while collecting agricultural tariff revenue and receiving a reimbursement from the EU budget to cover the cost of its farm payments (CAP receipts). After Brexit, the UK budget continues to collect agricultural tariff revenue and to make farm payments. We hold farm payments constant in all scenarios, and

[5]This is a simplification of the complex financing system of the EU budget. In addition to traditional own resources such as tariffs, the budget is financed by a VAT contribution and a contribution from member states based on their gross national income (GNI). We assume that these two contributions are approximated by a share based on each member state's GDP.

[6]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.

the agricultural tariff revenue changes calculated by CAPRI are counted as part of the taxpayer welfare change. In addition, the saving by retaining the net CAP budget contribution is also counted towards the taxpayer welfare change. The UK's net contribution (€1,861 billion in 2030 prices) would be a pure gain for the UK taxpayer and a loss for the EU taxpayer. This approach avoids entangling our trade analysis with speculative assumptions regarding future UK agricultural policy.

5. Scenarios

5.1. The baseline until 2030

The CAPRI database used in this study was built for the year 2012, based on a three-year average of the surrounding years. This was the latest year for which a complete database could be built. However, all scenarios are computed for 2030, and compared to a baseline for 2030 in which the UK remains in the EU. Economic trends in the agri-food sector 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 based on simulations with the AgLink-COSIMO model.[7] The projections are extended by CAPRI to 2030 by extrapolation using estimated non-linear trends subject to all supply model balance equations being satisfied. More 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 analyse the impacts of the multitude of changes that are likely to follow at the end of the transition period, we develop scenarios around two main aspects: the outcome of the negotiations on future trade arrangements; and tariff schedule changes in the UK (see Table 5). For Brexit negotiations, we consider four negotiation outcome scenarios: *EEA+*, *FTA*, and *NoDeal_H* (High UK tariffs), *NoDeal_L* (Low UK tariffs). Only in the *EEA+* scenario is it assumed that the UK continues to contribute to the EU budget in return for access to the single market. In all scenarios, we assume that the UK rolls over all the EU's preferential trade agreements after Brexit. TRQs are divided between the UK and EU27 based on domestic consumption levels of TRQ products in the *EEA+*, *FTA* and *NoDeal_H* scenarios. In the *NoDeal_L* scenario, additional autonomous TRQs are added in line with the UK's proposed Temporary Tariff in March 2019. Corresponding tariffs and non-tariff barrier costs are shown in Figure 2.

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 over trade policy. In addition to the current EEA, a tariff-free trade agreement is made for

[7]More recent outlooks have become available since the Brexit decision was taken, but the 2015 was the established one that had been incorporated into CAPRI when our study was carried out.

Table 5
Brexit scenarios and policy changes in each Brexit scenario

	Soft Brexit		Hard Brexit (no deal)	
	EEA+	*FTA*	*NoDeal_H* (High UK tariff)	*NoDeal_L* (Low UK tariff)
NTBs	5.0%	7.9–12.7%	12.6–24.2%	12.6–24.2%
UK tariffs on imports from EU27	No tariffs		MFN tariff rates of the EU	Tariff schedules of the UK as proposed in March 2019
EU27 tariffs on imports from UK				MFN tariff rates of the EU
UK's EU budget (CAP) contribution	Yes	No	No	No
TRQs[a]	Historical level TRQs remain in the UK and EU27			New TRQs for the UK, historical TRQs remain in EU27
UK's trade with the ROW	UK rolls over EU's FTAs with third countries			New TRQs and tariff rates between the UK and the ROW, UK rolls over EU's FTAs

Notes: NTB costs are shown in *ad-valorem* equivalent (AVE) tariff rates.
[a] Historical TRQs refer to the EU28's TRQs that are apportioned between the UK and the EU27. In the *NoDeal_L* scenario, the UK introduces new autonomous TRQs as set out in its 2019 Temporary Tariff proposal.
Source: Own compilation based on various sources.

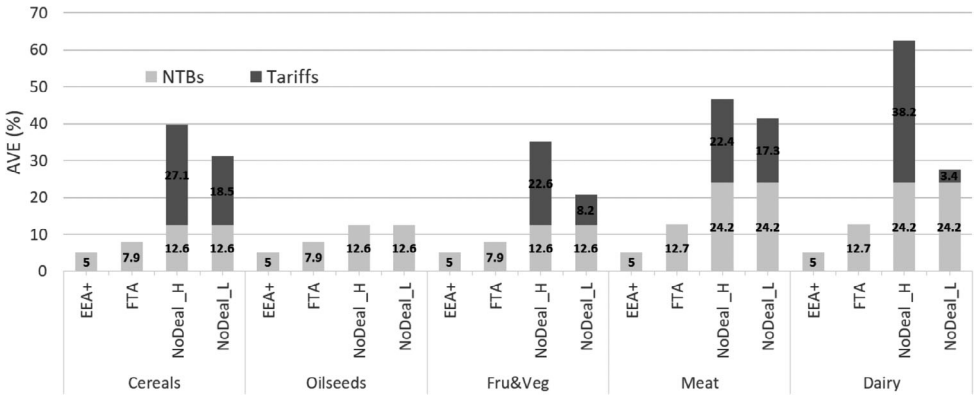

Figure 2. Comparison of NTB costs (in *ad-valorem* equivalent (AVE), %) in each Brexit negotiation scenario and MFN tariffs*Notes*: These cost changes are applied to trade between the UK and EU. Only in the case of the *NoDeal_L* scenario has the UK different tariffs and quotas with the rest of the world, following the announced tariff rates in the no deal Temporary Tariff (DIT, 2019). AVEs are calculated based on import prices simulated in 2030 in each scenario.*Source*: Own calculations, see text for explanation.

Table 6
Comparison between UK MFN tariff rates in *NoDeal_H* and *NoDeal_L* scenarios

		NoDeal_L tariffs[b]		
	NoDeal_H UK MFN tariff rate (%)[a]	UK's in-quota tariff rate (%)	UK's MFN tariff rate (%)	TRQs in the UK (tonnes)
Wheat	16.7	Zero	Zero	Zero
Barley	27.6	4.1	31.9	293
Beef	52.0	Zero	35.4	230,000
Pork	21.5	11.4	17.1	22,500
Poultry	62.3	Zero	10.0	275,000
Cheese	35.0	3.2	3.4	64
Cream	23.5	Zero	Zero	64

[a]Based on EU MFN tariff rates calculated in the CAPRI database.
[b]Original data from the UK Temporary Tariff announced in March 2019 (DIT, 2019) and processed in CAPRI. Ad-valorem equivalent (AVE, %) rates are calculated based on import prices simulated in 2030. Bilateral TRQs are not included in TRQ quantities.

agricultural products. In this scenario, we assume that NTBs related to sanitary, phytosanitary and technical standards do not increase trade costs and only border-related NTB costs increase by 5%. The overall increase stems from paperwork due to rules of origin and additional costs from border controls due to inspection and delays (Abreu, 2013). In this scenario, we assume that the UK would continue to make a transfer into the EU budget as a contribution to cohesion policy, as the EEA countries and Switzerland do at present.[8] For the UK, tariff revenues in agri-food trade are not transferred to the EU as the EEA is not a customs union.

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), who 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 *NoDeal_H* scenario, no trade deal is agreed in the negotiation and MFN tariffs equivalent to EU27 levels are charged on agricultural products according to WTO rules between the UK and EU27. Applying the EU's MFN tariff levels is similar to those which the UK has proposed in its UK Global Tariff. We further assume that the UK applies the same tariffs towards non-EU countries after the transition period

[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.

under the Withdrawal Agreement ends. NTB costs increase the most (12.6% for primary products and 24.2% for 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 these costs materialise as trade barriers in the FTA scenario. Thus, we assume that NTB costs in the *NoDeal_H* become larger than in *FTA* by assuming that there is a less favourable trade environment between the UK and the EU, and that the UK's food standards and regulations will diverge from the EU to a greater extent.

Finally, we consider the *NoDeal_L* scenario, which reflects the temporary tariff schedule and TRQs announced by the UK on March 2019 in case of a no-deal Brexit (DIT, 2019). Following the Brexit withdrawal agreement on 31 January 2020, the UK government withdrew this proposal, but we use this as a benchmark if the UK were to opt for low agricultural protection after the transition period. The proposed tariff rates are, in general, lower than the EU's MFN tariff rates (see Table 6). The tariff rate for wheat is zero and beef and poultry meat have zero tariff rates within TRQs. The TRQ for beef is about two thirds of current beef imports from the EU.

6. Results

This section presents the main results of the different outcome scenarios for the future trade relationship between the UK and the EU on the components of the market balances, prices and welfare.

6.1. Impacts on trade

In the baseline, the main trade flows in agricultural commodities go from the EU27 to the UK, albeit the pattern depends on the commodity. Brexit results in trade diversion. The UK reduces its imports from the EU, and strongly so in the no deal scenarios, and compensates by increasing imports from Asian and African countries. The UK domestic market also adapts by (in general) increased domestic supply and reduced human consumption. The reverse picture appears in the EU, where exports to the UK are reduced, and instead directed towards Asian and African markets. The EU markets also respond by reducing imports and domestic supply, and increasing human consumption. In value terms, meat, fruits and vegetables markets experience the largest changes. In terms of physical quantities, the impacts on cereals are larger.

Since the UK market is smaller than the EU single market, Brexit has a relatively larger impact on trade in the UK than in 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 than its imports (percentage change on basis of tonnes) 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 *NoDeal_H*, cereals, meat and dairy product exports decline by more than 60%. Imports to the UK decline in all product categories (except oilseeds). Dairy imports decline the most (about 50%) among all products. Imports of oilseeds increase slightly in all scenarios due to increased demand for feedstuffs in the UK resulting from expanding domestic meat production in combination with zero tariffs. As expected, the *NoDeal_L* scenario shows smaller impacts on trade than the *NoDeal_H* scenario because of lower tariff rates, however, changes are greater than in the *EEA+* and *FTA* scenarios.

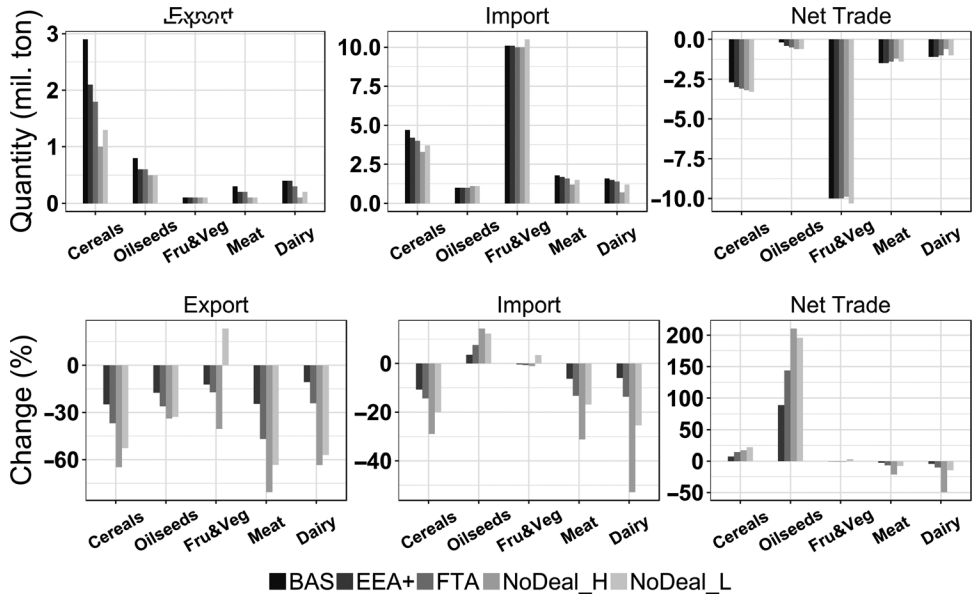

Figure 3. **Changes in UK's** total trade with EU27 and third countries under different scenarios for its future trade relationship with the EU27*Note*: Scenario outputs are compared to the baseline labelled 'BAS'.

In the EU27, the changes in trade are small in relation to the size of the single market. Exports of fruit and vegetables, meat and dairy products are most affected. In *EEA+* and *FTA*, the relative changes of exports and imports are less than 3%. In *NoDeal_H*, exports of fruit and vegetables 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.

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 the *EEA+* and *FTA* scenarios, 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 *NoDeal_H* scenario, where producer prices of meat and dairy products increase by 12% and 7.5%, respectively. On the other hand, the *NoDeal_L* scenario shows that low tariff rates in fruit and vegetables, and dairy products lead to decreases in producer prices. But meat prices still increase compared to the baseline because TRQs and tariffs in the *NoDeal_L* scenario limit increases of imports from the rest of the world (ROW) other than EU27. Only in oilseed markets, producer prices decrease in all scenarios because imports at lower prices increase from ROW. Production response follows the sign of changes in producer prices. In the UK, production of fruit and vegetables, meat, and dairy products increases the most in all scenarios. In the *NoDeal_H* scenario, meat and dairy production increases by 12% and 6%, respectively, due to 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

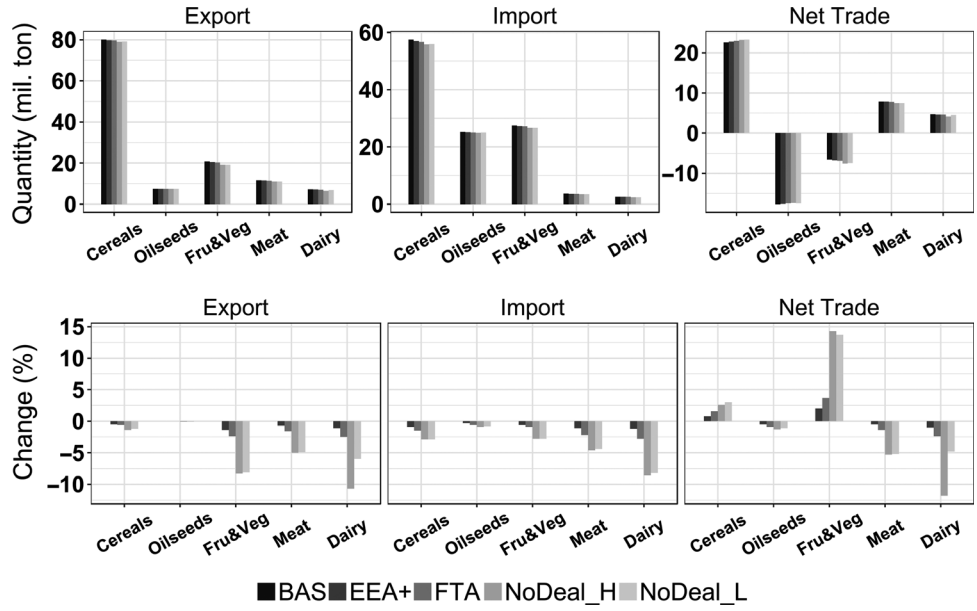

Figure 4. **Changes in UK's** trade with EU27 under different scenarios for its future trade relationship with the EU27*Note*: Scenario outputs are compared to the baseline labelled 'BAS'.

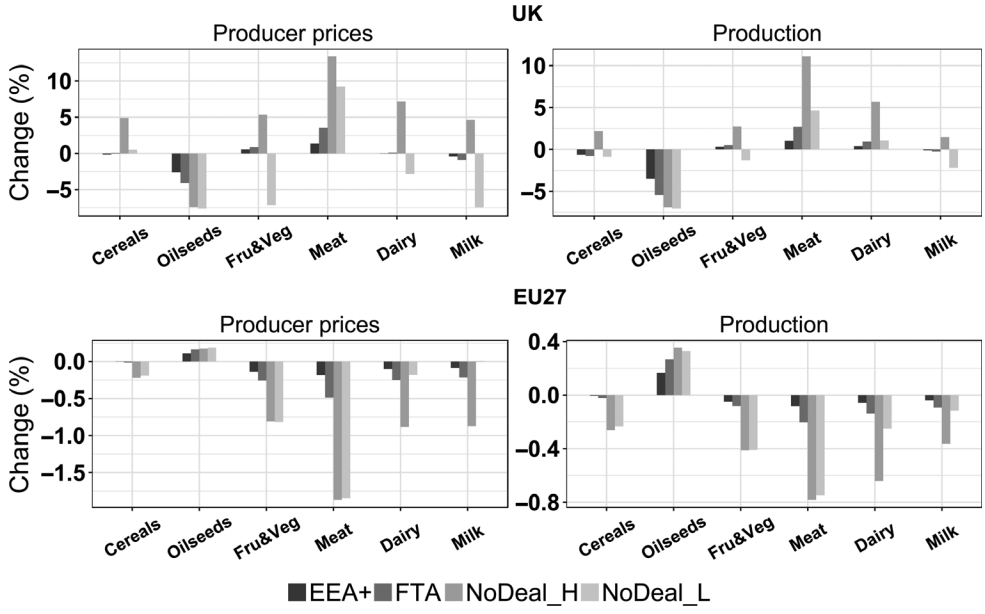

Figure 5. Changes in producer prices (left) and production (right) in the UK (upper) and EU27 (lower) in future trade relationship scenarios*Note*: Scenario outputs are compared to the baseline.

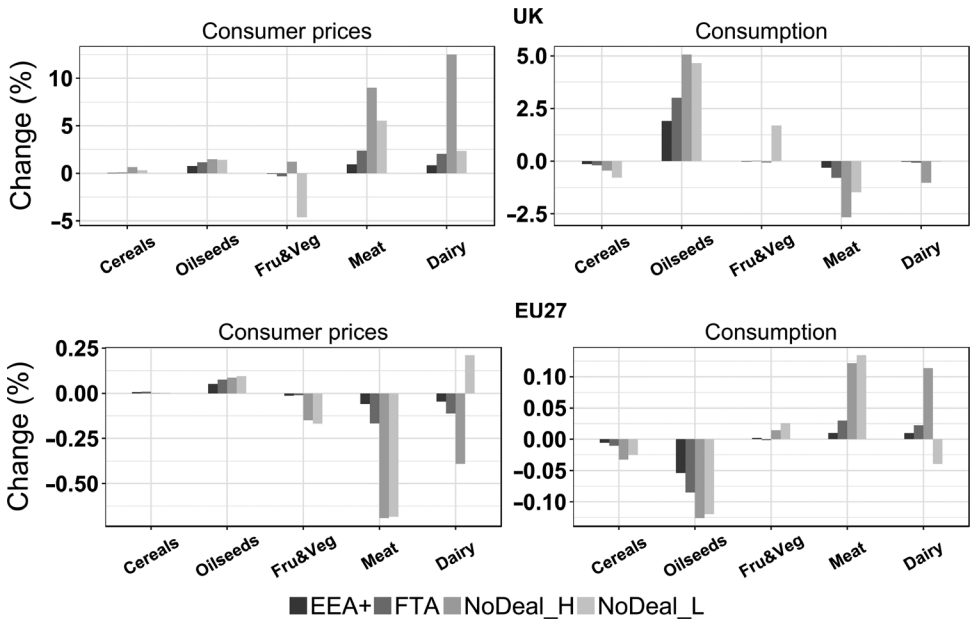

Figure 6. Changes in consumer prices (left) and consumption (right) in the UK (upper) and EU27 (lower) in future trade relationship scenarios*Note*: Scenario outputs are compared to the baseline.

the *EEA+* and *FTA* scenarios than in the *NoDeal_H* scenario, cereals production decreases slightly as net imports of cereals increase. However, the *NoDeal_H* scenario shows an increase in cereals production and prices because increased animal production due to fewer meat imports from the EU27 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 *NoDeal_H* 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. Given the partial equilibrium nature of the model, these impacts do not take into account any potential impact on production arising from a lower CAP budget following UK withdrawal.

Regarding the consumer side in the UK (Figure 6), consumer prices[9] increase in all product groups, except fruit and vegetables in some scenarios. In the *NoDeal_H* scenario, consumer prices of meat and dairy products increase substantially by about 9% and 12%, respectively. Consumption of cereals, meat and dairy products decreases in all scenarios. Fruit and vegetables consumption decreases in *NoDeal_H* but increases

[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.

in *NoDeal_L* as tariffs are removed. In EU27, consumers generally benefit from a decrease in prices, except cereals and oilseeds. In addition, consumer prices of dairy products increase in the scenario *NoDeal_L* because their exports to the UK increase due to lower tariff rates and increased milk prices.

6.3. Impacts on welfare

We compute the *welfare* impacts as changes in consumer surplus, producer income and changes in government revenue (Table 7). Consumer surplus is calculated as money metric in indirect utility functions. Producer income is defined as gross value added, that is, revenues minus variable costs, plus subsidies. Fixed costs such as machinery costs, depreciation, labour and taxes are not accounted for in CAPRI. Government revenue consists of revenues from import tariffs plus transfers between the UK and EU27 budgets, minus payments to farmers. Quota rents are, in principle, assigned to the entity that has the quota right. As CAPRI does not distinguish quota right authority, importers and exporters are assumed to split any TRQ rents equally.

As explained in section 4, the government revenue effects include the change in the net contribution to the CAP budget as well as changes in agricultural tariff revenue. Because changes in transfers to UK farmers are in principle held constant and do not change, this item should not appear as a change in the government revenue account. However, some rounding errors introduced by the CAPRI solution algorithm are included in Table 7 for completeness. Due to the partial equilibrium nature of the study, changes in agricultural production in the EU resulting from a possible EU CAP budget cut due to the departure of the UK are not reflected in the scenarios, nor do we account for any possible reduction in the GDP of the UK as a result of Brexit. The results are summarised in Table 7. The level of trade barriers assumed in the future trade relationship scenarios explains the extent of impacts on consumers and producers. The scenario *EEA+* shows the smallest, and the *NoDeal_H* the largest impacts. 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, compared to the baseline. In the *NoDeal_H* scenario, the consumer surplus loss in the UK amounts to −€8.8 billion (−€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.

Once we consider changes in taxpayer welfare (based on changes in government revenue including the UK's net contribution to the EU CAP budget), the final welfare levels change. The UK taxpayer gains in all scenarios from the elimination of its net CAP budget contribution. In three of the four scenarios, however, there is a reduction in tariff revenues, either because imports have been displaced by domestic production or, in the *NoDeal_L* scenario, because tariff rates levied on third country imports have been reduced. Only in the *NoDeal_H* where and in addition the UK levies high tariffs on imports from the EU is there an increase in tariff revenues.

Two of the scenarios, *EEA+* and *FTA*, show net overall welfare gains for the UK and the two No Deal scenarios show net welfare losses. However, in the *EEA+* scenario, account must be taken of the fact that, as in the case of the EEA countries and Switzerland, the UK would be asked to make a contribution to promoting cohesion

Table 7
Welfare impacts in the agri-food sector in 2030 (current prices) in future trade relationship scenarios

			UK				EU27x½			
Welfare items		Unit	*EEA+*	*FTA*	*NoDeal_H*	*NoDeal_L*	*EEA+*	*FTA*	*NoDeal_H*	*NoDeal_L*
Consumer surplus change		€m	−856	−1,974	−8,802	−1,750	+315	+776	+3,266	+2,372
		€/capita	−12	−28	−125	−25	+1	+2	+7	+5
Producer income change		€m	+115	+363	+2,923	+411	−372	−884	−3,874	−2,841
		%	+0.7	+2.2	+17.4	+2.4	−0.2	−0.6	−2.5	−1.8
Consumer surplus + producer income change		€m	−741	−1,611	−5,879	−1,339	−57	−108	−608	−469
TRQ rent change		€m	+1	+1	+25	+206	+1	+3	+54	+76
Taxpayer revenue change	Change in farm payments	€m	+1	+1	−1	+2	−2	−3	−15	-11
	Change in net tariff revenue	€m	−200	−97	+3,053	−973	−48	−63	5	2
	UK net contribution	€m	+1,861	+1,861	+1,861	+1,861	−1,861	−1,861	−1,861	-1,861
	Single market contribution	€m	$-X$				$+X$			
	Total taxpayer revenue change	€m	662	1765	4913	890	−911	−1927	−1871	−1870
Total welfare change		€m	$922 - X$	155	−941	−243	$-1{,}047 + X$	−2032	−2425	−2263

Notes: The UK net contribution figure is derived in Table 4. In principle farm payments are held constant in all scenarios but small rounding errors introduced in the computations are included for completeness. The figure for the UK's possible single market contribution in the *EEA+* scenario is represented by an '*X*' as the amount that might be involved is not known.
Sources: Own calculations.

within the single market. What the single market contribution might be in the *EEA+* scenario is unknown. Without this contribution, there is an overall net welfare gain to the UK from Brexit in the agri-food sector of €922 million. This can be treated as a threshold figure; any contribution greater than this amount would result in a net welfare loss, while any figure smaller than this amount would leave a net welfare gain.[10] Thus, only in the *FTA* scenario does the UK have an unambiguous welfare gain in the agri-food sector but of a relatively small magnitude (€155 million). In the No Deal scenarios, the welfare loss from leaving the CAP varies between €240 million and €940 million. However, these UK welfare losses are smaller than the welfare loss for the EU27 (which varies between €1.0 and −€2.4 billion). This welfare calculation refers to the agri-food sector alone and is not an economy-wide result.

7. Discussion and Conclusions

The form of the future trade relationship between the UK and the EU following the end of the transition period in the Withdrawal Agreement as a result of Brexit is expected to cause disturbances in international agri-food trade in various ways. This study analyses the impacts of different scenarios for the future trade relationship not only in the UK but also in the EU27. It also investigates the implications of different choices for future UK tariff policy. 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). All future trade arrangements introduce additional frictions in UK–EU trade. This will result in increases in agricultural prices (mainly meat, dairy products) in 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 1). Additional border controls, delay and certification requirements will inevitably increase trade costs between the UK and the EU27. The extent of NTB costs will depend on how much the UK harmonises food standards and regulations with the EU27 in the long term. In addition, our study helps to clarify the ambiguous effects on the cereal markets found in previous studies where Berkum *et al.* (2016) show increases but Davis *et al.* (2017) decreases in cereal prices. 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 *NoDeal_H*) would require higher feed demand and lead to higher cereal production than the baseline. But low increases of livestock production (Scenario *EEA+*, *FTA*, *NoDeal_L*) demand relatively less feedstuffs and cereal production decreases. According to our results, trade friction could impose stronger impacts on cereal exports and production in the UK than increases in feedstuff demand. In addition, UK's post-Brexit trade policy would be crucial to mitigate those

[10]The contributions currently made by EEA countries and Switzerland for access to the single market can give some guidance as to a possible outcome. As an order of magnitude, extrapolating Norway's per capita contribution through the Norway and EEA grants to the UK population (without adjusting for the substantial differences in per capita income) would yield a budget transfer to the cohesion countries of €2.2 billion. Extrapolating Switzerland's per capita annual contribution would result in a budget transfer of €1.1 billion. The actual level would, of course, be subject to negotiation. However, these figures show that it is not improbable that this option could produce a small net welfare loss for the UK.

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. Davis *et al.* (2017) show large price decreases of 45%, 29%, 12% in beef, sheep, pigs, respectively in a zero import tariff scenario.

Furthermore, this study supplements previous studies with a partial welfare analysis in the agri-food sector. The largest loss occurs to UK's consumers while producers and taxpayers gain.[11] Our study indicates that the level of trade protection chosen by the UK has important welfare implications. In the high trade protection scenario (*NoDeal_H*), despite the substantial gains to taxpayers, consumers bear large welfare losses and overall losses are much greater than gains for the UK. It also throws light on the significance of the UK net contribution to the CAP, which has long been a prominent point in UK political debate. Even taking the retention of this net contribution into account, we find that only in the *FTA* and, potentially, the *EEA+* scenarios, is the retention of the net CAP contribution large enough to lead to an increase of UK's partial net welfare. The reason for the uncertainty in the *EEA+* scenario is because the 'price' the UK would have to pay for continued access to the single market in terms of cohesion transfers to poorer member states is unknown. However, our estimates show that if this price were to exceed €920 million the UK's welfare gain in this scenario would turn negative. In the two No Deal scenarios, the welfare impacts are unambiguously negative (our results are more nuanced than those in Boulanger and Philippidis, 2015a, 2015b who found that when only considering the CAP elements of Brexit all scenarios would be unequivocally beneficial to the UK). In practice, of course, Brexit for the agri-food sector alone is not an option and any positive welfare gain in this sector would have to be weighed up against the welfare impacts of Brexit in other sectors.

Caution should also be used in interpreting the increase of farmers' income in the welfare results given that the UK has announced plans to reform domestic agricultural policy in England by transforming subsidies from area-based income support to payments for environmental and other public goods (Defra, 2020). The future level of agricultural support in England and in the other UK countries remains unknown in March 2020 and thus has not been included in these simulations. Results from Bradley and Hill (2019) and Ojo *et al.* (2020) show that UK farm income is very vulnerable to the reduction or removal of direct payments.

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 net welfare except in the scenario *EEA+*. Moreover, the withdrawal of the UK as a net contributor to the overall EU budget will 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 losses. This may lead to increased food prices and could offset the benefits of Brexit to EU 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 impact

[11]Changes of value added and employment in the food industry are not taken into account in the welfare analysis.

of no-deal on the sterling-euro 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 fertilisers). In addition, labour market disturbances (e.g. restricted mobility of seasonal workers from Eastern Europe to the UK) could impact labour-intensive agricultural sectors, such as horticulture in the UK (Bradley and Hill, 2019). The final determination of TRQs for third countries' preferential access to the UK will also be important. Moreover, CAPRI does not cover food markets such as beverages, alcohol and some processed products such as jam, frozen pizza or 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 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 van Tongeren, 2006).

In conclusion, our study implies that increased market inefficiency arising from trade barriers in the future trade relationship could lead to welfare losses for the UK and the EU27. In particular, the consumer surplus losses in the UK could be substantial (−€125/capita) in the scenario *NoDeal_H*. However, a net welfare gain in the agri-food sector could be achieved in the UK due to financial gains in producer income and from ending the EU CAP contribution in the scenarios *FTA* and *EEA+*. For the EU27, net market impacts are small, but loss of the CAP contribution from the UK can lead to a partial net welfare loss. For the UK, a no-deal scenario (*NoDeal_H*) would entail strong negative market impacts for consumers. It remains to be seen how the 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. Our partial welfare results should be interpreted considering the limits of CAPRI with respect to the commodity coverage and its partial representation of an agricultural economy.

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