Impact of hard Brexit on European fisheries

Scenario analysis using the MAGNET model

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Heleen Bartelings, Zuzana Smeets Kristkova
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WAGENINGEN UNIVERSITY & RESEARCH

Table of Contents

1. Introduction

An unprecedented and unexpected outcome of the British referendum on Brexit is one of the most discussed topics in the media nowadays. The economic consequences are not yet exactly known but most of the existing studies agree on negative impacts for the UK. According to Paul Krugman, Brexit could cost UK about 2% GDP. Recently, warnings appear that not only UK, but also the EU member states will be negatively affected. For instance the Guardian (19.1.2018) alerts that "*Europe must wake up to the drastic consequences of a hard Brexit"*. A study done by the Dutch economic institute CPB claims that "*a hard Brexit could make every Dutch person poorer by an average of €1,000*".

Most of the existing studies concentrate on the general impact of Brexit on the economy. However, some particular industries such as fisheries and agriculture may be affected by Brexit significantly more than the rest of the economy. As for the agri-food sector, it is well known that despite the efforts of the GATT rounds in the past 60 years, large part of trade in agricultural commodities remains protected by high tariffs. Leaving the EU, for Britain, thus (in theory) means leaving the common market and adapting these high agricultural tariffs (and the same for the EU). Although the "hard Brexit" option does not seem very likely at this moment, it is still open for discussion and remains a sensitive issue not only for the EU-UK but also for the third WTO parties who feel rightly offended in case a preferential regime is adopted for the trade between UK and EU.

The focus of our analysis is however the fisheries sector. The political importance of fisheries in the Brexit context is already advocated by the study of New Economics Foundation (2016). This is because leaving the Economic Union also suggests closing marine borders around the UK. This may effect several EU countries, which fish frequently in UK waters. For instance, around 40% of all Belgian and Dutch landings come from the UK. In turn, the importance of the EU waters for the landings of wild fish in the UK is much more limited. Therefore, there seems to be an opportunity for the UK to cash in on if closing marine borders becomes part of the hard Brexit conditions. On the other hand, the tight trade relations between UK and the EU, particularly in the connecting fish processing industry make UK vulnerable to trade protectionism. The available study on the impact of Brexit on the fisheries sector (New Economics Foundation, 2016) poses a relevant question "whether the Brexit really is a sea of opportunity for UK or rather a sea of risk".

In our study, we are going to respond to this question by looking at the impact of hard Brexit on UK and EU fisheries sector in the context of the whole economy, which entails not only wild fisheries, but also aquaculture, fish processing, and the other sectors of the economy. Moreover, we also take into account the tight trade relations between the EU countries which turns out to be very relevant for the consumer markets, where at present, various international fish sources are used to produce the final fish product consumed by households.

The methodology used in this study employs a CGE model MAGNET, which is particularly suitable to analyze the impact of Brexit. The most attractive features of MAGNET in this respect are that it is a global model that traces bilateral international trade flows and enables to carry out simulations concerning protectionism measures such as import tariffs or NTMs. Second, MAGNET has been recently extended to model detailed fish markets, with explicit distinction between wild fish sector, aquaculture and fish processing. On the endowment side, next to the standard labour, capital and other inputs, fish stock natural resources are newly modelled in MAGNET. This enables to carry out simulations concerning fish access. Third, MAGNET is a dynamic model which provides baseline projections into the future. With MAGNET, we bring in the Brexit simulation into the already changing world and capture all important interactions in the economy – e.g. in the factor markets, interconnection of wild fish sector to other industries and the international trade linkages.

Finally, it is important to note that the results of this study should be understood as supportive evidence for the ongoing negotiations. By the hard Brexit simulation, we can highlight the feasibility of the measures

and their potential impact if they are put in force. It may be argued that closing marine borders as we simulate in our exercise overwrites the history given that before the UK accessed the EU, no such a strict marine closure existed. However it is important to understand that if this happened at present, what are the consequences of such a strict measure.

2. Description of scenarios

In this section, we present the overview of the scenarios that aim to quantify the impact of UK leaving EU on the competitiveness of the EU fisheries sector and the economy. We focus on capturing three main channels of how Brexit can affect the economy: i) access to fish landings, ii) internal EU-UK tariffs and iii) non tarrif measures (NTM) and trade facilitation costs (TFC). In order to understand the impacts of all these channels, we introduce them step-by-step. This enables to isolate the effect of each and to assess which of the three channels prevail in their impact. The detailed description of the scenarios and modelling assumptions is given below.

2.1 Brexit_TFC scenario

Immediately after leaving the European Union, Great Britain will have to comply with the administrative matters valid for other non-EU countries, which include proof of origin, export licences etc. Details about concrete TFC measures can be found for instance in the KPMG study (2018) and a recent study prepared by Berkum et al. (2017). Therefore, the first Brexit scenario simulates increased trade facilitation costs (TFC). A TFC mark-up of 8% is chosen as the upper limit of the average transaction costs, as mentioned in Donner Abreau (2013, cit. in Berkum et al, 2017). We apply this 8 % trade costs increase homogenously across all trade in goods. Regarding trade in services, this additional administrative burden can be omitted due to higher share of electronic transactions when crossing the border. This is also in line with Yu et al. (2017) who do not report Rules of origin costs for services sectors.

2.2 Brexit fish (access) scenario

The second channel that we consider is the change in fish access where we take the most restrictive alternative, that is, we simulate an exclusive access to the North Sea territory around British waters solely by the UK (and vice-versa loss of access of UK boats to the EU fishing zone). For the UK, this would mean an increase of access to landings of about 60% and for certain EU member states a decrease of about 40%. The procedure we used to quantify the shocks of fish access for UK and EU countries is described below.

Calculating shocks to fish species

We make use of NAFC Marine Center report (Napier, 2016) that provides quantities and shares of fish landings acquired in British waters by 8 key EU-member states where fish landings from UK represent about 60% of all landings (see Appendix 1). The information is provided per species type which is very useful for our analysis. Table 1 shows the proportions of landings in quantity of landed fish as a percentage of countries' landings.

Table 1: Share of countries' landings from UK-EEZ by EU boats

	DEM	PELA	TOTAL	OTHER
	LANDINGS FROM UK BY EU BOATS (T)			
BEL	46%	27%	45%	40%
DEU	5%	47%	31%	15%
DNK	4%	67%	34%	0%
ESP	2%	0%	1%	2%
FRA	31%	13%	17%	5%
IRL	21%	46%	35%	29%
NLD	23%	45%	39%	50%
SWE	0%	19%	15%	2%

Source: NAFC Marine Center Report (2016)

Note: there is some discrepancy in the reported values. The total landings per country are in line with our data obtained from the FAOSTAT but the split between pelagic and demersal doesn't correspond. We keep the shares as provided from the report but the corresponding landing quantities then slightly differ in the report to those calculated based on the shares from our dataset.

The report also provides information on the landings of UK boats that proceed from EU territory. Expressed as a share of total landings by UK boats, the UK boats landed about 18% of fish from the EU Economic zone. It is apparent that UK waters are much more important to EU fisherman than the EU waters to the UK boats.

Table 2: Share of landings in EU-EEZ by UK boats

	DEM	PELA	TOTAL	OTHER
	LANDINGS IN TONS			
NORTH SEA	13,000	0	15,000	2,000
WEST SCOTLAND	1,000	19,000	22,000	2,000
SOUTH&WEST UK	10,000	34,000	50,000	6,000
TOTAL	**24,000**	**53,000**	**87,000**	**10,000**
	LANDINGS AS A % OF TOTAL UK LANDINGS			
NORTH SEA	14%	0%	5%	5%
WEST SCOTLAND	6%	17%	14%	7%
SOUTH&WEST UK	37%	69%	39%	11%
TOTAL	**18%**	**16%**	**15%**	**8%**

Source: NAFC Marine Center Report (2016)

The reduction of landings in the respective EU countries is then translated into the MAGNET shocks. For countries that are included individually in the MAGNET database, we shock (reduce) fish landings directly by the percentage given in Table 1. Given that Germany, Sweden and Denmark are included under the Western and Northern Europe groupings, we calculate corresponding percentage change reduction for the whole group. Furthermore, the reduction of landings by UK boats in the EEZ are proportionally distributed over the key EU member countries that fish in UK waters. Finally, we calculate the shocks for UK by adding the landings of EU countries that will be prohibited by Brexit and reducing the UK landings in EEZ by Brexit.

As pelagic fish are high migratory, the expected increase of fish stocks of 134% is not realistic as the fish will moves freely across the border. The study of the New Economics Foundation estimates that closing the marine border would lead to an overcrowding of pelagic fish by about 40% in the UK. We use this assumption in our scenario as well and we limit the increase of the pelagic fish stocks in UK by 40% as well.

The final shocks entering MAGNET are provided in Table 3. There will be a considerable increase of fish landings for UK boats due to the reduced competition of the EU countries (70% more resources). By limiting the shocks to pelagic fish, access to demersal fish is affected more. The EU countries that are mostly hit by the reduced fish access are Belgium, Ireland and the Netherlands.

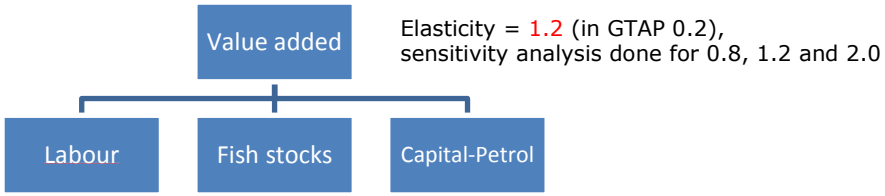
Table 3: Final reductions of fish landings in Brexit scenario

	TOTAL	DEMERSAL	PELAGIC	OTHER
BEL	-43%	-44%	-7%	-37%
DEU	-30%	-3%	-13%	-13%
DNK	-10%	-2%	-19%	2%
ESP	1%	0%	1%	0%
FRA	-15%	-29%	-3%	-2%

IRL	-33%	-19%	-13%	-27%
NLD	-38%	-21%	-13%	-48%
SWE	-14%	2%	-5%	0%
GBR	70%	58%	41%	21%
WEUROPE	-3%	0%	-2%	-1%
NEUROPE	-3%	0%	-5%	0%

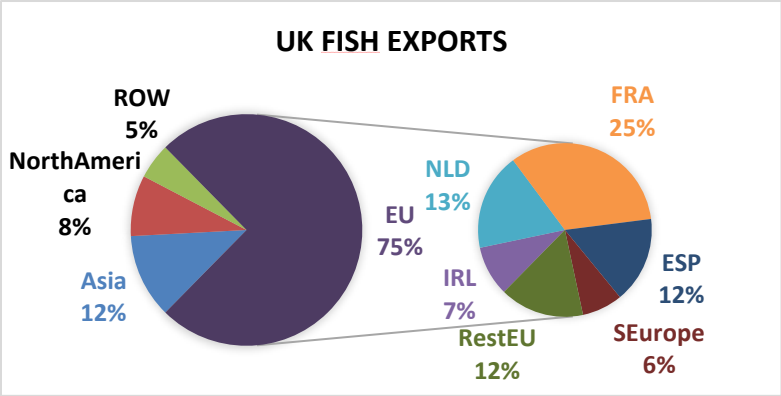
It is important to explain how these fish access shocks are transmitted into the final production of fish. Figure 1 shows, that value added in the fish sector is created by employing a set of inputs, such as labour, capital, petrol and fish stocks. By allowing a larger substitution between fish stocks and the rest of inputs, the radical decline of fish stocks can be compensated by an increased effort (use of other inputs). If the substitution would be less than one (as is in the standard GTAP model), a decline of fish stocks would result in a decline of fishing (factors are complements). In reality, we do not expect that fish production would contract totally, but rather that it would cost more resources to reach the fish. Substitution elasticity is therefore an important instrument to avoid a drastic impact on fish sector and induced price spikes. To reflect this, we employ a sensitivity analysis on the substitution possibility between natural resources and fishing effort such as fuel, labour and capital. We opt for a "middle of the road" version that we use in all scenarios but we also present the bounds for the fisheries sector with the different elasticity values.

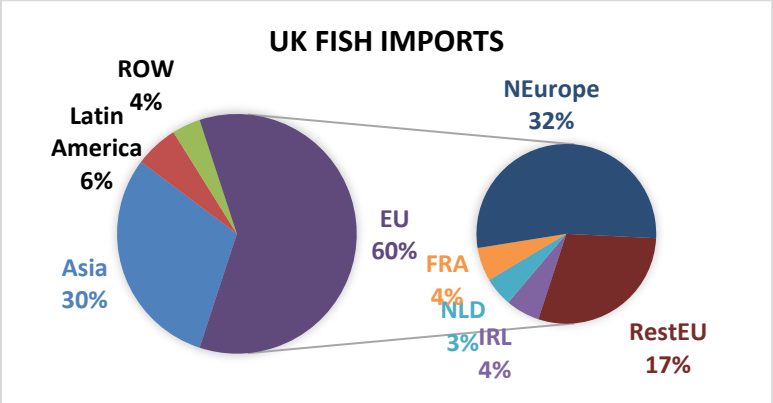
Figure 1: Production structure in the fisheries sector



Another important consideration to take into account is the role of trade in fish. Although an increased access of fish stocks clearly favours UK over the EU, there is a large dependence of EU as a major trading partner for the UK. Figure 2 shows that the proportion of fish traded with the EU is fundamental, where about 75% of exports of UK fish go to EU and about 60% imports come from EU. At the same time, for the whole EU, exports and imports from UK represent only 7% of the total. It will be therefore interesting to see which of the two aspects – fish access vs fish trade will dominate the final Brexit impact.

Figure 2: Share of EU in UK's fish exports and imports





2.3 Brexit NTM scenario

When simulating a hard Brexit, it is relevant to consider the imposition of non-tariff trade measures (NTMs). NTMs raise costs associated with regulatory differences across countries such as labelling requirements, health standards, control procedures, etc. The NTMs are probably the most significant economic measures of hard Brexit, because they affect trade in all sectors of the economy with potentially quite damaging impact. There are various studies that model the impact of NTMs, such as Egger et al. (2015), Yu et al. (2017), Francois et al. (2013) or Rojas-Romagosa (2016). Based on these sources, we introduce sector-specific NTM trade costs, where food processing has the highest trade increase (40%), followed by primary agriculture, chemical and petrochemical sector (20%). The lowest burden is registered for primary energy, services and utilities (5% – 10%).

SECTOR	NTM	NTM + TFC
AGRICULTURE, FISHERIES AND AQUACULTURE	20	28
FOOD PROCESSING	40	48
FORESTRY, COAL, GAS	5	13
CHEMICAL AND PETROCHEMICAL	20	28
OTHER INDUSTRY	10	18
SERVICES	10	10

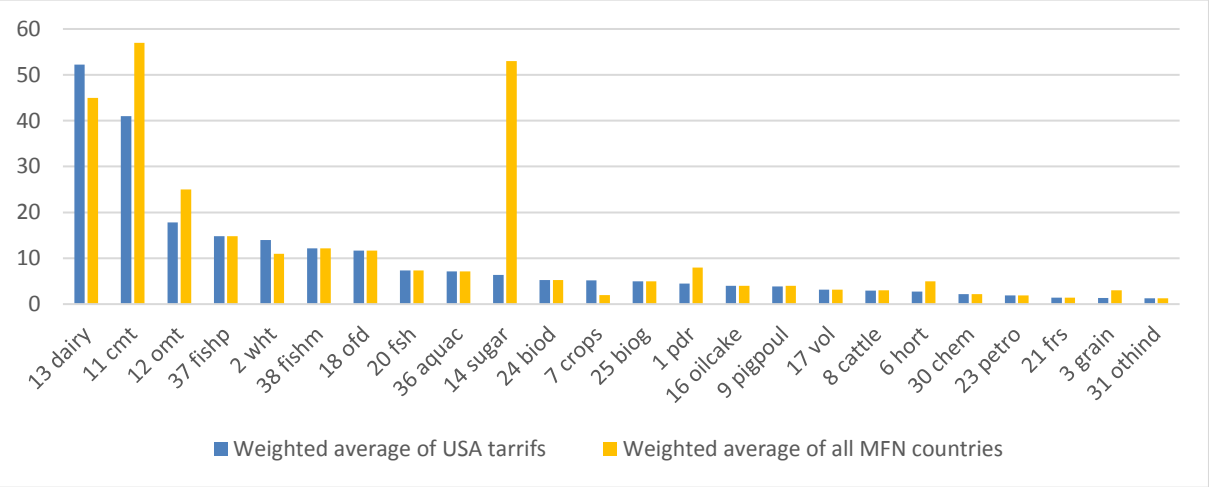
Note: The values represent expected trade costs increase

We also considered a sub-scenario in which we imposed additional NTMs for the imports of fish from the Netherlands to the UK due to the aversion against pulse fishing. However, this scenario provided no additional impact and therefore we removed it from the analysis.

2.4 Brexit TMS scenario

The last channel that we bring into our simulation is the possibility of a no trade deal between EU and UK which results in a WTO regime for both countries. Although EU is a custom union, in the MAGNET database, the import tariffs applied by each member state on the imports from NAM are not identical, due to the commodity aggregation (there are 41 aggregated commodities in MAGNET and the import tariffs are thus trade-weighted averages of individual tariffs). For our Brexit scenario, it is more transparent that we apply a common tariff table for all EU countries. We can apply a trade-weighted average of import tariffs that are imposed on the trade between the EU countries and North America. In the study by Yu et al. (2017), the authors weight the individual tarrif lines by the corresponding value of EU's import from all its MFN partners, providing a more precise WTO tariff aggregation. Figure 3 shows the comparison USA tariffs and weighted average of all MFN countries tariffs. In both cases, the highest tariffs are applied on the agri-food commodities, including the fishery products, whereas trade in manufacturing goods is mostly free of tariffs. It is apparent though that for some commodities such as sugar, using USA tariffs as a reference could lead to a bias where in fact the WTO regime is much stricter. For this reason, for the agri-food commodities, we borrow from Yu et al.(2017) to align to the MNF tariffs.

Figure 3: Weighted import tariff in Brexit scenario (weighted average of MFN tarriffs applied by EU)



Source: own calculation and Yu et al. (2017)

Finally, the overview of all scenarios is presented in Table 4.

Table 4: Overview of Brexit scenarios

Scenario name	Description	Assumptions
Baseline	Baseline	SSP 2, tech change in aquaculture, oil price shock, no (eq. to soft) Brexit
Hard Brexit components	Brexit_TFC	TFC applied on trade in goods (excl. serv & util) between EU-UK, set on 8%
	Brexit_fish	Brexit_TFC + Loss of fishing access to UK part of EU-EEZ and vice versa
	Brexit_NTM	Brexit_fish + NTM measures on imports of all goods and services between UK-EU (compilation of sources)
	Brexit_NTM_WTO	Brexit_NTM + WTO Import tariffs for UK-EU trade set on MFN rates (from Yu et al. 2017)

3. Results

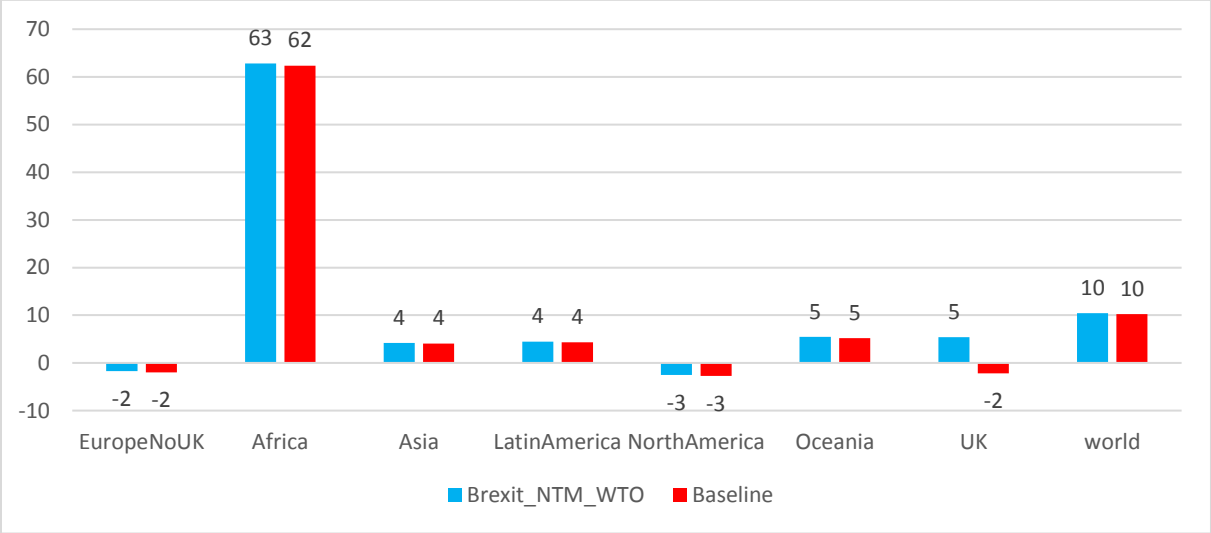
Since this study is focused on the competitiveness of the EU fisheries sector, we will first focus on analysing the impacts of Brexit on the production, consumption and trade of fish commodities. We will then look at the impact of Brexit on the other sectors of the economy. Finally, we will quantify the macroeconomic effects looking at GDP and welfare.

3.1 Impact on the fisheries sector

3.1.1 Fish production and producer prices

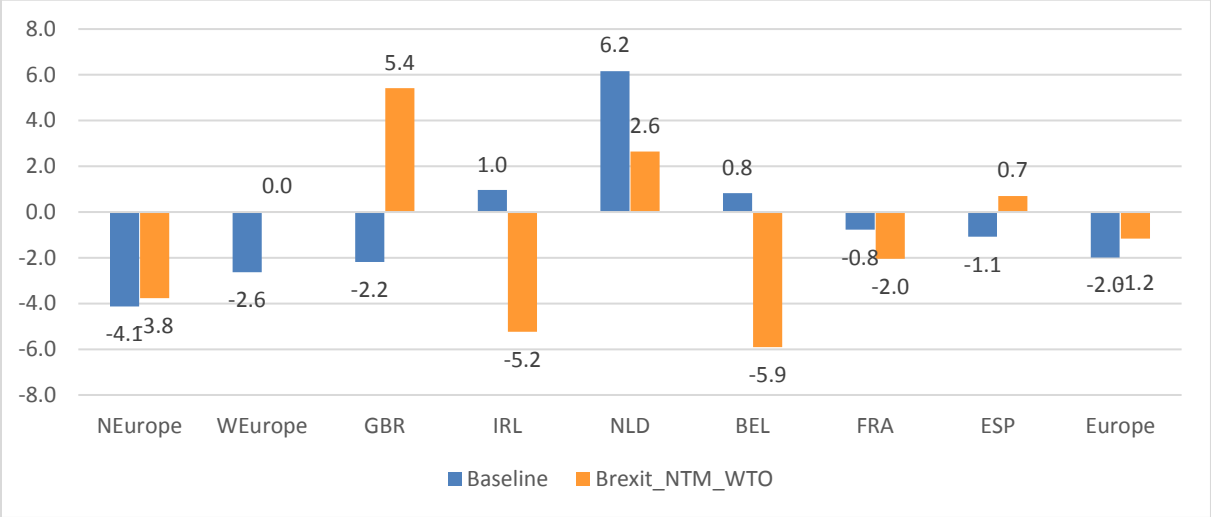
At first, the impact on the global fish production is analysed. Figure 4 displays the percentage growth of fish production (capture) in baseline and the Brexit_NTM_WTO scenario, which includes all considered channels of Brexit impact. Given that the Brexit scenarios affect mostly the EU-UK relations, it is no surprise that **the world-wide impact of Brexit on fish production is negligible**. World production of fish is expected to grow by 10% compared to 2015 and the growth will be mainly driven by Africa, due to dynamic population and economic growth. Concerning the EU, the Brexit will have a negative impact on the EU countries, whereas the UK would see a benefit in increased fish production.

Figure 4: Growth of fish production (capture) between 2015 - 2030



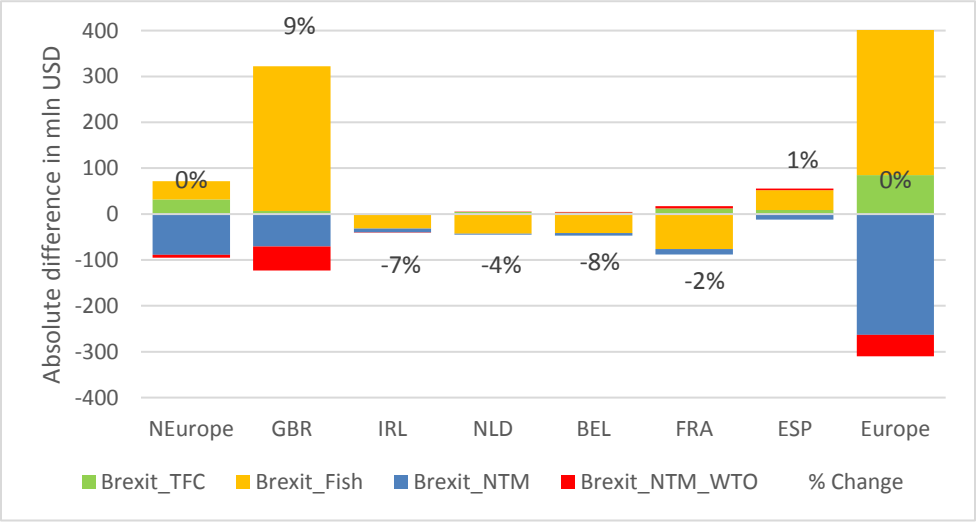
Given the little impact of Brexit on the global level, it is most interesting to concentrate now on the individual EU countries. Figure 5 zooms into the key EU countries that will be most heavily affected by Brexit. The impacts are analysed on the immediate horizon, after the policies are implemented (2020-2025). It is apparent, that Great Britain gains importantly from Brexit, as the **fish production would revert the trend from decline to an increase**. The advantage slightly fades over time but still, at the end of 2030, fish production would be 5% higher than in 2015, compared to a 2% decline in the baseline. On the other hand, **Ireland would be hit the most**, where fish production would go down by more than 5% instead of growing by 1%. Similarly in Belgium, a moderate growth of fish production would turn out to a decline of almost 6%. The other hit EU country would be the Netherlands, where the fish production would grow by 3% instead of 6% . Smaller impact is recorded for France and a little advantage is noted in North Europe, that takes over the trade in EU markets, as seen in the following charts. A region that clearly gains is Spain where the growth of wild fish production goes to positive numbers. On the European level in total, the impacts are negligible and we can see that the fish production is expected to slightly decline by 2030 with, or without Brexit.

Figure 5: Growth of wild fish production (% change 2020 -2030)



When decomposing the impact of different channels of Brexit (Figure 6), it is apparent that the **access issue dominates the results**, whereas the additional trade measures affect the fish production rather moderately. Looking at Great Britain, **the enforced border would lead to an increase of fish production by about 15%** compared to baseline. However, the advantage would be notably weakened in the presence of **import NTMs and tariffs that could reduce the gain** by about one third, due to a **high importance of EU markets as export territory for the UK**. As for the EU countries, the fish production would contract in range of 2% for France to 8% to Belgium, driven predominantly by fish access. The import tariffs play a minor role, as the UK is not such an important export territory, except for North Europe and Ireland (about 10% share of fish exports to the UK). An interesting situation occurs in North Europe, which benefits from the closure of marine borders as one of the few EU countries (next to Spain). However, with the additional NTM burden between UK and EU, the wild fish production declines as well, compared to the baseline. Looking at the cumulated impact on Europe, the impact of Brexit on wild fish sector depends on the measures that would be agreed. Gains of 400 mln USD could be expected if UK gains back its fishing territories and there are no trade protectionism measures. However, under NTMs and MFN tariffs, which is the more likely scenario, most of these gains are faded away and there is a zero sum.

Figure 6: The decomposition of impact of Brexit on wild fish production (difference from Baseline)



It is interesting now to turn the attention to the other fisheries sectors, which are aquaculture, processed fish and fish meal, that are lined to wild fish in the supply chain. Figure 7 shows a schematic representation of how the three new sectors have been implemented and how they interact with each other. Both fisheries and aquaculture provide part of raw fish to the processing industry, and the second part is directly consumed by consumers in their final demand. Fish meal is produced as a by-product of fish processing, and is used as feed in aquaculture and cattle sectors, capturing thus the competition between aquaculture and cattle sectors for available feed.

Figure 7: Relations between fish sectors in MAGNET

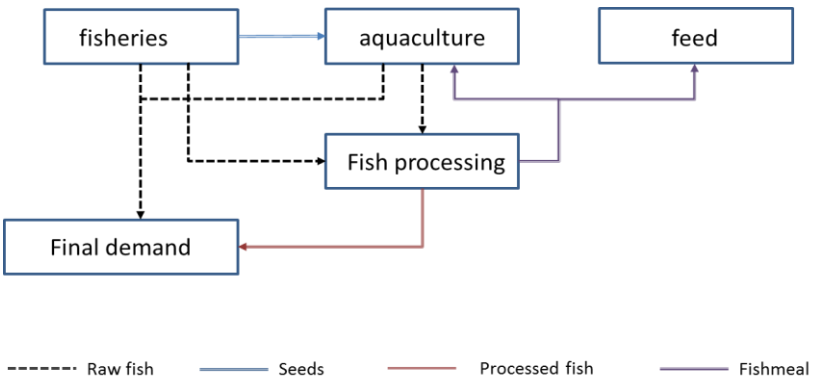


Table 5 shows the fish processing industry and fish meal sectors would be negatively affected by Brexit in the EU countries, driven by the decline of wild capture. Concerning aquaculture, it is the most dynamically developing sector and on the Europe as a whole, it will not be impacted much by Brexit. On the individual EU countries level, aquaculture sectors would gain in countries where there is a negative impact on wild fisheries sector (except for Ireland which depends partly on exports of aquaculture fish to Great Britain). On the other hand, in Great Britain, the gain in wild fisheries would be accompanied by a large negative effect on aquaculture. This is because **Brexit creates a comparative advantage for the wild fish sector** in the UK and aquaculture becomes less competitive on the internal UK market and abroad.

Table 5: Impact of Brexit on production volume (% change from Baseline in 2025, Brexi_NTM_WTO scenario)

	FISHPRODUCTS	FSH	AQUAC	FISHP	FISHM
NEUROPE	-0.1	-0.3	1.0	-0.9	-0.9
GBR	-1.1	9.4	-13.9	-1.9	-1.9
IRL	-8.9	-7.3	-5.6	-15.8	-15.8
NLD	-7.4	-4.3	-0.1	-12.7	-12.7
BEL	-9.6	-8.4	3.9	-16.0	-16.0
FRA	-1.5	-2.3	3.1	-3.1	-3.1
ESP	1.3	1.2	2.2	0.7	0.7
EUROPE	-0.6	0.3	-0.5	-1.8	-1.8

It is also important to look at the producer prices that drive the supply of fish products (Table 6). The increase of wild fish prices in the selected EU countries reflects the scarcity of the natural resources and the resulting increase of production costs. In the UK, in turn, prices of wild fish would go down benefiting from higher fish access. Prices of fish processing follow the same direction, only the impact is more moderate, as it reflects the use of other inputs. For the whole Europe, the impact of Brexit leads to a general increase of prices of fish products in the range of 0.5%.

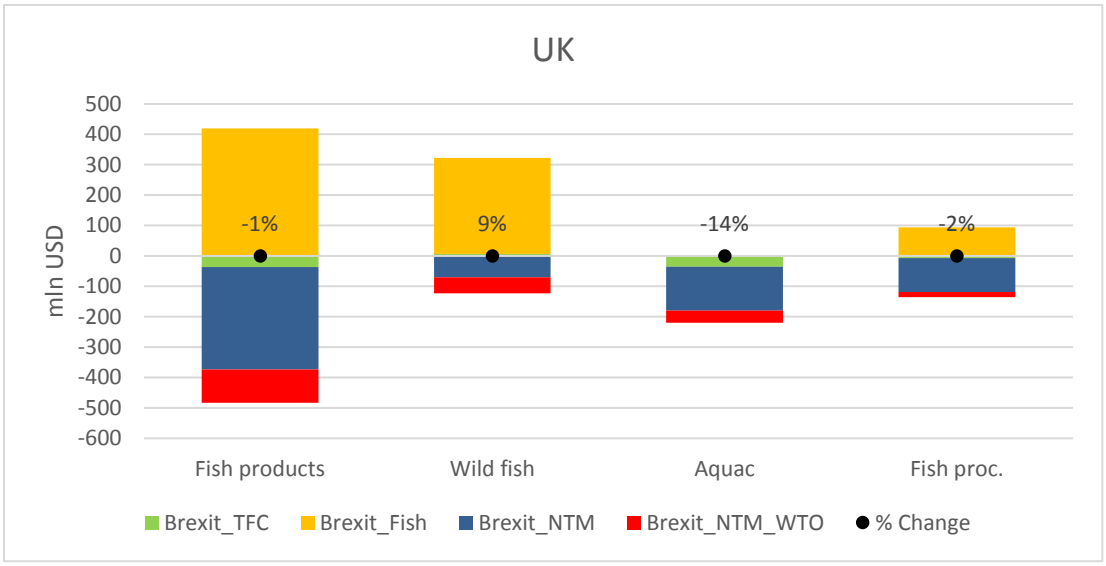
Table 5: Impact of Brexit on the Producer prices of fish products (% change from Baseline in 2025, Brexi_WTO_NTM scenario)

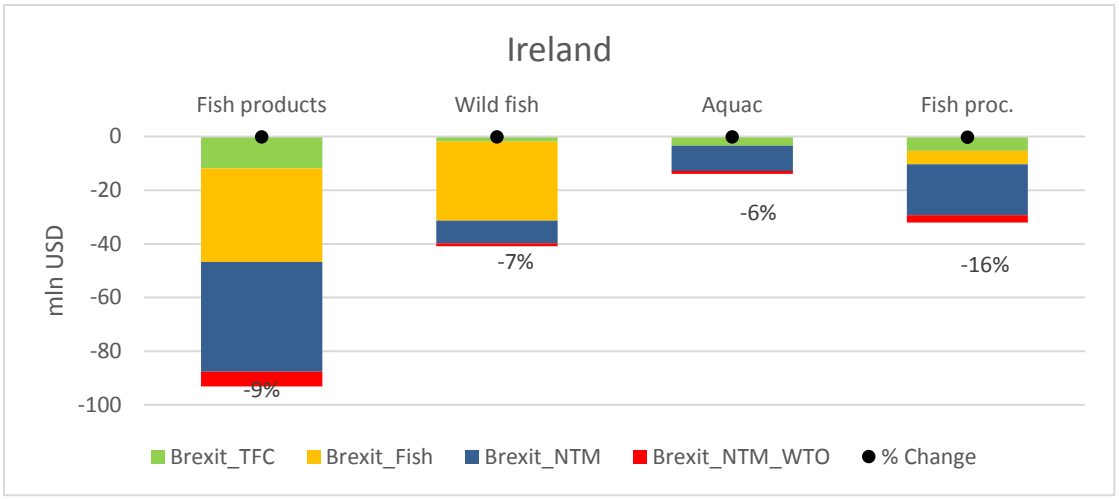
	FISHPRODUCTS	FSH	AQUAC	FISHP	FISHM
NEUROPE	0.3	0.8	0.1	-0.3	2.1
GBR	-3.7	-12.5	3.5	-0.1	4.2
IRL	3.9	4.9	4.2	1.1	8.5
NLD	3.3	3.5	0.7	3.3	4.4
BEL	6.9	7.5	1.3	3.9	2.8
FRA	2.1	3.7	0.6	1.4	2.9
ESP	-0.3	-0.2	-0.5	-0.6	0.4
EUROPE	0.1	-0.1	0.4	0.1	2.0

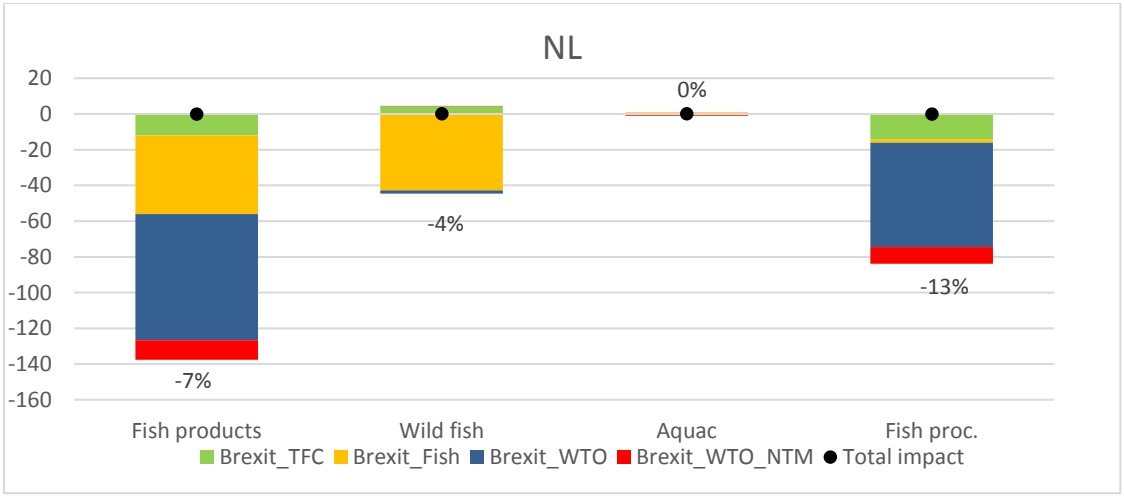
The analysis so far points to four countries, that are hit the most by Brexit, which is the UK, Ireland, Belgium and the Netherlands. We decompose the effect of each Brexit measures on fish markets separately for UK, NL and IRL (Figure 7). Netherlands is interesting not only because of large share of fish landings coming from the UK EEZ but also because it is a very open economy. It is apparent that fish access is the key driving factor for a positive effect of Brexit in UK and negative impact in the other two EU countries, as long as the wild fish market is considered. In the UK, the volume of fish production (aggregated), measured in constant prices, would go up by 420 million USD, from which 350 million would come from wild capture and 90 million from fish processing. However, if import tariffs and NTMs are in place, almost 500 million USD would be lost as a consequence of reduced exports to the EU countries. Particularly for aquaculture, this is the main channel of Brexit impact, pointing on the dependence of EU territories for the export of this commodity (about 85% of aquaculture exports is destined for EU members). EU markets are also equally important for the exports of wild fish, but the drop of fish prices due to increased access would keep the export competitiveness. Overall, the advantage of an increased fish access is completely overweighed by the costs of protectionism resulting in a moderate decline of fish industry in the UK.

Concerning the other two countries, it is apparent that the loss of fish access would harm wild fish production, but the additional NTM and WTO tariffs would cause even more damage, particularly for the fish processing sector due to high import tariffs. This is also because there are not much exports of wild fish between EU and UK - only 3 % of Dutch wild fish exports end up in the Great Britain. Unlike Ireland, there is no impact of Brexit on the aquaculture sector in the Netherlands as the Netherlands does not depend on the UK for aquaculture exports.

Figure 7a-c: Decomposition of impact of Brexit on fish production for UK, Ireland and the Netherlands







3.1.2 Impact on trade in fish products

Table 6 depicts the impact of full Brexit on the volume of exports of fish products in the key EU countries. The exports of wild fish would decline between 10% - 14% for the most affected EU countries including UK. Notable decline of exports would however occur in case of fish processing – up to 60% in the UK. The

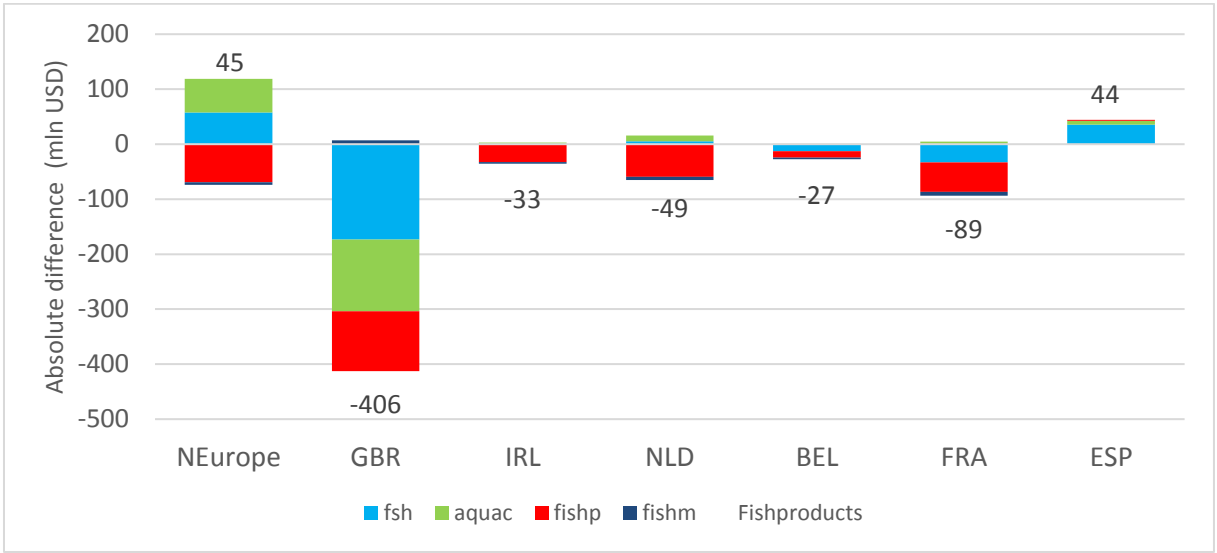
loss of UK exports of aggregated fish products would amount to 30%, which is considerably more than in Belgium or Ireland (12%). These figures show how drastic impact Brexit could have if trade protectionism measures would be in place. For the processed fish sector, the NTM trade costs are expected to increase by 28% in total and in the WTO regime, import prices would further increase by 15% tariff. Thus, the industry would face almost 45% increase in trade costs, resulting thus in a sharp decline of competitiveness. Although the trade measures are symmetric for the EU, the lower dependence of EU on UK market smoothens the total impact on exports.

Table 6: Impact of Brexit on exports of fish products (% Change from Baseline in 2025, Brexit_WTO_NTM scenario)

	FISHPRODUCTS	FSH	AQUAC	FISHP	FISHM
NEUROPE	0.0	0.6	4.4	-3.1	-11.2
WEUROPE	0.4	4.5	9.3	-5.1	-3.1
GBR	-30.6	-13.5	-40.0	-61.0	-55.5
IRL	-12.4	-7.1	-2.6	-23.7	-44.4
NLD	-8.7	-4.3	2.4	-18.1	-22.7
BEL	-12.4	-10.3	10.1	-20.1	-16.3
FRA	-6.1	-5.5	3.5	-10.5	-17.1
ESP	3.1	3.9	6.1	-1.7	-3.2
EUROPE	1.2	2.0	0.1	1.2	-2.3
EUROPENOUK	-8.6	-5.2	-2.4	-12.0	-21.8

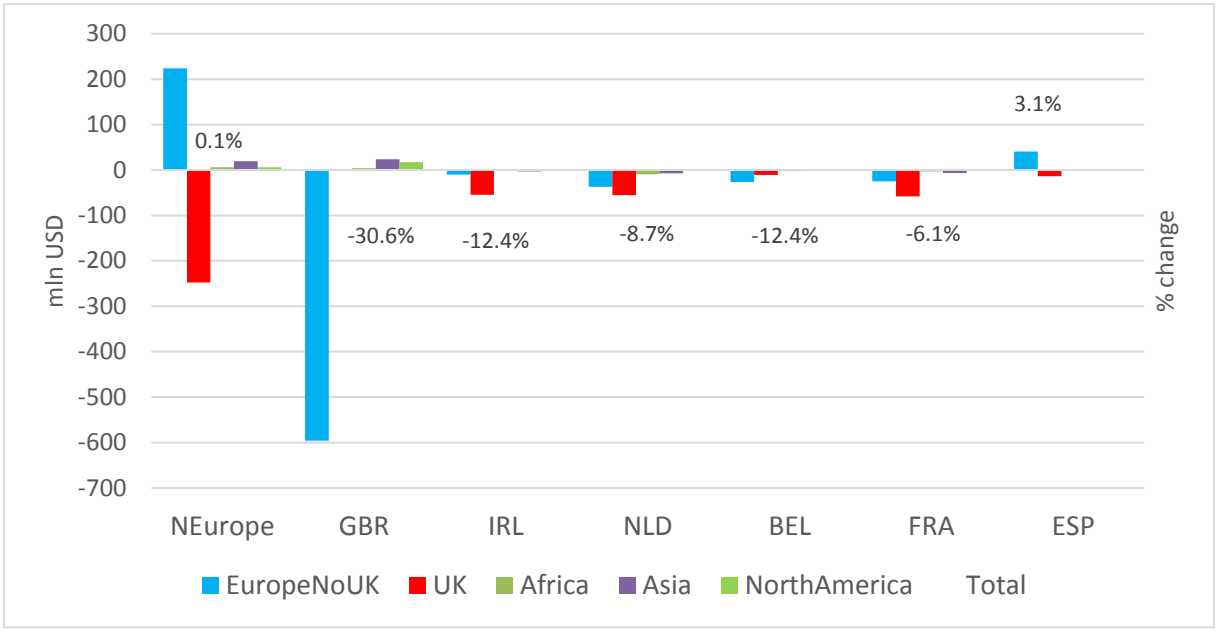
Figure 8 shows the impact of full Brexit on net trade in all fish products. Great Britain's net exports would decline by 400 mln USD in constant prices of 2011. It is interesting to note that exports volume would decline even in the wild fish sector, which benefits from increased access. The reason behind is that in the presence of the high NTMs and tariffs, the consumption of wild fish in the UK would be sourced from domestic production, and exporting less abroad. It is also apparent that North Europe and Spain would gain from Brexit with positive trade balance in fish products. After closing marine border, Spain is one of the few countries that would benefit with increased access to landings, due to reduced competition from UK boats.

Figure 8: Net trade in fish products with world (diff. from Baseline in 2025, Brexi_WTO_NTM scenario)



It is also interesting to see the changes in territorial structure of trade in fish (Figure 9). It is apparent that Great Britain would be forced to find new export markets in Asia and Africa, however, they would not compensate for the loss of the EU markets (at least not in the short term). On the other hand, North Europe and Spain would take over the EU markets and would benefit from this new situation.

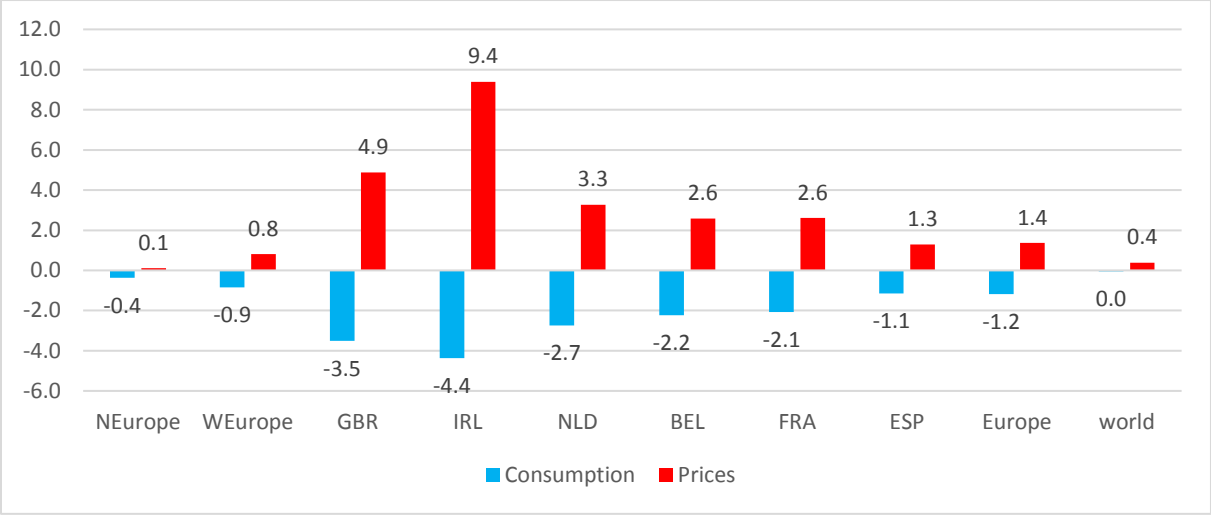
Figure 9: Impact of Brexit on exports of fish products (diff. from Baseline in 2025, Brexit_WTO_NTM)



3.1.3 Impact on consumption of fish

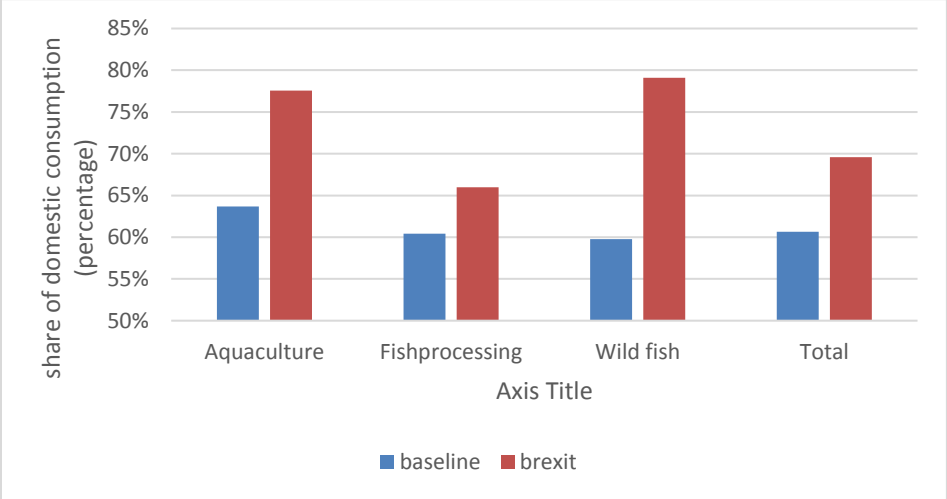
The impact of hard Brexit on the consumption of fish products and consumer prices is shown in Figure 10. It is clear that Brexit would negatively affect consumption of fish products in all selected EU regions including the UK, with drop of consumed quantity in range of 1% - 4%. The most visible impact of Brexit on fish consumption would be expected in Ireland (more than 4% decline), followed by UK. The change in consumption is directly linked to the changes in consumer prices. On the world level, Brexit has no impact on consumed quantity of fish and negligible impact on consumer prices. Within the EU, prices of fish products would grow between 1% - 9%. The strongest increase of fish prices occurs in Ireland, where consumer prices of fish products would grow by more than 9%. The reason for such a high price reaction is the large dependence on trade in the fish processing sector. In Ireland, about 80% of consumption is sourced by imports out of which 70% comes from Europe, leading to a high sensitivity of consumer prices on trade changes. In the Netherlands, there is a high dependency of aquaculture consumption on imports (almost 90% aquaculture products are imported), with 85 % of it coming from Europe.

Figure 10: Impact of Brexit on the volume of consumption and consumer prices (% diff. from Baseline in 2025, Brexit_WTO_NTM)



The source of consumption in Great Britain changes quite a bit as figure 11 shows. Domestic products become far more important for consumption. The domestic consumption share of wild fish for example increase to nearly 80% after the Brexit. In total 70% of fish products consumed in Britain are from domestic sources after the brexit, before the brexit this was about 60%. The source of imports also changes quite a bit. While over 50% of all fish imports came from Europe, after the brexit only 36% of all fish imports come from Europe. After the brexit, Great Britain will start importing far more from Asia and far less from especially Northern Europe.

Figure 11 Impact on source of consumption fishproducts



3.2 Impact of Brexit on other industries

In this section, the impact of Brexit outside of fisheries sector is analysed. Figure 12 shows absolute differences of Brexit impact and Table 7 % change from Baseline. It is noted that the impacts on fisheries sector are very marginal compared to the changes observed in other sectors of the economy such as

services and industry. Interestingly, large gains are observed for the agricultural sector in Great Britain after Brexit. The reason for this is increased protectionism, where the imposed tariffs and NTMs on the agricultural and food commodities increase the competitiveness of the domestic agri-food sector that benefits from this. In Ireland, on the other hand, the agri-food sector contracts by 30%, which is a major decline. It is important to note here that the hard Brexit imposes large tariffs on dairy and meat products which are very export oriented commodities in Ireland (dairy exports and cattle meat exports from 68% to 80% of domestic production resp.). Next to that, the share of exports to UK in total Irish exports ranges for these commodities from 38% for cattle meat to 92% to sugar. As a consequence of hard Brexit, the exports of the key food processing commodities from the UK decline by 80% - basically there is no trade with UK anymore. Such a drastic shock on food processing then also brings down the primary agriculture. With respect to industry and services, the impact is negative in the UK but in some EU countries such as France and Spain, positive impacts are noted.

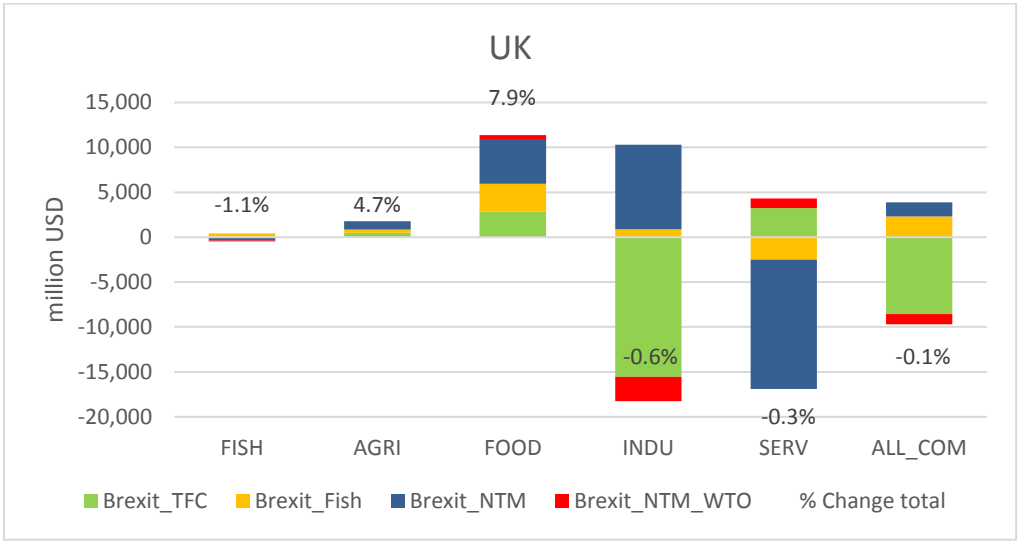
Figure 12: Changes of production volume due to Brexit in 2025 (change from Baseline, Brexit_fish_WTO_NTM)

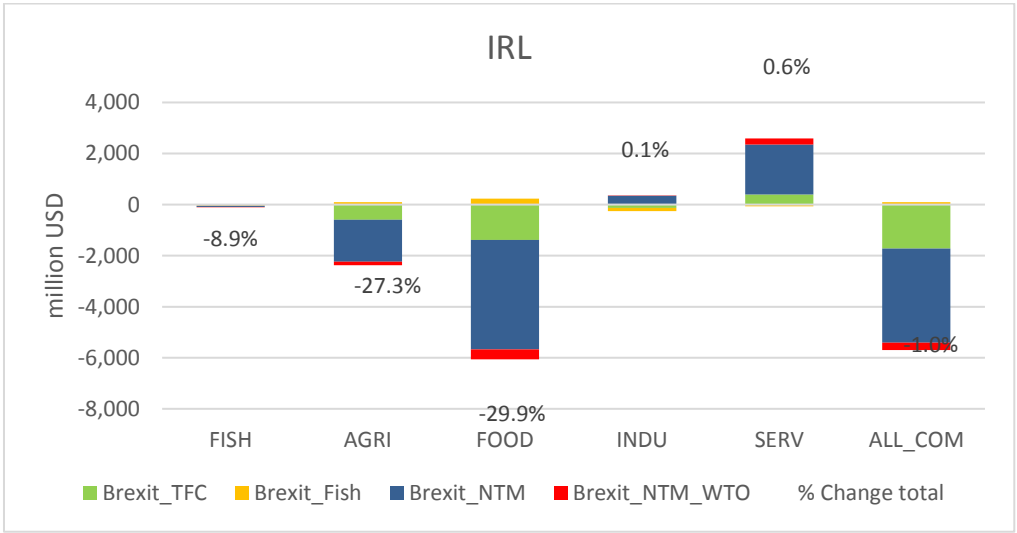
Table 7: Changes of production volume due to Brexit in 2025 (% change from Baseline, Brexit_fish_WTO_NTM)

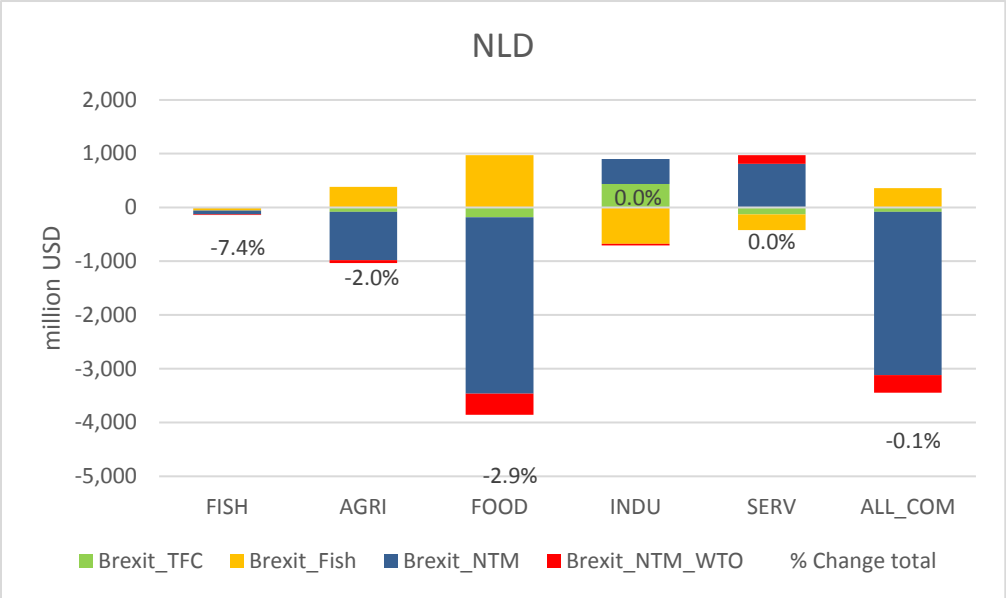
	FISH PRODUCTS	AGRI_PRIM	AGRI_PROC	OTHER_PRIM	INDUSTRY	SERV&UTIL	ALL_COM
NEUROPE	-0.1	-0.9	-1.3	-0.5	0.5	0.0	0.1
GBR	-1.1	4.7	7.9	2.7	-0.6	-0.3	-0.1
IRL	-8.9	-27.3	-29.9	-4.4	0.1	0.6	-1.0
NLD	-7.4	-2.0	-2.9	-0.9	0.0	0.0	-0.2
BEL	-9.6	0.2	-0.9	0.8	-0.3	0.1	-0.1
FRA	-1.5	0.1	-0.5	0.7	0.6	-0.1	0.1
ESP	1.3	0.0	0.3	0.9	0.7	-0.1	0.1
EUROPE	-0.6	-0.2	-0.1	0.3	0.2	-0.1	0.0
EUROPENOUK	-0.5	-0.6	-0.9	-0.2	0.3	0.0	0.0
WORLD	0.1	0.1	0.2	0.2	0.1	-0.1	0.0

It interesting to zoom into the impact of the individual Brexit measures on the key sectors of the economy (Figure 13). It is clear that the TFC and NTM measures are the most dominant drivers of the impact for industry and services. In the UK, the imposition of TFC creates a comparative advantage to services which do not face trade facilitation costs. However, in case additional NTM measures are imposed, the competitive advantage is reversed back to industry. In total, the industrial sector is affected more than services and that drives the overall decline of production volume in Great Britain in Brexit. In Ireland, the NTMs and TFCs are also the key drivers of Brexit impact, across all sectors. The overall decline of production is driven by the agri-food sector, whereas industry and services in fact benefit a bit from Brexit. The Dutch agri-food sector and the rest of the economy, compared to Ireland, is more resilient to Brexit. Interestingly, the impacts of fish access are transmitted positively to the Dutch agri-food sector. The decline of fish production and increased price of fish has a small positive impact on agricultural food demand and thus production. However, the NTM impact is stronger so the agri-food sector declines after Brexit, but the impact is small as is in the rest of the economy.

Figure 13 a-c: Decomposition of Brexit impact on production volume in the economy (difference from Baseline in 2025)



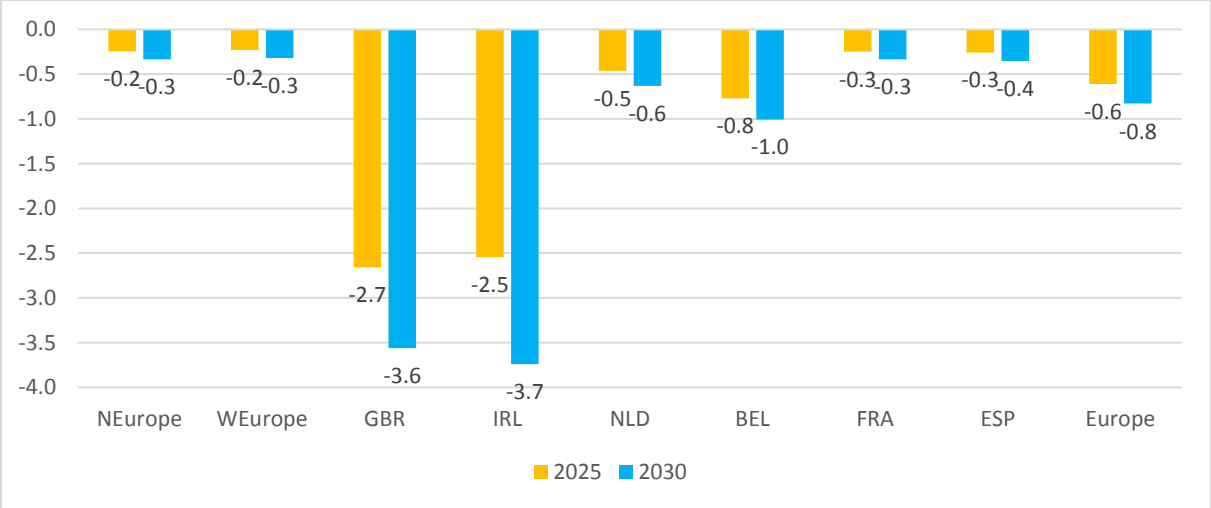




3.3 Macroeconomic impact

Finally, the macroeconomic impact of Brexit scenarios is analysed. Figure 14 plots the percentage difference of GDP in hard Brexit compared to Baseline in 2025 and 2030, showing both immediate effect and longer-term effect. It is apparent that the GDP effects are lasting in time, moreover, the gap between the GDP without and with Brexit becomes wider over time. For instance, in Great Britain, GDP in 2025 declines by almost 3%, and by 2030, it is almost 4% lower than if Britain remains an EU member in the same period. Similar effects are noted for Ireland. The impacts for the Netherlands are interestingly much lower. As already mentioned, t**he Dutch economy is more resilient to Brexit than Ireland.**

Figure 14: Impact of Brexit on GDP (% Difference from baseline, Brexit_fish_WTO_NTM scenario)



Again it is interesting to decompose the impact of the different Brexit measures on GDP volume (Table 8). Given that all scenarios concern EU-UK relations, the impact on world (and non-European regions) is limited. This holds particularly for the fish access scenario, which only simulates changes in the fisheries sector. The major impact on GDP is driven by the NTM measures. For instance, in the UK, the imposition of trade facilitation costs reduce GDP by 1% compared to Baseline and the additional NTM causes it to further decline to 2.6%. Given that import tariffs are charged on trade of mostly agri-food and fisheries products, the impacts on GDP range around - 0.01%, which is negligible, even for Ireland. About 0.6%

loss of GDP could be expected for the whole Europe and in Great Britain and Ireland, these impacts exceed 2%.

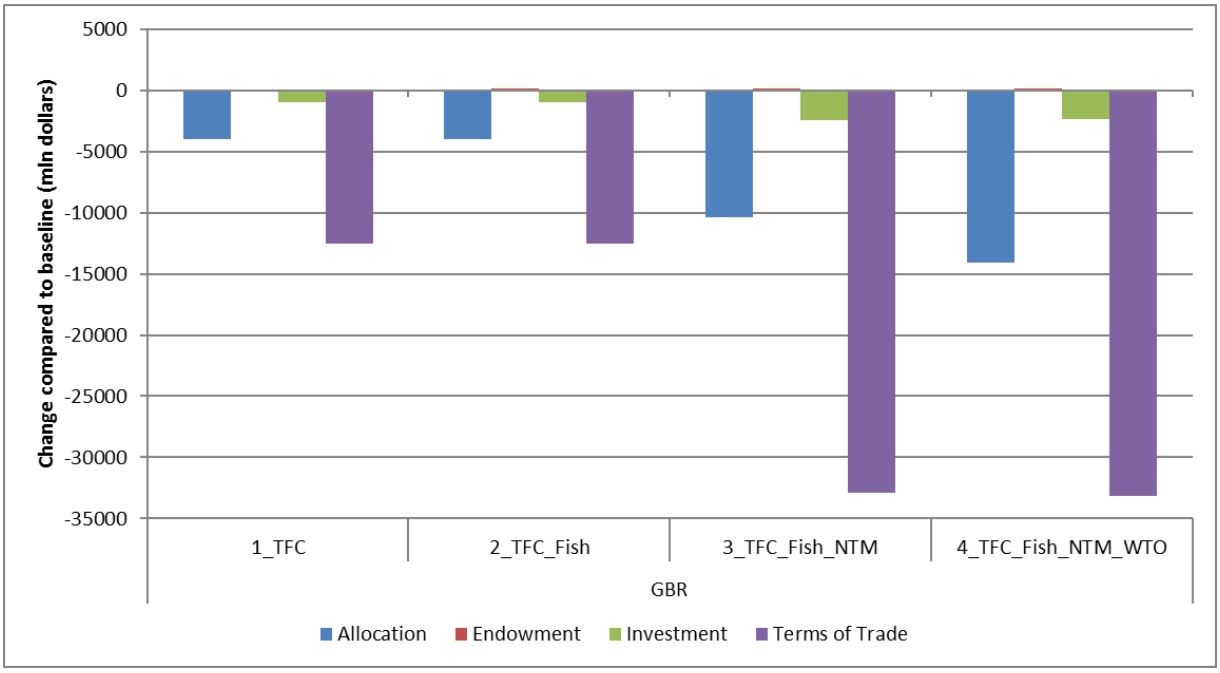
Table 8: Impact of Brexit on GDP volume (% difference from Baseline, 2025)

	BREXIT_TFC	BREXIT_FISH	BREXIT_NTM	BREXIT_NTM_WTO
NEUROPE	-0.1	-0.1	-0.2	-0.2
WEUROPE	-0.1	-0.1	-0.2	-0.2
GBR	-1.0	-1.0	-2.6	-2.7
IRL	-0.7	-0.8	-2.5	-2.5
NLD	-0.1	-0.2	-0.5	-0.5
BEL	-0.3	-0.4	-0.8	-0.8
FRA	-0.1	-0.1	-0.2	-0.3
ESP	-0.1	-0.1	-0.3	-0.3
EUROPE	-0.2	-0.3	-0.6	-0.6
AFRICA	0.01	-0.06	0.02	0.02
ASIA	0.01	-0.14	0.02	0.02
WORLD	-0.04	-0.14	-0.11	-0.11

GDP is often reported in country comparisons as a welfare measure and as indication for compensation payments. Kohli (2004), however, demonstrates that when one country experiences some terms of trade improvements this welfare indicator may be in fact misleading as it underestimates the increase of real domestic income and welfare. Real GDP is unable to capture the beneficial effect for an economy of an improvement in its terms of trade (say an increase in export or decrease of import prices) as it focuses only on production possibilities. As impacts of Brexit are driven by changes in trade and trade barriers, the welfare impacts are better measured by the equivalent variation which is the change in wealth, at current prices, that would have the same effect on consumer welfare as would the change in prices, with income unchanged. We use an adjusted for the MAGNET model version of the welfare decomposition method developed by Huff and Hertel (2001). As both GDP and equivalent variation are used as indicators for compensation we present both variables and use the equivalent variation as a method to decompose the overall welfare effect in their main components.

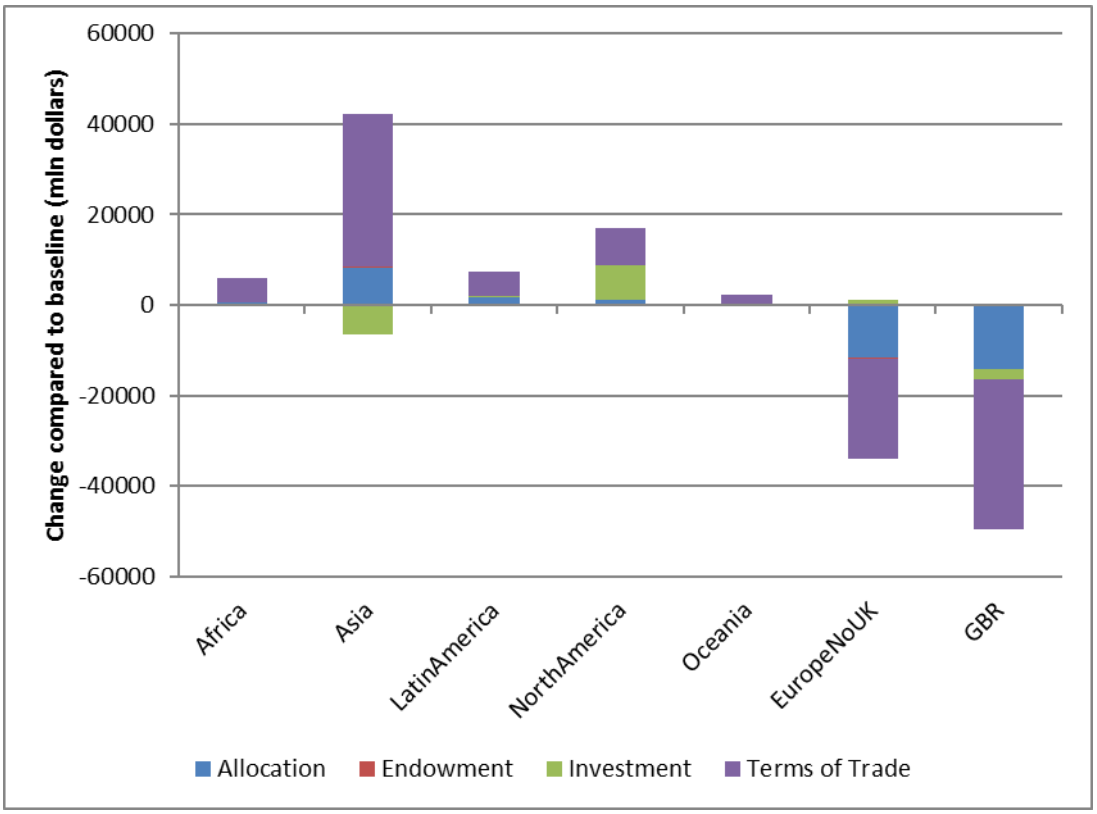
Welfare of Great Britain is negatively impacted as figure 15 shows. The biggest welfare loss is due to worsening terms of trade. Especially the NTM's have a significant negative impact on welfare. The welfare gain from extra fishing stock access in no way comparable with loss due to tariffs and NTM's. The higher tariffs and trade barriers also worsen the welfare due to an allocation impact. This measures how much welfare is lost due to a change in consumption as a reaction to higher prices for goods and services. The NTM's have an higher impact then the tariffs on the overall welfare.

Figure 15: Welfare change Great Britain (absolute difference from baseline in mln dollars



Welfare of Europe is also negatively impacted by the Brexit. Europe welfare will worsen due to deteriorating terms of trade and a negative allocation effect as figure 16 shows. This welfare loss is especially high for western European countries. Other regions in the world will benefit from the Brexit as figure 16 shows. Especially Asia and North America will increase trade with Europe and the UK and therefore benefit on their terms of trade.

Figure 16: Welfare change world (absolute difference from baseline in mln dollars, Brexit_fish_WTO_NTM scenario)



4. Sensitivity analysis

The crucial assumptions that determine the magnitude of impact of Brexit on the fisheries sector is the substitution elasticity between fish stocks and other production factors. For this reason, the sensitivity analysis was performed to test the assumptions. Table 9 shows the impact of Brexit fish scenario on the fisheries sector in the key EU countries (the impacts outside of fisheries are negligible, therefore we omit them from the analysis). This scenario simulates an increased (or reduced) access to fish stocks in the respective countries. The substitution elasticity of 2.0 assumes that fish stocks and the other production factors are substitutes, whereas 0.8 assumes they are complements. The elasticity of 1.2 allows a moderate level of substitution. As Table 9 shows, these assumptions are very important for the magnitude of reaction both for production volume and prices, but they do not change the direction. For instance, if we believe that under higher abundance of fish, fisherman can reduce their effort in the UK and vice versa, with a reduced access to UK fishing zones, the fishermen in the EU can increase their effort, the impacts on production volume and prices are more moderate. On the other hand, if we believe that an increased access to fish will lead to even higher effort to catch the fish and parallel, in the EU countries, a reduced acces to fish will also require less effort, the impacts are more dramatic. In the UK, this could mean an increase of production volume by up to 16.5% and a reduction of prices by 9.5%. In value terms, UK fisherman would gain in all cases, but if the factors behave as complements, gains are quite higher than if they are substitutes (1.9% increase of value vs 5.4%). These assumptions are then key for the reaction on the labour markets where they not only influence the magnitude, but also the direction of the fish access impact of Brexit. In case of high substitution, labour costs could be saved by 11% in the wild fish sector in the UK, but for instance in the Netherlands, this would on the other hand require almost 10% increase of labour input, to compensate for the decline of fish stocks. Under the assumption of complementarity, labour costs may go up in the UK by 2% and decline by the same rate in the Netherlands.

For our analysis, we opted for the medium value of 1.2, where assume that with an increased access to fish stocks, the fisherman are able, to a certain extent, reduce their effort and save the total fishing costs.

Table 9: Sensitivity analysis of Brexit_fish scenario in wild fish sector (% Change in 2020-2025)

	Elasticity = 2	Elasticity = 1.2	Elasticity = 0.8
Production volume			
GBR	9.6	13.3	16.5
IRL	-5.4	-7.2	-8.8
NLD	-0.9	-2.9	-4.7
Price production (market prices)			
GBR	-7.1	-8.1	-9.5
IRL	4.0	4.5	5.7
NLD	3.5	1.1	2.6
Production value, market prices			
GBR	1.9	4.1	5.4
IRL	-1.6	-3.0	-3.5
NLD	2.6	-1.8	-2.2
Labour costs			
GBR	-11.3	-4.4	2.1
IRL	6.0	-0.4	-3.2
NLD	9.4	0.5	-2.1

5. Conclusion

This study analysed the impact of hard Brexit on the fisheries sector and the rest of the economy. Regarding fisheries, if UK would completely close its marine areas, Ireland, the Netherlands and Belgium would be affected the most. The reduction of fish access for these countries, and in turn, an increase of fish access in UK, would cause an important trend reversion. From expected decline by 2025, UK would see a boost in wild fish production and vice-versa for the EU countries. The impacts on wild fish production range in 10-15% interval (positive for the UK and negative for the EU). However, if the other measures are accounted for, such as the imposition of the NTMs and the import tariffs, the gain for UK is lost because of a largely negative impact on aquaculture. In addition prices of wild fish decline faster than production meaning that the overall value of the wild fisheries sector declines for the UK. In the affected EU member states, the loss would be mostly driven by fish processing which would face a significant increase in trading costs. In aggregate, both EU and UK fish sectors would lose, except for Spain which can moderately benefit from reduced competition of UK boats in its marine waters. The Brexit trade measures have further negative repercussions on the consumer markets across all Europe. It is therefore not in the interest of consumers that the protectionist measures would be put in place.

With respect to the impact on other industries, the increased protectionism in agriculture favours the position of domestic producers and the agri-food sector in the UK would benefit from higher domestic prices. On the other hand, food processing industry, particularly dairy and meat in Ireland would be hit extremely hard, if UK does not trade with Ireland in the free trade zone anymore. The effects on industry and services are variable across the EU countries and depend on the type of measures. It has been shown that the UK industrial sector is rather vulnerable to the trade measures, whereas for instance Netherlands is much more resilient to the Brexit impact. The total GDP effects in for the Dutch economy are thus rather moderate and are below the estimates obtained by other studies (less than 1% in our study compared to CPB). On the other hand, Brexit could cost UK and Ireland about 2.5% GDP in the short-term horizon, but more than 3.5% in the longer horizon. This is more than the usual estimate of 2% from other studies.

With the results presented above we can argue that the employed MAGNET model proved to be useful in analysing the impact of Brexit. Not only that we were able to decompose the impact of each of the hard Brexit measures on the economy, but we could also capture the interlinkages between different fisheries sectors and the impact of Brexit on their relative competitiveness. Given that most of the Brexit measures impose comparably higher burden on the primary and secondary sectors of the economy such as fisheries, agriculture and food processing, alternative CGE models and methods that do not take into account this sectoral detail may obtain more biased impacts of their Brexit analyses.

It is also important to note that some assumptions are very important for assessing the impact of Brexit on the fisheries sector, which is the substitution possibility between the production factors employed in the wild fish sector. More expert assessment about the possible repercussion of an increased (or reduced) fish access on the employment of other factor such as labour is needed. This would however not influence the aggregated impact on the rest of the economy.

Finally, it can be concluded that if hard Brexit was adopted as it is simulated in this analysis, a lose-lose situation to all affected parties and notable welfare losses could be expected due to increased protectionism and misallocation of resources.

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Appendix 1: Marine Report Figures

Weight ('000 t.)

Everywhere	ALL Species Wt.	%	Demersal Fish Wt.	%	Pelagic Fish Wt.	%	All Finfish Wt.	%	Shellfish Wt.	%	Industrial Fish Wt.	%
Belgium	25	1%	22	2%	0	0%	22	1%	4	1%	0	0%
Denmark	639	13%	68	6%	194	8%	262	7%	56	10%	320	51%
France	547	11%	186	17%	220	9%	406	11%	83	15%	0	0%
Germany	215	4%	48	4%	131	5%	178	5%	17	3%	18	3%
Ireland	266	5%	29	3%	155	6%	184	5%	29	5%	54	8%
Netherlands	346	7%	57	5%	259	10%	316	9%	24	4%	6	1%
Spain	1,004	20%	358	32%	537	21%	895	24%	84	15%	1	0%
Sweden	166	3%	13	1%	79	3%	92	3%	3	1%	69	11%
Total EU-8	**3,209**	**64%**	**782**	**69%**	**1,574**	**61%**	**2,355**	**64%**	**299**	**53%**	**467**	**74%**
Other EU	1,127	23%	177	16%	648	25%	825	22%	106	19%	155	25%
Total EU-27	**4,335**	**87%**	**959**	**85%**	**2,222**	**87%**	**3,180**	**86%**	**405**	**72%**	**622**	**98%**
UK	671	13%	169	15%	338	13%	507	14%	155	28%	10	2%
TOTAL	**5,007**	**100%**	**1,128**	**100%**	**2,559**	**100%**	**3,687**	**100%**	**560**	**100%**	**632**	**100%**

UK EEZ	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%
Belgium	11	45%	10	46%	0	27%	10	45%	2	44%	0	0%
Denmark	218	34%	3	4%	129	67%	133	51%	0	0%	86	27%
France	94	17%	57	31%	29	13%	86	21%	8	9%	0	2%
Germany	68	31%	3	5%	62	47%	64	36%	0	0%	4	20%
Ireland	94	35%	6	21%	72	46%	78	42%	6	21%	10	19%
Netherlands	133	39%	13	23%	117	45%	130	41%	1	2%	2	41%
Spain	7	1%	7	2%	0	0%	7	1%	0	0%	0	0%
Sweden	24	15%	-	-%	15	19%	15	16%	-	-%	10	14%
Total EU-8	**650**	**20%**	**99**	**13%**	**424**	**27%**	**523**	**22%**	**16**	**5%**	**111**	**24%**
Other EU	-	-%	-	-%	-	-%	-	-%	-	-%	-	-%
Total EU-27	**650**	**15%**	**99**	**10%**	**424**	**19%**	**523**	**16%**	**16**	**4%**	**111**	**18%**
UK	476	71%	101	60%	266	79%	367	72%	101	65%	8	87%
TOTAL	**1,127**	**23%**	**199**	**18%**	**691**	**27%**	**890**	**24%**	**117**	**21%**	**119**	**19%**

Source: Napier (2016)