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The emission benefits of European integration

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Abstract

Simulating the implications of Brexit on the UK's emissions embodied in trade with a multi-region input–output table exposes the benefits of European integration. Under 2014 trade volumes, technologies and energy mixes, a hard Brexit—reverting to a trade pattern between the UK and the EU prior to the European Internal Market (EIM)—would imply a rise of about 0.215Gt of CO_2eq in the UK's emissions embodied in imports. This is equivalent to a 38% rise in UK's imported emissions in 2014 and roughly equal to the territorial emissions of the Netherlands in 2017. Substituting imports from the EU with those from the Rest of the World (RoW), under the same conditions, implies adding 0.35 kg of CO_2eq, on average, to each dollar of activity imported in the UK. This underlines the emission benefits of an integrated European market abiding to common environmental standards and climate policies. Filling the gap in imports lost from the UK to the EU by stepping up production within the EIM would result in an extra 0.012Gt of CO_2eq, a rather small increase when compared to the additional emissions in the UK's imports following Brexit. Should the EU reallocate the lost imports from the UK to the RoW, a total of 0.128Gt of CO_2eq would be added to the EIM imports. This exposes the environmental benefits in terms of emissions in keeping UK trade closely linked to the EU and the important role that Single Member States can play indirectly on EU's import emissions. In terms of emissions embodied in trade, the sum of the EU market is, paradoxically and for the better, less than the sum of its individual parts.

1. Introduction

Brexit exemplifies the complexity in reversing long-term processes of economic integration, especially since European Union (EU) membership goes far beyond trade and investment alone. The tide is turning on multilateralism elsewhere as trade agreements become increasingly bilateral. In the process of trade fragmentation, concerns over the greenhouse gas (GHG) emissions are unlikely to make it to the negotiations table. The EU Parliament for example, has focused on evaluating the economic consequences of Brexit for the rest of the EU (Emerson *et al* 2017).

In the November 2018 political declaration[3] between the EU and the UK, the energy and climate related intentions focus mostly on nuclear. Cooperation in the electricity and gas markets and the EU emission trading scheme are also mentioned. Uncoupling the electricity markets would raise generation costs by 1.5% in 2030, with 60% of those costs incurred in the UK in the form of lost infrastructures and overcapacity (Geske *et al* 2018). Beyond energy itself, the impacts on carbon emissions from a potentially new trade regime between the UK, the EU and the Rest of the World (RoW) has received little to no attention.

On the climate front, the EU has been pursuing a burden sharing strategy, joining forces to reduce emissions. A hard Brexit would also change national targets in the EU. Such impacts have already been quantified with most of the burden also falling onto the UK (Babonneau *et al* 2018). While this potentially reduces the efforts by remaining EU Member States, the UK will unlikely be the only one worse off as a result of leaving. Although economic integration through trade has brought benefits to countries across the world, the

[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/759021/25_November_Political_Declaration_setting_out_the_framework_for_the_future_relationship_between_the_European_Union_and_the_United_Kingdom__.pdf.

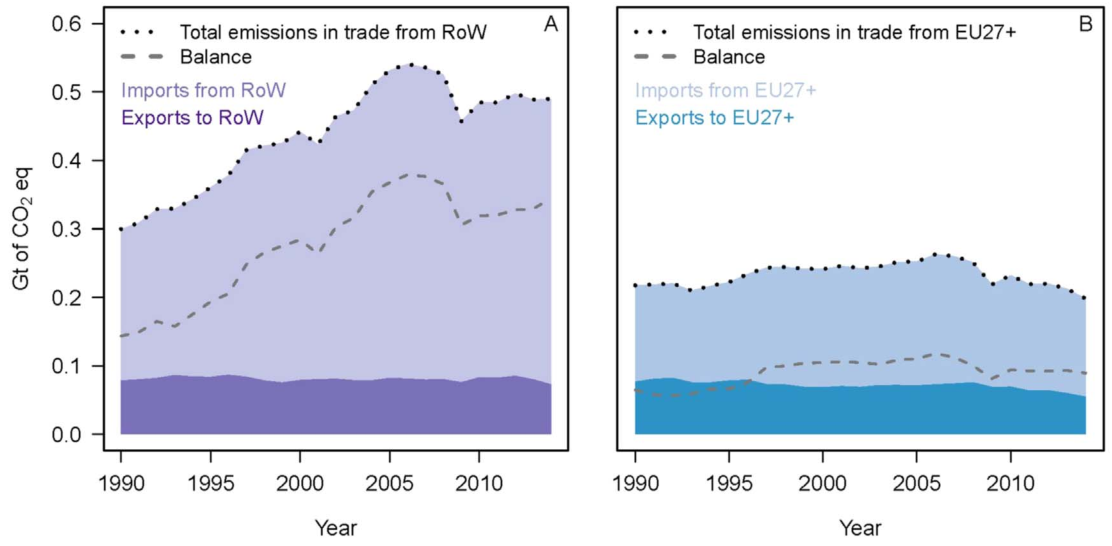

Figure 1. Evolution of emissions embodied in trade between (A) the UK and the RoW and (B) between the UK and the EU27+. Dotted lines = total emissions in trade (imports + exports). Dashed grey lines = Balance (imports − exports). Stacked areas = emissions in exports (dark tone) and imports (light tone).

environmental benefits remain unclear. China, for example, accessed the World Trade Organisation (WTO) in 2001, and since then its carbon terms of trade have worsened. In other words, the net emissions embodied in trade between China and the rest of the world have grown rapidly (Liu *et al* 2016). Other multilateral trade agreements, the North American Free Trade Agreement (NAFTA) or the Southern Common Market (MERCOSUR) and the lowering of trade barriers or tariffs, were shown to increase carbon emissions embodied in trade (Islam *et al* 2019).

Consumption based carbon accounting paves the way for more accurate assessment of emissions embodied in trade (e.g. Tukker *et al* 2018). With energy and climate policies focusing on territorial emissions, those embodied in trade result from economic structures. In the UK, offshoring energy intensive activities has been shown to contribute significantly to the decoupling of energy consumption and economic output (Hardt *et al* 2018). In the EU, part of the emissions embodied in trade are offset among Member States themselves, justifying a common climate policy (Moreau *et al* 2019). Hence, the EU might be remarkable as lower trade barriers or tariffs potentially reduce the overall emissions of its members.

Over the last decades the UK accumulated a large carbon debt as net imports of embodied emissions remain among the highest in the world (Matthews 2015, Baker 2018). Emission transfers to the UK reported in the Global Carbon Project dataset (Le Quéré *et al* 2018) have increased at an average rate of 4.58 Mt CO_2eq each year between 1990 and 2014. In 2004 alone the UK–China trade resulted in an additional 117 Mt CO_2 to global CO_2 emissions (or 0.4% of global emissions) compared with a scenario in which the same type and volume of goods were produced in the UK (Li and Hewitt 2008). Outsourcing of emissions has reached unprecedented levels up until the 2008 economic crisis (figure 1). The UK has been successful in shifting embodied emissions in imports onto the RoW (figure 1(A)) as imports from the rest of the EU and exports have stayed relatively constant (figure 1(B)) at about 0.07 and 0.2 GtCO_2eq, respectively. A change in trade patterns in the aftermath of Brexit will likely affect these proportions in the long-term, and by extent, the UK's consumption based emissions. In the absence of a preferential access to the EIM, part of the UK's current imports from the rest of the EU could end up originating in the RoW. We define the rest of the EU as EU27+ which comprises all current EU28 Member States minus the UK plus Norway and Switzerland, which have preferential access to the EIM as members of the European Free Trade Association. Concurrently, part of the exports from the UK to the EU27+ can either be supplied by the RoW or by the remaining members themselves. How this reconfiguration adds up to a new emission trade balance between the UK and the EU27+ is yet unexplored.

2. Scenario and data

To provide a first order estimate of the embodied carbon implications of the UK leaving the EU, a post-Brexit scenario was constructed as follows. The average monetary trade flows of the UK, over the period between 1990 and 1995, were adjusted for inflation and taken as representative of a post-Brexit trade pattern. We call this exercise the Brexit scenario. On the UK side, the loss of trade flows with the EU27+ was reallocated to the RoW. For the EU27+, offsetting the lost imports within its borders, by increasing production, is more likely than for the

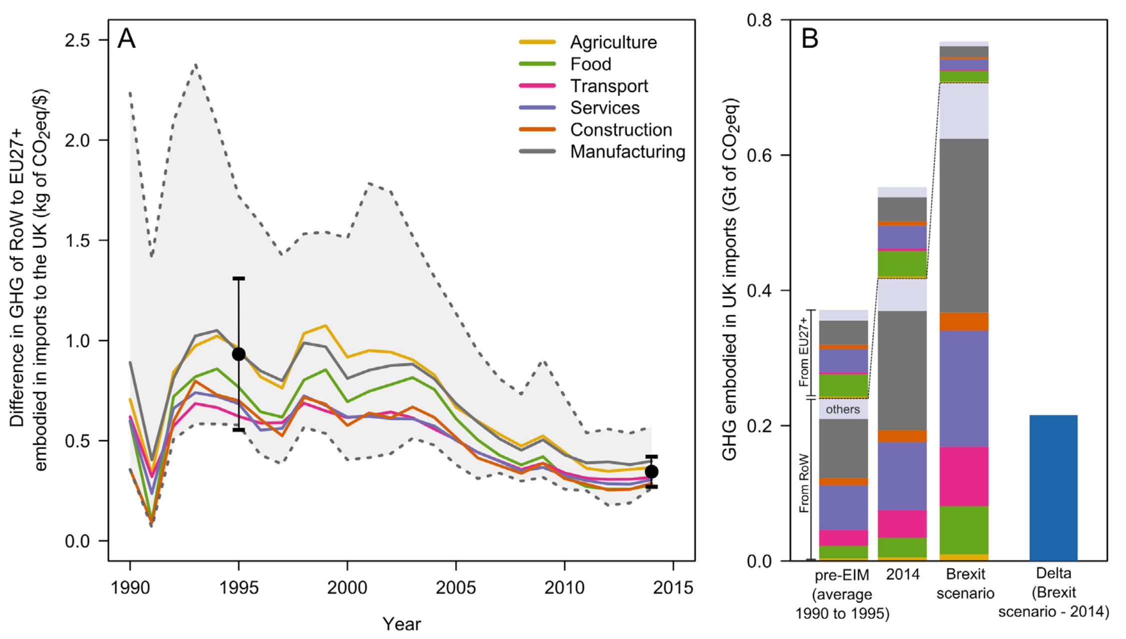

Figure 2. Evolution of the difference in GHG emissions per unit of economic activity between the RoW and the EU27+ embodied in UK's imports (A). Total GHG emissions embodied by major imported activity to the UK from the RoW and the EU27+ (B) for; the pre-EIM (approximated as the average of emissions imports between 1990 and 1995): the 2014 reference; and the Brexit scenario. Delta = difference between Brexit scenario and 2014 reference.

UK (Latorre *et al* 2018). Alternatively, the RoW can partially compensate for the imports lost from the UK (e.g. leveraging on the EU–JAPAN Economic Partnership Agreement, 1st February 2019). The corresponding changes in embodied emissions in trade were estimated based on average 2010–2014 emissions intensities.

We test the difference between the additional territorial emissions in an intra-EU27+ trade substitution following Brexit versus the embodied emissions if the global market becomes the source of the trade lost from the UK. Both of these sub scenarios are identical in the implementation of Brexit scenario, that is, imports lost from the EU27+ to the UK are shifted onto the RoW. No temporal dimension is attached to the trade scenarios proposed as it is impossible to understand how post-Brexit trade deals will unfold. Accordingly, our exercise should be understood as setting the bounds of what a pre-EIM trade pattern would entail, given current trade volumes and emission intensities. The post-Brexit reality will likely be within the range of the numbers provided.

The implications of emissions embodied in trade for the scenarios proposed were estimated with input–output analysis (Peters *et al* 2011). Monetary trade flows came from the Eora multi regional input–output (MRIO) database, particularly suitable for trade analysis with 189 countries (Lenzen *et al* 2013). Greenhouse gas emissions (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) were taken from PRIMAP (Gütschow *et al* 2016), and include fuel combustion emission from transportation. The additional emissions from potentially longer than current distances traveled by imports from the RoW to post-Brexit UK, were not accounted for. At the high level of aggregation of economic activities in Eora, 26 sectors, the uncertainties in emissions are limited. Otherwise the choice of MRIO database has little impact as their content was shown to converge (Moran and Wood 2014).

3. Results

From 1990 to 2014 the difference in GHG emissions per unit of economic activity between the RoW and the EU27+ embodied in UK's imports steadily declined, figure 2(A). Within this time frame, the efficiency gains of the RoW outpaced that of the EU27+ for the same type of traded products (goods and services), albeit starting from a worse level. In 1995 importing products from the RoW to the UK resulted, on average, in an additional 0.93 kg CO_2eq/$ (95% interval ranging between 0.59 and 1.86 kg CO_2eq/$) compared to imports of the same products from the EU27+. The difference then declined and from 2010 to 2014 stabilized at approximately 0.35 kg CO_2eq/$ (cross sectoral average of imports from the RoW and EU27+ of 0.47 and 0.12 kg CO_2eq/$, respectively, in 2014). This broadly implies that if imports to the UK from the RoW compensate a hypothetical loss of imports from the EU27+ due to Brexit, higher embodied emissions will most likely fall onto the UK. In quantitative terms, the Brexit scenario would release an additional 0.215 GtCO_2eq (an increase in 38%) in UK's embodied emissions compared to the year 2014. Under the Brexit scenario, emissions imported from the EU27+ drop from 24% of total embodied emissions in 2014 to 8% while those imported from the RoW rise from 75% of total embodied emissions in 2014 to 92%. Trade volumes with the EU27+ would not only be smaller, the EU27+ efficiency is also higher than that of the RoW. Further improvements in the efficiency of the RoW in providing comparable products at declining levels of emissions will continue, but are unlikely to overcome current levels in the EU27+ as the marginal cost of efficiency measures increases. In the short- to medium-term, a differential of emissions intensities between the EU27+ and the RoW will remain.

For the EU27+, the Brexit scenario would imply a rise in its import emissions of 0.128Gt CO_2eq referenced to 2014 in case imports lost from the UK are to be compensated by the RoW. Unlike the UK, the EU27+ has the scale to offset the import losses within its borders and take advantage of its fluid and relatively emission-efficient economy. If the EU27+ compensates part of the UK imports by increasing production domestically, its territorial emissions would increase by an estimated 0.012Gt $GtCO_2$eq. This highlights the importance of a Single Member State in keeping the EU market efficient in terms of CO_2 per $ of activity, an iconic result that in terms of emissions embodied in trade the sum of the EU market is, paradoxically and for the better, less than the sum of its individual parts.

4. Conclusions

Fair decarbonization pathways for countries need to encompass both territorial and traded emissions (Costa *et al* 2011, Peters *et al* 2015). Although trade agreements are seldom adopted to mitigate climate change, we demonstrate that in the UK case, a loss of trade with the EU following Brexit could result in significant additional GHG emissions embodied in trade. More importantly, the estimated growth of 38% of the UK's imported emissions, compounds what is already one of the worst carbon trade balance in the world. This can be further exacerbated by the fact that European decarbonization, though too slow to achieve ambitious climate targets, is outpacing that of the RoW. Average growth of wind, solar and other non-hydro renewable energy sources over the last 5 years in the EU is on track to supply more primary energy than coal by 2021 (Jackson *et al* 2018). Transportation and wholesale activities in the EU27+ are affected by changes in trade patterns more than others which could relocate elsewhere within the EU such as manufactured metal products and financial activities.

The post-Brexit trade pattern simulated here most likely represents an upper bound of UK–EU trade disruption. Changes in trade flows between the UK and the EU27+ in this study were found to be comparable with those simulating a hard Brexit with Computable General Equilibrium (CGE) (Rojas-Romagosa 2016, Latorre *et al* 2018) and gravity models (Oberhofer and Pfaffermayr 2018). Under our Brexit scenario, exports between the UK and the EU27+ drop by 21.4% and 4.4% relative to total exports in the period 2010–2015. Latorre *et al* (2018) reports a drop of 16.9% for the UK and 3.5% for the EU27 compared to a 2020 baseline by reverting to WTO tariffs.

In policy terms, the withdrawal agreement of 2018, has neither a clear objective to raise emission standards nor to implement border carbon adjustments to reduce trade related emissions (Mehling *et al* 2018). A related strategy would consist of systematically shifting trade flows to the lowest emission intensive exporters (de Boer *et al* 2019). However, as embodied emissions reach a plateau, re industrializing EU Member States at low emission intensities might prove most effective in the medium to long run (Wood *et al* 2019). For the sake of emission reduction, any divorce from the EU should carefully evaluate its carbon terms.

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Data availability statement

The data that support the findings of this study are openly available on the Eora website at www.worldmrio.com. Data deflators were taken from the World Bank CPI webpage at data.worldbank.org/indicator/FP.CPI.TOTL.

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References

Babonneau F, Haurie A and Vielle M 2018 Welfare implications of EU effort sharing decision and possible impact of a hard Brexit *Energy Econ.* **74** 470–89
Baker L 2018 Of embodied emissions and inequality: rethinking energy consumption *Energy Res. Soc. Sci.* **36** 52–60
Costa L, Rybski D and Kropp J P 2011 A human development framework for CO_2 reductions *PLoS One* **6** e29262

de Boer B F, Rodrigues J F D and Tukker A 2019 Modeling reductions in the environmental footprints embodied in European Union's imports through source shifting *Ecol. Econ.* **164** 106300

Emerson M, Busse M, Di Salvo M, Gros D and Pelkmans J 2017 An assessment of the economic impact of Brexit on the EU27 (*Policy Department A: Economic and Scientific Policy, European Parliament*) (www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU%282017%29595374)

Geske J, Green R and Staffell I 2018 *Elecxit: The Cost of Bilaterally Uncoupling British–EU Electricity Trade Cambridge Working Papers in Economics, Faculty of Economics, University of Cambridge* (https://EconPapers.repec.org/RePEc:cam:camdae:1947)

Gütschow J, Jeffery M L, Gieseke R, Gebel R, Stevens D, Krapp M and Rocha M 2016 The PRIMAP-hist national historical emissions time series *Earth Syst. Sci. Data* **8** 571–603

Hardt L, Owen A, Brockway P, Heun M K, Barrett J, Taylor P G and Foxon T J 2018 Untangling the drivers of energy reduction in the UK productive sectors: efficiency or offshoring? *Appl. Energy* **223** 124–33

Islam M, Kanemoto K and Managi S 2019 Growth potential for CO_2 emissions transfer by tariff reduction *Environ. Res. Lett.* **14** 024011

Jackson R B, Quéré C L, Andrew R M, Canadell J G, Korsbakken J I, Liu Z, Peters G P and Zheng B 2018 Global energy growth is outpacing decarbonization *Environ. Res. Lett.* **13** 120401

Latorre M C, Olekseyuk Z and Yonezawa H 2018 Brexit and the future of European trade and FDI agreements *Annual Conference on Global Economic Analysis* (Cartagena, Colombia: Global Trade Analysis Project (GTAP)) (https://gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5499)

Le Quéré C *et al* 2018 Global carbon budget 2018 *Earth Syst. Sci. Data* **10** 2141–94

Lenzen M, Moran D, Kanemoto K and Geschke A 2013 Building eora: a global multi-region input–output database at high country and sector resolution *Econ. Syst. Res.* **25** 20–49

Li Y and Hewitt C N 2008 The effect of trade between China and the UK on national and global carbon dioxide emissions *Energy Policy* **36** 1907–14

Liu Z, Song P and Mao X 2016 Accounting the effects of WTO accession on trade-embodied emissions: evidence from China *J. Clean. Prod.* **139** 1383–90

Matthews H D 2015 Quantifying historical carbon and climate debts among nations *Nat. Clim. Change* **6** 60

Mehling M A, Asselt H, van, Das K and Droege S 2018 Beat protectionism and emissions at a stroke *Nature* **559** 321

Moran D and Wood R 2014 Convergence between the Eora, Wiod, Exiobase, and Openeu's consumption-based carbon accounts *Econ. Syst. Res.* **26** 245–61

Moreau V, Neves C A D O and Vuille F 2019 Is decoupling a red herring? The role of structural effects and energy policies in Europe *Energy Policy* **128** 243–52

Oberhofer H and Pfaffermayr M 2018 *Estimating the Trade and Welfare Effects of Brexit: A Panel Data Structural Gravity Model* (Rochester, NY: Social Science Research Network) (https://papers.ssrn.com/abstract=3129951)

Peters G P, Andrew R M, Solomon S and Friedlingstein P 2015 Measuring a fair and ambitious climate agreement using cumulative emissions *Environ. Res. Lett.* **10** 105004

Peters G P, Minx J C, Weber C L and Edenhofer O 2011 Growth in emission transfers via international trade from 1990 to 2008 *Proc. Natl Acad. Sci.* **108** 8903–8

Rojas-Romagosa H 2016 *Trade Effects of Brexit for the Netherlands* The Hague: CPB Netherlands Bureau for Economic Policy Analysis (www.cpb.nl/sites/default/files/omnidownload/CPB-Backgroud-Document-June-2016-Trade-effects-of-brexit-for-the-netherlands.pdf)

Tukker A, Giljum S and Wood R 2018 Recent progress in assessment of resource efficiency and environmental impacts embodied in trade: an introduction to this special issue *J. Ind. Ecol.* **22** 489–501

Wood R, Grubb M, Anger-Kraavi A, Pollitt H, Rizzo B, Alexandri E, Stadler K, Moran D, Hertwich E and Tukker A 2019 Beyond peak emission transfers: historical impacts of globalization and future impacts of climate policies on international emission transfers *Clim. Policy* (https://doi.org/10.1080/14693062.2019.1619507)