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Abstract

This paper employs a computable general equilibrium (CGE) dynamic simulation model to analyse how Brexit is likely to impact the Welsh economy. The model simulates two potential future trade relationship scenarios between the United Kingdom (UK) and European Union (EU) for after 29 March 2019: (a) No-deal Brexit, i.e. trading partners revert to World Trade Organization (WTO) rules; (b) Limited transition period and/or extension of Article 50.

The model demonstrates how Welsh exports and imports, output, prices and employment are likely to be impacted from Brexit in the long-term. The scenarios modelled present a negative forecast for the Welsh (and UK) economy and industry, and show that the macroeconomic variables are sensitive to the policy disruption caused by Brexit. Projections show gross domestic product (GDP), GDP per capita, trade, investment and employment losses for the Welsh economy.

A no-deal Brexit, which sees the UK reverting to trading with the EU on WTO terms, generates maximum losses for Wales (and the UK) in the long-term. In light of the results, it is important to avoid a no-deal Brexit that sees high losses and tariff barriers returning.

A transition period arrangement or an extension to Article 50 also projects long-term losses for Wales. However, losses depend on the length of transition period and results show that a longer transition minimises losses for Wales (and the UK). From a policy perspective, a deal with an extended transition period should be agreed between the UK and EU as soon as possible to enable the continuation of existing EU-Wales trading arrangement.

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1. Introduction

On 29 March 2017, the United Kingdom (UK) government triggered Article 50 of the Lisbon Treaty which signalled that the UK would leave the European Union (EU), formally termed Brexit, at the end of the two-year period on 29 March 2019. While negotiations continue on the exit modalities the future of EU-UK relationship remains uncertain and undecided, and the draft Withdrawal Agreement is currently awaiting a vote in the British Parliament. The future of the EU-UK relationship remains uncertain due to an array of complexities arising from the intricate nature of Northern Ireland border with the Republic of Ireland, EU and UK citizen rights and a lack of clarity on what sort of trade policy would be adopted following the UK's departure from the EU (Khorana and Vickers, 2018).

Studies on the economic impact of Brexit examine trade and welfare aspects for the UK from exiting EU membership (Bank of England, 2018; Dhingra et al., 2017; Brakman et al., 2017; Ebell and Warren, 2016; HM Treasury, 2016; OECD, 2016; Oxford Economics, 2016; PWC, 2016, 2017). None, other than Dhingra et al. (2017) examine the local impact of Brexit for the four UK regions, i.e. England, Scotland, Wales and Northern Ireland. This paper adds to the body of literature and examines the potential impact of Brexit on Wales - a region that is closely integrated into the Single Market with 67% of Welsh goods exports and 49% of imports going to and from the EU (Welsh Government, 2018). Meat, Machinery and transport equipment are particularly important Welsh exports to the EU. In addition to direct trade in machinery and transport equipment, Welsh components are incorporated into goods and services exported to the EU from other parts of the UK. Thus, the impact of leaving the EU on Welsh exports requires a detailed assessment in the context of relative sector scale and of potential structural change that is likely to affect the composition of the economy post Brexit.

Using a dynamic computable general equilibrium (CGE) modelling framework the paper models two potential future partnership scenarios between the UK and EU. Scenario one examines the impact of a no-deal Brexit on 29 March 2019, i.e. trade between the UK and EU and the rest of the world would revert on World Trade Organisation (WTO) basis and default Most Favoured Nation (MFN) tariffs apply. Scenario two models a transition period, i.e. continue the existing arrangement that includes membership of the Customs Union and Single Market, for a limited period after Brexit. This models the possibility of a transition period to last for either two, three, five or 10 years.

The structure of the paper is as follows: section two provides an overview on Welsh economy and its dependence on the EU for trade. Section three presents the methodology, modelling framework and data. Section four discusses the results of the three scenarios modelled. Section five concludes.

2. Wales – EU Trade and Related Literature

The Welsh Government prepared a policy position, supported by Plaid Cymru, which proposes to remain in the Customs Union and Single Market. Several Welsh industries and sectors have been identified as being vulnerable to Brexit, in particular machinery and transport equipment, manufactured goods, food and live animals and chemicals and related products (Welsh Government, 2017).

In 2016 Welsh goods exports were £14.6 billion and in 2015 service exports were £1.7 billion (Welsh Government, 2018). In percentage terms, Welsh goods exports to the EU accounted for 61% of the total, compared to 59% in 2014. Data provides evidence that the total value of Welsh goods exports to EU countries is greater than that of goods to exports to non-EU countries. The analysis of main exports shows that for agricultural exports the EU is a principal market for Welsh beef and sheep meat (HCC, 2016). For manufactured goods, the machinery and transport equipment sector and the manufactured goods categories are important and this sector has been identified as being at a risk due to its dependence on EU trade either directly or indirectly as part of the supply chain (Welsh Government, 2018). With regards to services, 35% of services exports went to the EU. The top three categories of service sector exports from Wales in 2015 were: Manufacturing services (63%); Information and communications (16%); Real estate, professional, scientific and technical (13%).

Table 1 presents sectors of the Welsh economy that are heavily reliant on the EU as a principal export market. In seven out of the ten categories listed in table 1 Wales is more reliant on the EU as a market than the UK as a whole. As a proportion of output accounted for by exports to the EU three sectors in Wales have a higher dependence than the other sectors.

Table 1. Welsh exports to the EU by sectors affected

	Wales % exports to EU	% sector share in UK	% EU	% sector share
Food and live animals	81	2	71	5
Beverages and tobacco	39	1	38	2
Crude materials (inedible) excluding fuels	22	2	38	2
Mineral fuels, lubricants and related products	41	12	69	7
Animal and veg oils fats & waxes	44	0	78	0
Chemical and related products	59	12	54	18
Manufactured goods classified by material	67	16	55	9
Machinery and Transport equipment	80	45	43	41
Miscellaneous manufactures	56	10	49	14
Commodities nes	88	1	16	2
Total percent	67	100	49	100

Source: National Assembly for Wales, HMRC data, 2016

Dhingra et al. (2017) use a structural trade model to predict the local impact of Brexit under two scenarios - soft and hard Brexit.[1] Average effects are predicted to be negative under both scenarios, and more negative under hard Brexit. Table 2 presents a detailed analysis of how Brexit would impact the GDP of local authorities in Wales. Results show that losses vary – from 2.5 % losses from a no-deal Brexit for Cardiff to 1.7% for Carmarthenshire. Losses from a soft Brexit are, however, lower and range from 0.6% to 1.3% for Anglesey and Cardiff, respectively.

Table 2: Impact on the GDP of Wales

	Soft Brexit	Hard Brexit
Cardiff	-1.3	-2.5
Vale of Glamorgan	-1.3	-2.3
Swansea	-1.2	-2.3
Newport	-1.2	-2.1
Gwynedd	-1.1	-2.0
Conwy	-1.0	-1.9
Caerphilly	-1.2	-1.9
Blaenau Gwent	-1.2	-1.9
Ceredigion	-0.9	-1.8
Monmouthshire	-1.0	-1.8
Pembrokeshire	-1.0	-1.8
Wrexham	-1.1	-1.7
Carmarthenshire	-1.0	-1.7
Flintshire	-1.0	-1.7
Powys	-1.0	-1.6
Merthyr Tydfil	-0.8	-1.5
Neath Port Talbot	-1.0	-1.4
Anglesey	-0.6	-1.2

Source: Adapted from Dhingra, et al., 2017

Studies analysing the wider economic impact of Brexit examine trade and welfare aspects for the UK from exiting EU membership. The empirical models use gravity equations and CGE and unanimously forecast a negative economic outcome for the UK after Brexit (Bank of England, 2018; Dhingra et al., 2017; Brakman et al., 2017; Ebell and Warren, 2016; HM Treasury, 2016; OECD, 2016; Oxford Economics, 2016; PWC, 2017; Van Reenen, 2017). Trade is projected to be hit the hardest when the UK reverts to WTO tariffs, i.e. hard Brexit or unless the UK chooses to remain in the EU or negotiates a form of Brexit that allows it to retain membership of the Customs Union and Single Market, i.e. soft Brexit. An exception is the study by Minford (2016) that projects gains for the UK following its departure from the EU.

[1] The soft Brexit scenario is defined by assuming that the UK remains in the Single Market and negotiates a deal like that of Norway with tariffs remaining at zero. Under the hard Brexit scenario, the UK and the EU are not part of a free trade agreement (at least immediately) and so they must charge each other the tariffs that they charge to other members of the WTO. See Dhingra et al., (2017) Appendix A1 for precise definitions of the two scenarios.

Literature also expresses concerns about the impact of Brexit on developing countries (Langan, 2016; Murray-Evans, 2016; Sanders, 2016). Other studies focus on the overall impact of deep regional trade agreement (RTA) between the EU and UK report losses for the UK. Mulabdic et al. (2017) estimate that the domestic value added to gross exports increase by 35% on average for the UK from a deep RTA with the EU. Gudgin et al. (2017) estimate 20% losses of UK exports to the EU after a hard Brexit. Coutts et al. (2018) estimate a loss of 12% of UK exports, while Kee and Nicita (2017) suggest an even smaller negative impact of 2% that takes the price elasticity of demand for UK products into consideration.

3. Methodology, Scenarios and Data

This paper uses a dynamic CGE model that uses the Global Trade Analysis Program (GTAP) 9.2 version of Data base to capture the dynamic effects of Brexit for Wales. The national level trade flows and tariff data for each sector-country pair are taken from UN Comtrade. The regional aggregation includes Wales, Rest of the UK, Rest of the EU, and the Rest of the World (RoW) (see Appendix Table, A-1). The definition of sectors and mapping to GTAP 57 commodities are in Appendix Table A-2.

The modelling system uses specified equations to capture the inter-relationships between variables affecting supply and demand of the UK and Wales. Given the GTAP Database includes the UK as a single country the model develops intra-UK regions for Wales and the rest of the UK[2] using *SplitReg* to disaggregate UK data into Wales and the rest of UK (i.e. Scotland, Northern Ireland, and England).[3]

The specified trade scenarios used in this research are intended to enable a broad, illustrative assessment of the likely bounds of potential impacts under contrasting and stylised, theoretical trade arrangements, and are not intended to necessarily reflect the most likely negotiation outcomes. Specifically, the scenarios reflect:

a) No-deal with the EU i.e. revert to WTO rules default MFN tariffs on 29 March 2019. This scenario will reset UK relations with the remaining European members on a default WTO rules basis. This would imply 'hard Brexit' i.e. no formal agreement would be reached and this would mean that the UK would "crash out" of the trading agreement with the EU.
b) A transition arrangement after 29 March 2019 to ensure stability for businesses and economy. This provides for a limited transition period after which the current market access under the Customs Union and Single Market will come to an end. An alternative to the transition could be in the form of an extension to Article 50 of Lisbon Treaty between the UK and EU. The scenario means that an agreement on the transition period

[2] For Wales, we use the IO table and macro-economic and trade data available; for the rest of the UK, we take the residual between the UK and Wales datasets.

[3] SplitReg is a tool that has been developed to split regions that are commonly bundled together within the GTAP database. Examples of its use include for members of 'XOC' – Rest of Oceania, which include a multitude of Pacific Island nations (Horridge, 2011). This tool can also be used to split any one country based on simple weights. To perform the split using SplitReg, the program requires only proportional value-added information for each sector of every new region. Sectors in other regions remain unchanged, and the sums of headers of new regions remain equal to the original region, thereby maintaining database balance.

or an extension of Article 50 between the EU and UK would allow the economic relations to continue on current terms for a period of 2 (as proposed in the Withdrawal Agreement), 3, 5 and/or 10 years.

These scenarios were compared against a baseline which assumes continuation of current trade and domestic agricultural support arrangements (i.e. the UK remaining fully integrated within the EU Single market). The projection period covers 2020-2030, with the alternative trade arrangements under each scenario incorporated within the modelling. No changes are made to the underlying macroeconomic assumptions, e.g. exchange rates, for the purpose of this analysis

Data is taken from the Social Accounting Matrix (SAM) and macro data, i.e. GDP, aggregate consumption, investment, exports and imports for Wales.[4] The available macroeconomic and input-output (IO) data is projected from the Welsh IO Table[5] and shares of inputs compiled for each sector.[6] The following data has been obtained from the Welsh IO table to:

4. Long term Macroeconomic Assessment of Brexit on Wales: Results

4.1 Scenario one: No-Deal Brexit

This assumes that the two-year Article 50 process comes to an end with no agreement, and that the UK would leave the EU on 29 March 2019 without a deal. This implies that the rules of the WTO rules would apply, i.e. tariffs would be imposed on goods traded between the UK and EU. It is assumed, based on Ciuriak, Dadkhah and Xiao (2017) that tariffs on many industrial products would be 2-3%, but on cars these would be 10% and on many agricultural products between 20% and 40%. The trade in services would also suffer if nothing is agreed in advance. Under a pure 'no-deal' scenario, businesses would lose their passporting rights, which allow them to sell their services across the EU without having to obtain licences in each individual country. The effects of a no-deal scenario for Wales are as below.

[4] These include data on Production and Consumption by sector; Use of different intermediate inputs from different sectors by industries; Use of primary inputs by industry; Exports and imports; Taxes; Cost shares of each input in production costs (e.g. share of cost of steel in auto industry production); Sales shares for each commodity by industry (e.g. share of steel use in auto industry in total sales of steel across industries).

[5] See https://www.cardiff.ac.uk/__data/assets/pdf_file/0010/698869/input-output-tables-2007-final-30-6.pdf

[6] Gross Value Added data, by industry, has been taken from Welsh statistics which is consistent with the GDP numbers, for 2011, for Wales and rest of the UK. An excerpt from their documentation states:
"..These tables are part of the regional gross value added (production approach) release published on the 16th December 2016.They show economic activity as measured by gross value added using the production approach (GVA(P)) for NUTS1 and NUTS2 regions of the United Kingdom including industry section totals. Estimates of workplace based GVA allocate output to the region in which the economic activity takes place. The constant price data underpinning these chained volume measures are not constrained to sum to the national total for each industry. Therefore they represent real growth in output, rather than in GVA."
More information can be found in quality note 2 of the accompanying statistical bulletin. Source: https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedproductionapproachregionalgvapunconstraineddatatables"

4.1.1 Real GDP effect

Tables 3 and 4 summarise the macroeconomic impacts of Brexit for Wales, the rest of UK, the rest of the EU and RoW. The exit of the UK from the EU generates significant negative impacts for the Welsh economy, the Rest of United Kingdom, and the EU.

Results show a decline in real GDP for England, Scotland and Northern Ireland in the long-term, i.e. in 2030. Real GDP for Wales is projected to be lower by 0.5 % - 0.6% than would otherwise be the case by 2027-2028. While England is the most affected, Scotland is the least impacted. The decline in real GDP for the rest of the EU and RoW is marginal, with GDP losses ranging from -0.01 % to - 0.04 % in 2030. Real wages of labour (skilled and unskilled) are also lower by 2.5% to 3% in 2030.

Table 3: No-Deal: Long-term impact in 2030 (% Change from the baseline: 2011)[7]

	% change
Real GDP	-0.6
Exports	-19.7
Imports	-4.9
Unskilled labour	-2.5
Skilled labour	-2.9

Source: Model simulations

Table 4 presents the results of a no-deal between the UK and EU for all regions. Results show that there no gains for any region, and the highest overall negative impact of a no-deal scenario is in the UK (0.54% to 0.50% over 2025-2030). The impact on other regions is either zero (USA) or marginal (-0.02% for China and 0.02% for India in 2030).[8]

Table 4: % GDP Impacts of a No-Deal, Relative to the Baseline, by country

Regions	2020	2025	2030
RestofUK	-0.41	-0.44	-0.48
Wales	-0.50	-0.55	-0.59
United States	0.00	0.00	0.00
China	-0.02	-0.02	-0.02
India	-0.03	-0.03	-0.02
Rest of EU	-0.04	-0.04	-0.04
Rest of the World	-0.01	-0.01	-0.01

Source: Calculations by the authors

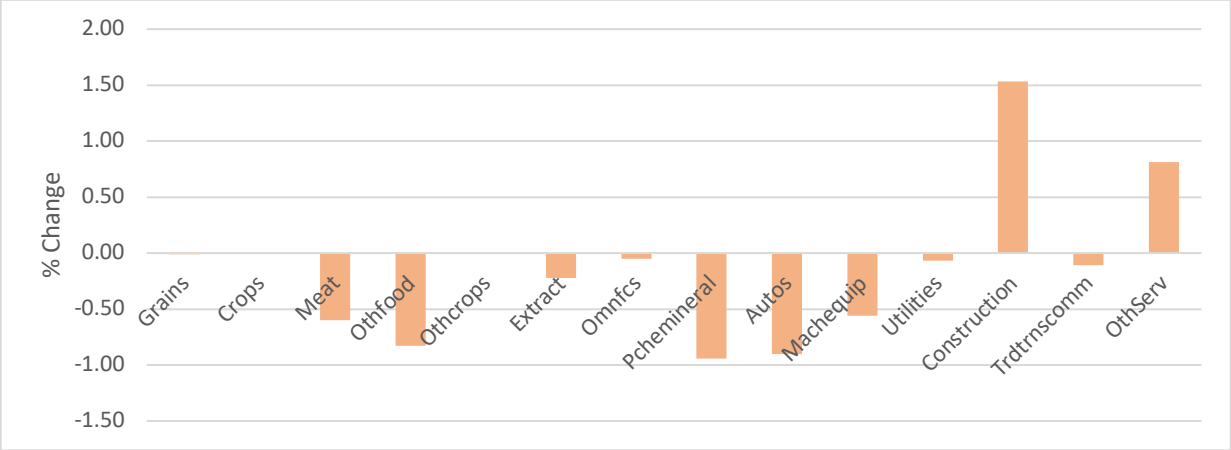
[7] In the baseline year (2011) population is shocked which means we assume that population grows over time, as a result the percent change in GDP and GDP per capita would be different. In terms of the % deviation in policy from baseline (which is reported here) if population does not change relative to the baseline, real GDP and real GDP per capita would grow at the same rate.

[8] Note that following Brexit some countries could benefit in terms of market share gains in both the UK and EU markets.

4.1.2 Sectoral effect

Figure 1 illustrates the long-term impact of a no-deal on sector level output for the Welsh industries. Manufacturing sectors, such as petrochemicals and minerals, automotive and machine equipment exhibit the largest decline in output levels in 2030. With tariffs at MFN rates under a no-deal, the EU's goods tariffs would be around 2% to 3% of the value of the good in some sectors through to as high as 45%. The cumulative effect of goods re-crossing borders could be significantly higher, as pointed out by the Welsh Government (2018).

Figure 1: Long term changes in output in the No-Deal scenario (% change from baseline)



Source: Model simulations

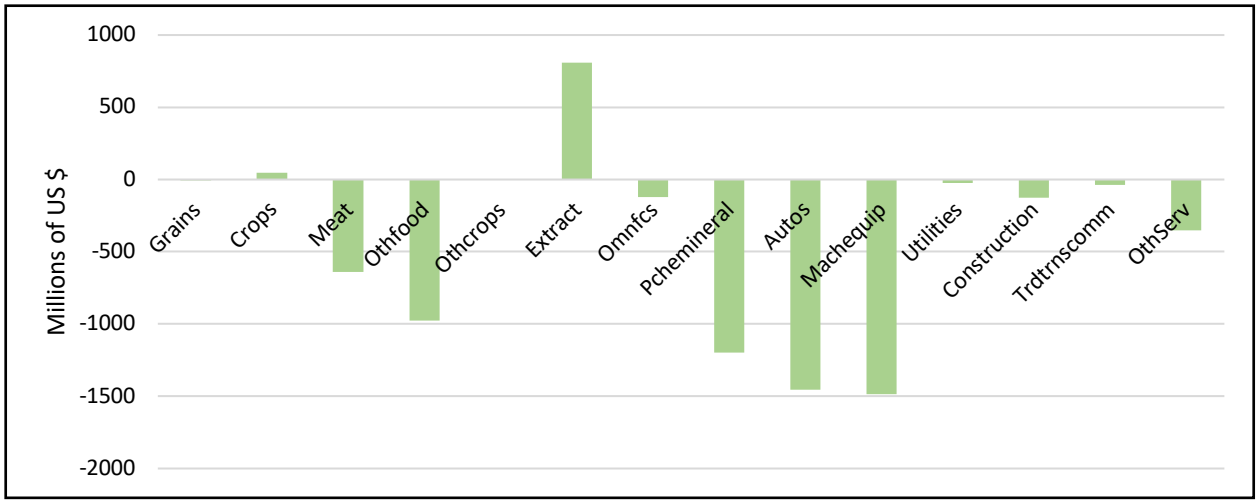
Meat also shows decline as MFN tariffs applied on UK exports to the EU adversely impact on the competitiveness of Welsh meat sector. The sector results also exhibit some degree of sensitivity as to how the existing EU tariff rate quotas (TRQs) would be divided.

In addition to tariffs and border costs, the negative sectoral impact results are driven by a combination of factors - direct EU-export intensity of the sector, size of the sector, sensitivity of the sector to competitiveness effects and regional linkages.

4.1.3 Trade effect

Figure 2 presents the long-term impact of a no-deal scenario in 2030. There is a positive trade balance for the extraction sector, which include forestry, fishing, and minerals. The explanation for export gains in these sectors is due to a reduction in import demand which allows the domestic Welsh production to expand to cater to exports, since domestic demand expansion for products is small. But these gains are small compared to the overall deterioration in the trade balance of other sectors by the end of 2030.

Figure 2: Change in Trade Balance: Long-term impact from a no-deal scenario

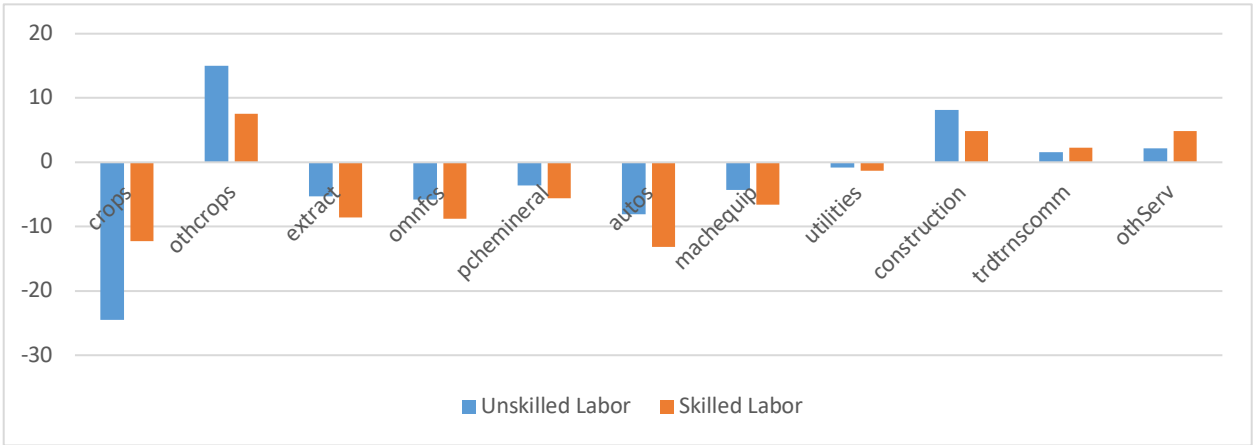


Source: Model simulations

4.1.4 Employment effect

Figure 3 presents the impact on skilled and unskilled labour demand by industry in the long-term (2030). All sectors show employment losses for skilled and unskilled labour, with the highest employment losses in Crops and Automobile sectors. The only exceptions are Construction and Other crops sectors. Given labour income is an important component of household total incomes, the implication of sustained decline in the employability of unskilled and skilled labour is likely to serious consequences for income distribution and result in high levels of inequality for Wales.

Figure 3: Long term impact of a No-Deal scenario on labour employment (% change from the baseline)

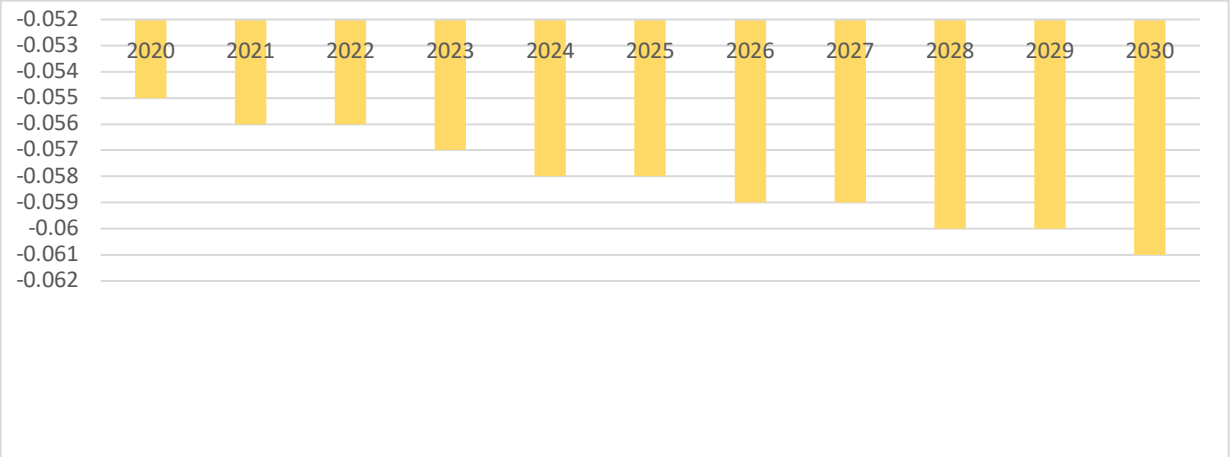


Source: Model simulations

4.1.5 Investment effect

Figure 4 on the impact of a no-deal Brexit on investment shows an overall declining negative effect over time, from -0.055% in 2020 to -0.061% in 2030. The break-up of FDI presents losses of -0.03% to -0.04 over 2020-2030. Detailed analysis of public and private investments show a marginal decline in private investment (0.0004%) but an increase in public investment (0.8-0.9%) in the long-term.

Figure 4: Long term impact of a no-deal on investment (% change from the baseline)



Source: Model simulations

Further breakup of investment by FDI, public and private investment presents a mixed picture. Public investment increases mainly due of increase in tariff revenues[9] that generate public-sector investments and funding. This type of investment, however, grows slower with time; in 2020, the growth is 0.86%, while in 2030 it is 0.79%. Private investment declines but at a slow rate and it gets flattened even more with time. In short, the investment effects are largely negative, with the exception of public investment.

4.2 Scenario two: A Transition Arrangement or an Extension to Article 50

Scenario 2 assumes either an agreement on a transition period, as provided for in the Draft Withdrawal Agreement agreed to by the UK and EU that allows continued access to the Customs Union and Single Market or an extension to Article 50 of TEU. This implies that the economic relations would continue on current terms within the existing structure of EU rules and regulations until the end of transition period. The model simulates the scenario by assuming that the arrangement could continue for 2, 3, 5 and 10 years after UK's exit from the EU on 29 March 2019.[10] In other words, during this limited period, the UK would continue to benefit from the existing arrangement with the EU.

4.2.1 Real GDP effect

Table 5 presents the long-term impact on real GDP for Wales from continuing the existing arrangement with the EU. The analysis presents evidence that the continuation of transition period is needed to mitigate the negative impact of Brexit and that a shorter transition period is likely to

[9] One may argue that GDP reduction may outweigh increase in tariff revenue; however, this is an empirical question which can only be answered based on the relative changes to imports, tariff revenue and GDP. We observe that, given that GDP reduction comes mostly from falling exports and consumption, imports also fall due to a small boost in some of domestic production. Further, a rise in tariff revenue outweighs fall in imports. Due to this combination of multiple effects, we see the public investment benefit marginally despite a tariff hike.

[10] While in reality, it may possibly matter as to whether this transition is agreed upon to begin with or not, but in the model it doesn't matter as we observe the effects only after the UK exits. This is an essential abstraction for effective quantification of these effects as the business uncertainty arising from the uncertainty about transition is difficult to capture/model.

damaging for the Welsh economy. For Wales, maintaining the existing arrangement with the EU for a longer period will bring economic gains compared to a no-deal Brexit.

Table 5: Long-term (2030) impact of a transition period, i.e. continuing the existing arrangement with the EU, on real GDP (% change from the baseline)

	2 year	3 year	5 year	10 year
Wales	-0.57	-0.56	-0.54	-0.50
Rest of UK	-0.47	-0.46	-0.44	-0.40
United States	0.00	0.00	0.00	0.00
China	-0.02	-0.02	-0.02	-0.02
India	-0.02	-0.02	-0.03	-0.03
Rest of EU	-0.04	-0.04	-0.04	-0.04
Rest of the World	-0.01	-0.01	-0.01	-0.01

Source: Model simulations

Table 6 presents the long run impact on macro-economic variables from continuing the transition arrangements. This shows that depending on the length of the transition period real GDP losses for Wales range between 0.57% to 0.50% in 2030. Aggregate exports take the largest hit (-19%) and employment of skilled and unskilled labour falls by as much as 2.46% to 2.7% during the period under consideration.

Table 6: Macroeconomic impact of a transition period with the EU (% change from the baseline)

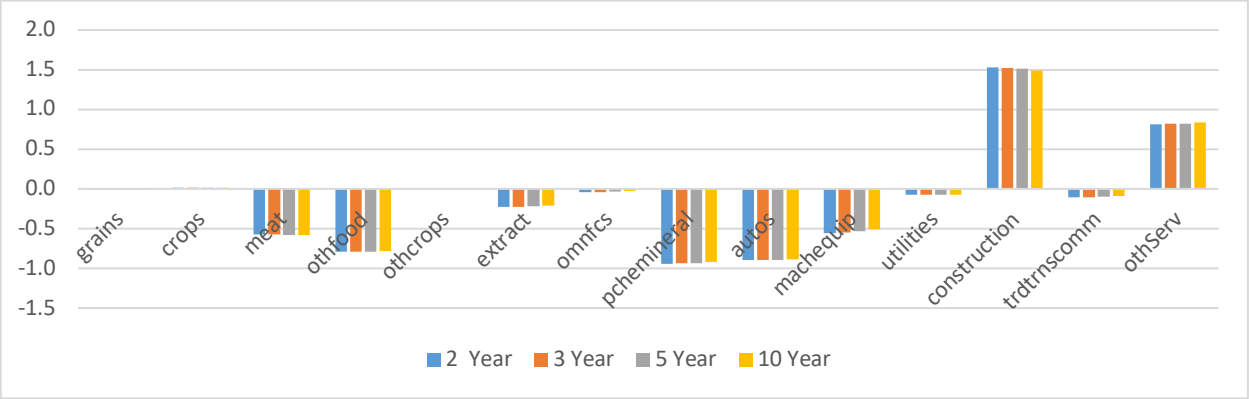
	2 year	3 year	5 year	10 year
Real GDP	-0.57	-0.56	-0.54	-0.50
Exports	-19.62	-19.57	-19.46	-19.24
Imports	-4.89	-4.90	-4.92	-4.98
Real Wages				
Unskilled labour	-2.47	-2.46	-2.46	-2.45
Skilled labour	-2.75	-2.75	-2.74	-2.71

Source: Model simulations

4.2.2 Sectoral effect

Similar to a no-deal simulation results, the long-term output effect of having a transition period, i.e. continuing existing relationship with the EU for a period, are presented (Figure 5) for output as percentage deviation from the baseline in 2030. The results hint be a structural shift for the Welsh economy away from current pattern of Manufacturing to Services and Construction in 2030.

Figure 5. Long-term impact of a transition by output (% change from the baseline)



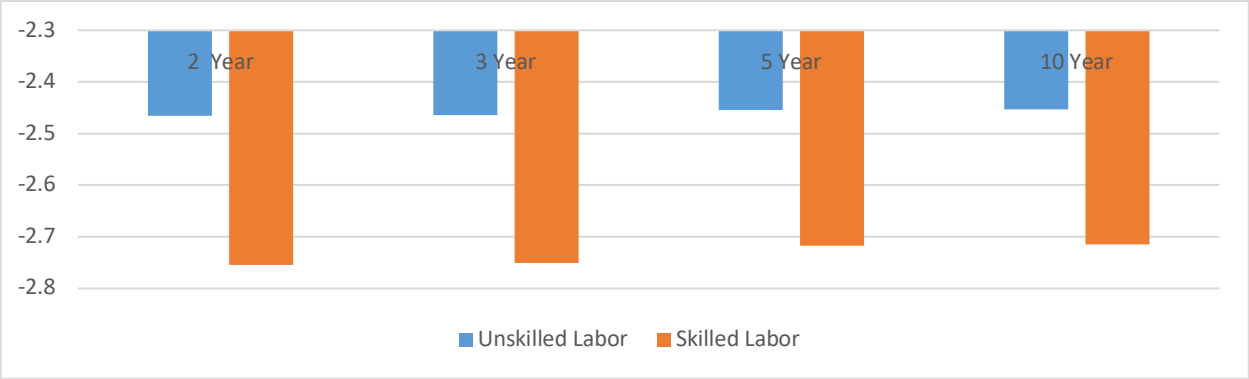
Source: Model simulations

The sectoral impact differs from a no-deal scenario, in that it reflects both the structure of the shock and impact of the current scenario on services and the overall manufacturing sector. Results reflect larger changes in real wages (see employment effects), which is expected to have a differential impact depending on how skilled labour intensive a particular sector is and how sensitive sectors are to changes in competitiveness brought about in 2030 by the continuation of current relationship with the EU.

4.2.3 Employment effect

Figure 6 shows a detrimental effect for skilled and unskilled labour. There are long-term impacts that need be considered as such with the implication that despite anticipated adjustments to the economy, both skilled and unskilled labour demand will decline and payments to the factors of production will fall under all transition period scenarios, i.e. 2, 3, 5 and 10 years, considered in the simulations.

Figure 6: Long term impact of a transition for factor returns (% change from the baseline)



Source: Model simulations

The projections show a larger decline in skilled labour demand compared to the real return on unskilled labour because the sectors that employ skilled labour (i.e. manufacturing, pharmaceuticals) reduce output and production substantially unlike other sectors (like grains and crops in our model) that traditionally use unskilled labour and show smaller output contraction.

4.2.4 Trade effect

Table 7 presents the current structure of Welsh exports in 2011, i.e. baseline year. This identifies manufacturing, machinery and equipment, and automotive as the prominent export sectors of Wales exporting to USA, China, Rest of the EU, and Other countries.

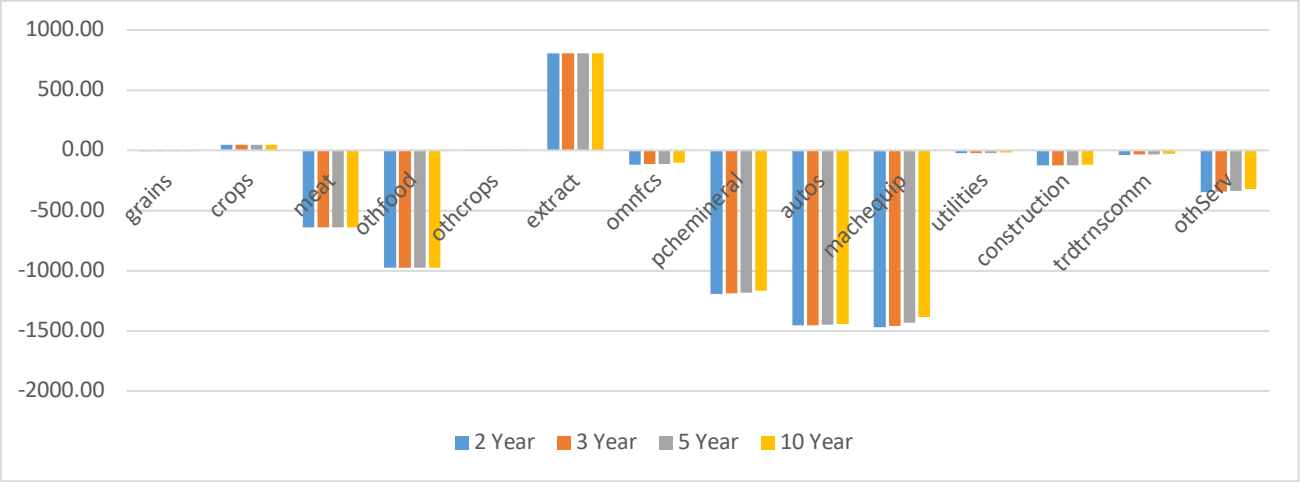
Table 7: Welsh exports by destination (% share for each country) in 2011

	USA	China	India	Rest of EU	ROW
Grains	0.00	0.00	0.00	0.00	0.00
Crops	0.00	0.00	0.00	0.10	0.10
Meat	0.10	0.20	0.00	1.00	0.30
Other food	3.10	1.60	1.50	5.10	4.60
Other crops	0.00	0.10	0.00	0.00	0.00
Extract	5.30	11.20	48.90	13.80	8.60
Other manufactures	2.60	10.50	3.50	4.30	4.20
Pchemineral	37.10	12.40	7.50	40.00	24.50
Autos	7.60	28.00	3.50	10.50	11.00
Machine Equipment	27.70	33.40	27.00	21.40	36.50
Utilities	0.40	0.10	0.40	0.50	1.10
Construction	0.00	0.00	0.00	0.00	0.10
Trade, transport & Communication	0.70	0.20	1.10	0.40	0.80
Other Services	15.50	2.30	6.30	2.40	8.00
Total	100	100	100	100	100

Source: GTAP Database 2011 and authors calculations

Figure 7 presents the effects of a transition period, of either 2, 3, 5 or 10 years, between the UK and EU for the Welsh economy. Given that the current structure of Wales's exports is mainly driven by manufacturing and machinery, the hardest hit sectors are manufacturing, i.e. automotive, machinery and equipment; and pharma-chemical sectors (Figure 7). The only sector that shows trade gains is the extraction sector, given that Wales is rich in mineral wealth.

Figure 7: Trade balance effects of a transition arrangement (in million US$)



Source: Model simulation

Table 8 shows the impact on Welsh exports and imports under the scenario of a transition. The effect of a transition arrangement between the UK and EU will have a less damaging effect on Welsh exports and imports, compared to a no-deal scenario. The sectors negatively impacted are Automotive, Petrochemicals and minerals, Machinery equipment and Other foods as well as Meat sectors given that these are heavily integrated for trade with the EU.

Table 8: Long-term (2030) impact of a transition on Welsh exports and imports (% change from the baseline)

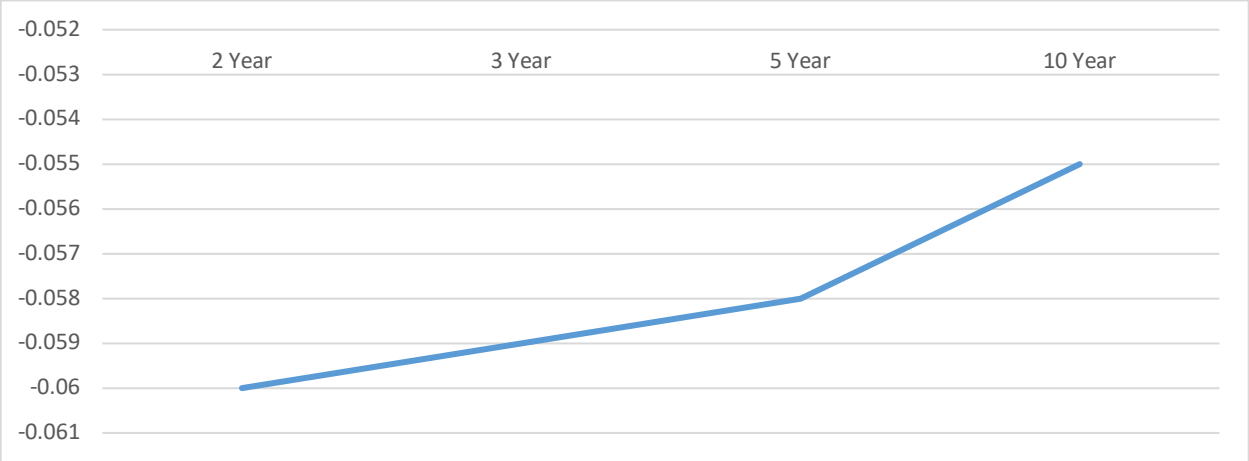
Products	Exports				Imports			
	2 Year	3 Year	5 Year	10 Year	2 Year	3 Year	5 Year	10 Year
Grains	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
Crops	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Meat	-3.5	-3.5	-3.5	-3.5	-1.7	-1.7	-1.7	-1.7
Other food	-4.1	-4.1	-4.1	-4.1	-1.3	-1.3	-1.3	-1.3
Other crops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Extract	-0.1	0.0	0.0	0.0	-1.8	-1.8	-1.7	-1.7
Other manufactures	-0.4	-0.4	-0.4	-0.3	0.0	-0.1	-0.1	-0.1
Petrochemicals and minerals	-3.8	-3.8	-3.8	-3.8	-0.7	-0.7	-0.7	-0.7
Automotive	-4.7	-4.6	-4.6	-4.6	-0.7	-0.7	-0.7	-0.7
Machinery equipment	-3.0	-3.0	-3.0	-2.9	0.7	0.7	0.7	0.6
Utilities	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3
Trade transport & communication	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Services	-0.3	-0.3	-0.3	-0.3	0.5	0.5	0.5	0.4

Source: Model simulations

4.2.5 Investment effect

The overall impact of a transition agreement is negative for investment in Wales, but this improves with a longer transition period (Figure 8). The economy faces an initial negative investment shock a transition period with FDI losses of 0.06% under a two-year transition compared to 0.05% for a ten-year transition. Thus, the longer the transition negotiated by the UK, the lower is the negative effect on private investment and FDI.

Figure 8: Long-term impact on investment of a transition arrangement (% change from the baseline)



Source: Model simulations

Table 9 presents the comparative macroeconomic results for a no-deal Brexit and an agreement between the EU and UK for a transition period. The results show losses under all scenarios and the longer the transition period the lower are GDP, trade and employment losses for Wales.

Table 9. Long-term comparative macroeconomic impact in 2030 (% change from the baseline)

	No-Deal Scenario	**A transition period**			
		2-yr	3-yr	5-yr	10-yr
Real GDP	-0.59	-0.57	-0.56	-0.54	-0.50
Exports	-19.70	-19.62	-19.57	-19.46	-19.24
Imports	-4.87	-4.89	-4.90	-4.92	-4.98
Unskilled labour	-2.47	-2.47	-2.46	-2.46	-2.45
Skilled labour	-2.76	-2.75	-2.75	-2.74	-2.71

Source: Model simulations

Exports and imports decline under both scenarios as does the demand for skilled and unskilled labour in Wales. The sectors most negatively affected by the exit of the UK (and Wales) from the EU are the automotive production, meat and agricultural processing industries and the pharma-chemical manufacturing sectors. The hardest hit sector are meat production and processing sector, while the rest of the Wales economy shows a marginal decline.

5. Conclusion and Policy Implications

The results for the economic impact of Brexit shows losses for the UK (Black, 2017; Fraser of Allander Institute, 2016; Dhingra, et al, 2016; Dhingra et al, 2017; Scottish Government, 2018). The magnitudes of losses vary due to the use of different methodologies and scenarios simulated by earlier studies. Our analysis confirms that under all the scenarios simulated, i.e., no-deal and on a transition arrangement, the long-term potential macroeconomic impact (GDP, GDP per capita, trade, investment and employment) shows losses for Wales and the UK.

With the introduction of MFN tariffs on UK-EU27 under a no-deal scenario trade losses will be high and the effects most damaging when the UK reverts to trading at WTO terms. The negative GDP impact of Brexit from a no-deal scenario for the EU is estimated to be -0.04%, for Wales it ranges from -0.5% to -0.59%, and for the rest of UK the losses range from -0.41% to -0.48%.so the losses for EU are marginal. Given that the EU stands to lose less compared to the UK and Wales, the results might explain the lack of EU flexibility on negotiating the backstop arrangement with the UK. For many commodities mainly agricultural goods, the relevant default MFN tariffs are significant, and the modelling suggests that this would lead to significant adjustments to trade flows between the UK and EU27 for some products, with consequent impacts on the UK domestic market. The transmission mechanism will lead higher prices to feed through into consumer prices hence impacting consumers' budgets and consumption patterns and disproportionately lowering income households. Additional losses will come from the imposition of costs, either through an imposition of tariffs and/or from loss of preferential access for UK exports to the single market which explains why the losses for the UK as a whole are higher under a no-deal scenario.

A transition arrangement for a limited period, i.e. to continue the current relationship with the EU, presents lower economic losses for the Welsh (and UK) economy. The longer the transition period between the UK and EU the lower are the losses for Wales. A transitional deal is vital as it provides continuity and clarity for businesses, with no new tariff or non-tariff barriers including customs procedures, no divergence on regulatory standards or certification requirements to access the EU Single Market. In addition during the transition period, Welsh businesses will be able to retain full access to the Single Market and remaining part of the Customs Union with the EU, on the basis of full alignment of product and regulatory standards with the EU. This explains why the Welsh Government has been consistent in asking for a full and unfettered access to the EU's Single Market to be the top priority for the UK Government. The findings explain the Prime Minister's insistence to put the current deal with the EU to vote in the Parliament given that a transition period will minimise the negative impact for the UK (and Wales).

In light of the findings, the principal objective of UK trade officials negotiating Brexit with the EU should be to mitigate the costs of Brexit as far as possible. The option to reduce costs is to obtain a transition arrangement with the EU that will grant as much market access for the Welsh (and UK) products. A transitional arrangement should stay in place until a long-term deal is agreed and not be time-limited in an arbitrary way given the strong independence of Wales on the EU. The other alternative is to undertake domestic policy changes to reduce the costs to business but this will involve additional time and costs. Some researchers have advocated that the UK should adopt a unilateral free trade policy and remove domestic regulations but the simulation results do not attempt to review the policy impact of such a proposal for Wales.

Table A1. GTAP 57 sector classification and mapping employed for the analysis

No.	GTAP 57	Long Name	Aggregate Sectors
1	Pdr	Paddy rice	Grains
2	Wht	Wheat	Grains
3	Gro	Cereal grains nec	Grains
4	v_f	Vegetables, fruit, nuts	Crops
5	Osd	Oil seeds	Crops
6	c_b	Sugar cane, sugar beet	Crops
7	Pfb	Plant-based fibers	Crops
8	Ocr	Crops nec	Crops
9	Ctl	Cattle,sheep,goats,horses	MeatLvstk
10	oap	Animal products nec	MeatLvstk
11	rmk	Raw milk	OthFood
12	wol	Wool, silk-worm cocoons	Crops
13	Frs	Forestry	Extraction
14	fsh	Fishing	Extraction
15	coa	Coal	Extraction
16	oil	Oil	Extraction
17	gas	Gas	Extraction
18	omn	Minerals nec	Extraction
19	cmt	Meat: cattle,sheep,goats,horse	MeatLvstk
20	omt	Meat products nec	MeatLvstk
21	vol	Vegetable oils and fats	OthFood
22	mil	Dairy products	OthFood
23	pcr	Processed rice	OthFood
24	sgr	Sugar	OthFood
25	ofd	Food products nec	OthFood
26	b_t	Beverages and tobacco products	OthFood
27	tex	Textiles	Omnfcs
28	wap	Wearing apparel	Omnfcs
29	lea	Leather products	Omnfcs
30	lum	Wood products	Omnfcs
31	ppp	Paper products, publishing	Omnfcs
32	p_c	Petroleum, coal products	Chemineral
33	crp	Chemical,rubber,plastic prods	Chemineral
34	nmm	Mineral products nec	Chemineral
35	i_s	Ferrous metals	Extraction
36	nfm	Metals nec	Extraction
37	fmp	Metal products	Extraction
38	mvh	Motor vehicles and parts	Omnfcs
39	otn	Transport equipment nec	Machequip
40	ele	Electronic equipment	Machequip

No.	GTAP 57	Long Name	Aggregate Sectors
41	ome	Machinery and equipment nec	Machequip
42	omf	Manufactures nec	Omnfcs
43	ely	Electricity	Utilities
44	gdt	Gas manufacture, distribution	Utilities
45	wtr	Water	Utilities
46	cns	Construction	Construction
47	trd	Trade	Trdtrnscomm
48	otp	Transport nec	Trdtrnscomm
49	wtp	Sea transport	Trdtrnscomm
50	atp	Air transport	Trdtrnscomm
51	cmn	Communication	Trdtrnscomm
52	ofi	Financial services nec	OthServ
53	isr	Insurance	OthServ
54	obs	Business services nec	OthServ
55	ros	Recreation and other services	OthServ
56	osg	PubAdmin/Defence/Health/Educa t	OthServ
57	dwe	Dwellings	OthServ

Table A2. GTAP country classification and mapping used for the analysis

Rest of UK	England, Northern Ireland and Scotland
Wales	Wales
USA	United States of America
China	China
India	India
Rest of EU	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia,
	Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania,
	Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain,
	Sweden, Bulgaria, Belarus, Croatia, Romania
Rest of the World	Rest of the World

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