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No Deal

The economic consequences & how they could be mitigated

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Contents

Foreword 2

Executive summary 3

1. Introduction 5

2. Modelling framework and scenario design 6

3. Results 8

3.1 Qualifications that should be considered when interpreting the results 10

3.2 How do our results compare to other estimates? 11

3.3 Brexit effects in context of other economic factors determining UK growth 13

4. Conclusions 16

Annex 1: Scenario specification 17

1. Baseline Development and policy implementation 17

2. Brexit 17

Tariffs 17

Border Costs 18

Non-tariff barriers to goods trade 18

Services and Investment 19

Movement of persons 20

3. Unilateral liberalisation 20

Tariffs 20

Rules of Origin Compliance Costs 20

Services and Investment 21

Annex 2: Methodology 22

2.1. The GTAP-FDI Model 22

2.2. Implementation 23

Foreword

Since June 2016, my view has always been that the economic impact of Brexit would end up much less than feared (by some Remainers, on the downside), or hoped for (by some Leavers, on the upside). The political impact has clearly been huge and will continue to be so for some time. But before and since the Referendum, we have seen wildly exaggerated claims about both the costs of leaving the European Union and the benefits of doing so. The same is true regarding the economic risks of leaving without a deal.

Look back at the 1970s, when Britain entered the European community, and held its first referendum on membership. Many of the claims made then were heavily exaggerated. The reality was that in economic terms membership didn't make a huge difference one way or the other.

I believe that the same is likely to prove to be the case this time. Brexit will come with both costs and opportunities but leaving the EU, even without a deal, will neither be a bed of roses nor armageddon.

This study of the macroeconomic impact of UK withdrawal from the EU without a preferential trade deal suggests that there would be some material costs but that the economy would nonetheless continue significantly to grow. It deserves careful consideration in Westminster but also in Brussels and the capitals of EU member states. Brexit - even under a No Deal scenario - would not be the determining factor for UK medium-term growth prospects, and if the UK government took steps to mitigate the effects of No Deal, the reduction in growth could be minimised even further.

This reinforces my view that the over-excited debate about Brexit is distracting us from the crucial decisions about the real challenges that we as a country ought to be focused on - how to rebalance our economy, how to save enough for our ageing population, how to finance the NHS and our public services, and so on.

The Government should continue to press hard for a negotiated exit from the EU and to reach a preferential free trade agreement. However, should that prove impossible, the primary impact of a No Deal exit would be political and geo-strategic, rather than economic.

Rt Hon Greg Hands MP
Conservative Member for Chelsea and Fulham
Former Chief Secretary to the Treasury

Executive summary

Open Europe's new study of the macroeconomic impact of a 'No Deal' Brexit concludes that a UK withdrawal from the European Union without a preferential trade deal would not be ideal and would bring some material costs. However, it would be a relatively mild negative economic event. Brexit will therefore not be the determining factor for the UK economy's medium-term growth prospects. Open Europe's strong recommendation remains that the Government seeks to secure a negotiated exit from the EU, while also being prepared for all scenarios including a No Deal exit in March 2019.

Our model suggests that a No Deal Brexit would mean the UK economy continuing to grow but with an effect equivalent to an average annual drag of -0.17% on real GDP growth over the 13 years up to 2030. This could be reduced to an average reduction in growth of -0.04% a year if the government deploys maximum mitigation measures in the form of unilateral trade liberalisation. The economic impact of an exit on so-called WTO terms is, over a 13 year period, small. And as we go on to demonstrate, the effects are limited in comparison with the forecasting noise typically seen in GDP models.

Key Findings

Open Europe's new study of the macroeconomic impact of a No Deal Brexit comes to three important conclusions:

1. UK withdrawal from the European Union without a preferential trade deal is sub-optimal and would bring a small material economic cost equivalent to an annual drag on growth of -0.17% per annum for thirteen years to 2030. However this cost is limited in absolute terms, but also relative to other factors affecting medium term UK economic growth.

   To put this in context estimates suggest that the construction of an additional 30,000 houses per year would more than compensate a -0.17% drag on GDP. We agree with the Office for Budget Responsibility's conclusion that the impact of Brexit "is likely to be relatively small compared to the degree of uncertainty surrounding the underlying path" of UK economic growth.[1]

2. This economic drag could be reduced to an average reduction in growth of -0.04% a year if the government deploys maximum mitigation measures in the form of unilateral trade liberalisation.

3. Whilst the costs of 'no deal' are material, they are much milder than is generally assumed and the terms of the UK's departure from the EU are very unlikely to be the determining factor for the UK economy's medium-term and long-term growth prospects.

There are two elements to this study:

- The first quantifies the impact of a No Deal Brexit against a baseline projection of future UK economic performance. The modelling exercise includes the assumption that a tariff wall and customs border would be imposed between the UK and the EU, and accounts for the emergence of some non-tariff barriers to UK-EU bilateral trade.

[1] *Office for Budget Responsibility*, 'Brexit and the OBR's forecasts', October 2018, p97: https://obr.uk/docs/dlm_uploads/BrexitDiscussionWebVersion.pdf

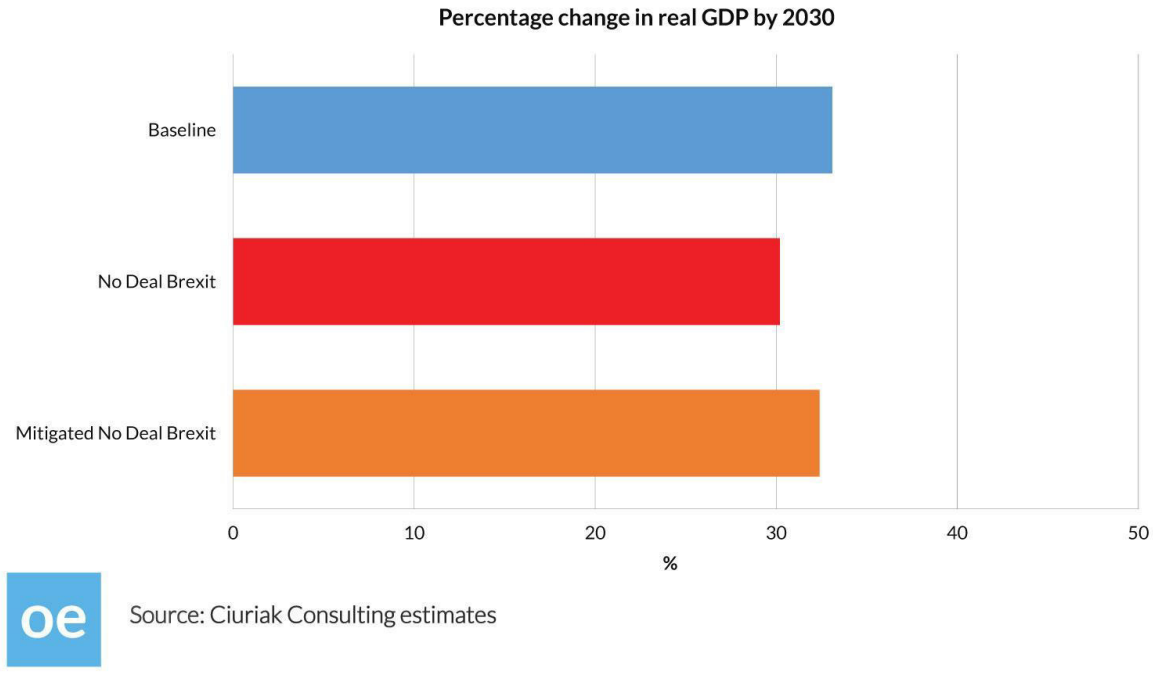
- The second quantifies the UK's ability to mitigate the effects of a No Deal Brexit by unilaterally removing UK tariffs on EU trade (as well as on trade with the Rest of the World) and unilaterally moving the UK to globally least-restrictive standards for services and foreign direct investment.

The modelling suggests that the cumulative effects of a No Deal Brexit would see the UK's real GDP growing overall but with the economy 2.2% smaller in real terms by 2030 than would have otherwise been the case. Unilateral liberalisation would see the UK recover up to 1.7% of that reduction in real GDP over the same period, with the net effect leaving UK real GDP 0.5% lower in 2030 than would have otherwise been the case.

Our study does not consider the one-time costs faced by government and business of adjusting to Brexit, nor does the model capture the sector-specific impact on deeply integrated UK-EU supply chains, such as on the automotive sector, which is likely to be negative. At the same time, these figures do not account for the cessation of the UK's net fiscal contribution to the EU budget, which would have a positive effect on UK GDP.

The size of these Brexit impacts is small compared to other long-term economic factors that are likely to drive future UK growth. For example, a June 2017 PwC study estimated that UK GDP could be 10.3% higher by 2030 as a result of advances in Artificial Intelligence.[2]

In summary, we can see no relationship between the cold numbers of our economic analysis, which are in line with other comparable studies, and the rhetoric of those who argue that Brexit will make a dramatic difference to Britain's growth trajectory in either a negative or positive direction. Leaving on WTO terms is not Open Europe's preferred option but in narrowly economic terms it would not, according to this model, be an unreasonable path for the UK to take, if a negotiated exit was unavailable.



[2] *PwC*, 'The economic impact of artificial intelligence on the UK economy', June 2017; https://www.pwc.co.uk/economic-services/assets/ai-uk-report-v2.pdf

1. Introduction

This study assesses the economic impact of the UK leaving the EU without a preferential trade deal. We do not assess the short-term implications of a No Deal Brexit. We estimate the impact of moving to a steady-state relationship whereby UK-EU trade is subject to tariffs, a customs border, and new non-tariff barriers. The premise is that the EU would treat the UK no worse than any other important trade partner with which it does not have a trade agreement in place. Our assumption is that the UK would be treated like the United States of America rather than, say, North Korea.

Against this background, we assess the scope for the UK unilaterally to mitigate the costs of Brexit. We do this by measuring the impact of the UK introducing unilateral liberalising measures to seek to address the negative effects of new barriers on UK-EU trade under a No Deal Brexit outcome.

The benefit of unilateral trade liberalisation is that it does not depend on negotiation with third parties, and hence is not limited by negotiating capacity (or desire) in either the UK or its prospective trade partners. In any event, even under a negotiated free trade agreement, the main gain from trade liberalisation comes from a country's own liberalisation. Trade liberalisation, through numerous mechanisms, drives a country's exports, increasing its openness to trade both through imports and exports. Indeed, a fundamental proposition of trade theory is that a tax on imports (through tariffs) is equivalent to a tax on exports.

Unilateral liberalisation has been a common trade policy tool. China and India, in particular, paved their way to becoming major global traders principally through unilateral tariff cuts, although their tariffs remain high. Other countries such as Canada, Australia and New Zealand have also engaged in extensive unilateral tariff elimination to improve economic efficiency and to facilitate integration into global supply chains.[3]

This leads to the question of why governments continue to negotiate reciprocal trade agreements rather than simply pursuing unilateral liberalisation? The main reason is that, after decades of multilateral liberalisation through the General Agreement on Tariffs and Trade (GATT) and World Trade Organisation (WTO), tariffs are generally low and remaining trade protection in most countries is in sectors that have either proven difficult to open, such as agriculture, or are protected by so-called "behind-the-border" trade barriers. Accordingly, governments can use the market access promised by a partner country's liberalisation as leverage to pry open their own protected sectors and vice-versa.

By the same token, unilateral liberalisation faces the political challenge of explaining to domestic constituents and protected sectors the economics of trade liberalisation. Equally, the aggregate benefits of unilateral liberalisation mask the effects on individual winners and losers. Winners tend to be diffuse while losers can be concentrated in individual sectors or important political constituencies. Another disadvantage of unilateral liberalisation as a trade policy tool is the issue of giving up leverage to conclude future bilateral trade agreements where market access in specific sectors might be genuinely of interest to the UK.

Section 2 of this report sets out the modelling framework used and outlines the assumptions made in the Brexit and unilateral liberalisation scenarios. Section 3 sets out the results, and Section 4 the conclusions.

[3] See *Baldwin*, 'Trade and Industrialisation After Globalisation's 2nd Unbundling: How Building and Joining a Supply Chain Are Different and Why It Matters', 2011; and *Ciuriak and Jingliang*, 'Should Canada Unilaterally Adopt Global Free Trade?', 2014: http://ssrn.com/abstract=2435302

2. Modelling framework and scenario design

The modelling framework and scenario design has been developed with Ciuriak Consulting, a Canadian based analytics firm, and builds upon the modelling framework in Open Europe's "*What if?*" study in 2015, which was also provided by Ciuriak Consulting.[4] The major difference is that the 2015 study assessed the impact of unilateral liberalisation with the rest of the world against the background of a successfully negotiated UK-EU trade deal in which tariffs between the UK and the EU27 remained at zero. This study instead assumes that the EU would treat the UK as a third country under WTO rules after Brexit and apply its Common External Tariff on UK trade. Against this scenario, we apply unilateral liberalisation measures to UK trade both with the EU27 and the rest of the world.

We use a Computable General Equilibrium (CGE) Global Trade Analysis Project (GTAP) model to estimate the economy-wide effects of the trade policy changes of Brexit and unilateral liberalisation in comparison to an economic baseline scenario.

The changes are implemented in year 2018 over a 13-year timeframe to 2030 to assess the impacts (this timeframe follows the same time period modelled in the previous Open Europe "*What if?*" study and allows the dynamic effects of the policy change to work through the model. Projecting beyond 2030 would be subject to very significant uncertainty). The reported gains relative to the baseline counterfactual in 2030 may be interpreted as a permanent change in the level of economic output, once full equilibrium has been restored following the policy shifts, including the reallocation of capital and labour across sectors in response to the changed opportunities in the liberalised economy.

We set out the key assumptions for our projections below.

Baseline

- The baseline counterfactual is that the UK remains in the EU (a scenario that we recognise will not happen but include purely for comparator purposes).
- The database for the simulations is the GTAP V10 dataset with a base year of 2014. For the simulations, the database is extrapolated to 2030 using GTAP dynamic tools and drawing on the International Monetary Fund's (IMF) World Economic Outlook database (Spring 2018) for guidance as to growth rates for the projection period.

Brexit scenario

- UK-EU trade shifts to a most-favoured nation (MFN) tariff basis, which creates a new tariff and customs wall in trade with the EU. We also introduce a border cost from new non-tariff barriers to UK-EU trade.
- The UK inherits EU WTO commitments, including the tariff regime and commitments under the General Agreement on Trade in Services (GATS), the Generalised Scheme of Preferences (GSP), Government Procurement Agreement (GPA), etc, and trades with the rest of the world on this basis.
- Free Trade Agreements (FTAs) with third countries stay in place. Both the UK and the EU honour outstanding liberalisation commitments vis-à-vis third parties under existing treaties and we assume that third parties do the same. This avoids attributing to unilateral liberalisation potential gains from trade that have already been realised through trade agreements.
- We adopt what might be termed "halfway house" assumptions for trade in a few highly protected agricultural products, where a move to MFN tariffs would shut down trade entirely.

[4] *Open Europe*, 'What If? The consequences, challenges and opportunities facing Britain outside the EU', 2015; https://openeurope.org.uk/intelligence/britain-and-the-eu/what-if-there-were-a-brexit/

In these cases, we limit the increase in bilateral protection levels to no more than those that currently apply between the EU and the US.
- We phase in non-tariff barrier (NTB) costs between the UK and EU for goods, services and Foreign Direct Investment (FDI).
- We do not incorporate a Brexit effect for movement of persons, since our modelling framework does not incorporate international labour mobility.

Unilateral trade liberalisation scenario

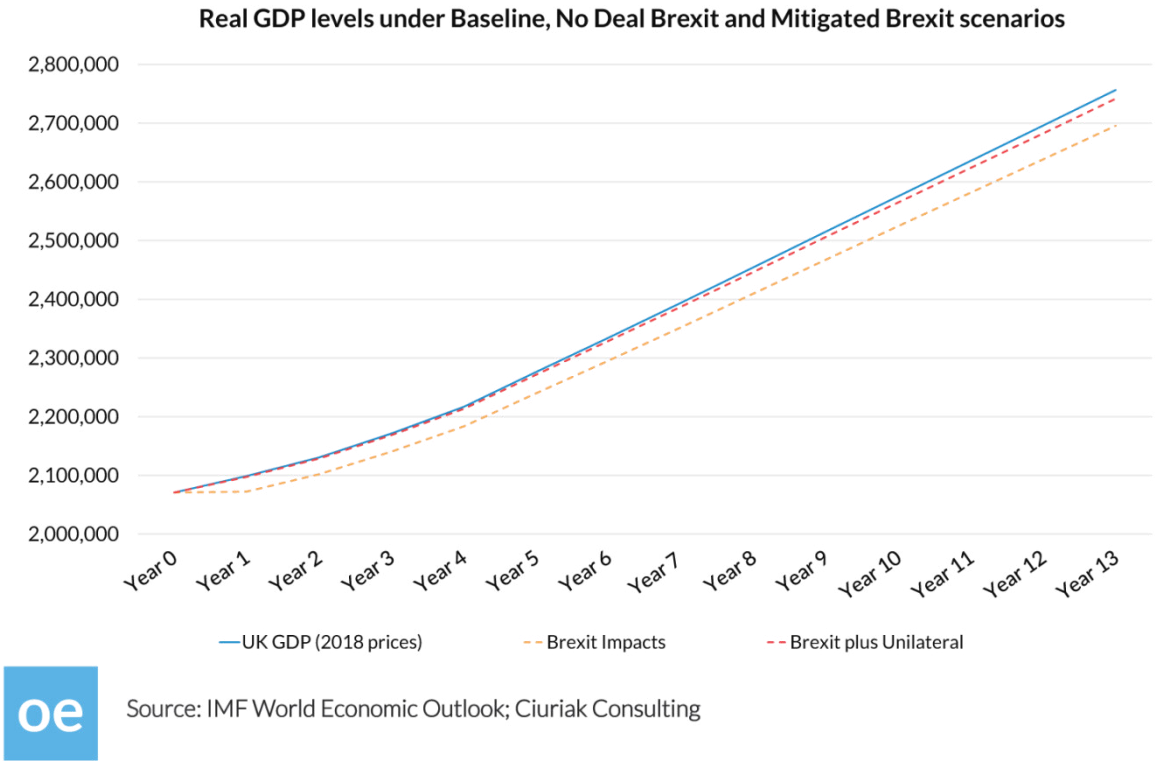
- The UK dismantles industrial tariffs immediately against the EU and the rest of the world, including the remaining restrictions on imports from current FTA partners.
- Agricultural tariffs are phased out over the period 2020-2030.
- We remove costs from complying with rules of origin requirements.
- For services and investment, we move the UK's scores on the OECD's Services Trade Restrictiveness Index (STRI) on cross-border access to the UK market from current levels to minimums established by global pace setters, and we reduce restrictions on FDI to minimums established by global pace setters.

For more details of the technical specifications of the baseline, Brexit and unilateral scenarios see Annex 1, which also discusses how they are likely to affect the scale of the impact of unilateral liberalisation, and on the margin between Brexit and unilateral scenarios. For further methodological information on the modelling framework see Annex 2.

3. Results

The impact of a Brexit scenario, whereby UK-EU trade was not facilitated by a preferential trade agreement, on future UK growth would be small but not immaterial. The UK economy would continue to grow but such a scenario would have an impact equivalent to an average annual drag of -0.17% on real GDP growth over 13 years. However, this impact could be reduced to an average -0.04% a year if the UK deploys maximum mitigation measures in the form of unilateral trade liberalisation, which includes tariff elimination (although we assume that tariffs are reduced gradually for agriculture) and adoption of globally least-restrictive services and investment policies.

The impacts of both Brexit and unilateral liberalisation would not be felt equally in each year over the projection period to 2030. The effects would be strongest in the first years when the tariff and border costs of Brexit and unilateral liberalisation measures are applied. The effect of these impacts would decrease as the economy returned to equilibrium towards 2030.



Source: IMF World Economic Outlook; Ciuriak Consulting

The cumulative effects of a Brexit without a UK-EU deal would see the UK's real GDP only 2.2% lower in real terms, at the end of a 13-year period in 2030, than would have otherwise been the case. [5] Unilateral liberalisation could see the UK recover up to 1.7% in real GDP over the same period, with the net effect leaving UK real GDP just 0.5% lower in 2030 than would have otherwise been the case.

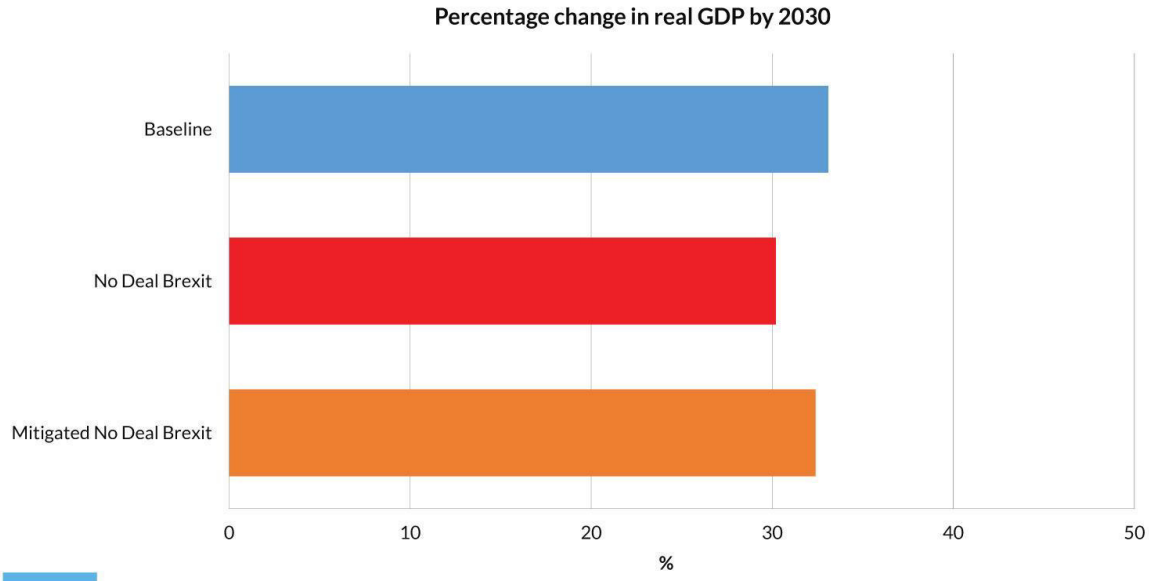
[5] CGE model runs from 2017-2030. UK GDP in Year 0 and 1 based on IMF World Economic Outlook data for 2017 and 2018.

Table 1: Cumulative change to real GDP from baseline levels in 2030

	Real GDP (%)
No Deal Brexit impacts	**-2.21**
Total Unilateral liberalisation impacts	**1.71**
Unilateral Goods	*1.26*
Unilateral Services	*0.41*
Unilateral FDI	*0.04*
No Deal Brexit + Unilateral liberalisation impacts	**-0.50**

oe Ciuriak Consulting estimates

As the chart above illustrates, the UK economy would be larger in 2030 under all scenarios. In other words, under our model, compared to 2017, the level of UK real GDP would be 30.2% higher by 2030 under a No Deal Brexit and 32.4% higher if the UK deployed maximum trade liberalisation measures. This compares to our counterfactual baseline where the level of UK real GDP would have been 33.1% higher in 2030. The impact on UK real GDP is therefore material but relatively small. The cumulative effect of a Brexit without a deal is equivalent to just under one year's trend growth in the counterfactual Brexit scenario.



oe Source: Ciuriak Consulting estimates

Measured in terms of economic welfare, another measure of prosperity and living standards, a Brexit without UK mitigation would reduce economic welfare by £62 billion by 2030 compared to what would otherwise have been the case. However, a UK trade policy of unilateral liberalisation generates welfare improvements of £35 billion, leaving welfare £27 billion lower in 2030 than would otherwise have been the case. Importantly though, like real GDP, our results show that

economic welfare would still increase over the 13-year period to 2030 under all Brexit scenarios modelled.

The net effect of unilateral liberalisation in mitigating the costs of Brexit is stronger for the level of real UK GDP than for economic welfare. This is due to the fact that, in the model, unilateral liberalisation leads to terms of trade declines, affecting relative prices and wages in the UK. Reciprocal trade liberalisation via bilateral trade agreements rather than via unilateral liberalisation would not generate such terms of trade effects, a factor which the UK should consider when developing its post-Brexit trade strategy.

Table 2: Cumulative change to Economic Welfare from baseline levels in 2030

	Economic Welfare (£million at 2018 prices)
Brexit impacts	**-61,887**
Total Unilateral liberalisation impacts	**34,554**
Unilateral Goods	*24,397*
Unilateral Services	*9,089*
Unilateral FDI	*1,068*
Brexit + Unilateral liberalisation impacts	**-27,333**

oe Ciuriak Consulting estimates

3.1 Qualifications that should be considered when interpreting the results

All economic modelling relies on the assumptions made and is constrained by the limitations of what effects the modelling framework is able to capture. Our assumptions and the limitations of the modelling framework are set out in detail in the Annexes to this paper. In the table below, we set out the key factors to consider when interpreting our results, which include those that would be likely to affect the results on both the downside and the upside.

Table 3: Qualifications when interpreting the results

Factors likely to increase downside impacts	Factors likely to increase upside impacts
• Our estimates do not reflect one-off adjustment costs from the status quo to a No Deal Brexit. These costs include putting in place the infrastructure to deal with a border and the one-time costs for business putting in place the arrangements to continue business outside the Single Market and modifying websites, letterheads, etc. • We assume the UK remains party to EU free trade agreements with third countries. The UK government is actively working towards this aim, but there is uncertainty as to whether the UK will face a period where some of these agreements no longer apply	• The results do not take into account the net fiscal transfer from the UK to the EU under its membership commitments, or UK regulatory reforms. • Cessation of the fiscal transfer to the EU would reduce the welfare cost of Brexit to the UK. Estimates of the net transfer at current levels are between £8 to 9 billion a year, about 13-14% of the welfare cost of a No Deal Brexit or about one-third of the net of Brexit plus unilateral as estimated in this study. • Open Europe has previously estimated the potential benefits of deregulation outside

or do so on different terms. ● The CGE modelling framework does not capture the effects of the disruption of deeply integrated value chains, sector-specific regulatory impediments to UK-EU27 trade, the labour market impacts of limiting access to EU labour, or the impact of Brexit on the strategic considerations of multinationals where to locate business. ● Sector-specific studies of Brexit impacts suggest a slightly bigger negative impact on the auto and financial services sectors and marginally more positive impact on the fisheries sector than our study. These sector-specific considerations would slightly increase the implied negative effect of a No Deal Brexit reported in this study.	the EU to be in the region 0.7% of GDP, stemming from the following areas: social and employment law, environmental regulation and, to a more limited extent, financial services. PwC's Brexit analysis modelled how these estimates of regulatory cost savings would be distributed across the UK economy with the effect that deregulation produced a 0.3% increase to UK GDP in their model. ● The results do not take into account the potential introduction of measures to alleviate border processes, including increased availability and usage of bonded warehousing, or the expansion of Automatic Economic Operator schemes.

3.2 How do our results compare to other estimates?

Compared to the 2015 Open Europe study "What if?", which estimated the impacts of a No Deal Brexit on real GDP and welfare of -2.76% and about £72 billion by 2030, our results are slightly smaller. This reflects a difference in the baseline data (in this study we use the latest GTAP V10 versus GTAP V9 in 2015), and differences in regional aggregations (in Open Europe "What If?", the EU27 was disaggregated into 16 regions, whereas for this study it is aggregated into one; this study in turn disaggregated the rest of the world trade to a greater extent than our 2015 research).

The Brexit impacts we report are in line with other estimates which use a similar methodology. There is a cluster of studies reporting No Deal Brexit trade impacts of -2% to -3% to UK GDP by 2030 – see Table 4. HM Treasury and the OECD report significantly bigger impacts because the studies incorporate additional dynamic effects, including on FDI and productivity, the effects of which are inherently more difficult to determine.

Table 4: Main findings and assumptions of various Brexit models (No Deal scenario)[6]

Study	No Deal Brexit overall impact on UK	Breakdown of impacts	Model	Key assumptions
Minford, 'How the Civil Service has misled us about the costs of Brexit and the Customs Union,' *Economists for Free Trade* (2018)	**+4%** to GDP by 2030		GTAP model.	Assumes unilateral liberalisation, minimal damage from NTBs, and gains from regulatory divergence. Does not account for fiscal savings from EU budget contributions.

[6] For further discussion see *Paczos*, 'Modelling the economic effects of trade policies', *NIESR*, July 2018: https://www.niesr.ac.uk/sites/default/files/publications/pp007.pdf; and *European Parliament*, 'An assessment of the impact of Brexit on the EU27', 2017: http://www.europarl.europa.eu/RegData/etudes/STUD/2017/595374/IPOL_STU(2017)595374_EN.pdf

Open Europe, 'What if...? The Consequences, challenges & opportunities facing Britain outside EU' (2015)	**-2.23%** to GDP by 2030	Trade impacts: **-2.76%** (-2.31% by 2025); Partially offset by savings on EU budget contributions (+0.53%)	GTAP CGE model.	Includes tariffs, border friction, goods NTBs, service NTBs and FDI NTBs. Assumes 3rd country FTAs stay in place. Accounts for some dynamic effects but does not fully consider impact on global supply chains.
Ottaviano et al, 'The Costs and Benefits of Leaving the EU: Trade Effects.' *Centre for Economic Performance, London School of Economics* (2016)	**-2.61%** to GDP by 2030	Trade impacts: **-2.92%;** Partially offset by savings on EU budget contributions (+0.31%)	NQTM using gravity model.	Perfect competition and trade in intermediaries. Includes dynamic effects.
Dhingra et al, 'The Costs and Benefits of Leaving the EU: Trade Effects,' *Centre for Economic Performance, London School of Economics* (2017)	**-2.7%** to real consumption (welfare) by 2029		New Ricardian model.	Assumes loss from long-term differences between intra-EU and extra-EU non-tariff trade costs.
Aichele and Felbermayr, 'Costs and benefits of a United Kingdom exit from the European Union,' *IFO* (2015)	**-2.8 to -3%** to GDP by 2030		NQTM using gravity model.	Higher negative GDP figure represents scenario where UK also loses all existing FTAs with third countries.
Mayer et al., 'The cost of non-Europe, revisited,' *CEPII* (2018)	**-2.9%** to real consumption (welfare)		Structural gravity estimation fed into a new Ricardian framework.	Includes trade in intermediate goods. No explicit assumption of the non-tariff and tariff costs.
PwC/CBI, 'Leaving the EU: implications for the UK economy' (2016)	**-3.5%** to GDP by 2030	Trade impacts: **-2.1%;** Further impacts from reduced immigration (-1.6%), uncertainty (-0.1%); offset by reduction to regulatory burden (+0.3%).	CGE model.	Assumes EU FTAs are not rolled over, end of free movement, and no increase in high-skilled migration. Assumption that new FTAs, including with with US, come into effect in 2026. Includes impact on productivity.

Rojas-Romagosas, 'Trade effects of Brexit for the Netherlands,' *NL Central Planning Bureau* (2016)	**- 4.1%** to GDP by 2030		CGE model.	Dynamic effect between trade volumes and productivity.
HM Treasury, 'HM Treasury analysis: the long-term economic impact of EU membership and the alternatives' (2016)	**-7.5%** to GDP by 2030		Gravity model approach, + macroeconomic & NiGEM modelling for productivity and FDI impacts.	Dynamic effect of FDI and productivity are considered. Welfare effects are included.
OECD, 'The economic consequences of Brexit: a taxing decision' (2016)	**-7.7%** to GDP by 2030		NiGEM macroeconomic modelling.	Dynamic effect of FDI and productivity are considered.

3.3 Brexit effects in context of other economic factors determining UK growth

Firstly, it is important to put the Brexit effects we report above in context. The projected average annual drag on GDP growth of between -0.17% and -0.04% in our Brexit scenarios is well within the average error rate for short-term year-ahead GDP forecasts by the IMF, OECD and Office for Budgetary Responsibility (OBR).

Table 5: Average error rates for short-term GDP forecast

Growth forecast	Average annual forecast error (% of GDP)
IMF Year-Ahead Forecasts for advanced countries (1991-2011)	-0.19 to -0.3
OECD Spring one year ahead forecasts for the UK (1991-2006)	0.48 to 0.5
UK Office for Budget Responsibility (Q1 2010 – Q1 2016)	-0.61

oe IMF, OECD and OBR

Similarly, in its most recent discussion paper on forecasting the effects of Brexit, the OBR notes, "It is important to emphasise that any adjustment we do make to our potential growth forecast as a result of Brexit is likely to be relatively small compared to the degree of uncertainty surrounding the underlying path. Estimates in external studies of the long-run hit to GDP from leaving the EU to trade solely on WTO terms, compared to staying in the EU, are concentrated around 2 to 7 per cent – with the full effect only felt over a period of greater than ten years."[7]

Secondly, it is important to note that Brexit will be only one of a number of factors driving the UK's economic performance over the coming decade. There are several other factors, independent of Brexit, which will alter the domestic and global environment and the trajectory of UK growth. Some are measures that the government might take to boost UK competitiveness, such as tax or planning

[7] *Office for Budget Responsibility*, 'Brexit and the OBR's forecasts', October 2018, p97: https://obr.uk/docs/dlm_uploads/BrexitDiscussionWebVersion.pdf

reform. Others, including Artificial Intelligence (AI) and the advent of driverless transportation, will be the result of rapidly advancing technological developments and innovation in the private sector in coming years.

The former special representative for the City of London to the EU, Jeremy Browne has argued that the UK faces "a multiplicity of disruptive effects" in the medium to long term, from automation and AI to US President Donald Trump's protectionist policies, noting that it will be "impossible to isolate the impact of Brexit on the economy."[8] Similarly, the Director General of the British Chamber of Commerce, Adam Marshall, has stressed, "Our future success depends not just on Brexit negotiations, but also on the big economic decisions that must be made here in the UK,"[9] and, "The message to government from Chamber business communities is that an ambitious domestic agenda matters as much, if not more, to their success than any eventual Brexit deal."

Projecting future economic developments with pinpoint accuracy is impossible but there are a range of factors that will compete with Brexit to determine the long-term future of the UK economy:

Government measures

- ***Reforming business taxation.*** The Institute of Fiscal Studies (IFS) has previously suggested the UK could introduce a "revenue-neutral tax reform package", which it is estimated could deliver long-run increases of 1.4% in GDP, 6.1% in investments and 1.7% in wages.[10] Among other things, this would introduce an allowance for corporate equity (ACE) within the corporate income tax, with an offsetting increase in consumption taxation.
- ***Reforming fuel and excise duty***. The IFS also suggested that replacing most fuel and vehicle excise duty with a national road pricing scheme could boost GDP by around 0.5% by 2025.[11]
- ***Abolishing Air Passenger Duty***. A PwC report suggests scrapping Air Passenger Duty could provide an initial short-term boost to UK GDP levels of 0.45% in the first 12 months, and a small but longer-term increase of 0.1%.[12]
- ***Boosting housing supply.*** According to a 2010 report by Savills and Oxford Economics, increasing housing output by an additional 100,000 properties per annum would deliver a 1% increase in GDP by the end of the second year, with further indirect economic gains over time.[13]
- ***Increasing public investment in research and development (R&D) programmes***. The IMF estimates that if the UK were to adopt a "balanced-budget" increase in public infrastructure spending of 0.35% of GDP and public R&D spending of 0.15% of GDP, this "would raise the level of both actual and potential output by 0.35% after five years."[14] The IMF suggests spending increases would raise UK public investment to the OECD average in the medium term, and could be offset by removing some preferential VAT rates.

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[8] *London Business School*, 'Brexit may be less disruptive than AI', 9 July 2018: https://www.london.edu/news-and-events/news/brexit-may-be-less-disruptive-than-ai-1504

[9] *British Chambers of Commerce*, 'BCC to Prime Minister: Time to 'fix the fundamentals' for UK growth', 22 May 2018: https://www.britishchambers.org.uk/news/2018/05/bcc-to-prime-minister-time-to-fix-the-fundamentals-for-uk-growth

[10] *Institute for Fiscal Studies*, 'Tax by Design,' 13 September 2011, p491-4: https://www.ifs.org.uk/publications/5353

[11] *Economic and Social Research Council*, 'Re-Igniting Growth. Research findings on achieving long-term economic recovery, '11 February 2013, p37: https://www.ifs.org.uk/docs/Reigniting_Growth_ESRC.pdf

[12] *PwC*, 'The Economic impact of Air Passenger Duty', February 2013: http://airlinesuk.org/wp-content/uploads/2013/09/APD-study-Abridged.pdf

[13] *Savills*, 'The case for housing: Impact of house building on the UK economy', Spring/Summer 2010, p3: http://pdf.euro.savills.co.uk/uk/market-insights/the-case-for-housing---spring-2010.pdf

[14] *International Monetary Fund*, 'IMF country report No. 18/42 - United Kingdom', February 2018, p22: https://www.imf.org/~/media/Files/Publications/CR/2018/cr1842.ashx

- ***Supporting female participation in the labour market***. The IMF has also noted that, while the UK female participation rate is already relatively high, "fully closing the participation rate gap would boost output by 5-6% in the long run."[15] It suggests policies to facilitate job sharing and compressed work schedules.
- ***Maintaining an open immigration system***. The government's Brexit economic analysis has found that expanding the existing UK immigration system to EU nationals under a no deal exit would lead to 90,000 fewer EU immigrants arriving in the UK per year, and could account for around 1% reduced GDP.[16] Government choices regarding the UK's future immigration system will therefore be a major factor in determining growth of UK GDP.

Innovation and private sector investment

The rise of new and disruptive technologies – in particular the data-driven economy, AI and driverless transportation – is also likely to have an important impact on the future economic development of the UK, independently of Brexit:

- A recent report by PwC estimates that AI will increase UK GDP by 10.3% by 2030, an order of magnitude five-times larger than our long-run no deal estimate.[17]
- Elsewhere, a 2016 joint study by Accenture and Frontline Economics estimates that the rise of AI could boost the UK's annual growth rate by 1.4% in 2035.[18]

None of these examples are cited as firm predictions of how the UK economy might develop, nor are these factors contingent on Brexit. The fact that growth enhancing government reforms have not already been implemented illustrates that they come with political challenges. Nevertheless, there is a wide range of economic factors that could alter the UK's future growth in ways that, individually or combined, could dwarf the Brexit impacts outlined above. In other words, Brexit is not a self-determining event nor can it be an end in itself. It is what UK policymakers do next that is just as important.

[15] *International Monetary Fund*, 'United Kingdom: Staff concluding statement of the 2018 Article IV mission', 17 September 2018: https://www.imf.org/en/News/Articles/2018/09/17/United-Kingdom-Staff-Concluding-Statement-of-the-2018-Article-IV-Mission

[16] *House of Commons Exiting the EU Committee*, 'EU exit analysis cross-Whitehall briefing', January 2018, p13, 18: https://www.parliament.uk/documents/commons-committees/Exiting-the-European-Union/17-19/Cross-Whitehall-briefing/EU-Exit-Analysis-Cross-Whitehall-Briefing.pdf

[17] *PwC*, 'The economic impact of artificial intelligence on the UK economy,' June 2017: https://www.pwc.co.uk/services/economics-policy/insights/the-impact-of-artificial-intelligence-on-the-uk-economy.html

[18] *Accenture and Frontline Economics*, 'Why Artificial Intelligence is the Future of Growth,' 28 September 2016: https://www.accenture.com/us-en/insight-artificial-intelligence-future-growth

4. Conclusions

This study quantifies the effect of a No Deal Brexit on medium-term UK economic growth, and the extent to which a UK policy of unilateral trade liberalisation could mitigate this negative impact. The modelling exercise includes imposing a tariff wall and customs border between the UK and the EU and the emergence of non-tariff barriers, in order to simulate the trade impact of a No Deal Brexit whereby the EU were to treat the UK as a third country akin to the USA. Then we remove UK tariffs on imports from the EU and the rest of the world and unilaterally move the UK to globally least-restrictive standards for services and FDI.

Firstly, as we concluded in our 2015 study, the trade impact of a No Deal Brexit is not, in of itself, likely to have a significant impact on long-term UK growth. Trading with the EU without a preferential trade agreement would not be ideal and would bring some material costs. However, it would be a relatively mild negative economic event. There is a wide range of other economic factors, from potential government reforms to advances in the data-driven economy, that individually or combined, could dwarf the effects of Brexit described in this study.

Secondly, our modelling suggests unilateral trade liberalisation could provide a significant offset to the trade costs imposed by Brexit. The net effect of unilateral liberalisation on real GDP reduces the next impact from -2.2% under No Deal Brexit to -0.5% under a unilateral mitigation scenario, while it reduces the impact on welfare from -£61.8 billion to -£27.3 billion. The positive offsetting effect of unilateral liberalisation on the level of real GDP is more pronounced than its effect on economic welfare. This is because, while unilateral liberalisation provides benefits in terms of lower prices for consumers, the terms of trade effects mean that UK prices and wages fall overall relative to world prices. Reciprocal liberalisation in the form of negotiated bilateral trade agreements, both with the EU and rest of the world partners, would not come with such strong terms of trade effects and would therefore be likely to generate more positive welfare impacts.

Comparison with Open Europe's 2015 study also suggests that a negotiated reciprocal UK-EU trade deal would be economically preferable to UK unilateral liberalisation. Open Europe's 2015 study found that the combined effects of a UK-EU deal followed by unilateral liberalisation with the rest of the world would have a smaller negative impact versus the counterfactual than we find from a No Deal Brexit followed by UK unilateral liberalisation with both the EU and the rest of the world.

Thirdly, a UK policy of unilateral trade liberalisation would pose domestic political challenges. While unilateral liberalisation works to offset the costs of a No Deal Brexit in aggregate, the effects at the sectoral or firm level are likely to work in different directions: there will be winners and losers and the sector-specific effects are likely to be greater under a No Deal Brexit than a negotiated Brexit outcome.

While we found the economic effects over the medium-term of a No Deal Brexit to be small, we do not believe that the political and foreign policy effects would be limited. It is our view that the strategic impact of a failure to reach a negotiated exit of the UK from the EU, could be profound. However, this was outside the scope of this report.

Annex 1: Scenario specification

1. Baseline Development and policy implementation

We first establish a baseline projection of the global economy to 2030. The underlying database is the GTAP V10 dataset with a base year of 2014.The tariff wall between the UK and the rest of the EU (REU) is based on that developed for the Brexit analysis in Open Europe (2015).

The changes are implemented in 2018, which mirrors the timescale used in Open Europe (2015) and allows for direct comparison. Results reported are changes relative to the baseline at 2030. The reported gains in 2030 may be interpreted as a permanent change in the level of economic output, once full equilibrium has been restored following the changes, including the reallocation of capital and labour across sectors in response to the changed opportunities in the liberalised economy.

2. Brexit

The Brexit scenario implements the scenarios developed for Open Europe (2015) adapted to an updated database (GTAP V10 versus GTAP V9). Other noteworthy changes include the aggregation of the REU into one region – in Open Europe (2015), the REU was disaggregated into 16 regions.

Below, we review the No Deal Brexit scenario with a focus on how the construction of the scenario might impact on the scale of the unilateral liberalisation effects, and particularly on the margin between No Deal Brexit and unilateral mitigation.

Tariffs

The UK inherits EU WTO commitments, including the tariff regime and commitments under the General Agreement on Trade in Services (GATS), the Government Procurement Agreement (GPA), etc., and trades with the rest of the world on this basis.

The EU's current FTAs stay in place. Both the UK and the REU honour outstanding liberalisation commitments vis-à-vis third parties under existing treaties and we assume that third parties do the same. This avoids attributing to unilateral liberalisation potential gains from trade that have already been realised through trade agreements.

UK-REU trade shifts to a most-favoured nation (MFN) tariff basis. The tariffs applied are based on the Open Europe (2015) tariffs, aggregated from 16 REU regions to the single REU region in the present study. It is to be noted that trade-weighted tariffs change from year to year as the composition of trade changes; accordingly, the tariffs that would be in place in 2020 when we implement unilateral liberalisation would differ somewhat from the tariffs used to quantify the effects of the shift. However, of relevance for the purposes of this study, the Brexit tariff effect is symmetrical to the unilateral liberalisation effect of removing those tariffs on the UK side under unilateral; accordingly, to the extent that sector-specific trade-weighted tariffs are higher or lower, both the Brexit and unilateral effects would scale in the same magnitude, leaving the relative impact more or less the same.

Brexit would raise issues regarding the managed agricultural trade regime under the EU's Common Agricultural Policy (CAP). Over the years and the course of numerous General Agreement on Tariffs and Trade (GATT)/WTO negotiations, the EU has accommodated the agricultural export interests of third parties with tariff rate quotas on sensitive products. But no such agreements have been put in place for the UK – or, conversely, for REU exporters in the UK. We adopt what might be termed "halfway house" assumptions for trade in a few highly protected agricultural products, where a move to MFN tariffs would shut down trade entirely. In these cases, we assume that the

UK and the REU would reach a pragmatic accommodation that limits the increase in bilateral protection levels to no more than those that currently apply between the EU and the US.

Border Costs

We introduce a border cost for UK-REU trade of 3.26% in ad valorem terms, following the assumptions in Open Europe (2015). This is based on estimates drawn from the literature on the time costs for customs clearance and some additional administrative costs (for example, submitting customs declarations at the border and paying value-added tax as they cross the border) scaled to the average value of a container as the representative unit of trade. This is a moderate estimate of border costs. Moïse and Le Bris (2013) estimate that the cost of crossing borders, including due to time and documentation, can increase the transaction costs of trade by between 2% and 24% of the value of traded goods. For time-sensitive industries, estimates suggest that every 1 hour of customs delay adds 0.8 percentage points to the ad valorem trade-cost rate and leads to 5% less trade (Hornok, 2011). Our estimate is thus at the low end of this range and readily accounted for by the time and administrative costs of a container crossing a relatively efficient border. This is reasonably consistent with World Bank Doing Business data which positions the UK as average for high-income economies with a "distance to the frontier" score of 93.76% (World Bank, 2018).

We do not factor in the one-time costs of erecting a possible customs border control between Ireland and Northern Ireland (a scenario that Brexit Secretary Dominic Raab has himself ruled out), nor the one-time administrative costs of a Brexit on British and REU firms. For example, VAT would no longer be charged on UK-REU shipments, so firms would have to put in place the paperwork to modify their VAT collection and reporting systems. Membership of UK firms in EU internal organisations would lapse, requiring repatriation of representatives, etc. Websites, letterheads, advertising, etc. would all have to be modified. We could not find a basis to calibrate these latter costs and so do not include them, although they are likely to be non-negligible when cumulated across businesses.[19]

Non-tariff barriers to goods trade

We phase in non-tariff barrier (NTB) costs between the UK and REU equivalent to those faced by EU firms in Canada, which is a reasonable proxy for a liberal, efficient trade environment tailored for access to both EU and US markets.[20] Such estimates, which emerge from analysis of trade patterns of countries that do not operate within a Single Market, may not fully pick up the full NTB cost reduction achieved within the Single Market and that might be foregone on exit. For example, our estimate generates a negative impact of about -0.5% on GDP, which is modest compared to some estimates of the long-term effect that run to as high as about -4.5% of GDP (Giles, 2018). Since one would not expect the EU regulatory acquis ingrained in UK regulation over decades to be eliminated from UK regulation immediately upon Brexit, for the time frame evaluated in this study a discount on any long-term impact might be more appropriate, especially given that the EU would remain by far the UK's largest trading partner; at the same time, an aggressive de-regulation that in turn limited market access for UK exports in the REU could result in larger bilateral NTB frictions.

One source of non-tariff barriers to trade is uncertainty. Uncertainty acts like a business cost and reduces trade engagement at the firm level. Crowley et al. (2018), using the universe of UK export transactions at the firm and product level and cross-sectional variation in 'threat point' tariffs, estimate that in 2016 over 5,200 firms did not enter into exporting new products to the EU, and almost 4,000 firms exited from exporting products to the EU due to Brexit-related uncertainty. These reductions are significant: entry (exit) in 2016 would have been 5.1% higher (4.3% lower) if

[19] See *Centre for International Economics*, 'Nutrition, health and related claims: A benefit cost analysis', 2008, which estimates that the cost of one-off label changes was around 1.1% of product costs.

[20] See *Petri, Plummer and Zhai*, 'The Trans-Pacific Partnership and Asia-Pacific integration: A quantitative assessment', 24 October 2011, p66: https://www.eastwestcenter.org/system/tdf/private/econwp119_2.pdf?file=1&type=node&id=33123

firms exporting from the UK to the EU had not faced increased trade policy uncertainty after June 2016. This uncertainty effect is not captured by estimates of tariff effects alone. Since affected firms are likely small and medium-sized enterprises (SMEs), the impact on aggregate trade flows is smaller than the percentages cited; however, since export market entry and exit has implications for firm-level productivity (good in the case of entry and bad in the case of exit), the knock-on efficiency and dynamism effects are likely more significant.

Another uncertainty effect might be transient – for example, recent estimates suggest that UK real GDP was lowered by as much as 2.5% due to Brexit-induced uncertainty, with the main operational factor being a pause in consumer spending and investment; this delay would presumably not be a permanent effect.

However, some sources of uncertainty would persist. For example, the EU tariff features many tariff lines that are suspended, but could be reimposed within the EU's tariff bindings under the WTO Agreement. We do not include this uncertainty effect in constructing the tariff wall between the UK and the REU, which results in some understatement of the impact of No Deal Brexit. At the same time, this reduces our estimate of liberalisation potential since the UK could in principle choose to bind its own zero tariffs at the WTO to give firms increased confidence of the future UK tariff regime. Since the binding effect would be one-sided, it follows that the margin between Brexit and unilateral would be marginally greater than estimated due to this effect.

Another permanent source of uncertainty for bilateral market access created by exit from the Single Market is that bilateral UK-REU trade becomes exposed to trade remedy actions, including anti-dumping, anti-subsidy, safeguard measures and even potentially carbon border offsets (the EU at one point sought to impose landing fees for non-EU aircraft, although it did not proceed due to pushback from the United States).

Overall, there are good reasons to anticipate that while some sources of uncertainty might be transient, others could be permanent, and could result in less trade engagement by certain firms with ensuing consequences for trade and economic dynamism, and by their nature could not be offset by unilateral liberalisation.

Services and Investment

In the No Deal Brexit scenario, bilateral restrictions on services and investment change from assumed EU internal standards to the levels applied by the UK and REU to third parties. We base our estimate of Community internal standards for cross-border services and FDI on the least restrictive regime maintained by any EU Member State under the OECD's Services Trade Restrictiveness Index (STRI). This introduces a relatively modest trade-restrictive effects for cross-border trade in services and for investment. This appears to be reasonable given evidence that intra-EU trade in services is generally deeper than external services trade but the deepening is much less than for goods (Stráský, 2016; Fournier, 2015). Mayer et al. (2018) find that the intra-EU services trade is deepened by the Single Market to an extent about half the effect on goods trade.

Of particular relevance for this study, the Brexit services scenario increases potential for unilateral liberalisation. Accordingly, to the extent that we under- or over-estimate the Brexit services scenario, the margin between Brexit and unilateral should not be materially affected.

More significantly, we do not account for sector-specific issues related to the Single Market such as the Passport issue for financial services and air transport issues which would not, in any event, be amenable to unilateral measures. These considerations suggest that the margin between No Deal Brexit and unilateral mitigation could be somewhat larger than assumed in this study.

The implications of reduced inward FDI in our modelling environment are primarily on the efficiency of capital. Firms capable of outward investment tend to the very best firms in any given

economy; accordingly, if FDI crowds out domestic investment, then a negative impact on inward FDI from Brexit would "crowd in" domestic investment. The net difference would be that between the productivity of capital in a multinational firm and the productivity of purely domestic investment.

Movement of persons

We do not incorporate a Brexit effect for movement of persons, since our modelling framework does not incorporate international labour mobility. Implicitly, this assumes that Mode 4 (commercial presence) services trade is significantly grandfathered for expatriates currently employed, and the increase in restrictiveness under Brexit would only impact on future workers, or those without jobs. Open Europe (2015) comments on this and observes that, since the labour supply exchange between the UK and the REU within the Single Market is roughly balanced, the main impact would be in terms of improved matching of jobs and workers and that this effect would likely be small. Some estimates of the impact of reduced labour mobility between the UK and the REU suggest it is relatively significant: e.g., Giles (2018) indicates that the impact might be as large as -0.5% of GDP.

Liberalising inward movement of persons would be open to the UK under unilateral liberalisation. Accordingly, not including it in the Brexit scenario, nor in the unilateral scenarios, scales down the effects of both. This is not likely to have a significant impact on the relative scale of the two effects.

3. Unilateral liberalisation

Tariffs

The UK dismantles industrial tariffs immediately against all of its trading partners, including the remaining restrictions on imports from current EU FTA partners whose tariffs are at free trade levels (Mexico in our regional disaggregation), and the new tariff wall that would be constructed vis-à-vis the REU under Brexit. Agricultural tariffs are phased out over the period 2020-2030 on a straight-line basis.

For Canada, Japan and Korea, which have signed FTAs that are not reflected in the GTAP dataset, we assume that the UK would be able to either immediately or eventually convert EU trade agreements into bilateral agreements and so, to avoid attributing to unilateral liberalisation what has already been largely accomplished through negotiated in-place deals, we reduce tariffs for these countries only by an amount equivalent to assumed under-utilization of preferences. About 12.8% of preference-eligible trade into the EU does not use preferences (Keck and Lendle, 2012). Since about 30% of EU tariff lines are bound at zero, we assume that about 8.9% (=0.7*12.8%) of trade with preferential partners continues to pay the tariff. We assume this would be liberalized under unilateral liberalisation. We reduce the GTAP tariff by 8.9% as the liberalisation effect.

Rules of Origin Compliance Costs

For preferential trade partners, the use of tariff preferences comes with a cost of complying with rules of origin (ROOs). We add in a cost reduction for ROOs cost elimination. Compliance with the EU family of ROOs is generally considered to be relatively costly and in the middle of the range of empirical estimates of ROOs costs; accordingly, we adopt an often-cited estimate by Francois et al. (2006) and Manchin (2006), who identified the tariff threshold of about 4-4.5% below which preferences lose their attraction to trading firms because of compliance costs. We use 4% for our simulations.

Implementation of the removal of ROOs compliance costs takes into account available evidence concerning utilization of EU preferences. Following the same logic as used to construct a liberalisation effect for tariffs for Canada, Japan and Korea, we assume that 61% of trade with these partners is subject to compliance costs (based on the 70% eligible and 9% which does not use preferences). Hence the ROOs cost saving is 0.61*4% = 2.44%. For ASEAN and India, which

benefits from EU GSP, we apply the same cost reduction. For the rest of the world, which includes the African, Caribbean and Pacific (ACP) GSP beneficiaries, we assume that 15% of the UK's imports from the ROW are under a form of preference, including the GSP. Taking into account the EU share of trade subject to preferences, which we apply to the UK, this results in a cost reduction of 0.37% (4%*0.15*0.7*0.872) for imports from the ROW.

Services and Investment

The UK could also include services and investment liberalisation in its unilateral liberalisation. We develop the following effects:

- Reducing current restrictions as measured by the UK's scores on the OECD's Services Trade Restrictiveness Index (STRI) on cross-border access to the UK market to minimums established by global pace setters;
- Reducing FDI restrictions to minimums established by global pace setters.

Annex 2: Methodology

To assess the global impacts of the policy changes, we apply a computable general equilibrium (CGE) model that incorporates foreign direct investment (FDI). In this appendix, we provide an overview of the GTAP FDI model (Ciuriak, et al., 2017), set out the modelling protocols and assumptions for implementing the scenarios, and describe the derivation of the policy changes.

2.1. The GTAP-FDI Model

The GTAP-FDI model is a recursive-dynamic variant of the widely used Global Trade Analysis Project (GTAP). We use a perfect competition specification of the GTAP model. For a technical description of the basic GTAP model, see Hertel (1997); for a discussion of the degree of confidence in CGE estimates, see Hertel et al. (2003).

General

The GTAP-FDI model integrates a number of accounts to provide a complete description of an economy:

- The standard national income and expenditure accounts;
- A breakdown of industry by sector that reflects inter-sectoral input-output links that take into account internationally-sourced intermediate goods and services (in all, the GTAP dataset allows for the representation of up to 57 sectors, 43 of which are goods);
- A production function for each sector that combines sector-specific inputs of capital, skilled and unskilled labour, and intermediate inputs; and
- A trade account that models the international linkages for each sector of the economy.

On the production side, the model evaluates efficiency gains from reallocation of factors of production across sectors. In the first stage, land, labour (skilled and unskilled), and capital substitute for one another to generate domestic value added by sector; intermediate inputs, which include imported intermediates, substitute for domestic value added in a second stage.

On the demand side of the model, an aggregate Cobb-Douglas utility function allocates expenditures to private consumption, government spending, and savings so as to maximise per capita aggregate utility. Following a policy change, the resulting shifts in consumption are allocated across these three aggregates based on their income shares in each region. Private household demand responds to changes in prices and income based on the standard Constant Difference of Elasticities demand system in the GTAP model.

The trade module assumes imperfect substitution based on product differentiation across regions. The key parameter determining the scale of impacts on trade from a tariff change is the elasticity of substitution – a high substitution elasticity generates relatively large trade impacts for a given size of tariffs. Note that the GTAP sectors reflect relatively large aggregates of individual products; accordingly, substitution elasticities are lower than they would be for product categories that are defined more narrowly and, thus, are more substitutable for each other.

Economic welfare is based on "equivalent variation", the lump sum payment at pre-changed scenario prices that would have to be made to households to leave them as well off as in the post-changed scenario economy.

The Recursive-Dynamic Framework

The recursive dynamic feature is based on an investment module in which capital supply responds to changes in the rates of return (ROR) to capital. The investment response is based on the Monash-type investment function (Dixon and Rimmer, 2002). In this function, the growth rate of capital (and, hence, the level of investment) is determined by investors' willingness to supply increased capital to each sector in each country, which in turn depends on changes in the expected ROR for capital in that sector and region.

Assuming that investors are cautious, any effect to the ROR in a given sector and region is, however, eliminated only gradually. This results in similar treatment of investment as in models that incorporate costs of adjustment that are positively related to the level of investment in a given year (based on, e.g., construction/installation costs of capital suppliers). The Monash model, however, instead of relying on increasing adjustment costs as the mechanism to limit investment, incorporates investor perceptions of risk for this purpose.

The parameter that mediates the supply response of capital – i.e., the elasticity of the supply of capital to RORs – is set at unity, based on firm-level gravity modelling.

Incorporating FDI

The GTAP-FDI model modifies the standard GTAP framework by having two investors for each sector and each region: one domestic investor and one foreign investor. By contrast, the GTAP database has only one composite investor for each region-sector. The sum of FDI and domestically owned FDI in each region sector equals the capital stock in the original GTAP database to preserve the integrity of the overall database. Similarly, the sum of domestic sales of foreign affiliates (FAS) and domestic companies equals total domestic sales in the GTAP database. We utilise the FDI and FAS data in Lakatos et al. (2011) to breakdown the corresponding GTAP aggregates.

The characteristics of the foreign-owned investor are derived from firm-level data from Standard & Poor's Capital IQ database, aggregated to GTAP sectors. Consistent with the empirical findings from the heterogeneous firms literature, foreign-owned firms tend to have higher returns on capital. This higher return is explained by a phantom tax on FDI that restricts FDI inflows. FDI flows respond to changes in rates of return across economies due to policy change, including for changes in policies that liberalise or restrict FDI. For the detailed description of the derivation of the FDI model, see Ciuriak, et al. (2017).

2.2. Implementation

The database for the simulations is the GTAP V10 dataset with a base year of 2014. For the simulations, the database is extrapolated to 2030 using GTAP dynamic tools and drawing on the International Monetary Fund's World Economic Outlook database (Spring 2018) for guidance as to growth rates for the projection period.

Regions and Sectors

Table A1: Study sectors for the GTAP-FDI Model Simulations

Agriculture	Resource-based	Manufacturing	Services
Cereal grains	Forestry and Wood Products	Textiles, Apparel and Leather	Construction
Fruit and Vegetables	Fishing	Chemicals, Rubber and Plastics	Trade
Oilseeds and Vegetable Oil	Fossil Fuels	Ferrous Metals	Transportation Services

Other Farming	Mineral Products	Non-Ferrous Metals	Communication
Sugar		Metal Products	Financial Services
Dairy		Automotive	Recreational Services
Beef		Transport Equipment	Other Services
Pork and Poultry		Electronic equipment	
Food Products		Machinery & Equipment	
Beverages and Tobacco		Other Manufacturing	

Source: the study team.

Table A2: Regions for the GTAP-FDI Simulations

UK	China	Brazil
EU27	Taiwan	Argentina
Turkey	Japan	Australia
USA	Korea	Russia
Canada	ASEAN	ROW
Mexico	India	

Source: the study team.

Closures

Both labour and capital are mobile across all sectors within a country. Since capital is mobile internationally, we adopt the external closure that allows the external trade balance to adjust.

Given that we use a dynamic version of the GTAP model, capital responds to changes in the rate of return on capital.

The labour supply closure assumes that the quantity of labour supply moves in line with real wages; this assumption is implemented by splitting the change in the total wage bill into wages and quantity. (Ciuriak and Xiao, 2016). The impact on the quantity of labour can be interpreted as either a change in job totals, a change in productivity or a combination of the two. The co-movement of wages and productivity is consistent with microeconomic theory which anticipates that labour will be paid its marginal product. It is also consistent with heterogeneous firms theory and empirics which establish that stronger firms, which gain market share under trade liberalisation, are more productive and pay higher wages.

While the model does not establish the split of labour quantity impacts into productivity and jobs, this can be backed out of the simulation results on the basis of an assumption concerning the elasticity of labour supply to real wages. For this purpose, we assume a long-run labour supply elasticity of 0.35 to a change in real wages.

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