

THE LONG-TERM ECONOMIC IMPACT OF LEAVING THE EU

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The aim of this paper is to analyse the long-term implications of leaving the EU for the UK economy. To do this, we consider three main channels by which the UK economy could be affected in the long run:

- 1) Reductions in trade with EU countries and a modest increase in tariff barriers.
- 2) A reduction in foreign direct investment (FDI), particularly affecting services FDI.
- 3) A reduction in the UK's net fiscal contribution to the EU.

We input these effects of leaving the EU into NiGEM, the National Institute Global Econometric Model, a multi-country economic forecasting model. NiGEM has been developed at NIESR over the past three decades and is funded by subscriptions from international institutions, central banks and finance ministries from around the world, as well as some private sector institutions. Both the OECD and HM Treasury have also chosen to use NiGEM to conduct their analysis of the economic impact of leaving the EU. This is not surprising, as NiGEM's explicit trade linkages make it particularly well-suited to modelling the impact on the UK economy of shifts in trade policy.

This article presents our estimates of the long-run impact of leaving the EU over the next fifteen years, not only on GDP, but on consumption, real wages, unemployment, and a range of other (endogenously determined) variables. We find that by 2030, GDP is projected to

be between 1.5 per cent and 3.7 per cent lower than in the baseline forecast in which the UK remains in the EU. Real wages fall somewhat more, by between 2.2 per cent and 6.3 per cent. Consumption is also hit somewhat harder than GDP, falling by between 2.4 and 5.4 per cent. Real wages and consumption decline more than GDP in the long term due to a long-term deterioration in the terms of trade, coupled with a shift towards savings.

Table 14 compares our estimated long-run reductions in GDP to those of three other prominent studies published by the OECD, the Centre for Economic Performance (CEP) at the LSE and HM Treasury. While the studies assume broadly similar reductions in trade and FDI, as well as similar reductions in the UK's net contributions to the EU, the range of estimated impacts on GDP relative to the 2030 baseline is considerably larger. We summarise these results by reporting the estimated reduction in GDP for each percentage point reduction in total trade. In the CEP analysis, GDP is reduced by 0.5 per cent to 0.75 per cent for each 1 per cent reduction in total trade, while in the OECD and HM Treasury studies, the reduction is about 0.3 per cent to 0.4 per cent of GDP for each 1 per cent decrease in total trade. In our analysis, GDP is reduced by 0.1 per cent for each 1 per cent reduction in trade, so that our estimates can be seen as more conservative.

Our modelling strategy is to focus on a small number of the clearest and most well-understood potential impacts on the EU economy of leaving the EU in our core scenarios. As a result, it is not surprising that our estimated reductions in GDP are smaller than those of

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studies allowing for a wider range of impacts. One key distinguishing feature of our analysis is that our core scenarios abstract from any direct impact of openness on productivity. This differentiates our analysis from the two other published studies which also use NiGEM: HM Treasury (2016) and OECD (2016).¹

While HMT (2016) and OECD (2016) cite a large body of empirical evidence suggesting that openness might be associated with higher levels of productivity, there is also considerable uncertainty about the factors driving the UK's recent productivity performance.² For this reason, we think it prudent and valuable to focus only on the most well understood impacts of trade and FDI of leaving the EU in our core scenarios. Any reductions to productivity stemming from reductions in openness should be layered on top of these estimates, as should any increases to productivity from reductions in EU regulation.

However, it is important to note that there is a very real risk that leaving the EU might have a negative impact on productivity. Abstracting from any direct impact on productivity may account for much of the difference between our lower and the OECD and HM Treasury's higher estimates of the long-run GDP impact of leaving the EU. We find that adding a productivity shock of similar magnitude to the Treasury's to one of our scenarios brings our results roughly into line with the Treasury's, and we now find a GDP decline of 7.8 per cent relative to the 2030 baseline for this scenario, compared to a decline of 2.7 per cent without the productivity shock, a difference of 5.1 per cent of GDP.³ This illustrates that the estimates from our core scenarios are conservative, and that there is a risk that the negative economic impact of leaving the EU could be substantially larger. We discuss this and other unmodelled risks in more detail when presenting the results in full.

As a model with general equilibrium properties, NiGEM allows the economy to adapt to its new situation outside the EU. EU demand for our exports falls, but so do export prices and the effective exchange rate, which helps to stem the decline in exports. However, we estimate that the decline in the effective exchange rate leads exports to drop only by at most 2.4 per cent less than they would have done in the absence of currency depreciation. The net effect of leaving the EU on trade remains strongly negative. The UK model's flexible labour markets also adjust over the long run, so that our analysis does not lead to any appreciable increase in long-run unemployment. That is, NiGEM allows the UK economy to adjust to its new situation in a variety of

ways, and some of these adjustments tend to temper the negative impacts of Brexit in the long run.

Of course, a key question concerns the counterfactual: what would the relationship between the UK and the rest of the EU, and the rest of the world, look like after a UK exit from the EU? There are many possibilities. We focus on three main scenarios:

- 'Norway', membership in EEA, free trade in goods and services with the EU, including access to EEA financial services markets via passporting.
- 'Switzerland', bilateral agreements with the EU on free trade in goods, but no free trade in services and no access to EEA financial services markets via passporting.
- 'WTO', no membership in free trade agreements for goods or services with EU, no passporting.

In all three cases, the UK would no longer belong to the EU's customs union. This implies that rules of origin would need to be applied to UK exports to the EU, and there is no access to the EU's free trade agreements with third parties.⁴ In all three scenarios, we consider optimistic and pessimistic estimates of the declines in the UK's total trade.

We base our scenarios on estimates of the magnitudes of the reductions in trade and FDI, and the likely increase in tariffs, on a synthesis of the existing academic literature. In the next section, we present a brief overview of the existing evidence on the impact of trading block membership on trade in goods and services and FDI in manufacturing and services. We also use HM Treasury and European Commission data on the UK's contributions to the EU to estimate the fiscal savings from exit. Then, we go on to use the National Institute Global Econometric Model (NiGEM) to present the impact of these three main effects on the UK economy.

All of the scenarios involving UK exit from the EU lead to substantial exchange rate depreciations and current account deterioration in the wake of the Referendum. As a consequence, in a companion article (Baker *et al.* in this issue), we also model explicitly the impact of post-Brexit uncertainty on the UK economy in the period immediately after a vote to leave the EU. We undertake this modelling exercise by increasing a variety of risk premia in the model. We then run our trade, FDI and fiscal shocks on the new path where there is a greater degree of short-run uncertainty faced by the UK economy. That is,

our modelling approach takes into account that in order to arrive at the new long-run state of the UK economy on exit from the EU, the economy is expected to transit through a period of considerable uncertainty in the short run. The uncertainty in the immediate post-Brexit period has little appreciable impact on the long-run outcomes, however.

Scenarios

Decrease in trade volumes

Table 1 summarises the declines in trading volumes with the EU used to calibrate the shock to the UK's export market shares to the EU for each of our three scenarios: Norway, Switzerland and WTO. These estimates are based on a synthesis of the available evidence. These declines in EU export market shares lead to declines in total trade reported in the final two columns of table 1.⁵

The European Union covers trade in both goods and in many important categories of services, while most other preferential trade agreements (PTAs) cover trade in goods only. This makes it difficult to draw conclusions from the econometric studies covering a large number of goods-only PTAs for trade in services, especially since the UK is one of the world's leading exporters of services. We address this issue by looking separately at the impact of PTAs on goods and on services. We base our estimates on four key papers: Baier *et al.* (2008), van der Marel and Shepherd (2013), Ceglowski (2006), and Egger *et al.* (2011).

Goods trade

The standard framework for estimating the impact of trading block membership on trade volumes is the theoretically based gravity model (Anderson and van Wincoop, 2003). Gravity models estimate bilateral trading volumes as depending on measures of trading costs such as distance, common border, common language, as well as on membership in the same trading block. Gravity models are the standard framework used by economists for estimating the impact of trade

barriers, borders and free trade agreements on the volume of trade.

First we consider the impact on goods trade with the EU associated with the Norway or Switzerland scenarios. Baier *et al.* (2008) use a theoretically-based gravity model to estimate the reduction in trade from being a member of EFTA (i.e. being in the EEA but not the EU) on trade as 38 per cent over ten years or 25 per cent over five years (table 2).⁶ Although Baier *et al.* (2008) use data on both goods and services in these estimates, we consider them to be mainly relevant for goods trade, and much less so for services trade.⁷ This is because Baier *et al.* (2008) use panel data at 5-year intervals from 1960 until 2000, and most of the variation in EU versus EFTA/EEA membership occurs before 1990. Before 1990, trade was much more heavily weighted towards goods than it is today, especially for the UK (table 4). After 1995, the period of most substantial trade in services, the only EFTA/EEA members remaining were Norway and Switzerland – and Switzerland does not participate in the single market for services. So it seems likely that the estimates are largely capturing the impact of EU vs EFTA/EEA membership on goods trade.

Table 2. Trade: reduction in bilateral goods trade from leaving the EU, Baier *et al.* (2008)

	Regression results from Baier <i>et al.</i> (2008)			
	Levels		First differences	
	Table 5 (1)	Table 5 (3)	Table 6 (1)	Table 6 (2)
EU(t)	0.65** [7.86]	0.45** [4.01]	0.48** [8.91]	0.47** [8.63]
EU(t-1)		0.37** [3.13]		0.23** [4.41]
sum	0.65	0.82	0.48	0.70
EEA(t)	0.19* [2.11]	0.05 [0.48]	0.19** [4.02]	0.17** [3.49]
EEA(t-1)		0.29** [2.85]		0.06 [1.40]
sum	0.19	0.34	0.19	0.23
<i>Percentage change in bilateral trade</i>				
EU > EFTA	-36.9%	-38.1%	-25.2%	-37.5%
EU > No EIA	-47.8%	-56.0%	-38.1%	-50.3%

Notes: Regressions are run in logs, so the percentage change in trade from moving from the EU to EFTA is obtained as: $\frac{\exp(x_{EFTA}) - \exp(x_{EU})}{\exp(x_{EU})}$. The percentage change in trade from leaving the EU but joining no other economic integration area (EIA) is obtained as: $\frac{\exp(0) - \exp(x_{EU})}{\exp(x_{EU})}$. EU(t) gives the impact of currently being an EU member on trade (i.e. over the last 5-year period), while EU(t-1) gives the impact on trade of also having a member 5 years previously, while their sum gives the impact of having been an EU member over the past 10 years.

Table 1. Trade: impact of leaving the EU on total trade, long-run NiGEM outcome

	Declines in EU export market shares		Declines in total trade (NiGEM)	
	Optimistic	Pessimistic	Optimistic	Pessimistic
Norway	23%	39%	10.5%	16.5%
Switzerland	31%	42%	13.3%	17.5%
WTO	50%	72%	20.7%	29.2%

Note: Declines in total trade are calculated as $(x_{Brexit} - x_{Baseline})/x_{Baseline}$.

Table 3. Trade: impact of leaving the EU on EU export market shares

	Goods		Services		Total	
	Baier <i>et al.</i>	v d Marel Shepherd	Ceglowski	Baier + v d Marel Shepherd	Baier + Ceglowski	Egger <i>et al.</i>
Norway	25% – 38%	40%	19% – 28%	29% – 39%	23% – 35%	–
Switzerland	25% – 38%	40%	45% – 54%	29% – 39%	31% – 42%	–
WTO	53%	43%	63%	50%	56%	72%

Note: We calculate the decline in total trade in goods and services by using that in 2014, 72.4 per cent of trade with the EU was in goods and 27.6 per cent was in services trade.

The estimated reduction in goods trade for Switzerland and Norway may be due to the fact that neither of these countries belongs to the EU's customs union. Despite being inside the single market, being outside the EU's customs union imposes additional non-tariff barriers on Norway and Switzerland. A customs union is like Schengen for goods: once a good is inside the customs union, it can move around freely with no further questions asked. Norway and Switzerland, however, are subject to the EU's rules of origin in goods trade. For example, a car produced in Germany, and containing an engine imported from Japan, can be sold anywhere in the EU without further ado. If the same car had been produced in Norway, it would have to obtain a sort of 'visa' which details the origin of its components, and potentially pay a tariff for the Japanese engine. This complicates Swiss and Norwegian goods trade with the EU, especially for products with complex supply chains. Augier *et al.* (2005) study the impact of rules of origin on trade between EU countries and their free-trade agreement (FTA) partners, and find that they can reduce trade by up to 70 per cent, with central estimates lying around 40 per cent.

Next, we consider the impact on goods trade of leaving the EEA entirely, and not joining any other trading block. Baier *et al.* (2008)'s point estimates, reproduced in table 2, indicate that the reduction in goods trade lies between 50 per cent and 56 per cent over ten years, depending on whether the regression is run in levels or in first differences, and we take the average of 53 per cent.⁸

Table 4. Trade: long-term trends in UK share of commercial services in total trade

	Exports	Imports	Total trade
1980	31.1	21.8	26.4
1990	29.1	20.1	24.1
2000	41.5	27.7	33.9
2010	63.4	27.8	42.5

Source: WTO Time Series Database and own calculations.

Services trade

Next, we consider the evidence on the impact of trading block membership on bilateral services trade. There is reason to believe that estimating services trade separately from goods trade might be advisable. *Prima facie* it would seem that some of the key determinants of goods trade – distance as a proxy for transport costs, for example – would matter less for trade in some kinds of services, especially for the high value-added financial and business services in which the UK specialises. Rather, services face a host of non-tariff barriers to trade, regulatory and legal impediments to selling services across borders. Being a member of a trading block might be important in reducing these types of trade barriers. For example, non-EU banks can only do business in the EU by establishing a subsidiary in an EU country. Once a bank has acquired an EU 'passport', however, it is free to do business across the EU.

We present the evidence from two articles which have attempted to estimate the impact of trading block membership on services trade. Both are based on gravity models, but differ somewhat in their focus and in the data used.

Ceglowski (2006) estimates theoretical gravity models for bilateral trade in services, and examines the relationship to trade in goods. The Norway scenario involves continued free trade in services, including access to EU financial markets via 'passporting'. However, one hypothesis about services trade is that it is in part a by-product of goods trade, in particular for services such as transport, communications or cross-border finance (Fieleke, 1995). Ceglowski (2006) tests this hypothesis by running a 2SLS regression, using the log of lagged goods trade as an instrument. She finds that a 1 per cent increase in goods trade should lead to a 0.74 per cent increase in services trade. Combined with the 25 per cent (38 per cent) reduction in goods trade from leaving the EU for EFTA/EEA, we get a decrease in services trade of 19 per cent (28 per cent) by the 'goods channel' for

Norway and also for Switzerland. In the Island Nation scenario, the 53 per cent reduction in goods trade leads to a decrease in services trade of 39 per cent by the ‘goods channel’.

Once the log of lagged goods trade is included as an instrument in Ceglowski (2006)’s gravity regressions, none of the other standard gravity variables such as the product of GDPs, distance, common border or common language is significant in explaining bilateral service trade flows. The only exception is the variable for membership in a trading block, which would decrease the UK’s trade in services with other EU members by 26 per cent *over and above* the impact on goods trade.⁹ We call this the ‘EU channel’.

We obtain the impact of trading EU membership for Switzerland’s bilateral agreements, which do not cover services, as the sum of the 19 per cent (28 per cent) reduction in services trade by the ‘goods channel’ and the 26 per cent reduction by the ‘EU channel’. Similarly, we obtain the estimated reduction in services trade with the EU by combining the 39 per cent reduction by the ‘goods channel’ with the 26 per cent reduction by the ‘EU channel’.

Goods and services trade

Egger *et al.* (2011) provide the most methodologically up-to-date estimates of the impact of Preferential Trade Area membership on trade, but their estimates do not differentiate specifically between EU membership and EEA membership, nor do they differentiate between goods and services.¹⁰ Using 2005 data from the UN World Trade Database, Egger *et al.* (2011) both accounts for endogeneity of preferential trade agreements by a two-stage instrumental variables procedure, and for the large numbers of ‘zeros’ in the UN trade data by using a non-linear Poisson Pseudo-Maximum Likelihood estimator, as suggested by Santos Silva and Tenreyro (2006). Their coefficient estimate of 1.2701 (standard error of 0.3961) corresponds to a decline in total trade of 72 per cent from leaving a PTA completely.¹¹ We take this to be our most pessimistic estimate for the WTO scenario.

Over the past decades, there have been very few examples of trading blocks or free-trade agreements breaking down. Hence, most of the variation in the data underlying the gravity estimates reported above refers to countries which join free trade agreements (FTAs). This raises questions about asymmetries: are the estimated trade increases from joining a FTA larger or smaller than the estimated trade decreases from leaving a FTA? While there are not enough such break-ups of FTAs to make a reliable comparison,

there is some evidence on the presence of asymmetries in the trade effects from the formation or break-up of *currency* unions. Glick and Rose (2002) found evidence in favour of large trade effects from currency union break-ups, but subsequent analyses focusing on currency union formation found much smaller or no trade creation.¹² Campbell (2013) finds that controlling for country-pair trends might be important to avoid bias. Thus, it is prudent to remain aware that there might be some risks to assuming symmetry of the trade effects of joining a free trade area and leaving one.

Tariffs

In all three cases, the UK would no longer belong to the EU’s customs union, and the UK would lose access to the EU’s free trade agreements with third parties. The UK would be facing most-favoured-nation (MFN) tariffs with all its non-EU trading partners, until it was able to negotiate new trading deals. The average WTO most-favoured-nation import tariff is 9 per cent.¹³ We assume that UK goods would face an average 5 per cent increase in tariffs. This allows some scope for the negotiation of preferential trading agreements.

FDI

Membership in the European Union might matter for inward foreign direct investment (FDI) for two reasons:

- 1) Free movement of capital might make it easier for firms from other EU-28 countries to invest in the UK.
- 2) Free trade in goods and services, including passporting, and labour mobility across the EU, might make the UK a more attractive destination for FDI from outside of the EU.

All other things equal, membership in the European Union should increase inward FDI to the UK, both from the rest of the EU and from the rest of the world.¹⁴

There is relatively little direct evidence on the quantitative impact of belonging to the European Union – or to any other free trade area – on FDI. There are three main methods for estimating the impact of EU membership on FDI: gravity models, synthetic cohorts, and regressions of FDI on trade openness.

Table 5 summarises the evidence from gravity models. Gravity models and the synthetic cohort approach both generate estimates of the decline in FDI from leaving the EU completely, corresponding to our Island Nation scenario. The range of estimates for the decrease in FDI to leaving the EU lies between 12 per cent and 28 per

Table 5. FDI: gravity estimates of the impact of EU membership on inward FDI

Authors	Type of FDI	Data	Controls for zeros?	Coefficient on inward FDI flows	Increase in trade from joining EU	Decrease in trade from leaving EU
Bruno <i>et al.</i> (2016)	All to EU	34 OECD countries, 1985–2013	No	0.285 (0.077)	33%	25%
	All to EU	34 OECD countries, 1985–2013	Yes	0.320 (0.163)	38%	28%
	All to EU	34 OECD countries, 1985–2013	Yes	0.132 (0.050)	14%	12%
Straathof <i>et al.</i> (2008)	Intra-EU	30 OECD countries, 194–2004	No	0.25 (0.09)	28%	22%
	Non-EU to EU	30 OECD countries, 1994–2004	No	0.11 (0.05)	12%	11%
HM Treasury (2016)	Intra-EU	40 countries, 2000–2012	Not reported	0.298**	35%	26%

Table 6. FDI: declines in inward FDI flows to the UK

	Decline in services trade to GDP ratio	Decline in annual services FDI inflows (2013 \$ bn)	Average FDI inflows to UK 2009–13	% decline in FDI inflows to the UK	% decline in FDI inflows to the UK
	(a)	(b)	(c)	(b)/(c)	Midpoints
Norway	2.2%–3.1%	\$4.4–\$6.1bn	\$54.4bn	8.0%–11.3%	9.7%
Switzerland	3.1%–6.3%	\$6.1–\$12.5bn	\$54.4bn	11.3%–22.9%	17.1%
Island Nation	5.6%–7.4%	\$11.1–\$14.7bn	\$54.4bn	20.4%–26.9%	23.7%

Sources: Own calculations (a), (b) and OECD (c).

Table 7. FDI: declines in UK private sector investment

	Decline in annual services FDI inflows	UK PSI 2013 (2013 \$ bn)	% decline in UK PSI	% decline in UK PSI	Decline in FDI as % of GDP
	(a)	(b)	(a)/(b)	Midpoints	
Norway	\$4.4–\$6.1bn	\$364.9bn	1.2%–1.7%	1.5%	0.2%
Switzerland	\$6.1–\$12.5bn	\$364.9bn	1.7%–3.4%	2.6%	0.35%
Island Nation	\$11.1–\$14.7bn	\$364.9bn	3.0%–4.0%	3.5%	0.5%

Sources: Own calculations (a) and ONS (b).

cent for gravity models (table 5), and between 25 per cent and 30 per cent for the synthetic controls approach of Campos and Coricelli (2015).¹⁵

While these gravity and synthetic control estimates are instructive, they are also difficult to project onto the Norwegian or Swiss scenarios. The HMT (2016) study cited in table 5 also attempts to estimate an FDI impact of EEA membership, but concludes that the insignificant coefficient estimates are due to the limitations of the data, in particular the very small number of countries in the EEA in the 2000s.

Greater openness to trade might also make a host country more attractive for inward FDI, if the goods

and services produced there can easily also be exported to other nearby markets. There are two key advantages of using estimates of the impact of openness on inward FDI to the UK. First, this measure captures total inward FDI flows, rather than only the FDI from intra-EU trade. Second, it allows us to map the differential impact on trade in the Norwegian, Swiss and WTO scenarios directly into impacts on FDI.

Evidence on the impact of openness to trade on FDI in both services and manufacturing is provided by Ramasamy and Yeung (2010). They use data from the OECD countries covering 1980 to 2003 to estimate a fixed effects panel model. They find that openness is a much more important determinant of inward FDI flows

for services than for manufacturing. A 1 percentage point increase in the services trade to GDP ratio results in an increase of \$1.98 billion in inward services FDI flows, but an increase of only \$1.66 million in inward manufacturing FDI flows.¹⁶ As a result, we focus the rest of our discussion on this services channel.¹⁷

Table 6 presents estimates of the reductions in inward FDI to the UK in each of the three scenarios from the Ramasamy and Yeung (2010) estimates of the impact of openness, measured as the change in the services trade to GDP ratio, on inward services FDI flows. Column (a) translates the declines in services trade in table 1 into reductions in the services trade to GDP ratio, while column (b) multiplies these by Ramasamy and Yeung's estimate of \$1.98 billion. Column (c) reports average FDI inflows to the UK (OECD, 2015) in \$billions in 2009–13, while the neighbouring column gives the range of estimated percentage declines in inward FDI post-Brexit. We use the midpoints of each of these ranges to calibrate the decline in FDI inflows.

Our estimates for the decline in FDI inflows to the UK are quite similar to those reported in HMT (2016): 9.7 per cent for Norway (against 10.0 per cent in the Treasury analysis), 17.1 per cent for our Swiss scenario (compared to 15–20 per cent for the Treasury's FTA scenario and 23.7 per cent for the WTO scenario (compared to 18–26 per cent in the Treasury's WTO case), although our estimates were obtained using a different methodology. Finally, table 7 converts the reductions in FDI inflows to declines in UK private sector investment (PSI). We calibrate a shock such that UK PSI decreases by the midpoints of these estimates for each scenario into NiGEM, coupled with a corresponding negative shock to the balance of payments. The final two columns of table 7 show that these are rather modest negative shocks to PSI of between 1.5 per cent and 3.5 per cent, never exceeding 0.5 per cent of GDP.

Fiscal costs and benefits

Each year, the UK government contributes to the European Union budget. At the same time, the EU allocates some of its spending to the UK. Some of this EU spending is funnelled through the UK government: for example, the UK government uses some EU funding to finance a public investment project or to support farmers. Some EU funding goes directly to private-sector bodies in the UK: for example, some UK universities receive research grants directly from the European Union.

The UK is a net contributor to the EU budget: we contribute a larger amount to the UK budget than we

receive back in EU spending. The amounts involved are fairly small, however. In 2014, the UK contributed 0.8 per cent of its GDP to the EU, and received EU spending equivalent to 0.3 per cent of GDP, for a net contribution to the EU budget of 0.5 per cent of GDP (table 8). This corresponds to a gross contribution of €17.8bn or £14.4bn, and a net contribution of £8.6bn (table 9).¹⁸

In the case of the UK leaving the EU, there would be scope for increasing domestic spending or reducing taxes by the projected level of the UK's net contribution to the EU. We examine the size of the direct fiscal adjustments, that is, how much the UK government would save if the UK were to leave the EU.

Tables 8 and 9 give the OBR's projections for the evolution of the UK's contributions to the EU, as well as for the UK's public sector receipts from the EU. We add a projection of a constant 0.08 per cent of GDP in private sector receipts from the EU, largely research funding, based on the average over the period 2009–15.

The UK's total net contribution, defined as its contributions to the EU budget net of both public and private sector receipts from the EU, is set to peak in 2016 at £9.5 billion, or 0.49 per cent of GDP. After this, the total net contribution is projected to fall to between 0.31 per cent and 0.36 per cent between 2017 and 2020.

There are three possibilities for the direct fiscal impact of leaving the EU. By direct fiscal impact, we mean only the impact from no longer contributing to the EU budget. In all cases, we assume that the government would replace the spending that the EU currently undertakes in the UK, both to private and to public sector bodies. This means that the government would be left with a choice on what to do with the net contributions it would have made to the EU: spend it, use it to reduce the deficit or to reduce taxes. We assume that the government would use the repatriated contributions to increase spending. We also make an appropriate adjustment to the balance of payments.

The UK is projected to contribute 0.63 per cent of GDP to the EU budget, but also to receive 0.30 per cent of GDP in EU spending. Assuming that the UK government would replace all projected EU spending in the UK, then the saved net contributions to the EU would be 0.33 per cent of GDP.

In the WTO scenario the UK would cut all ties to the EU and EEA. In this case, we assume that the UK government would gain 0.3 per cent of GDP to use either for debt

Table 8. UK and the EU budget, based on HMT and OBR figures and forecasts, % of UK GDP

	Gross contribution (a)	Rebate (b)	Total contribution (b)	Public sector receipts (d)	Public sector net contribution (c)-(d)	Imputed private sector receipts (e)	Total net contribution (c)-(d)-(e)
2009	0.95	0.36	0.59	0.30	0.29	0.08	0.21
2010	0.98	0.19	0.78	0.31	0.48	0.06	0.42
2011	0.95	0.19	0.75	0.25	0.51	0.10	0.41
2012	0.94	0.19	0.76	0.25	0.50	0.09	0.42
2013	1.04	0.21	0.84	0.23	0.60	0.09	0.51
2014	1.03	0.24	0.79	0.25	0.54	0.07	0.47
2015	0.95	0.26	0.69	0.23	0.45	0.08	0.37
2016	1.00	0.22	0.78	0.21	0.57	0.08	0.49
2017	0.87	0.27	0.59	0.21	0.39	0.08	0.31
2018	0.87	0.23	0.64	0.21	0.44	0.08	0.36
2019	0.88	0.23	0.66	0.22	0.44	0.08	0.36
2020	0.87	0.24	0.64	0.22	0.42	0.08	0.34
Ave 2009-14	0.98	0.23	0.75	0.27	0.49	0.08	0.41
Ave 2015-20	0.91	0.24	0.67	0.22	0.45	0.08	0.37

Sources: UK GDP: OBR November 2015 Economic and Fiscal Outlook, Supplementary Economy Tables, Table I.4. Gross contributions to EU budget, Rebate, Public sector receipts, 2009-14: HM Treasury. Gross contributions to EU budget, Rebate, Public sector receipts, 2015-20 forecasts: Webb and Keep, 2016, citing OBR.

Notes: Private sector receipts are imputed to be the difference between public sector receipts reported by the OBR, and the total receipts reported by EU (2016). For the forecasts for 2015-20, we take private sector receipts to be 0.08% of UK GDP, their average over 2009 to 2014. Remaining data for 2015-20 are based on OBR projections, as reported in Webb and Keep (2016).

Table 9. UK and the EU budget, based on HMT and OBR figures and forecasts, £ billions

	Gross contribution (a)	Rebate (b)	Total contribution (c)=(a)-(b)	Public sector receipts (d)	Public sector net contribution (c)-(d)	Imputed private sector receipts (e)	Total net contribution (c)-(d)-(e)	UK GDP
2009	14.1	5.4	8.7	4.4	4.3	1.2	3.1	1,486
2010	15.2	3.0	12.2	4.8	7.4	0.9	6.5	1,556
2011	15.4	3.1	12.2	4.1	8.2	1.5	6.7	1,620
2012	15.7	3.1	12.6	4.2	8.4	1.5	6.9	1,665
2013	18.1	3.7	14.5	4.0	10.4	1.5	8.9	1,735
2014	18.8	4.4	14.4	4.6	9.8	1.2	8.6	1,817
2015	17.8	4.9	12.9	4.4	8.5	1.5	7.0	1,882
2016	19.6	4.3	15.3	4.2	11.1	1.6	9.5	1,958
2017	17.8	5.6	12.1	4.3	7.9	1.6	6.3	2,044
2018	18.5	4.8	13.7	4.4	9.3	1.7	7.6	2,133
2019	19.7	5.1	14.6	4.9	9.7	1.8	7.9	2,227
2020	20.3	5.5	14.8	5.1	9.7	1.9	7.8	2,327

Sources: As table 1.

Notes: Private sector receipts are imputed to be the difference between public sector receipts reported by the OBR, and the total receipts reported by EU (2016). For the forecasts for 2015-20, we take private sector receipts to be 0.08% of UK GDP, their average over 2009 to 2014. Remaining data for 2015-20 are based on OBR projections, as reported in Webb and Keep (2016).

reduction, tax reduction or additional spending. Norway and Switzerland, however, still contribute to the EU budget, although their contributions are somewhat smaller than the UK's. It is difficult to estimate what the UK's contributions to the EU would be in these scenarios, as this would be subject to negotiation. The House of Commons (2013) reports that Norway's

per capita net fiscal contribution to the EU is 83 per cent of the UK's, and there are EU countries whose net contributions are close to or lower than Norway's. We assume, therefore, that the UK's contribution to the EU would not change in the Norway scenario, while in the Swiss and WTO cases we assume savings of 0.3 per cent of GDP.

Long-term impact on the UK economy of leaving the EU

We now present the results of our NiGEM modelling of the projected long-term impact on the UK economy of leaving the EU relative to the baseline. Tables 10–12 summarise the main results for key macroeconomic aggregates for each of the three scenarios. In this text, we focus on the long-run implications for the UK economy and compare outcomes for each of the Brexit scenarios to the baseline of remaining in the EU in 2030.

Norway

The most favourable outcome would occur if the UK were successful at retaining the same kind of market access to the EU as EEA member Norway. In this case, GDP is projected to decline by between 1.5 per cent and 2.1 per cent relative to the 2030 baseline. Households are expected to be hit somewhat harder: real wages for households are projected to decline by 2.2 per cent to 3.2 per cent, and consumption is projected to decline by 2.4 per cent to 3.3 per cent, while total private sector investment drops by 0.6 per cent to 0.7 per cent compared to the baseline. The greater impact on real wages and consumption can be traced back to the permanent deterioration in the terms of trade. Import prices rise permanently, while export prices fall, so that the consumption basket becomes more expensive relative to domestically produced output. The fall in investment is much smaller, also reflecting the shift in the relative price of consumption.

Norway currently obtains its market access in exchange for taking on virtually all EU regulation, accepting free movement of people, and making contributions to the EU budget which are not much smaller on a per capita basis than those of the UK today. As a result, it is difficult to see what benefits in terms of reduced regulation or control of migration (although it is far from clear that taking over control of migration would bring economic benefits) might be set against the projected GDP losses. Indeed, the Norway scenario does not seem to be favoured by proponents of leaving the EU.¹⁹

Switzerland

The Switzerland scenario assumes somewhat looser links with the EU, but would still involve a free trade agreement in goods with the EU. There would be no free trade agreement in services, and UK-domiciled banks would no longer have automatic access to EEA markets via passporting. As a result, this scenario involves somewhat larger losses in market share with the EU, leading to larger declines in trade of between 13.3 per

cent and 17.4 per cent. Now, GDP declines by between 1.9 per cent in the optimistic and 2.3 per cent in the pessimistic version, both relative to the 2030 baseline. Again, households are hit somewhat harder: real wages fall by 3.1 per cent to 3.8 per cent, and consumption is projected to drop by 2.8 per cent to 3.5 per cent compared to the non-Brexit baseline.

Again, Switzerland's bilateral agreements involve accepting large areas of EU regulation and free movement of people, as well as a somewhat more modest contribution to the EU budget than the UK.²⁰ Similarly to the Norwegian model, it is difficult to see how this arrangement would bring substantial regulatory control to the UK, and it is far from clear whether control of migration would be feasible. Indeed, the Switzerland scenario also does not seem to find favour with proponents of Brexit.²¹

WTO

The WTO scenario assumes the loosest links with the EU: there would be no free trade with the EU in either goods or services. The larger loss in EU market share would also result in larger long-term declines in total trade of between 20.7 per cent and 29.2 per cent. The resulting declines in GDP relative to the 2030 baseline are projected to lie between 2.7 per cent and 3.7 per cent. Once again, the impact on households is projected to be stronger: real wages are projected to fall by 4.6 per cent to 6.3 per cent, while consumption is projected to drop by 4.0 per cent to 5.4 per cent, all relative to the 2030 baseline.

While the WTO scenario implies the greatest negative economic impact on the UK economy, it is also the scenario which seems most likely to generate some benefit in terms of reductions in regulation. However, the UK economy has been judged by the OECD, the World Bank and the World Economic Forum to be one of the most lightly regulated among the advanced economies. It is not clear that there is much scope for efficiency gains from even lighter touch regulation.

Mechanism

To understand how leaving the EU might damage the UK's long-term economic performance, it is useful to begin with the declines in trade. The overwhelming weight of evidence is that belonging to a free trade agreement increases trade with other members of the trading block, so that leaving a trading block would result in lower trading volumes with one's ex-FTA partners.²² We implement this in NiGEM by reducing the UK's export market shares in EU countries, in line with the estimated reductions in bilateral trade of table 3.

Table 10a. Summary: Norway

		2016	2017	2018	2019	2020	2025	2030
GDP % change from base	Optimistic	-0.2	-1.2	-2.1	-2.1	-1.7	-1.6	-1.5
	Pessimistic	-0.2	-1.0	-2.2	-2.4	-2.1	-2.1	-2.1
Consumption % change from base	Optimistic	-0.1	-0.9	-1.2	-1.4	-1.4	-2.0	-2.4
	Pessimistic	-0.1	-1.1	-1.5	-1.8	-2.0	-2.7	-3.3
Investment (PSI) % change from base	Optimistic	-4.8	-14.8	-11.2	-4.2	-1.0	-0.7	-0.7
	Pessimistic	-4.8	-14.9	-11.6	-4.6	-1	-0.7	-0.6
Real consumer wages % change from base	Optimistic	-0.6	-1.2	-1.1	-1.6	-1.8	-2.1	-2.2
	Pessimistic	-0.6	-1.6	-1.7	-2.3	-2.7	-3.1	-3.2
Output per hour worked % change from base	Optimistic	-0.4	-1.7	-1.7	-1.4	-1.5	-1.5	-1.6
	Pessimistic	-0.4	-1.3	-1.5	-1.3	-1.6	-1.9	-2.1
Unemployment, % Change in levels	Optimistic	-0.2	-0.4	0.5	0.7	0.3	0.2	0.0
	Pessimistic	-0.2	-0.2	0.6	0.9	0.5	0.2	0.1
Inflation Change in levels	Optimistic	0.7	0.6	0.5	0.7	0.1	0.1	0.0
	Pessimistic	0.7	1.5	0.9	0.9	0.2	0.1	0.0
Bank rate, % Change in levels	Optimistic	0.0	0.0	0.0	0.25	0.0	0.25	0.0
	Pessimistic	0.0	0.0	0.25	0.25	0.0	0.0	-0.25
Long rate, % Change in levels	Optimistic	0.5	1.0	0.2	0.1	0.0	-0.1	-0.1
	Pessimistic	0.5	1.0	0.2	0.0	0.0	-0.1	-0.2
Effective direct tax rate, % Change in levels	Optimistic	0.0	0.0	0.1	0.3	0.3	0.3	0.4
	Pessimistic	0.0	0.1	0.2	0.4	0.5	0.4	0.5

Table 10b. External sector: Norway

		2016	2017	2018	2019	2020	2025	2030
Exports % change from base	Optimistic	0.5	-4.7	-10.6	-13.3	-13.1	-11.2	-10.3
	Pessimistic	0.5	-5.4	-14.5	-18.9	-19.1	-17.3	-16.3
Imports % change from base	Optimistic	-1.4	-9.2	-11.4	-11.6	-11.2	-10.8	-10.7
	Pessimistic	-1.4	-10.5	-15.6	-17.0	-16.8	-16.8	-16.7
Trade % change from base	Optimistic	-0.5	-7.1	-11.0	-12.4	-12.1	-11.0	-10.5
	Pessimistic	-0.5	-8.1	-15.1	-17.9	-17.9	-17.1	-16.5
Effective exchange rate % change from base	Optimistic	-7.3	-10.9	-10.1	-10.6	-10.8	-11.0	-11.2
	Pessimistic	-7.3	-12.3	-11.6	-12.1	-12.3	-12.4	-12.5
Terms of trade % change from base	Optimistic	0.7	4.1	3.2	1.5	0.8	-1.3	-1.7
	Pessimistic	0.7	1.1	0.8	-0.5	-1.2	-2.9	-3.2
Trade balance % of GDP	Optimistic	-2.7	-1.0	-2.0	-2.7	-2.7	-2.4	-1.8
	Pessimistic	-2.7	-1.8	-2.6	-3.3	-3.3	-2.9	-2.2
	Base	-3.4	-3.7	-3.3	-2.7	-2.3	-2.0	-1.4
Income balance % of GDP	Optimistic	1.1	0.6	0.2	-0.2	0.1	0.0	1.6
	Pessimistic	1.1	1.1	0.5	0.0	0.3	0.2	1.8
	Base	0.7	0.4	0.1	0.0	0.2	0.2	1.5
Current account balance % of GDP	Optimistic	-3.1	-1.8	-3.3	-4.5	-4.2	-3.9	-1.7
	Pessimistic	-3.1	-2.1	-3.6	-5.0	-4.7	-4.3	-1.9
	Base	-4.1	-4.7	-4.6	-4.0	-3.5	-3.1	-1.2

Table I I a. Summary: Switzerland

		2016	2017	2018	2019	2020	2025	2030
GDP % change from base	Optimistic	-0.2	-1.1	-2.1	-2.2	-1.9	-1.9	-1.9
	Pessimistic	-0.2	-1.0	-2.2	-2.5	-2.2	-2.3	-2.3
Consumption % change from base	Optimistic	-0.1	-1.0	-1.4	-1.6	-1.6	-2.3	-2.8
	Pessimistic	-0.1	-1.1	-1.6	-1.9	-2.0	-2.8	-3.5
Investment (PSI) % change from base	Optimistic	-4.8	-14.9	-11.8	-6.2	-3.3	-2.3	-2.1
	Pessimistic	-4.8	-14.9	-12.1	-6.6	-3.3	-2.3	-2.0
Real consumer wages % change from base	Optimistic	-0.6	-1.4	-1.4	-1.9	-2.3	-2.8	-3.1
	Pessimistic	-0.6	-1.7	-1.8	-2.4	-2.9	-3.5	-3.8
Output per hour worked % change from base	Optimistic	-0.4	-1.5	-1.6	-1.5	-1.6	-1.8	-1.9
	Pessimistic	-0.4	-1.3	-1.6	-1.5	-1.7	-2.1	-2.3
Unemployment, % Change in levels	Optimistic	-0.2	-0.3	0.5	0.7	0.4	0.2	0.1
	Pessimistic	-0.2	-0.2	0.6	0.9	0.6	0.2	0.1
Inflation Change in levels	Optimistic	0.7	1.0	0.7	0.8	0.2	0.1	0.0
	Pessimistic	0.7	1.7	1.0	1.0	0.3	0.1	0.0
Bank rate, % Change in levels	Optimistic	0.0	0.0	0.0	0.25	0.0	0.25	0.0
	Pessimistic	0.0	0.0	0.25	0.25	0.0	0.0	0.0
Long rate, % Change in levels	Optimistic	0.5	1.0	0.2	0.0	0.0	0.0	-0.1
	Pessimistic	0.5	1.0	0.2	0.0	0.0	-0.1	-0.1
Effective direct tax rate, % Change in levels	Optimistic	0.0	0.0	0.1	0.3	0.4	0.3	0.4
	Pessimistic	0.0	0.1	0.2	0.4	0.5	0.4	0.6

Table I I b. External sector: Switzerland

		2016	2017	2018	2019	2020	2025	2030
Exports % change from base	Optimistic	0.5	-5.2	-12.6	-16.1	-16.2	-14.3	-13.3
	Pessimistic	0.5	-5.7	-15.4	-20.2	-20.4	-18.6	-17.6
Imports % change from base	Optimistic	-1.4	-9.9	-13.3	-14.2	-14.0	-13.5	-13.3
	Pessimistic	-1.4	-10.8	-16.3	-18.0	-17.9	-17.7	-17.4
Trade % change from base	Optimistic	-0.5	-7.6	-13.0	-15.1	-15.0	-13.9	-13.3
	Pessimistic	-0.5	-8.4	-15.9	-19.0	-19.1	-18.2	-17.5
Effective exchange rate % change from base	Optimistic	-7.3	-12.3	-11.6	-12.1	-12.2	-12.2	-12.3
	Pessimistic	-7.3	-16.5	-15.9	-16.5	-16.8	-16.6	-16.6
Terms of trade % change from base	Optimistic	0.7	2.8	2.1	0.6	-0.1	-2.0	-2.3
	Pessimistic	0.7	0.8	0.6	-0.7	-1.3	-3.0	-3.2
Trade balance % of GDP	Optimistic	-2.7	-1.3	-2.3	-3.0	-3.0	-2.8	-2.1
	Pessimistic	-2.7	-1.8	-2.7	-3.5	-3.4	-3.1	-2.4
	Base	-3.4	-3.7	-3.3	-2.7	-2.3	-2.0	-1.4
Income balance % of GDP	Optimistic	1.1	0.9	0.4	-0.1	0.2	0.1	1.6
	Pessimistic	1.1	1.2	0.6	0.0	0.3	0.2	1.8
	Base	0.7	0.4	0.1	0.0	0.2	0.2	1.5
Current account balance % of GDP	Optimistic	-3.1	-1.9	-3.3	-4.4	-4.0	-3.9	-1.7
	Pessimistic	-3.1	-2.1	-3.5	-4.7	-4.4	-4.1	-1.8
	Base	-4.1	-4.7	-4.6	-4.0	-3.5	-3.1	-1.2

Table 12a. Summary: WTO

		2016	2017	2018	2019	2020	2025	2030
GDP % change from base	Optimistic	-0.2	-1.0	-2.3	-2.8	-2.5	-2.6	-2.7
	Pessimistic	-0.2	-0.7	-2.4	-3.5	-3.3	-3.4	-3.7
Consumption % change from base	Optimistic	-0.1	-1.2	-1.7	-2.1	-2.4	-3.2	-4.0
	Pessimistic	-0.1	-1.5	-2.1	-2.8	-3.3	-4.2	-5.4
Investment (PSI) % change from base	Optimistic	-4.8	-15.0	-12.8	-8.1	-4.6	-3.4	-2.7
	Pessimistic	-4.8	-15.1	-13.8	-9.0	-4.6	-3.3	-2.4
Real consumer wages % change from base	Optimistic	-0.6	-1.9	-2.1	-2.9	-3.5	-4.2	-4.6
	Pessimistic	-0.6	-2.6	-3.0	-4.1	-4.9	-5.8	-6.3
Output per hour worked % change from base	Optimistic	-0.4	-1.1	-1.6	-1.6	-1.8	-2.4	-2.7
	Pessimistic	-0.4	-0.5	-1.6	-1.8	-2.2	-3.2	-3.6
Unemployment, % Change in levels	Optimistic	-0.2	-0.1	0.7	1.2	0.8	0.3	0.1
	Pessimistic	-0.2	0.2	0.8	1.7	1.2	0.3	0.2
Inflation Change in levels	Optimistic	0.7	2.2	1.3	1.3	0.4	0.1	0.0
	Pessimistic	0.7	3.8	2.1	1.8	0.6	0.1	0.0
Bank rate, % Change in levels	Optimistic	0.0	0.0	0.25	0.50	0.00	0.00	-0.25
	Pessimistic	0.0	0.0	0.25	0.75	0.25	0.00	-0.25
Long rate, % Change in levels	Optimistic	0.5	1.0	0.1	-0.1	-0.1	-0.1	-0.2
	Pessimistic	0.5	1.0	0.1	-0.1	-0.2	-0.2	-0.3
Effective direct tax rate, % Change in levels	Optimistic	0.0	0.1	0.2	0.4	0.6	0.3	0.6
	Pessimistic	0.0	0.1	0.3	0.6	0.8	0.4	0.8

Table 12b. External sector: WTO

		2016	2017	2018	2019	2020	2025	2030
Exports % change from base	Optimistic	0.5	-6.1	-17.5	-23.1	-23.3	-21.8	-20.7
	Pessimistic	0.5	-7.1	-23.3	-31.5	-32.1	-30.6	-29.3
Imports % change from base	Optimistic	-1.4	-11.6	-18.6	-21.1	-21.2	-20.9	-20.7
	Pessimistic	-1.4	-13.7	-24.8	-28.9	-29.3	-29.4	-29.0
Trade % change from base	Optimistic	-0.5	-9.0	-18.1	-22.0	-22.2	-21.3	-20.7
	Pessimistic	-0.5	-10.6	-24.1	-30.2	-30.7	-30.0	-29.2
Effective exchange rate % change from base	Optimistic	-7.3	-16.0	-15.5	-16.3	-16.7	-16.1	-16.1
	Pessimistic	-7.3	-23.9	-23.6	-24.5	-25.1	-24.3	-24.0
Terms of trade % change from base	Optimistic	0.7	-0.5	-0.5	-1.8	-2.5	-3.8	-4.0
	Pessimistic	0.7	-4.8	-3.9	-4.7	-5.4	-6.1	-6.1
Trade balance % of GDP	Optimistic	-2.7	-2.2	-3.0	-3.8	-3.7	-3.3	-2.5
	Pessimistic	-2.7	-3.4	-3.8	-4.8	-4.7	-4.0	-3.2
	Base	-3.4	-3.7	-3.3	-2.7	-2.3	-2.0	-1.4
Income balance % of GDP	Optimistic	1.1	1.5	0.7	0.1	0.5	0.3	1.9
	Pessimistic	1.1	2.3	1.3	0.4	0.8	0.6	2.4
	Base	0.7	0.4	0.1	0.0	0.2	0.2	1.5
Current account balance % of GDP	Optimistic	-3.1	-2.2	-3.7	-5.1	-4.7	-4.4	-2.1
	Pessimistic	-3.1	-2.5	-4.0	-6.0	-5.4	-4.9	-2.2
	Base	-4.1	-4.7	-4.6	-4.0	-3.5	-3.1	-1.2

Table 13. Mechanisms

	Norway		Switzerland		WTO	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
Effective exchange rate, % decline	-11.2	-12.5	-12.3	-16.6	-16.1	-24.0
Exports, % decline	-10.3	-16.3	-13.3	-17.6	-20.7	-29.3
Export bounce-back, % increase	1.1	1.3	1.2	1.7	1.6	2.4

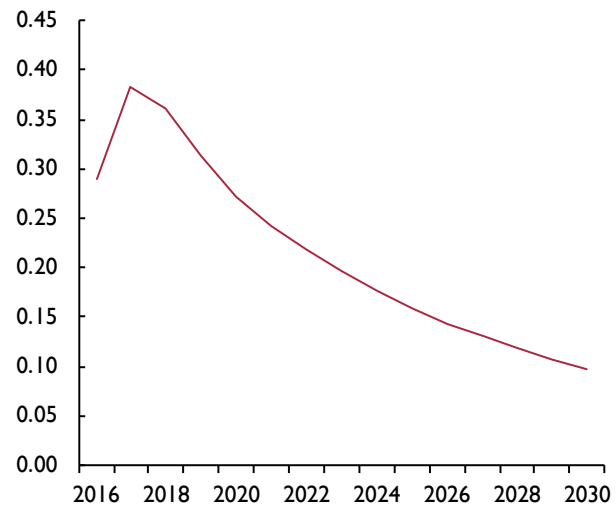
The reductions in export market shares manifest themselves as a decline in demand for UK exports. This has two main impacts on prices: a reduction in export prices and a depreciation of the pound. Both of these changes would then tend to increase demand for UK exports from outside the EU. In addition, depreciation raises import prices. The currency depreciation manifests itself in a short-lived improvement in the trade balance and current account. However, these are reversed in the longer run, as the reductions in EU market share are progressively phased in.

We illustrate the ability of exchange rate depreciation to temper the fall in exports associated with the UK leaving the EU in figure 1, which shows the percentage increase in exports from a 1 per cent decline in the real exchange rate.²³ By 2030, exports increase by only about 0.1 per cent for every 1 per cent decline in effective exchange rate. This translates into an exchange-rate bounce-back for exports (i.e. the amount by which exports increase due to currency depreciation) of between 1.1 per cent and 2.4 per cent compared to the baseline (table 13). This exchange rate bounce-back for exports is rather small compared to the total declines in exports by 2030 of between 11.2 per cent and 24.0 per cent. As a result, despite the fact that the currency depreciation seems to be able to temper the impact of the loss of market access, its impact is small compared to the loss in exports in all scenarios.

The rise in import prices and reduction in export prices comprise a long-run deterioration in the terms of trade by between 1.7 per cent and 6.1 per cent relative to the 2030 baseline (tables 10b, 11b, 12b). This implies that a consumption basket including imported goods will become more expensive relative to domestically produced goods, and hence consumption and real wages fall more sharply than GDP. In the long run, households may react to higher consumption prices by increasing savings, reflected in the relatively small declines in investment of between 0.6 and 2.7 per cent.

In addition, a currency depreciation tends to be inflationary, as a weaker currency raises the sterling price of imports. This can be seen by the rise in inflation in the

Figure 1. Response of UK exports to a 1 per cent decline in effective exchange rate (per cent)



wake of Brexit taking effect. This might place the Bank of England in a difficult position in the post-Referendum period, as it might face a surge in inflation together with a negative demand shock weighing down on GDP. The companion piece on the short-term implications of leaving the EU discusses the short-term monetary policy implications in more detail. Here, we assume that the Bank of England would initially 'look through' the one-off surge in inflation brought about by currency depreciation, holding interest rates constant until the third quarter of 2018. In the longer run, however, inflation returns to very close to its baseline.

NiGEM also allows for the UK's flexible labour markets to respond to the decline in employment demand. Despite a short-run increase in unemployment in the adjustment period, the degree of long-run wage flexibility in the UK model ensures that the long-run increase in unemployment does not exceed 0.2 per cent in any of the scenarios. However, this same long-run wage flexibility means that the long-run losses from Brexit do manifest themselves in terms of rather substantial real wage declines relative to the 2030 baseline of between 2.2 per cent and 6.3 per cent. This is broadly in line

with the behaviour of UK unemployment and wages in the wake of the financial crisis, when the increases in unemployment were short-lived and fairly muted, with real wages remaining more persistently weak.

As a result of the projected declines in real wages, UK consumers who depend upon labour income would be worse off, and their consumption is projected to decline between 2.4 per cent and 5.4 per cent. UK households might also face marginally higher rates of direct taxes. The decline in economic activity would also lead to a

decline in tax revenues. In order for the government to stick to its long-run fiscal consolidation plans, the average direct tax rate would need to rise by between 0.5p and 0.8p.

Comparison to other studies

Table 14 compares our key assumptions and results to those of other studies. All of the comparator studies use similar estimates of the reductions in trade from leaving the EU, often based on the same gravity estimates. The OECD and HM Treasury analyses also use the same

Table 14. Comparison of recent studies on the impact of Brexit on the United Kingdom

	OECD	LSE/CEP	HM Treasury			NIESR			NIESR
	WTO/FTA	EEA/FTA	EEA	FTA	WTO	EEA	FTA	WTO	WTO+
Brexit Modelling									
Reduction in total trade (%)	-10 to -20	-12.6	-9	-14 to -19	-17 to -24	-11 to -16	-13 to -18	-21 to -29	-22
Reduction in FDI (%)	-10 to -45	none	-10	-15 to -20	-18 to -26	-10	-17	-24	-24
EU budget savings, % of GDP	0.3 to 0.4	0.0	0.4	0.4	0.4	0.0	0.3	0.3	0.3
Method	NiGEM	Estimated trade elasticities ^(a)	NiGEM			NiGEM			NiGEM
Results									
GDP, % change									
Central estimate (%)	-5.1	-7.9	-3.8	-6.2	-7.5	-1.8	-2.1	-3.2	-7.8
Range (%)	-2.7 to -7.7	6.3 - 9.5	-3.4 to 4.3	-4.6 to 7.8	-5.4 to 9.5	-1.5 to -2.1	-1.9 to -2.3	-2.7 to -3.7	-7.8
Wages, % change									
Central estimate (%)	n.a.	n.a.	n.a.	n.a.	n.a.	-2.7	-3.4	-5.5	-7.0
Range (%)	n.a.	n.a.	n.a.	n.a.	n.a.	-2.2 to -3.2	-3.1 to -3.8	-4.6 to -6.3	-7.0
Ratio of GDP to trade declines	0.27 - 0.39	0.5 - 0.75	0.42	0.33 - 0.41	0.32 - 0.40	0.13	0.14	0.13	0.35
Channels									
Reduced trade with EU	x	x	x	x	x	x	x	x	x
Productivity losses from reduced trade	x	x ^(a)	x	x	x				x
Reduction in FDI	x		x	x	x	x	x	x	x
Productivity losses from reduced FDI	x		x	x	x				
Change in migration	x								
Productivity gains from deregulation	x								
Lower or zero contributions to the EU budget	x		x	x	x		x	x	x

Notes: (a) The LSE/CEP analysis uses econometric estimates of the relationship between trade and GDP to estimate the impact of a given reduction in trade on GDP. These estimates would, in principle, capture any and all impact of trade on GDP, including productivity gains from increases to openness. They might also capture any increase in FDI which is associated with greater trade volumes, as well as any increases in productivity associated with this additional FDI. WTO+ is the scenario which includes a 5% shock to labour-augmenting technological progress.

model, NiGEM. Still, the estimated impacts on GDP vary. In the most pessimistic scenarios, our analysis suggests a GDP decline of 3.7 per cent, compared to 7.7 per cent for the OECD, and 9.5 per cent for HM Treasury and the LSE.

What accounts for these differences? In our assessment, one important factor is the treatment of productivity. Both the OECD and the HM Treasury analyses appeal to evidence on the impact of openness on productivity as a basis for inputting direct reductions in productivity into NiGEM. The OECD also assumes that productivity might rise if regulation were to decline. In contrast, our core scenarios do not include any impact of either a reduction in openness or a reduction in regulation on productivity.²⁴

To understand how important the downside risks from productivity losses might be, we add a decline in productivity to our optimistic WTO scenario. We calibrate the decline to approximate the productivity losses from declines in trade assumed by HM Treasury in its long-run Brexit analysis.²⁵ Assuming that productivity (modelled as labour-augmenting technology) declines by 5 per cent causes long-run GDP to decline by a further 5.1 per cent relative to its 2030 baseline. That is, GDP declines by 7.8 per cent rather than 2.7 per cent compared to its long-run baseline. This brings our estimate of the GDP impact of the WTO scenario into line with the Treasury's impact of 7.5 per cent for a similar scenario.

We have chosen to step back from attempting to quantify the potential impact of Brexit on productivity in our core scenarios, not because we think that productivity is unimportant, but rather because of the difficulties in applying econometric evidence to the current UK case. Econometric evidence on the relationship between openness and productivity essentially uses information on this relationship over a large number of countries and/or time periods, in order to extract an average impact of openness on productivity, while controlling for as many coincident factors as possible. Thus, such econometric relationships can be thought of as holding in 'normal times'. While the weight of the evidence does seem to suggest that reducing the openness of an economy would tend to decrease productivity and decreasing regulation would tend to increase productivity in 'normal times', it is far from clear that these are in fact 'normal times' with respect to UK productivity. UK productivity has been unusually weak since the crisis, and it is not well understood why this is the case, i.e. the factors which are currently driving the weak UK productivity performance remain unknown.

As a result, it is also impossible to know whether and how these factors might interact with a reduction in openness or a reduction in regulation. It might be that a reduction in openness would have a greater impact than in 'normal times', or the opposite might be true. The same goes for any improvements in productivity from reductions in regulation. In addition, the UK's product and labour markets are already ranked as among the most lightly regulated among major economies by the OECD, the World Bank and the World Economic Forum. This makes it difficult to see that there is much space to deregulate further, making it equally difficult to see how the productivity gains from deregulation could be large. So while our core scenarios focus on a small number of the clearest and most well-understood potential impacts on the UK economy of leaving the EU, we are aware that there are a number of additional unmodelled risks. We have demonstrated that the impact of productivity losses might be substantial. We discuss more of these additional unmodelled risks in the next section.

Unmodelled risks to leaving the EU

As emphasised above, our modelling strategy is to focus on a small number of the clearest and most well-understood potential impacts on the EU economy of leaving the EU. There is a range of further risks to leaving the EU, including impacts on productivity, the impact of future migration policy, and a potential for constitutional changes within the UK. It goes beyond the scope of this article to discuss these factors in depth. Rather, we give a brief assessment of each.

Scotland and Northern Ireland

In the Commentary to this issue, Armstrong and Portes argue that there is a risk of break-up of the UK in the event of a vote to leave the EU. If there were a second independence referendum, and the Scottish electorate were to judge that its interests were better served as an EU member outside the UK, then some additional disruption to the UK economy could be expected. One of the issues which would again come up is the division of the UK's national debt, with accompanying risks for the rest of the UK's fiscal position. Similar risks may exist with respect to Northern Ireland's constitutional position. In addition, any break-up of the UK would also be likely to be accompanied by a period of further uncertainty. All of this points to issues around Scotland's and Northern Ireland's constitutional status posing a risk of larger declines in GDP and other macro aggregates from leaving the EU.

Migration

Our analysis abstracts from migration. For one thing, in the Norwegian and Swiss cases, there is no reason

to assume that free movement of people with the EU would end. Changes in migration policy would only seem to be relevant in the WTO scenario. For another, representative agent models like NiGEM are not ideally suited to quantifying the impact of changing migration policy. In the long run, increasing or decreasing migration would mainly scale the economy up or down and have little impact either way on GDP. If restricting migration were to lead to productivity losses – perhaps because loss of access to the EU talent pool were to worsen skills shortages or skill mismatch – then we may be underestimating the economic costs to leaving the EU. Moreover, there is evidence that EU migration has net fiscal benefits for the UK, and these might counterbalance any positive fiscal impact from repatriating the UK's net contributions to the EU.²⁶ At the same time, it is at least conceivable that if the freedom to set migration policy were used optimally, then this might have some positive impact on productivity.

Current account

Finally, there is some risk that we have underestimated the impact of leaving the EU on the current account. Currently, the UK has a current account deficit of about 5.2 per cent of GDP in 2015, reaching 7 per cent in the final quarter of 2015.²⁷ That is, in 2015, the UK relied on inflows of foreign capital equivalent to 5.2 per cent of GDP to finance the domestic economy. If a vote to leave the EU were to worsen the sentiment of foreign investors regarding the prospects for the UK economy more than expected, it could become difficult to attract such large capital inflows at current interest rates.

Conclusion

We present estimates of the reductions in GDP and other key macroeconomic aggregates for three scenarios for the post-Brexit UK. We project that by 2030, UK GDP would be 1.5 per cent to 2.1 per cent lower in a Norwegian scenario, 1.9 per cent to 2.3 per cent lower in a Swiss scenario, and 2.7 per cent to 3.7 per cent in the WTO scenario. The long-run deterioration in the terms of trade leads the declines in wages to be somewhat larger, ranging between 2.2 per cent and 6.3 per cent, but there would be little perceptible long-run impact on unemployment.

Our core scenarios focus on a small number of the most well-understood potential impacts of leaving the EU: the impact of reduced demand for UK exports from the loss in EU market access, and the reduction in UK investment associated with reductions in FDI, counterbalanced by the projected savings from repatriating the UK's net contributions to the EU.

There are both upside and downside risks to these estimates. As for upside risks, there might be a modest amount of scope for increases to productivity from reducing regulation, and it cannot be excluded that migration policy could be formulated so as to increase productivity. If they were to materialise, these upside risks might decrease the size of the long-run GDP losses from leaving the EU. One substantial downside risk is that reducing openness might lead to a decline in productivity. Adding a productivity decline that is similar to that assumed by HM Treasury in its long-run analysis leads to a further 5.1% decline in GDP relative to the 2030 baseline. Further downside risks include a break-up of the UK, losses in productivity from restrictive migration policies and current account instability.

NOTES

- 1 Pain and Young (2004) base their estimates of the GDP impact of leaving the EU on NiDEM, a predecessor of the current NiGEM model which included greater detail on the UK domestic economy, but which is no longer supported. Pain and Young's work pre-dates the rise of gravity models of trade, so they model the trade impacts of leaving the EU through an increase in tariff barriers, rather than as a reduction in EU export market shares. They report an estimated reduction in GDP from leaving the EU of 2.25 per cent
- 2 See recent NIESR research by Riley *et al.* (2015) and Bryson and Forth (2015).
- 3 We explain how we calibrated our productivity shock to be similar in magnitude to HM Treasury when we present this scenario in detail.
- 4 See the following section for a discussion of how rules of origin might act as a barrier to trade.
- 5 To be clear: the declines in EU market shares are fed into NiGEM, the total trade reductions are long-run outcomes from NiGEM.
- 6 Baier *et al.* (2008) run panel gravity regressions with country-pair and time effects, both in levels and first differences. Results are reproduced and converted to reductions in bilateral trade with the EU in table 2.
- 7 Ottaviano *et al.* (2013) use Baier *et al.* (2008) to approximate the reduction in trade in both goods and services from moving from the EU to EEA/EFTA, using their estimate over five years.
- 8 Baier *et al.* (2008), Table 5 column 3 provides the results of regressions in levels, while Table 6 column 2 reports results from regressions in first differences.
- 9 Table 1, column 11 in Ceglowski (2006), which reports the results of the IV regressions with time and country fixed effects.
- 10 This is potentially a difficulty, because most PTAs have little if any coverage of services, while the impact of PTAs is measured on trade in goods and services.
- 11 The percentage decline in total trade is calculated as $\frac{e^{1.291} - 1}{e^{1.291}} = 72$.
- 12 Cf. Berger and Nitsch (2008), Santos Silva and Tenreyro (2010), Ritschl and Wolf (2011).
- 13 World Trade Organization (2015).
- 14 Membership in the EU might also have an ambiguous effect on outward FDI, increasing it to the rest of the EU, but possibly at the expense of displacing some FDI that might otherwise have been destined for countries outside the EU.
- 15 The synthetic controls approach constructs a counterfactual scenario for the UK by combining data from the non-EU countries

- who jointly form the best proxy for the UK in a statistical sense. Campos and Coricelli (2015) construct the counterfactual for the UK as a combination of Canada (44 per cent), New Zealand (36 per cent) and the US (20 per cent). See Abadie and Gardeazabal (2003) for more details on the methodology.
- 16 We have converted Ramasamy and Yeung's (2010) estimate for the impact of openness on FDI of \$1.31 billion to 2013 \$ using the US GDP deflator.
 - 17 Earlier evidence provided by Kolstad and Villanger (2008) had not found evidence that openness increased FDI flows in services. This might be due to differences in the sample studied: Kolstad and Villanger use data from 57 countries, both developed and emerging between 1989 and 2000, while Ramasamy and Yeung restrict their analysis to OECD countries but cover the longer period of 1980 to 2003.
 - 18 HMT (2016) gives the UK's net contribution as £9.8 bn or 0.54 per cent of UK GDP, which does not seem to count private sector receipts from the EU.
 - 19 Economists for Brexit (2016), 'The Economy after Brexit'.
 - 20 The referendum of February 2014 requires the Swiss government to renegotiate its bilateral agreement with the EU on the free movement of people within three years. As of yet, no agreement has been reached, and it is not yet clear how and whether restricting migration will be compatible with Switzerland's current level of EU market access.
 - 21 Economists for Brexit (2016), 'The Economy after Brexit'.
 - 22 See Head and Mayer (2014) for an overview of the literature on gravity models of trade.
 - 23 We obtain these estimates by shocking the exchange rate premium, inducing a depreciation in the effective exchange rate of 1 per cent, and comparing to the resulting increase in exports.
 - 24 It is important to distinguish between total factor productivity and productivity measured as output per hour worked. Total factor productivity is the part of output which is explained by technology and unknown factors, that part that goes beyond just the combination of labour and capital. Productivity measured as output per hour worked, in contrast, depends on the capital to labour ratio, the amount of capital (machines, patents, software) that each worker has to work with. While TFP is unassumed to be unchanged in our analysis, productivity measured as output per worker does decline, in line with the decline in investment and hence the decline in the capital to labour ratio.
 - 25 Specifically, HM Treasury reports on page 182 that it uses elasticities of productivity to trade of between 0.2 and 0.3 in its analysis. We apply an elasticity of 0.25 to the 20 per cent decline in trade for our optimistic WTO scenario to arrive at a decrease in labour-augmenting productivity of 5 per cent.
 - 26 Dustman and Frattini, 2014.
 - 27 Office for National Statistics (2016). See Lane (2016) for a discussion of the challenges in interpreting the UK's recent current account figures.

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