



National Audit Office

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**Report**

by the National Audit Office

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# HM Treasury's economic analysis in the lead-up to the referendum on European Union membership

**JUNE 2017**

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# Part One

## Introduction

### Background

**1.1** In the lead-up to the referendum, HM Treasury published two reports analysing the economic impact of leaving the European Union (EU):

- The first report (the 'long-term analysis report') focused on a 15-year period following a leave vote, by which time HM Treasury believed that the new relationship with the EU would be fully embedded and any uncertainty resolved.<sup>1</sup>
- The second report (the 'short-term analysis report') covers the period from 2016 Q3 to 2018 Q2 immediately following a vote to leave, in order to capture the impact of any short-term economic adjustment.<sup>2</sup>

**1.2** HM Treasury's stated purpose for these two reports was to help inform the public debate ahead of the referendum on EU membership. The reports formed part of a series of papers the UK government published on EU membership.<sup>3</sup>

### Our scope and approach

**1.3** In this paper we look at HM Treasury's analysis in the lead-up to the referendum. We looked at the systems and processes that HM Treasury used to create the figures, rather than the assumptions and estimated results themselves. Estimating impacts on economic variables is complex, particularly in assessing the potential consequences of leaving the EU, which has no precedent. The extent of the impact depends on future government policy and international negotiations which are yet to take place. This means that any estimates will be subject to a high degree of uncertainty.

<sup>1</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/517415/treasury\\_analysis\\_economic\\_impact\\_of\\_eu\\_membership\\_web.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/517415/treasury_analysis_economic_impact_of_eu_membership_web.pdf)

<sup>2</sup> HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/524967/hm\\_treasury\\_analysis\\_the\\_immediate\\_economic\\_impact\\_of\\_leaving\\_the\\_eu\\_web.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/524967/hm_treasury_analysis_the_immediate_economic_impact_of_leaving_the_eu_web.pdf)

<sup>3</sup> HM Government, *The best of both worlds: the United Kingdom's special status in a reformed European Union*, February 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/502291/54284\\_EU\\_Series\\_No1\\_Web\\_Accessible.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/502291/54284_EU_Series_No1_Web_Accessible.pdf); HM Government, *The process for withdrawing from the European Union*, February 2016, available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/503908/54538\\_EU\\_Series\\_No2\\_Accessible.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503908/54538_EU_Series_No2_Accessible.pdf); HM Government, *Alternatives to membership: possible models for the United Kingdom outside the European Union*, March 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/504661/Alternatives\\_to\\_membership\\_possible\\_models\\_for\\_the\\_UK\\_outside\\_the\\_EU\\_Accessible.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/504661/Alternatives_to_membership_possible_models_for_the_UK_outside_the_EU_Accessible.pdf); HM Government, *Rights and obligations of European Union membership*, April 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/516501/Rights\\_and\\_obligations\\_of\\_European\\_Union\\_membership\\_web\\_version.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516501/Rights_and_obligations_of_European_Union_membership_web_version.pdf)

**1.4** In this part we set out the purpose of HM Treasury's analysis (paragraph 1.2) and the work that HM Treasury undertook in preparing the two reports (paragraphs 1.9 to 1.23).

**1.5** In Part Two we consider HM Treasury's processes supporting its analysis:

- what were HM Treasury's processes around quality of data and assumptions (see paragraphs 2.1 to 2.10)?
- what sensitivity analysis was performed and how were uncertainties around the estimates presented (see paragraphs 2.11 to 2.14)?
- what quality assurance review processes were in place (see paragraphs 2.15 to 2.20)?

**1.6** In Part Three we consider the context surrounding HM Treasury's analysis:

- how does HM Treasury's analysis compare with analysis from other sources? (paragraphs 3.3 to 3.20);<sup>4</sup> and
- what is the context of events since the referendum, when comparing estimated impacts with outturns? (paragraphs 3.21 and 3.22).

**1.7** The National Audit Office (NAO) scrutinises public spending for Parliament and is independent of government. In preparing this report we reviewed HM Treasury's two key analysis documents published in the lead-up to the referendum, and we held discussions with HM Treasury officials to understand how they undertook and produced their analyses. For the purposes of this report, we did not audit the data that HM Treasury used in its analyses. We have reviewed a number of documents published by third parties that are relevant to our review, and we make specific references to these documents in the report. We have not consulted with any third parties in preparing this report.

**1.8** Where it is possible to do so, we have compared HM Treasury's estimates to those made in other studies using publicly available information, but we have made no judgements on any of these estimates or the underlying assumptions. We have drawn on our previous work on forecasting across government and, while this focused on the production and use of forecasts to inform departments' decisions on expenditure and not on macroeconomic estimates, the identified areas of good practice are still relevant.

<sup>4</sup> We looked at seven different studies that the Institute of Fiscal Studies (IFS) included in its report '*Brexit and the UK's Public Finances*', May 2016. We also looked at the December 2016 study by the Centre for Business Research (CBR) at the University of Cambridge, titled '*The Macro-Economic Impact of Brexit: Using the CBR Macro-Economic Model of the UK Economy*'.

## The long-term analysis report

**1.9** In April 2016 HM Treasury published its long-term analysis report, where it analysed the long-term economic impact of leaving the EU. The document assessed continued membership of the EU against possible alternatives outside the EU (previously outlined in a March 2016 paper):<sup>5</sup>

- membership of the European Economic Area (EEA);
- a negotiated bilateral agreement; and
- the UK trades with the EU under World Trade Organization (WTO) rules.

**1.10** HM Treasury concluded from its analysis that the UK would be permanently poorer if it left the EU and adopted any of these three alternatives, with lower productivity, gross domestic product (GDP) and tax receipts for all the alternative scenarios, compared with remaining in the EU.

**1.11** HM Treasury modelled the long-term impact of leaving the EU by:

- estimating the impact on UK trade and the impact on inward foreign direct investment (FDI);
- estimating the effect that the impact on trade and FDI would have on the level of productivity; and
- combining these estimates with a global macroeconomic model to estimate their effect on UK GDP after 15 years.

**1.12** HM Treasury adopted a 'gravity' modelling approach to estimate the impact of leaving the EU on UK trade. These models measure trade flows between two countries based on a number of factors, some of which do not change over time, such as proximity, culture and language; while others change over time, such as GDP and population. Under the gravity model approach, two large, high-income countries in close proximity trade with one another more than those mismatched in size or income, and further apart. The gravity model allowed HM Treasury to isolate specific effects of EU membership on trade between two countries, and measure the impact of membership on bilateral trade flows, compared with other alternatives such as an EEA membership. HM Treasury also used a gravity modelling approach to assess the impact of leaving the EU on FDI.

<sup>5</sup> HM Government, *Alternatives to membership: possible models for the United Kingdom outside the European Union*, March 2016. Available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/504604/Alternatives\\_to\\_membership\\_-\\_possible\\_models\\_for\\_the\\_UK\\_outside\\_the\\_EU.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/504604/Alternatives_to_membership_-_possible_models_for_the_UK_outside_the_EU.pdf)

**1.13** In estimating the impact of changes in trade on UK economic productivity, HM Treasury reviewed a range of existing empirical studies and selected what it considered to be a cautious 'elasticity' to represent the relationship between trade and productivity.<sup>6</sup> An elasticity is the degree of responsiveness of one variable to a change in another variable, in this case the extent to which productivity changes when trade increases or decreases. HM Treasury selected what it considered to be a cautious range of estimates towards the lower end of the spectrum of elasticities in the external analysis, using an elasticity range of between 0.2 and 0.3, implying that a 10% reduction in trade would cause an assumed productivity decrease of between 2% and 3%. HM Treasury said it did this to ensure that the elasticity captured the impact on productivity directly from trade, rather than other aspects such as FDI and wider global integration. HM Treasury could not use this survey approach to estimate the impact of changes in FDI, because the empirical literature was limited to measuring industry-specific elasticities only, and it therefore estimated a UK-specific whole economy effect.<sup>7</sup>

**1.14** HM Treasury used the National Institute Global Econometric Model (NiGEM) to translate its estimated impacts on trade, FDI and productivity into an estimate of the impact on UK national income. The NiGEM model was developed by the independent National Institute of Economic and Social Research (NIESR), and is designed to aid forecasting and policy analysis at a country level. To estimate the impact on GDP, HM Treasury used its estimates of trade, FDI and productivity as inputs to the NiGEM model. For the other NiGEM standard assumptions, HM Treasury said that it adopted most of these to keep the model as consistent with its original format as possible, but varied some assumptions as follows:

- HM Treasury incorporated assumptions reflecting its intention to be 'policy neutral' in its analysis (that is, HM Treasury assumed there would be no policy response to a vote to leave the EU). For example on fiscal policy, the NiGEM imposes a fiscal constraint, limiting budget deficits to stay within bounds through a targeted adjustment of income tax rates. For its analysis HM Treasury switched off this rule in order to avoid offsetting or reinforcing fiscal policy effects.
- HM Treasury also made an additional adjustment to the NiGEM to reflect the effect of a shock to GDP growth from the immediate uncertainty following a leave vote, on the basis that this could have a persistent effect in the long term. HM Treasury included this as an added 'shock' to productivity in the NiGEM model, which it assumed as 1% of GDP across all scenarios. HM Treasury based this adjustment of 1% on evidence of the impact of previous economic shocks, for example, from the US Federal Reserve, the Office for Budget Responsibility and the Bank of England.<sup>8</sup>

6 Frankel and Rose, *Estimating the effect of currency unions on trade and output*, 2000. Available at: [www.nber.org/papers/w7857.pdf](http://www.nber.org/papers/w7857.pdf). Feyrer, *Trade and Income: Exploiting time series in geography*, 2009. Available at: [www.dartmouth.edu/~jfeyrer/Feyrer\\_AirSea2009\\_10\\_21.pdf](http://www.dartmouth.edu/~jfeyrer/Feyrer_AirSea2009_10_21.pdf). Feyrer, *Distance, Trade, and Income – The 1967 to 1975 Closing of the Suez Canal as a Natural Experiment*, 2011. Available at: [www.nber.org/papers/w15557.pdf](http://www.nber.org/papers/w15557.pdf)

7 HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraphs A.113 to A.126.

8 HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph 3.36 to 3.43 and A.147 to A.149.

## Modelling results

**1.15** In the long-term analysis report HM Treasury found that, under all three scenarios, GDP would be lower compared with the counterfactual of remaining in the EU. HM Treasury's analysis indicated that the UK would be less open and therefore trade and FDI would fall, ultimately lowering productivity and GDP (**Figure 1**). In the central estimate for the EEA scenario, GDP is 3.8% lower, while the figure for the bilateral trade agreement is 6.2%. The largest GDP reduction is found in the WTO scenario with GDP falling 7.5% in the central estimate.

### Figure 1

HM Treasury's estimated UK GDP impact of leaving the EU and trading under the three alternative scenarios after a period of 15 years

	European Economic Area (EEA)	Bilateral trade agreement	World Trade Organization (WTO)
GDP level (%) – central	-3.8	-6.2	-7.5
GDP level range (%)	-3.4 to -4.3	-4.6 to -7.8	-5.4 to -9.5
GDP per capita – central	-£1,100	-£1,800	-£2,100
GDP per capita range	-£1,000 to -£1,200	-£1,300 to -£2,200	-£1,500 to -£2,700

Source: HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016

## The short-term analysis report

**1.16** In May 2016, HM Treasury published its short-term analysis report where it presented two scenarios for the economic impact in the two-year period immediately following a leave vote, compared with a counterfactual of remaining in the EU in its current format. In the short-term analysis, HM Treasury considered a 'shock scenario' and a 'severe shock scenario':

- In the 'shock scenario', HM Treasury assumed that a vote to leave would generate a rise in uncertainty from (then) current levels, in line with historical experience, to just below the peak of uncertainty experienced during the early 1990s recession; and it assumed an effect from financial conditions similar in scale. The size of the transition effect was linked to the central estimate of the negotiated bilateral agreement alternative from the long-term document.
- In the 'severe shock scenario', HM Treasury explored the risk that the rise in uncertainty, the effect on financial conditions and the transition effects would be larger. The rise in both uncertainty and financial market volatility was assumed around 50% larger than in the 'shock scenario', but still only half of that seen during the financial crisis in 2008 and 2009. The size of the transition effect was linked to the estimate of leaving the Single Market and defaulting to WTO membership and rules.



**1.17** HM Treasury concluded from its short-term analysis that a “vote to leave would cause an immediate and profound economic shock creating instability and uncertainty, which would be compounded by the complex and interdependent negotiations that would follow. The central conclusion of the analysis is that the effect of this profound shock would be to push the UK into recession and lead to a sharp rise in unemployment.”<sup>9</sup>

**1.18** HM Treasury modelled the short-term impact of leaving the EU by:

- assessing the transition effect. HM Treasury assumed that businesses and households would start to make decisions about spending that were consistent with its expectation of the long-term impact on the economy (which it described as “becoming permanently poorer”);<sup>10</sup> for example, reductions in investment spending and jobs, and lower household spending;
- assessing the uncertainty effect. HM Treasury assumed that immediate and ongoing uncertainty about what the UK’s new relationships would mean in practice, would affect the decisions of business and households; for example, businesses would delay making decisions on some projects, while individuals would postpone or scale back their spending as they waited for conditions to become clearer, lowering overall demand in the economy;
- assessing the financial conditions effect. HM Treasury assumed that financial markets would reassess the UK’s economic prospects, immediately resulting in greater volatility with overseas investors seeing the UK as a bigger risk and charging a higher risk premium for lending, resulting in higher finance costs for businesses and households; and
- modelling the overall impact. HM Treasury used the NiGEM model to estimate the impact of the transition, uncertainty and financial conditions effects on demand, supply and asset prices.

**1.19** In assessing the transition effect, HM Treasury used the first two years of its long-term estimates of the economic impact of reduced trade, FDI and productivity. HM Treasury noted that the scale of the short-term impact of transition would depend crucially on the nature of the relationship the UK seeks with the EU, and that the modelling assumed that these impacts would build up over 15 years from the time of a vote to leave the EU. In the ‘shock scenario’, HM Treasury used its results from the bilateral trade agreement central estimate in its long-term analysis (a 6.2% reduction in GDP), while the ‘severe shock scenario’ uses the long-term analysis central estimate from the WTO alternative (a 7.5% reduction in GDP).

9 HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016, p 5.

10 HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016, p 11.

**1.20** HM Treasury assessed the uncertainty effect by constructing an indicator of uncertainty, and then using a model to estimate the relationship between uncertainty and a set of economic variables. It noted that there was no existing single measure able to capture uncertainty across the economy and over different episodes, and therefore it constructed an indicator for this analysis from six existing measures. HM Treasury then used a Vector Autoregression (VAR) model to test how changes in uncertainty affected various macroeconomic variables. The VAR modelling approach estimates the relationship between the uncertainty indicator, overall economic activity and financial market conditions, and makes it possible to isolate the impact of an uncertainty shock on other economic and financial variables.<sup>11</sup>

**1.21** HM Treasury analysed how the uncertainty and transition effects would affect financial markets, increasing volatility and leading to falls in asset prices. HM Treasury measured the impact on key financial variables including household and corporate borrowing rates, the risk premium on equity and government debt term premium. These variables were selected because they provided broad coverage of the likely effects on financial markets, as well as featuring in the NiGEM model. HM Treasury assumed that UK asset prices would fall, since the lower future GDP implied lower returns on assets and higher uncertainty that would lead to an additional return – or risk premium – being required by investors to hold UK assets. HM Treasury made assumptions about increases on risk premiums for longer-term UK government debt and other financial variables, and for the exchange rate on the basis that a sterling depreciation was anticipated in the event of a vote to leave.

**1.22** To estimate the short-term economic impact of a leave vote, HM Treasury used the same NiGEM model as for its long-term analysis. HM Treasury ran the NiGEM model using the outputs from its analysis of short-term transition, uncertainty and financial conditions effects. As with its long-term analysis, HM Treasury adopted most of the NiGEM standard default assumptions, except for monetary policy which it assumed would remain fixed over the two-year period, to avoid prejudging future policy.<sup>12</sup> At the time, the Bank of England's Monetary Policy Committee (MPC) noted that it would be likely to face a trade-off following a vote to leave; in particular that it "would face a trade-off between stabilising inflation on the one hand and stabilising output and employment on the other. The implications for the direction of monetary policy would depend on the relative magnitude of the demand, supply and exchange rate effects".<sup>13</sup>

11 HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016, table A.1 and paragraphs A.19 to A.23.

12 The original NiGEM assumption is that short-term interest rates respond to variations in GDP growth rate and inflation.

13 Open letter from Mark Carney, Governor of the Bank of England, to George Osborne, Chancellor of the Exchequer, May 2016. Available at: [www.bankofengland.co.uk/monetarypolicy/Documents/pdf/cpiletter120516.pdf](http://www.bankofengland.co.uk/monetarypolicy/Documents/pdf/cpiletter120516.pdf)

## Modelling Results

**1.23** Under both the 'shock' and 'severe shock' scenarios in the short-term analysis report, HM Treasury estimated lower GDP in the two-year period following a vote to leave, compared with remaining in the EU. HM Treasury estimated GDP would be 3.6% lower in the 'shock scenario', and 6% lower in the 'severe shock scenario' (**Figure 2**), compared with remaining in the EU.

### Figure 2

HM Treasury's estimated impact of leaving the EU on key economic indicators under its 'shock' and 'severe shock' scenarios after a two year period following a vote to leave the EU<sup>1</sup>

	Shock scenario <sup>2</sup>	Severe shock scenario <sup>2</sup>
GDP	-3.6%	-6.0%
CPI inflation rate (percentage points)	+2.3	+2.7
Unemployment rate (percentage points)	+1.6	+2.4
Unemployment (level)	+520,000	+820,000
Average real wages	-2.8%	-4.0%
House prices	-10%	-18%
Sterling exchange rate index	-12%	-15%
Public sector net borrowing (£ billion) <sup>3</sup>	+£24 billion	+£39 billion

#### Notes

- 1 Figures represent the percentage difference from base levels.
- 2 Peak impact over two years.
- 3 Fiscal year 2017-18.

Source: HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016

## Part Two

### Review of HM Treasury's processes, data and assumptions

**2.1** As with any analysis of the impact on economic variables, HM Treasury had to make assumptions about key inputs to the modelling and about relationships between them. We have not made any judgements about the suitability of any of HM Treasury's assumptions.

**2.2** HM Treasury does not include the likely benefits from the implementation of the next stage of the Single Market.<sup>14</sup> However the long-term analysis report quantifies the impacts of these reforms.<sup>15</sup> HM Treasury estimates that the reforms to the European Union (EU) could increase gross domestic product (GDP) by up to 4% after 15 years.

**2.3** HM Treasury made no assumptions about future government policy. As a result, HM Treasury assumes:

- no fiscal policy response after leaving the EU;
- no policy response from the Bank of England. Interest rates in the National Institute Global Econometric Model (NiGEM) remain fixed over the short term;
- Article 50 is triggered immediately, in line with the then Prime Minister's statement to Parliament on 22 February 2016;
- population growth will slow in line with the Office for National Statistics (ONS) current principal population projections, where net international migration to the UK falls from 329,000 per year in 2014 towards 185,000 per year from 2021 onwards;
- no quantification of possible benefits from greater deregulation after leaving; and
- after 15 years the UK will have replicated the scope of all existing trade deals with non-EU countries but not beyond this.

<sup>14</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, part 4, paragraph 1.137 to 1.149.

<sup>15</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph 3.89 to 3.91.

**2.4** Under the European Economic Area (EEA) scenario, and the upper end of the estimated range for the other two scenarios, HM Treasury assumed that the negative effects of leaving the EU are a mirror of the positive effects of joining. At the lower end of the estimated range for either a negotiated bilateral trade agreement or a World Trade Organization (WTO) scenario, HM Treasury assumed that only half of the negative trade and FDI effects associated with leaving the EU would occur within the 15-year timeframe. HM Treasury made this assumption because it expected some barriers to trade, such as custom controls, would appear immediately; but others, like changes to regulations, could take longer to materialise. HM Treasury considers this was a cautious assumption, which would reduce the estimated impact on GDP of leaving the EU (that is, make the estimated fall in GDP smaller).

**2.5** In looking at HM Treasury's processes for producing the two reports, we considered some of the principles set out in our past reports:<sup>16</sup>

- departments should use the most accurate and timely data available in their analysis;
- where proxies or imperfect data have to be used, departments should present how this affects the level of uncertainty in the forecasts;
- departments should document assumptions made and their underlying rationale, with a documented audit trail; and
- data and assumptions should be tested to ensure that they are, and will remain, 'fit for purpose'. When high-quality data are not available this should be explicitly stated, together with an explanation of why the data are considered robust enough to use.

**2.6** There is evidence that HM Treasury has sought to use data suitable for the purposes of its modelling, and that it has sought to use accurate and timely data, including from independent data sources and over long time periods. For example, the data on goods that support the trade gravity models (see paragraph 1.12) were taken from the International Monetary Fund's Direction of Trade (DOTS) database, which covers bilateral trade for more than 200 countries from 1948 to 2013.<sup>17</sup> Throughout both reports HM Treasury has included information on the coverage, timeframe and source of different data used, which makes it easier for other parties to replicate and test HM Treasury's analysis.

**2.7** HM Treasury provided details of areas where it had concerns about data quality. HM Treasury reported concerns about the quality of data used in the foreign direct investment (FDI) gravity modelling because it only covered a period between 2000 and 2012. HM Treasury also highlighted that the FDI data could be skewed by complex ownership structures employed by multinational companies. HM Treasury discussed both of these issues in the long-term report, with a brief explanation of how it tested robustness of the data.<sup>18</sup>

<sup>16</sup> Comptroller and Auditor General, *Forecasting in government to achieve value for money*, Session 2013-14, HC 969, National Audit Office, January 2014.

<sup>17</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph A.31.

<sup>18</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph A.79.

**2.8** HM Treasury's published reports have, in most cases, outlined both the assumptions that HM Treasury made, and the underlying rationale. For example, in the long-term report HM Treasury explained the rationale for using a 15-year time horizon compared with similar studies.

**2.9** HM Treasury told us that assumptions were discussed and tested before publication within HM Treasury, for example at the EU Analysis Board and with external experts, such as leading academics.

**2.10** HM Treasury said many of its assumptions were cautious, and that this cautious approach helped to ensure robust analysis. HM Treasury said that using cautious assumptions may in fact mean its analysis underestimated the full impact of leaving the EU, compared with the counterfactual of remaining.

### **Sensitivity analysis and presentation to reflect uncertainty**

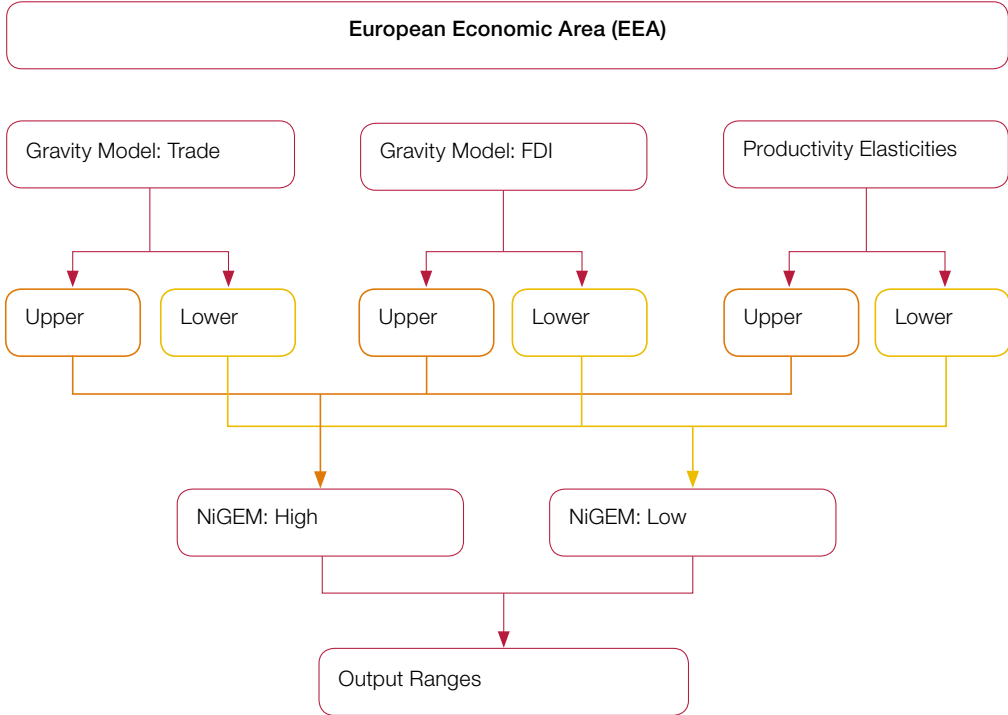
**2.11** Small changes in assumptions can potentially lead to significant variation in model outputs, so it is important that departments use sensitivity analysis to test the potential impact of changing assumptions on modelled estimates. Similarly, any analysis of future economic variables will inevitably involve uncertainty around estimates made. In general, departments should:

- incorporate sensitivity analysis, to test how modelling outputs change in relation to assumptions made;
- present estimates clearly, communicating the level and causes of uncertainty around estimates; and
- where feasible, present ranges rather than point estimates.

**2.12** In the long-term document HM Treasury reflected the uncertainties regarding future relationships with the EU in a number of ways. First, HM Treasury produced estimates for three different existing alternatives to EU membership: an EEA arrangement, a negotiated bilateral trade agreement and trading under WTO rules. Under each alternative, HM Treasury varied its modelling assumptions for trade and FDI, using the outputs from the gravity model, as well as varying the productivity elasticities. For example, the impact on total trade volumes from leaving the EU and trading under a negotiated bilateral agreement differed to the trade impact of a WTO scenario. Second, for each of the three alternatives, HM Treasury also presented an upper and a lower range of estimates. These upper and lower ranges for trade and FDI were produced using the gravity model.<sup>19</sup> All three alternatives therefore had an upper and lower estimate for each of the input assumptions (trade, FDI and the productivity elasticities). The NiGEM was then run twice for each alternative, once having input all the lower bound estimates, and a second time with all the upper bound assumptions to produce the estimate ranges for each alternative (**Figure 3**).

<sup>19</sup> HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph 3.8.

**Figure 3**  
Illustration of HM Treasury's approach to producing the upper and lower estimate ranges for the EEA scenario<sup>1</sup>



- ➔ Inputs to the model
- ➡ Lower estimate range
- ➡ Upper estimate range

**Note**  
1 Figure 3 is an illustration of the process for the EEA scenario. The same approach is adopted under the bilateral free trade agreement and World Trade Organization (WTO) scenarios.

**2.13** In the short-term report, HM Treasury considers the 'severe shock scenario' to be a sensitivity analysis of the cautious assumptions in the main 'shock scenario'. HM Treasury also undertook more specific sensitivity analysis to establish the impact of different assumptions about its modelling inputs on the estimates generated through the modelling. For example, HM Treasury tested the VAR model in the short-term report by varying specific elements of the model, such as the number of lagged variables.<sup>20</sup>

**2.14** It is important that reports containing economic estimates present the uncertainties involved clearly and prominently. A PwC study (see paragraph 3.4) on the impact of leaving the EU contained a specific disclaimer in the executive summary stating the scope of its work, and clearly draws attention to the limitations of its analysis.<sup>21</sup> HM Treasury included a statement about uncertainties involved in the main body of the long-term analysis report, but this is not referenced in the summary.<sup>22</sup> Similarly, HM Treasury did not refer to this uncertainty prominently (for example in the summary) in the short-term document. The Chancellor's foreword to both documents refers to HM Treasury's analysis as "economic facts", without mention of the inherent uncertainties associated with the outputs of the analysis.

## **Quality assurance processes**

**2.15** HM Treasury told us that it adopted an enhanced quality assurance approach for both reports, compared with its usual approach to published analysis. This included engaging and utilising a larger number of analysts across HM Treasury, who were not directly involved in the underlying analysis, as part of its quality assurance; and a higher level of engagement with senior officials through the senior management boards. It also pointed to external review by Professor Sir Charles Bean of the National Institute of Economic and Social Research (NIESR), the former Deputy Governor of the Bank of England.

**2.16** An effective quality assurance process should guard against technical errors and ensure the modelling approach and assumptions are appropriate. Departments should:

- establish and maintain quality assurance processes that provide effective challenge, informing and improving the quality of estimates;
- incorporate expert input from specialists within the department or government, for example through peer review; and
- be sufficiently independent, or include elements suitably independent, of the analytical processes.

<sup>20</sup> HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016, paragraph A.25.

<sup>21</sup> PwC, *Leaving the EU: Implications for the UK Economy*, March 2016. Available at: [www.cbi.org.uk/news/leaving-eu-would-cause-a-serious-shock-to-uk-economy-new-pwc-analysis/leaving-the-eu-implications-for-the-uk-economy/](http://www.cbi.org.uk/news/leaving-eu-would-cause-a-serious-shock-to-uk-economy-new-pwc-analysis/leaving-the-eu-implications-for-the-uk-economy/)

<sup>22</sup> HM Treasury says that "there is no precedent for an economy like the UK leaving the EU. Any quantitative analysis is therefore subject to uncertainty." HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016, paragraph 3.8.



**2.17** HM Treasury told us it undertook two types of internal review, covering board oversight and model testing. The purpose of these meetings was to challenge the analysis. Findings were presented and discussed at working-level groups and management boards. HM Treasury told us that the seniority and frequency of these meetings varied – for example, the working-level groups met weekly or bi-weekly, while the more senior management boards initially occurred on a monthly basis, becoming more frequent in the run-up to the publications.

**2.18** Treasury experts, independent of the analysis and with modelling experience, tested the modelling work. The testing involved recreating the model's outputs in order to identify any potential errors. Other subject experts were engaged throughout the work, for example HM Treasury economists and lawyers.

**2.19** HM Treasury asked Professor Sir Charles Bean, the former Deputy Governor for Monetary Policy at the Bank of England, who was at the time acting in a personal capacity as an academic consultant to HM Treasury, to review the short-term analysis report.<sup>23</sup> He concluded that the analysis was comprehensive, employed best practice techniques and produced reasonable estimates of the likely short-term impact of leaving the EU. He highlighted, however, the uncertainty in reports of this nature, making particular reference to the future trading relationship with the EU.<sup>24</sup>

**2.20** HM Treasury told us that it held discussions with other external experts to discuss specific aspects of the published academic literature, and that these conversations influenced HM Treasury's analysis in those specific areas. For example, HM Treasury discussed with an external expert its approach to estimating the link between the uncertainty indicator and other macroeconomic variables in the VAR model. As a result HM Treasury extended the set of robustness tests which it performed. HM Treasury also discussed with an external expert the link between trade and productivity, which helped inform HM Treasury's decision over which trade-GDP elasticity to use in the analysis.

23 Professor Bean is now a member of the Office for Budget Responsibility's Budget Responsibility Committee. More information is available here: <http://budgetresponsibility.org.uk/about-the-obr/who-we-are/>. He is also the President of the Council of Management of the National Institute of Economic and Social Research.

24 HM Government, *HM Treasury analysis: the immediate economic impact of leaving the EU*, May 2016.

## Part Three

### Setting HM Treasury's analysis in context

#### Context

**3.1** HM Treasury told us that its modelling was not a forecast of the UK economy post referendum. Instead HM Treasury assessed the impact on the economy of leaving the European Union (EU), compared with a counterfactual of remaining in the EU in its current state, using scenario-based analysis. HM Treasury based its modelling on historic relationships between openness of the economy (through trade and foreign direct investment (FDI)) and gross domestic product (GDP), and therefore that reducing a country's openness (through, for example, increased trade barriers under various alternatives to EU membership) was estimated to have a negative effect on the economy.

**3.2** HM Treasury's analysis provided estimates of a vote to leave, compared with remaining in the EU. This means that wording such as 'permanently poorer if we leave the EU' meant a lower level of output compared with remaining, rather than a reduction in economic levels from the time of the referendum.

#### Comparison with other studies

**3.3** In the lead to the referendum a range of academics, think tanks and other institutions published studies of the potential impacts (both short-term and long-term) of leaving the EU. These studies shared similarities with HM Treasury's analysis such as timeframe, models and scenarios, but there are also differences.

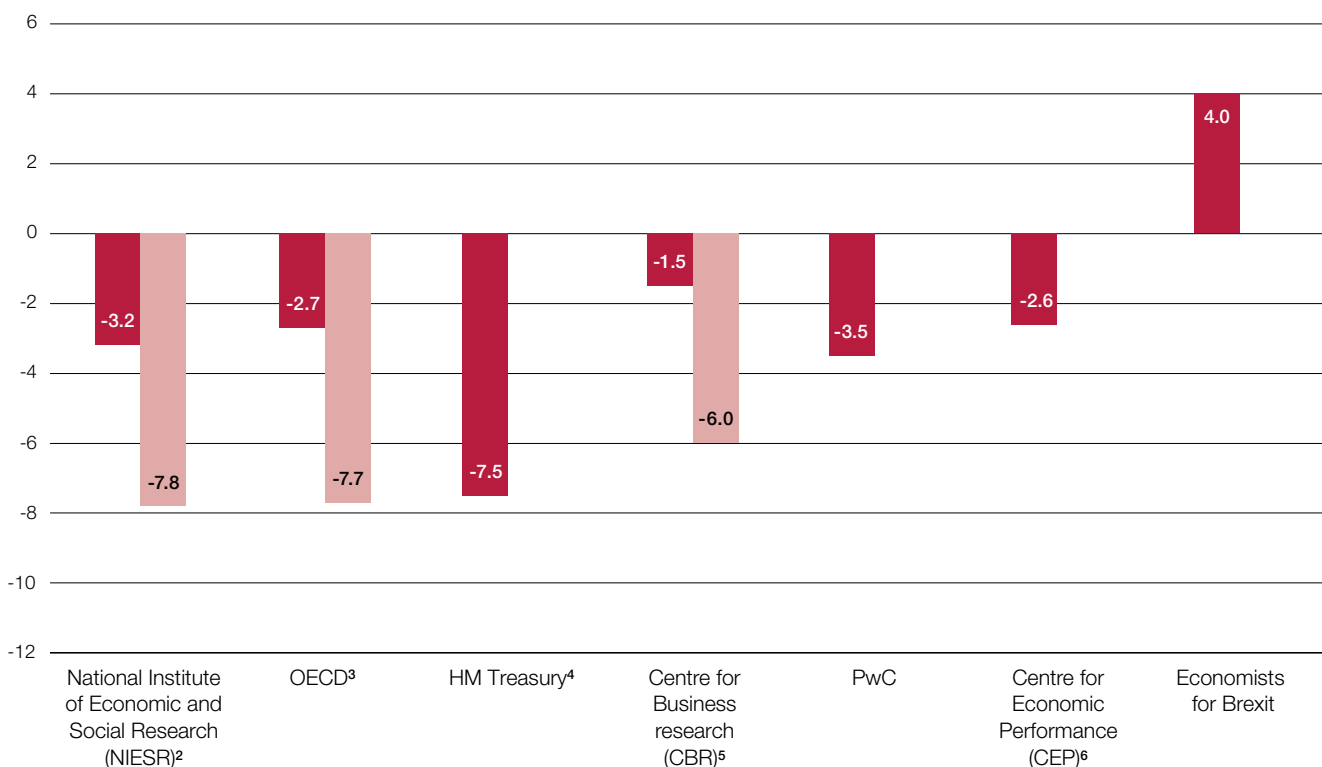
**3.4** **Figure 4** shows the estimated long-term changes to GDP under the World Trade Organization (WTO) scenario, from HM Treasury's analysis and from six other sources. Of the seven studies, six estimated a negative impact on GDP from leaving the EU, in both the central estimates and in the upper and lower ranges. HM Treasury's estimate of a 7.5% reduction was similar to those made by the National Institute of Economic and Social Research (NIESR) and the Organisation for Economic Cooperation and Development (OECD), while PwC and the Centre for Economic Performance (CEP) produced lower estimated changes. The Economists for Brexit group estimated that GDP would be 4% higher after leaving the EU.

**Figure 4**

Estimated changes in long-term GDP under the World Trade Organization (WTO) scenario across selected studies after a period of 15 years<sup>1</sup>

Six out of seven studies reviewed by the NAO estimated a negative GDP impact from leaving the EU

GDP (percentage change)



**Notes**

- 1 All estimates cover the period up to 2030, except the study by the Centre for Business Research (CBR) which covers the period until 2025.
- 2 NIESR produced two World Trade Organization (WTO) estimates. The first WTO estimate of a 3.2% fall in GDP, excluded any impact from productivity. The second WTO scenario (referred to as WTO+ by NIESR) included a productivity impact using similar elasticities to those adopted by HM Treasury. The WTO+ scenario produced an estimate of 7.8%.
- 3 The OECD produced an estimate range of -2.7% to -7.7% for a Free Trade Agreement (FTA)/WTO scenario. The OECD did not state how this range related to either the WTO or FTA scenario.
- 4 HM Treasury produced a range of estimates, with a lower estimate of -5.4% and an upper estimate of -9.5%. The figure in the above graph is the central estimate (-7.5%).
- 5 The Centre for Business Research (CBR) produced two estimates: a mild scenario and a more severe scenario. The more severe scenario adopted similar assumptions to HM Treasury's model while the mild scenario had more cautious assumptions. Both of these scenarios estimate the UK trading under WTO rules. The chart above reflects the two different scenarios.
- 6 The CEP produced two estimates using a static trade model: an optimistic estimate, representing an EEA scenario and a pessimistic estimate, representing a WTO scenario. The static trade model did not include any impact on productivity. The CEP then conducted a separate analysis looking at the dynamic effects of trade on productivity. This dynamic effects estimate represented an EEA/FTA scenario. The figure above is the static WTO estimate.

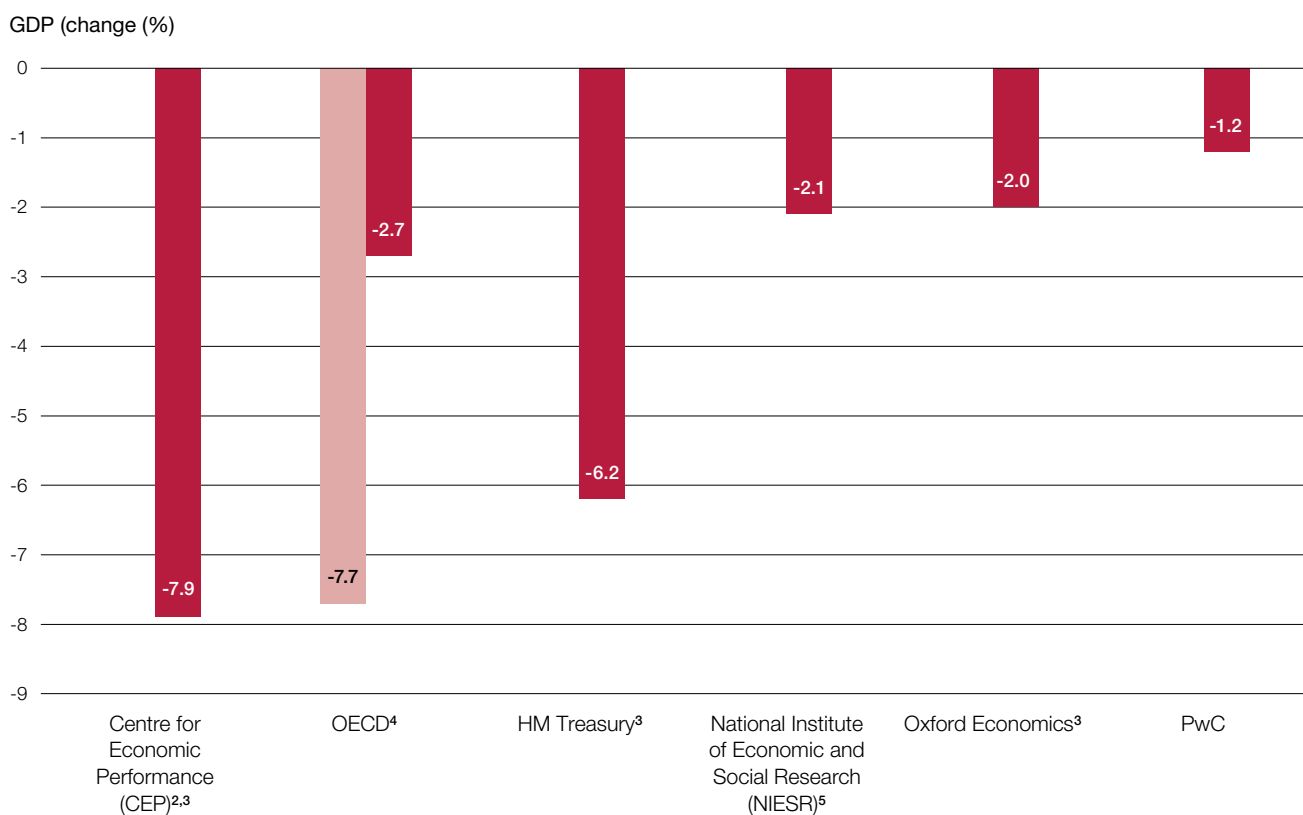
Source: National Institute of Economic and Social Research (NIESR), *The Long-Term Economic Impact of Leaving the EU*, May 2016; Centre for Economic Performance (CEP), *The Consequences of Brexit for UK Trade and Living Standards*, March 2016; Organisation for Economic Co-operation and Development (OECD), *The Economic Consequences of Brexit: A Taxing Decision*, April 2016; PwC, *Leaving the EU: Implications for the UK Economy*, March 2016; Economists for Brexit, *The Economy after Brexit*, 2016; Centre for Business Research (CBR), University of Cambridge, *The Macro-Economic Impact of Brexit: Using the CBR Macro-Economic Model of the UK Economy*, December 2016, HM Government, *HM Treasury: The long-term economic impact of EU membership and the alternatives*, April 2016

**3.5 Figure 5** compares the estimated long-term impact on GDP under the FTA scenario. All six studies estimated a negative impact. HM Treasury's estimated impact (-6.2%) is smaller than the CEP's estimate and the upper range of the OECD's estimate, but is substantially larger than the negative impact estimated by the other studies.

### Figure 5

Estimated changes in long-term GDP under the Free Trade Agreement (FTA) scenario across selected studies after a period of 15 years<sup>1</sup>

All six studies estimated a negative GDP impact as a result of moving from the EU to an FTA arrangement



#### Notes

- 1 The estimates cover the period to 2030.
- 2 The CEP produced two estimates using a static trade model: an optimistic estimate, representing an EEA scenario and a pessimistic estimate, representing a WTO scenario. The static trade model did not include any impact on productivity. The CEP then conducted a separate analysis looking at the dynamic effects of trade on productivity. This dynamic effects estimate represented an EEA/FTA scenario. The figure above is the dynamic EEA/FTA scenario.
- 3 HM Treasury (-4.6% to -7.8%), Oxford Economics (-0.8% to -3.1%) and Centre for Economic Performance (-6.3% to -9.5%) produced a range of estimates for the FTA scenario. The figures above are central estimates.
- 4 The OECD produced an estimate range of -2.7% to -7.7% for a Free Trade Agreement (FTA)/WTO scenario. The OECD did not state how this range related to either the WTO or FTA scenario. It has therefore been included in both Figure 4 which looks at all the World Trade Organization (WTO) scenarios and Figure 5 which looks at all the FTA scenarios.
- 5 The NIESR figure is an average of their optimistic (-1.9%) and pessimistic (-2.3%) scenarios.

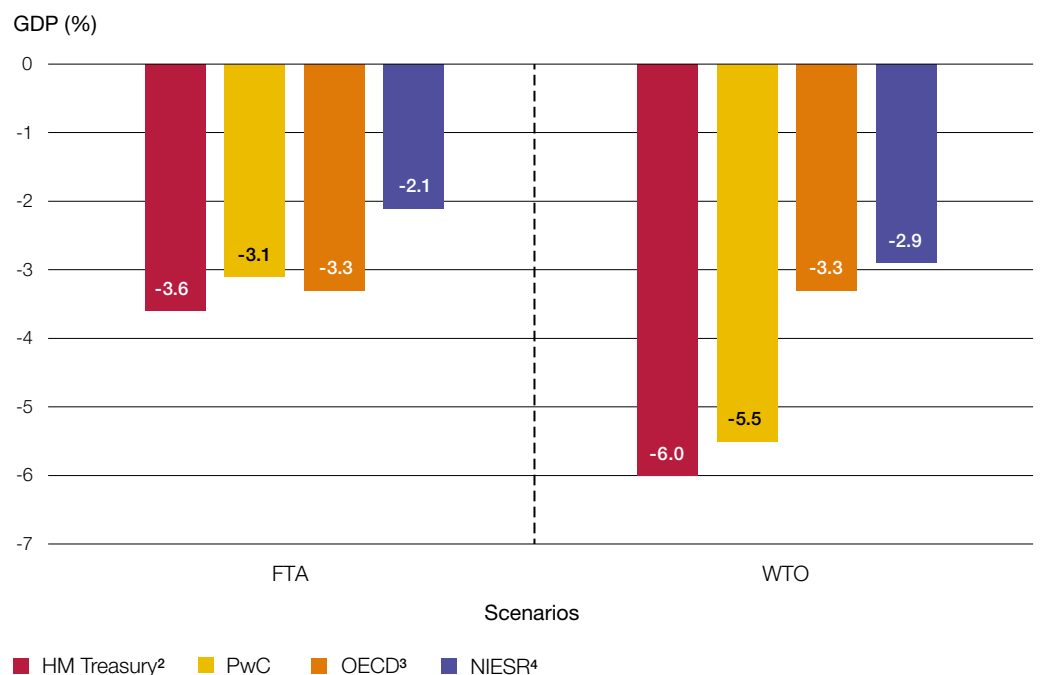
Source: National Institute of Economic and Social Research (NIESR), *The Long-Term Economic Impact of Leaving the EU*, May 2016; Centre for Economic Performance (CEP), *The Consequences of Brexit for UK Trade and Living Standards*, March 2016; Organisation for Economic Co-operation and Development (OECD), *The Economic Consequences of Brexit: A Taxing Decision*, April 2016; PwC, *Leaving the EU: Implications for the UK Economy*, March 2016; Oxford Economics, *Assessing the Economic Implications of Brexit*, March 2016, HM Government, *HM Treasury analysis: The long-term economic impact of EU membership and the alternatives*, April 2016

**3.6** Figure 6 shows results from four studies covering the shorter-term implications of a vote to leave, covering the period 2016 to 2020. All four studies estimate a negative short-term impact from leaving the EU. HM Treasury's estimates were larger than those of all other studies, at 3.6% for the shock scenario and 6% for the severe shock scenario (paragraphs 1.23).<sup>25</sup> NIESR produced the smallest GDP impact, of 2.1% for the FTA scenario and 2.9% for the WTO scenario.

**Figure 6**

Short term impacts on GDP as a result of leaving the EU and trading under a Free Trade Agreement (FTA) and World Trade Organization (WTO) scenarios across selected studies after a period of two years<sup>1</sup>

**HM Treasury produced the largest negative short-term GDP estimate under both the FTA and WTO scenarios**



**Notes**

- 1 HM Treasury's short-term estimates cover the period between 2016 Q3 to 2018 Q2. The estimates from the other studies all cover the period to 2020.
- 2 The HM Treasury figures are central estimates.
- 3 The OECD produced an estimate of -3.3% for an FTA/WTO scenario. The OECD did not state how this estimate related to either the WTO or FTA scenario. It has therefore been included in both columns.
- 4 The NIESR figure for the FTA scenario is an average of their short-term optimistic (-1.9%) and pessimistic (-2.2%) scenarios. The WTO figure is the average of their short-term optimistic (-2.5%) and pessimistic (-3.3%) scenarios.

Source: National Institute of Economic and Social Research (NIESR), *The Long-Term Economic Impact of Leaving the EU*, May 2016, Organisation for Economic Co-operation and Development (OECD), *The Economic Consequences of Brexit: A Taxing Decision*, April 2016, PwC, *Leaving the EU: Implications for the UK Economy*, March 2016, HM Government, *HM Treasury analysis: The immediate economic impact of leaving the EU*, May 2016

<sup>25</sup> The main difference between the two scenarios is that HM Treasury considers the severe shock scenario to be a sensitivity analysis of the cautious assumptions in the main shock scenario, specifically exploring the risk that the rise in uncertainty and the effect on financial conditions are larger, beyond the transition effect also being linked to the central estimate of the WTO alternative in the long-term analysis.

### Some reasons for differences

**3.7** The studies we reviewed often took different approaches, which all contribute to the variations in their resulting estimates. These differences were likely to be particularly important given that leaving the EU would be unprecedented, and given the uncertainty about trading relationships after a leave vote. The key differences involve:

- the impacts that other sources choose to model;
- the modelling approaches undertaken for each impact;
- the scenarios modelled;
- the assumptions made; and
- the modelling of counterfactuals.

**3.8** **Figure 7** illustrates the impacts modelled by other sources. HM Treasury and most other sources estimated the impacts of changes in short-term uncertainty, trade, FDI and productivity on UK GDP. Some went further than HM Treasury and assumed changes to migration policy and possible benefits from greater deregulation.

### Trade

**3.9** All the studies reviewed in this section incorporated the potential impact on trade into their modelling. **Figure 8** on page 24 shows that across the studies, estimated trade reductions (from the counterfactual) range from 8% to 29%. HM Treasury estimated a trade reduction of between 17% and 24% for the WTO scenario, which is similar to the estimates made by OECD and NIESR.

**3.10** Not all of the studies have modelled the same three alternatives (effects of EEA membership, a negotiated bilateral trade agreement, and trading under the WTO rules) as HM Treasury, and where they did, other studies adopted different approaches to modelling each alternative in some cases. PwC did not model an EEA scenario, considering it to be unnecessary because it was inconsistent with the main arguments from the leave supporters, such as a reduction in the free movement of labour and greater regulatory autonomy.

**3.11** The studies we reviewed adopted different approaches to modelling the impact on trade. HM Treasury adopted a gravity modelling approach and then used the National Institute Global Econometric Model (NiGEM) to produce GDP figures. NIESR and the OECD adopted a similar approach. CEP and PwC used a computable general equilibrium model, while Oxford Economics used a structural model. Uniquely among the studies we reviewed, the Economists for Brexit group did not adopt the gravity theory for their trade analysis, but assumed that all UK imports and exports behave like commodity goods such as oil. Under this assumption UK trade would be unaffected by leaving the EU, because all UK goods could be sold in alternative markets at the prevailing world prices. This assumption is the main explanation for the difference between their estimates and those of the other studies.

**Figure 7**  
Impacts modelled by different sources

Impacts modelled	HM Treasury	National Institute of Economic and Social Research (NIESR) <sup>1</sup>	Centre for Economic Performance (CEP) <sup>2</sup>	OECD	PwC/CBI	Oxford Economics	Economists for Brexit
Short-term uncertainty	✓	✓	-	✓	✓	-	-
Change in trade with EU	✓	✓	✓	✓	✓	✓	✓
Change in FDI	✓	✓	✓	✓	✓	✓	-
Productivity impact from trade	✓	✓	✓	✓	✓	✓	-
Productivity impact from FDI	✓	-	-	✓	-	✓	-
Lower contribution to EU budget	✓	✓	✓	✓	✓	✓	✓
Change in migration	-	-	-	✓	✓	✓	-
Gains from deregulation	-	-	-	✓	✓	✓	-

**Notes**

- 1 The main estimates produced by NIESR exclude the impact on productivity as a result of leaving the EU. NIESR produced an additional estimate which included a decline in productivity in their optimistic WTO scenario, using similar productivity declines used by HM Treasury in their long-term analysis.
- 2 The CEP's optimistic and pessimistic static estimates did include the productivity impact from trade. The CEP's dynamic long-term estimate considered the impact of productivity changes.

Source: Institute for Fiscal Studies (IFS), *Brexit and the UK's Public Finances*, May 2016; NIESR, *The Long-Term Economic Impact of Leaving the EU*, May 2016; Organisation for Economic Co-operation and Development (OECD), *The Economic Consequences of Brexit: A Taxing Decision*, April 2016; HM Government, *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, April 2016

**Figure 8**

Estimated impact on trade under different scenarios after a period of 15 years

Organisation	Scenario	Trade impact (%)
Centre for Economic Performance (CEP) <sup>1</sup>	European Economic Area (EEA)/ Free Trade Agreement (FTA)	-8
	World Trade Organization (WTO)	-14.5
HM Treasury	EEA	-9
	FTA	-14 to -19
	WTO	-17 to -24
OECD <sup>2</sup>	WTO/FTA	-10 to -20
NIESR <sup>3</sup>	EEA	-11 to -16
	FTA	-13 to -18
	WTO	-21 to -29
	WTO+	-22

**Notes**

- 1 The CEP produced trade estimates for two scenarios: an optimistic scenario equivalent to an EEA/FTA scenario and a pessimistic scenario equivalent to a WTO scenario. The figures are an average of CEP's import and export estimates.
- 2 The study by the OECD produced an estimate range of -10% to -20% for an FTA/WTO scenario. The OECD did not state how this range relates to either the WTO or FTA scenario.
- 3 The NIESR WTO+ scenario includes a productivity impact similar in magnitude to the HM Treasury estimate.

Source: Institute for Fiscal Studies (IFS), *Brexit and the UK's Public Finances*, May 2016

**3.12** Some studies adopted different approaches to modelling counterfactuals.

HM Treasury examined the impact of leaving the EU against a counterfactual of remaining in the EU in its current format. PwC adopted a 'counterfactual economic scenario in which the UK remains a member of a reformed EU under the deal secured by the UK government in February 2016'.<sup>26</sup> PwC estimated that the UK economy would grow annually by 2.3% and attributed (without quantifying) some of this growth to the reforms.

**3.13** The studies we reviewed included different assumptions in their modelling.

HM Treasury assumed that in the long-term the UK would replicate existing trade deals with non-EU countries but not beyond this, although it noted that this was unlikely in practice. PwC assumed that after a leave vote the UK would be able to negotiate a new FTA with the US by 2021. The CEP assumed that in the event of a vote to remain, the UK would benefit from an EU trade deal with the US and Japan, which it estimated could lower UK prices by 0.6% annually, or £6.3 billion, in the long-term.

26 PwC, *Leaving the EU: Implications for the UK economy*, March 2016, p3.



**3.14** In its commentary on HM Treasury's long-term analysis, the CEP's overall assessment was that HM Treasury's analysis was credible, but it criticised some of HM Treasury's assumptions as overly cautious.<sup>27</sup> It questioned why HM Treasury had only included half of the negative trade and FDI effects at the lower end of the ranges from moving from the EU to a bilateral trade agreement or WTO scenario, within the 15-year timeframe (paragraph 2.4). The CEP considered that HM Treasury had provided no obvious reason for making this adjustment, apart from wanting to be very cautious.

### **Productivity**

**3.15** Not all studies included the productivity impact from reduced trade openness, which explains part of the variation in estimates across the studies. NIESR, for example, intentionally took a narrower approach, only looking at the clearest and most well-understood channels such as trade, FDI and lower contributions to the EU budget, and excluding the direct impact of trade openness on productivity due to the difficulties in applying modelling techniques specifically to the UK. By taking a narrower modelling approach, NIESR's central estimates of (negative) impacts are lower than HM Treasury's estimates – excluding the productivity link, in NIESR's more pessimistic scenario (WTO), GDP is 3.2% lower than the counterfactual, compared with HM Treasury's 7.5% estimated impact. However, NIESR recognised the potential importance of modelling a productivity fall, and attempted to capture this using elasticities similar in magnitude (0.25) to those that HM Treasury used. Incorporating this productivity impact, NIESR estimated a negative impact of 7.8% on GDP in the pessimistic WTO scenario, slightly larger than HM Treasury's estimate (illustrated in Figure 4).

**3.16** Studies that included the productivity impact included different assumptions in modelling the impact. HM Treasury used an elasticity of 0.2 to 0.3 in its modelling of the productivity impact of trade (paragraph 1.13). The CEP adopted a similar approach to HM Treasury, by selecting productivity elasticities from the empirical literature and applying them to trade figures. The CEP selected a higher set of elasticities (0.5 to 0.75), and its central estimate of a 7.9% negative impact on GDP for an EEA/FTA alternative is larger than HM Treasury's 6.2% estimate of a negotiated bilateral agreement. CEP has commented that HM Treasury's use of elasticities for the productivity impact (from a study by Feyrer, 2011) was excessively cautious because Feyrer considered an eight-year period, which is shorter than HM Treasury's 15-year (long-term) horizon, and that elasticities from Feyrer's 2009 paper are more appropriate because of the longer time period used there.<sup>28</sup> HM Treasury told us that the larger elasticities from Feyrer (2009) capture other factors such as FDI, which it wanted to exclude from the productivity impact and model separately.

**3.17** Figure 7 on page 23 illustrates that six out of the seven studies reviewed here include the impact on UK productivity from leaving the EU.

<sup>27</sup> Centre for Economic Performance, *The UK Treasury analysis of 'The long-term economic impact of EU membership and the alternatives': CEP Commentary*, April 2016. Available at: <http://cep.lse.ac.uk/pubs/download/brexit04.pdf>

<sup>28</sup> See footnote 26.

### Migration

**3.18** Other sources made different assumptions regarding future migration levels. HM Treasury, CEP, NIESR and Economists for Brexit do not include changes in migration policy in their analysis. The extent to which migration is affected after leaving the EU depends on the government's policy choices. HM Treasury decided not to prejudge what future government policy will be. Instead it used the Office for National Statistics (ONS) current principal population projections where total net migration to the UK would fall from 329,000 per year in 2014 to 185,000 per year in 2021, and remain at this level until 2030.

**3.19** PwC assumed that all EU migrants currently in the UK could remain with future restrictions on inward migration. In both FTA and WTO scenarios PwC assumed that no low-skilled workers from the EU would be allowed entry, but assumed that rules for skilled workers will be relaxed in the FTA scenario, and would remain in the current format in the WTO scenario. PwC estimated that UK labour supply would contract by 0.7% in the FTA case and 1.4% in the WTO case, with a negative impact on GDP of 1% and 1.6% respectively. Oxford Economics used a different set of assumptions on what future government policy would be, with migration controls ranging from 'modest' to more 'aggressive'. Oxford Economics also estimated a negative impact on GDP after leaving the EU: in 2030, GDP would be 0.2% lower than the counterfactual in the modest control scenario, and 1.1% lower in the more aggressive case.

### Deregulation

**3.20** Other sources also made different assumptions about the potential impacts on GDP from greater deregulation after leaving the EU. HM Treasury did not make a direct assumption about deregulation, to avoid prejudging future government policy. Oxford Economics explicitly included a positive impact of deregulation in their modelling, through higher investment increasing productivity.<sup>29</sup> The CEP did not directly model the possible benefits of deregulation, but considered the impact of 56 regulations attributed to EU membership where the costs were estimated to exceed the benefits, based on a study by Booth et al (2015). A study by Crafts (2016) estimated that these 56 regulations could cost the UK economy 0.9% of GDP. The CEP considered that, even if a benefit of 0.9% of GDP could be realised by removing these regulations, this was still significantly smaller than the CEP's central estimate of a 7.9% negative impact on GDP.

### Context of developments since the referendum when comparing estimated impacts to actuals

**3.21** Since the referendum some economic variables have changed in ways that are consistent with HM Treasury's short-term analysis, while others have not. For example, HM Treasury's short-term analysis estimated a fall in the exchange rate, and since the referendum sterling has depreciated by 13%.<sup>30</sup> Other economic variables, for example output and employment, have behaved very differently from HM Treasury's expectations.

<sup>29</sup> Oxford Economics, *Assessing the Economic Implications of Brexit*, March 2016.

<sup>30</sup> From 23 June 2016 to 23 June 2017.

**3.22** In considering the context of developments since the referendum, we observe the following:

- **HM Treasury said it was not producing a forecast in its analyses.** As stated above, instead HM Treasury assessed the impact of leaving the EU and moving to an alternative, compared with a counterfactual of remaining in the EU in its current state, and based on its understanding of the relationship between openness (through trade and FDI), productivity and GDP.
- **HM Treasury intentionally assumed no policy response.** HM Treasury made this assumption in its modelling to avoid prejudging future government policy decisions; similarly, it excluded from the modelling any potential policy response from the Bank of England. However, since the outcome of the referendum in June, the Bank of England has announced a package of measures designed to support the UK economy, including:
  - an interest rate cut from 0.5% to 0.25%;
  - the introduction of a Term Funding Scheme (TFS) designed to ensure banks pass on the interest rate cut to customers. This could represent increased lending of £100 billion;
  - the purchase of up to £10 billion of UK corporate bonds; and
  - an expansion of the quantitative easing (QE) programme by £60 billion.
- **Some other key assumptions have not held in practice.** In its short-term modelling, HM Treasury assumed that after a leave vote the government would trigger Article 50 immediately, in line with the then Prime Minister's statement to Parliament on 22 February 2016, whereas in practice it was not triggered until March 2017. Uncertainty will continue to remain for some time around the forms that trading relationships will eventually take after the UK leaves the EU.

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