Greater London Authority

Preparing for Brexit

Final Report

January 2018

Cambridge Econometrics
Cambridge, UK

bg@camecon.com
www.camecon.com

Cambridge Econometrics' mission is to provide clear insights, based on rigorous and independent economic analysis, to support policy-makers and strategic planners in government, civil society and business in addressing the complex challenges facing society.

Cambridge Econometrics Limited is owned by a charitable body,
the Cambridge Trust for New Thinking in Economics.
www.neweconomicthinking.org

Contents

Executive Summary

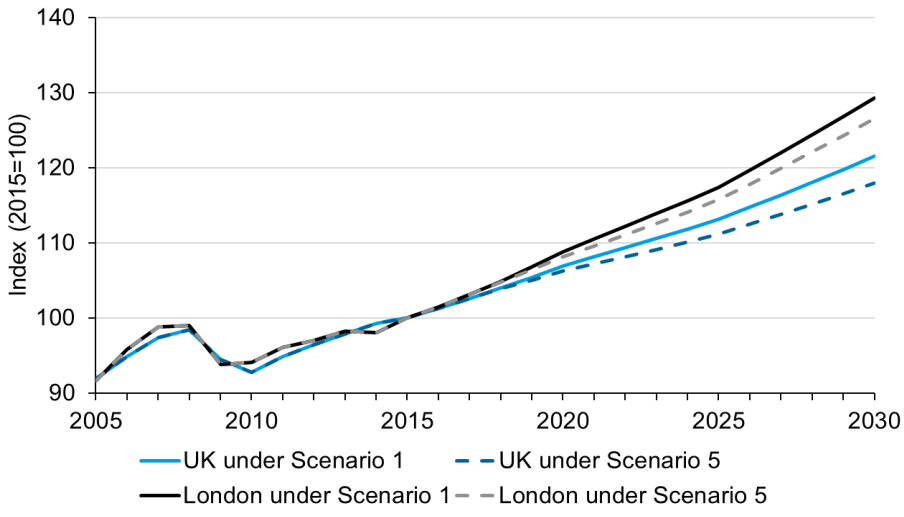
- Following the EU referendum on 23 June 2016, the UK voted to leave the EU (with 52% voting in favour of leaving). The official withdrawal process began when Article 50 was triggered on 29 March 2017, giving the UK until 29 March 2019 to negotiate an exit deal. The impact of the vote to leave the EU is likely to be one of the largest potential economic impacts on both the London and the UK economies, in both the short and long-run. However, the magnitude of these effects remains unknown as they depend on the eventual form of Brexit, and knowledge of the post-Brexit UK economic environment across a range of dimensions such as trade, migration, and regulation. For London in particular, which has greatly benefited from the prevailing economic environment and a large international labour force, the consequences could be especially challenging.
- As part of this study, five scenarios were developed to model five possible outcomes for the UK and London of the UK leaving the European Union Customs Union and Single Market (see table below). Scenario 1 reflects a status quo situation where the UK remain in the Single Market and Customs Union (the baseline), and then Scenarios 2 and 3 move from a softer version of Brexit (the UK is part of the EEA, but not the Customs Union in Scenario 2; and is part of the Customs Unions, but not the EEA in Scenario 3), to a harder Brexit in Scenarios 4 and 5 (UK is no longer part of the EEA or the Customs Union). Scenario 4 is the closest scenario to the government's current position, while Scenario 5 is a more extreme outcome of Scenario 4, which is still plausible within the government's approach.

Scenario	Two-year 'status quo' transition period from March 2019	Single Market membership	Customs union membership	EU/UK trade deal
1 – Continued SM and CU membership from March 2019	N/A	Y	Y	N/A
2 – Two-year transition followed by SM membership without CU	Y	Y	N	N/A
3 – Two-year transition followed by CU membership without SM	Y	N	Y	N/A
4 – Two-year transition followed by no membership of the SM or CU and falling back to WTO rules	Y	N	N	WTO rules
5 – No transition, no membership of the SM or CU, and no preferential EU/UK trade agreement	N	N	N	WTO rules

- Assumptions were made for each scenario, focusing on the effects Brexit could have on trade, investment and migration/the labour market. The assumptions are based on a mix of: directly borrowing inputs from existing studies; making adjustments made on short-term evidence from the data; using existing information on government targets and guidelines; and making more judgemental assessments using additional literature.

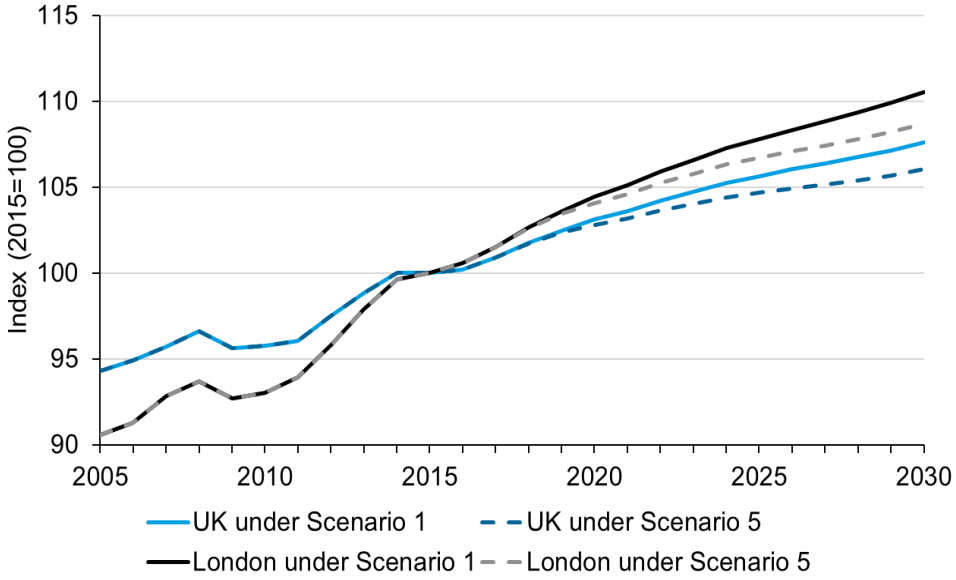
- The trade assumptions for each scenario, disaggregated by the type of trade costs (tariffs and non-tariff barriers), the flow of trade (imports and exports), the group of trading partners (EU and non-EU), and by sector were based on the assumptions used in the Dhingra et al (2016a) study.
- Recent changes in investment (a 1.5% fall in the average year-on-year growth in total business investment over the last five quarters) from the ONS Business investment in the UK dataset were used in order to quantify the potential short-term change in investment due to uncertainty. The longer-term investment assumptions were made relative to the baseline trajectory in the form of a slowdown in investment growth. Taking into consideration that growth in total investment in the baseline (Scenario 1) is 1.9% pa over 2021-30, it was assumed that growth in total investment would fall to 1% pa over 2021-2030 in Scenarios 4 and 5, and assumed that the slowdown would be smaller in Scenarios 2 (1.5% pa) and 3 (1.3% pa).
- The harder Brexit scenarios assumed that the government's tens of thousands migration target would be achieved, and the softer Brexit scenarios built up to this from Scenario 1, in which migration is based on the GLA 2016-based projections. Lastly, the assumptions for the impact on skills level and so productivity of the UK labour force from a change in migration patterns were based on the CEP study by Dearden, Reed and Van Reenen (2005), which estimated that the elasticity of productivity with respect to the proportion of trained (skilled) workers is 0.6.
- The scenario results were driven by CE's macro-sectoral model, E3ME. E3ME is a global model that includes coverage of all of Europe's Member States and candidate countries, the world's largest economies and all other economies in groups. It has a detailed sectoral disaggregation, and the model has been used to develop many scenarios in order to model trade and other policy effects across the European Union and globally.
- **As expected, the more severe the type of Brexit (going from Scenario 2 to Scenario 5), the greater the negative impact will be on London and the UK (see graphs below). The results show that Brexit will not only reduce the size of the UK economy (compared to what may have happened if the UK remained in the Single Market and Customs Union), but also put it on a slower long-term growth trajectory (i.e. the**

GVA growth in the UK and London

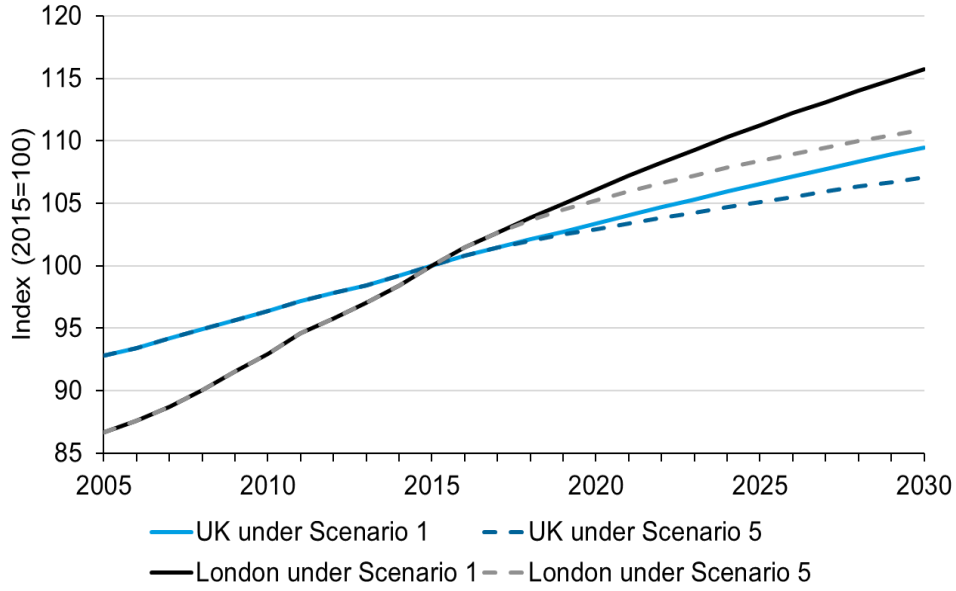


economy is still growing, but at a slower rate than if the UK remained in the Single Market and Customs Union). So the cumulative change in GVA over time will keep increasing in the long-term.

Employment growth in the UK and London



Population growth in the UK and London



- **The modelling results show that Brexit will have a negative impact on the UK economy across all key indicators, in particular, investment (see table below). The UK is expected to experience a loss of 1.0% (£18.6bn) in GVA by 2030, 6.7% (20.2bn) in investment and 0.5% (176,000 people) in employment under Scenario 2 (compared to what may have happened if the UK remained in the Single Market and Customs Union). This loss would be 2.7% (£49.1bn) in GVA, 13.8% (£41.6bn) in investment and 1.4% (468,000 people) under Scenario 4 and 3.0% (£54.5bn) in GVA, 15.4% (£46.7bn) in investment and 1.5% (482,000 people) in employment under Scenario 5.** The fall in the value of investment is greater than that of overall GVA, as the expected fall in

imports is greater than the fall in exports, so the improvement in the trade balance helps recover some of the loss in investment.

Differences from Scenario 1 (baseline) for the UK by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
Export to rest of the world	-0.4	-0.6	-2.3	-2.3
Import from rest of the world	-1.5	-2.3	-4.4	-4.6
Population	-0.7	-1.4	-2.2	-2.2
GVA	-1.0	-1.6	-2.7	-3.0
Investment	-6.7	-9.9	-13.8	-15.4
Employment	-0.5	-0.9	-1.4	-1.5
Productivity	-0.5	-0.7	-1.3	-1.5

- **London is expected to experience a loss of 0.8% (£4.1bn) in GVA by 2030 and 0.6% (30,500 people) in employment under Scenario 2 (compared to what may have happened if the UK remained in the Single Market and Customs Union), a loss of 1.9% (£9.6bn) in GVA and 1.6% (83,800 people) in employment under Scenario 4 and a loss of 2.1% (£10.8bn) in GVA and 1.6% (87,000 people) in employment under Scenario 5 (see table below). It is not expected to be affected as much as the UK, in terms of GVA and productivity. This reflects that London has a higher concentration of higher-value sectors, which are more resilient, and are able to recover from economic shocks more quickly. Population (and so employment) impacts in London are noticeably stronger than in the UK. London has a larger proportion of non-UK workers, so border restrictions and a reduction in EU migration are expected to impact London the most.**

Differences from Scenario 1 (baseline) for London by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
GVA	-0.8	-1.2	-1.9	-2.1
Employment	-0.6	-1.0	-1.6	-1.6
Productivity	-0.2	-0.2	-0.3	-0.5
Population[1]	-1.3	-2.7	-4.2	-4.2

- **Financial & professional services, Science and Technology, Creative and Construction, which make up a high proportion of economic activity in the UK, particularly in London, are among the sectors hit the hardest by Brexit. Construction and Hospitality, which tend to require less skilled labour and employ a larger proportion of EU migrants than other key sectors, are expected to see larger impacts on employment in London than in the UK.**

[1] The population estimates show the potential impact of Brexit based on several simplifying assumptions. They are also static in the sense that they do not consider any wider dynamic effects on future migration trends. Consequently, they are not suitable for long-term planning purposes.

1 Introduction

1.1 Background

Following the EU referendum on 23 June 2016, the UK voted to leave the EU (with 52% voting in favour of leaving). The official withdrawal process began when Article 50 was triggered on 29 March 2017, giving the UK until 29 March 2019 to negotiate an exit deal.

The impact of the vote to leave the EU is likely to be one of the largest potential economic impacts on both the London and the UK economies, in both the short and long run as has been highlighted by research published by a number of organisations prior to the June 2016 referendum[2]. However, the magnitude of these effects remains uncertain as they depend on the eventual form of Brexit, and knowledge of the post-Brexit UK economic environment across a range of dimensions such as trade, migration, and regulation.

1.2 Scope of the study

The aim of the study was to develop scenarios to model five possible outcomes for the UK and London of the UK leaving the European Union Customs Union and Single Market.

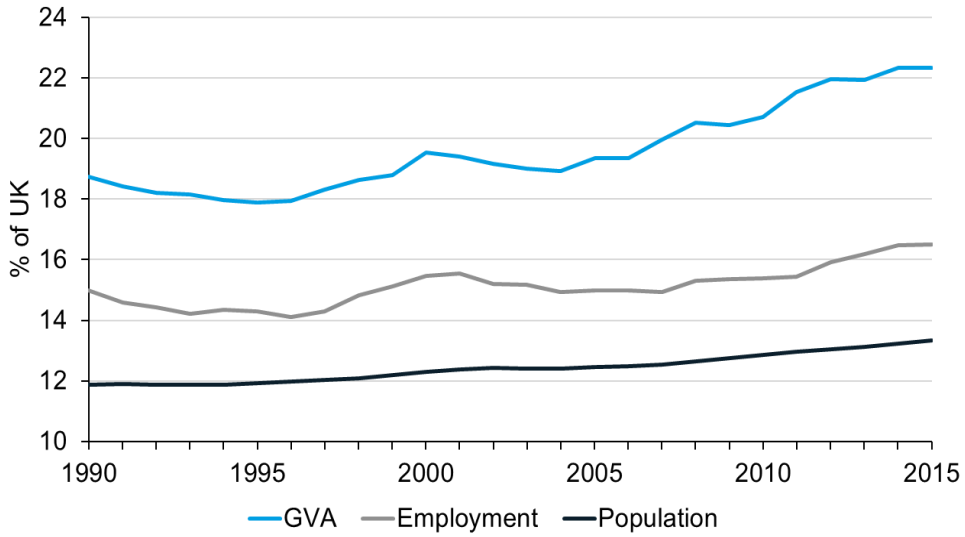
This is a particularly complex study, as the long-term consequences of the UK leaving the EU remain unclear given the continuing uncertainties surrounding what an eventual Brexit deal will look like. This is why scenario analysis is such a useful tool, because, given an appropriate structure being set in place for undertaking the modelling, it allows for a range of different assumptions to be tested for their impact.

For London in particular, which has greatly benefited from the prevailing economic environment and a large international labour force, the consequences could be especially challenging. London has grown substantially over the past decades to account for an increasing share of UK population, output, and employment (see Figure 1.1), with its population and skills growth supported by international, in particular, EU migration.

The principle challenge for the study is how to incorporate the nuances and effects of a Brexit scenario within a modelling framework so that a set of consistent and coherent results can be obtained. The truth is that a model which moves from the global level (i.e. capable of capturing international trade impacts from changing tariff effects, and also incorporating investment and international migration effects) to the local area / city level within a single framework does not exist. Instead, a hybrid framework has been established, which firstly calculates the macro-sector effects for the UK, and then spreads them out at the local level, in particular taking account of London's dominant position within the national economy.

[2] See for example: Mayor of London, August 2014, 'The Europe report: a win-win situation: Appendix A'. HM Treasury, 18 April 2016, 'HM Treasury analysis: the long-term economic impact of EU membership and the alternatives'. IMF, June 2016, 'United Kingdom: Selected Issues'. IMF Country Report No. 16/169. OECD, April 2016, 'The Economic Consequences of Brexit: A Taxing Decision'.

Figure 1.1 Total employment, GVA and population in London



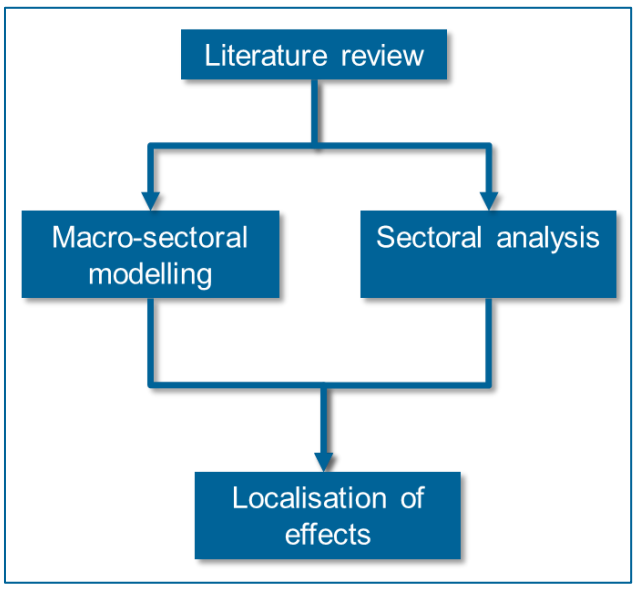
Source: Cambridge Econometrics, August 2017.

A secondary challenge is, even with an agreed approach to the modelling structure, how to obtain the necessary assumptions. This is a somewhat easier challenge to overcome, as there are already examples of studies having attempted (some of) these effects through modelling frameworks which incorporate global trade networks and substitution effects. Assumptions were made for each scenario, focusing on the effects Brexit could have on trade, investment and migration/the labour market. The assumptions are based on a mix of: directly borrowing inputs from existing studies; making adjustments based on short-term evidence from the data; using existing information on government targets and guidelines; and making more judgemental assessments using additional literature.

1.3 Modelling stages

An overview of the modelling stages is provided in Figure 1.2. The study begins with a review of the existing literature focusing on the potential impacts of the UK leaving the European Union. The focus of the review was not to undertake a wide-ranging review of Brexit, but rather to locate research that looks at

Figure 1.2: Modelling stages



impacts on the UK and London economy, and how these impacts have been modelled, especially the assumptions that have been made in terms of driving factors from trade, investment and migration/labour market effects.

Following the literature review, the scenario assumptions were developed and modelled. The scenario results were driven by CE's macro-sectoral model, E3ME, a global model that includes coverage of all of Europe's Member States and candidate countries, the world's largest economies and all other economies in groups. E3ME has a detailed sectoral disaggregation, and has been used to develop many scenarios in order to model trade and other policy effects across the European Union and globally. Chapter 4 provides a more detailed description of E3ME and the economic relationships within the model.

Alongside the modelling process, and in consultation with the GLA, a number of sectors were identified to focus more detailed attention on as part of the analysis. More information on the key sectors is given in Section 4.3.

The UK results for each scenario from E3ME were disaggregated to London and sub-London geographies, based on historical growth in the local area relative to the UK (or London), on an industry-by-industry basis. See Chapter 4.3 for more information.

1.4 Report structure

This report describes the methodology and findings of this project. Chapter 2 gives an overview of the literature review. A description of each of the scenarios developed as part of this study and a summary of the key assumptions made for each scenario is given in Chapter 3. A description of the macro-sectoral model used to model the scenarios at the UK-level, and the methodology used to localise the effects to the London and sub-regional level and disaggregate the results by key sectors is described in Chapter 4. The key scenario results by geography and key sectors are provided in Chapter 5. The last step of the study was to provide a qualitative analysis of business start-ups and scale-ups, based on historical data and the E3ME modelling results. This is presented in Chapter 6.

2 Findings from the Literature

2.1 Introduction

The literature on Brexit often tends to focus on headline outcomes, e.g. an X% fall in GDP by 2030. While this is of interest, it is not the primary focus of this study's literature review, which is to inform on setting the range of assumptions underpinning the analysis.

It is thus a different and somewhat more difficult task, when reviewing the literature on Brexit, to understand what assumptions have been made by the various authors being reviewed. The three main questions to ask are:

1. What form of Brexit was being analysed?
2. Were specific or multiple elements of Brexit being assessed?
3. What values were assumed for key drivers such as tariffs and non-tariff barriers, migration, skills, and inward investment?

This chapter seeks to tease out the answers to these questions in a bid to get a range of values within which it would seem sensible to frame the project's own assumptions.

2.2 Trade

The impact of Brexit on trade is the most direct effect to capture in any model. Indeed, the effects of Brexit have already started to affect the UK economy, most noticeably through the depreciation of sterling immediately after the referendum and the impacts it has on the values of imports and exports between the UK and the EU, and knock-on effects to inflation. Therefore, this has been the focus of much of the existing literature and so is where the most assumptions have been explored.

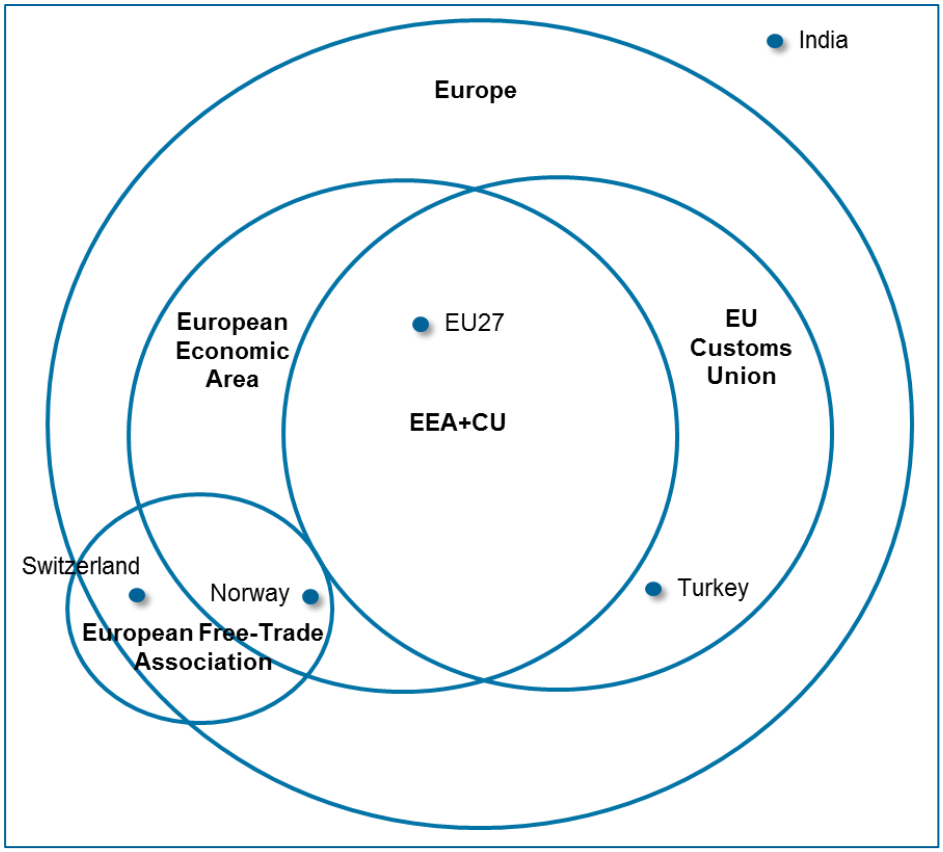
The literature covers a range of scenarios regarding the trading relationship between the UK and the EU, but most often the following three[3], ordered from the most to the least optimistic regarding UK-EU trade relations:

- A soft Brexit in which the UK joins the European Economic Area (EEA)
- A semi-hard Brexit in which the UK enters a free trade agreement (FTA) or negotiates a bilateral trade agreement with the EU
- A hard Brexit in which the UK trades with the EU under the terms of the World Trade Organisation (WTO)

Figure 2.1 illustrates the different trading relationships countries have with the EU. See the box beneath for a description of what being in the Single Market and Customs Union entail.

[3] Clarke, Serwicka and Winters (2017) also explore a scenario in which the UK does not obtain EEA membership or enter a trade agreement, but instead chooses to unilaterally bring tariffs for all countries down to the level currently applicable to the EU, effectively eliminating all tariffs. However, this is most unlikely to take place.

Figure 2.1: Overview of trading relationships with the EU



Single Market

Single Market membership is effectively 'EEA membership', which includes the current EU28 countries and Iceland, Liechtenstein and Norway (but not Switzerland, which is part of the European Free Trade Association (EFTA), but not the EEA). It refers to the countries as one territory without any internal borders or other regulatory obstacles to the free movement of goods and services (i.e. it eliminates tariffs, quotas or taxes on trade and attempts to remove non-tariff barriers such as rules on packaging, safety and standards). The EEA includes the four freedoms (free movement of goods, capital, services and labour) plus all the legislation supporting them, competition/state aid rules and all the accompanying measures (rules on social policy, consumer protection and environment). It also provides for participation in funding programmes, in particular the main "Framework" programmes on research and innovation. EEA does not cover the common agriculture or fisheries policies nor Justice & Home Affairs, nor foreign and security policy.

Customs Union

In the EU Customs Union all the Member States follow a set of common rules in exercising customs controls over goods entering the EU from outside the EU. This means that goods which come into the EU from outside are subject to a common external tariff, but once they have entered through an external port and paid any duty which is due on them, they can then circulate freely inside the customs union. Goods which are made inside the customs union can likewise circulate freely without being subject to tariffs at the internal borders within the customs union.

Individual members cannot negotiate trade deals with non-member countries and are not able to set its own tariffs. It is possible for a country to be part of a customs union with the EU but not in the single market (e.g. Turkey).

Under the soft Brexit scenario, it is assumed that the UK would obtain EEA membership to give it access to the Single Market, or at least it negotiates a trade agreement that is as favourable as EEA membership[4]. This means that UK-EU trade is not subject to tariffs. Non-tariff barriers, such as customs checks, border controls, differences in product market regulations, legal barriers and other transactions costs, may be introduced and will depend on the deal the UK negotiates with the EU. In addition, the UK would be required to comply with EU regulations without the power to influence them, although it could implement policies to ensure equivalence and reduce non-tariff barriers. This is often referred to as a Norway-type scenario (see Figure 2.1).

At the other end of the spectrum, under a hard Brexit, it is assumed that the UK would trade with the EU under WTO rules[5]. This would introduce tariffs at the Most Favoured Nation (MFN) rates, as well as raising non-tariff barriers at a level higher than those assumed in the soft Brexit scenario. The UK would have no passporting rights and restricted access to the EU market in the absence of a Preferential Trade Agreement (PTA). In other words, it would be treated as a third country (e.g. India).

In contrast with the above two scenarios, there is neither a consensus nor a clear picture in the literature about what the medium scenario, a so-called semi-hard Brexit, would entail exactly. All studies assume that the UK would enter a trade agreement that allows it to access the Single Market[6], some under more restrictive provisions than others, at a relatively low cost (with respect to tariffs).

In terms of sectoral variations, it is generally the case that production or export-intensive sectors (including food & drinks[7], motor vehicles and electronics[8]) would be most affected by an increase in trade costs (tariffs or non-tariff barriers) as a result of Brexit, which generates knock-on impacts further down the supply chain in transport and distribution. In services, finance & insurance is expected to see the largest impact from changes in non-tariff barriers such as passporting rights and regulations, but the distribution is unlikely to be even across different sub-sectors. For example, banking is likely to be more affected than insurance, private equity and hedge funds, as it is more closely connected to the EU (KPMG, 2017a).

A detailed summary of all assumptions found in the literature is provided in Appendix A.

2.3 Investment

There have been limited assumptions directly related to the investment impact in the literature, as it is inherently difficult to model and is related to corporate strategy, which is something that larger-scale macro models don't deal with very well. Most of the discussion has centred on inward foreign direct investment

[4] Such as in Dhingra et al (2016a) and Mulabdic, Osnago and Ruta (2017)

[5] Such as in Dhingra et al (2016a) and Mulabdic, Osnago and Ruta (2017), Lawless and Morgenroth (2016) and Pelkmans (2017)

[6] Such as in Mulabdic, Osnago and Ruta (2017) and Pelkmans (2017)

[7] According to Lawless and Morgenroth (2016) and KPMG (2017a)

[8] According to PwC (2016a) and Pelkmans (2017)

(FDI) and agrees that it would be lower in any scenario compared to the baseline of the UK remaining in the EU[9].

Ebell and Warren (2016) is the only study that explored quantitatively different scenarios (similar to those discussed in Section 2.2) with respect to business investment, although the result is derived from the FDI impact and is only produced at the aggregate level. Nevertheless, there is an underlying agreement that the impacts would be negative and not uniform across sectors. Those most mentioned in the literature to be affected by Brexit are financial & insurance, manufacturing, construction and research & development[10]. Detailed assumptions are provided in Appendix A.

In addition to long-term effects on investment, in July 2017 the CBI reported[11] on a survey it had conducted which revealed that 40% of firms had already had investment decisions affected by the uncertainty created by the Brexit process, with the vast majority indicating a negative effect. This pre-Brexit adverse effect on investment is also something that should be taken account of while the precise details of the UK's future relationship with the EU remain unknown.

2.4 Demographics and labour market

Out of the studies that were covered by the literature review, only two[12] consider assumptions directly related to population, migration and the labour market. In addition, they only offer a qualitative discussion, but both envision a Brexit in which the UK would not continue to have free movement of labour and would implement control of EU migration, particularly for work purposes (see box below for details on the government's migration targets). On one end of the spectrum, the current visa system could be maintained with a relaxed approach to EU migration, not too dissimilar to the current freedom of movement of people. On the other end of the spectrum, a points-based approach could be taken to EU migration, regulating it in the same way as for migrants from outside the EEA. The reality of restricting EU migration is questionable in some scenarios, for example, any formal restriction on migration would violate one of the four freedoms encompassed by Single Market membership. However, an equivalent might still be achieved if the migration reduction is induced by people's preferences rather than by direct control (i.e. the UK becomes a less attractive place to live), as has been the case since the referendum.

The impact of Brexit on migration is more often presented as results of an estimation or a modelling exercise, rather than assumptions feeding into the analysis. A number of studies[13] estimate that in the absence of free movement of labour, the level of net EU migration will be between 62,000 and 100,000 people lower each year than the current figure.

[9] Such as in Baldwin (2016), Ebell and Warren (2016) and Pelkmans (2017)

[10] According to Baldwin (2016), Borchert (2016), Oliver Wyman (2016) and Lavery, Quaglia and Dannreuther (2017)

[11] See http://www.cbi.org.uk/news/brexit-is-affecting-investment-decisions/.

[12] Baldwin (2016) and GLA (2016a)

[13] Portesy and Fortez (2016); Migration Watch (2016) and Global Futures (2017)

The government's migration targets

The UK government has pledged to lower net migration to what are called sustainable levels, aiming to reduce net migration to below 100,000 a year. This is likely to be an ambitious target, considering that net migration to the UK has not been below 100,000 since 1997. While migration from the rest of the EU may decrease following Brexit if the UK no longer adheres to the free movement of people, the majority of migrants to the UK come from outside of the EU, which is likely to be affected to a lesser extent. Additionally, the majority of migrants from outside the EU are international students living temporarily in the UK, which is not regulated. There is also the question whether the UK will restrict migration and face the risk of losing out on a skilled and experienced labour force that the UK economy may need. Lastly, the government doesn't have control over the number of people leaving the UK (e.g. British pensioners retiring abroad), making it quite difficult for the government to have control over achieving an ambitious net migration target.

A change in migration is likely to have an impact on the labour supply for different skill levels, which consequently impacts the overall level of productivity. This has been incorporated into the model results using an elasticity linking productivity to human capital, which has been found to be about 0.6 by Dearden, Reed and Van Reenen (2005).

A list of assumptions and results related to migration are provided in Appendix A.

2.5 Summary

This study will include a variation of the three main Brexit scenarios (soft Brexit, semi-hard Brexit and hard Brexit) as discussed in Section 2.2, each with a set of assumptions for trade, investment and migration.

The trade assumptions will be developed for tariffs and non-tariff barriers and will be based directly on Dhingra et al (2016a) as they are widely referenced and highly detailed. This will also capture the impacts on business investment through higher production costs and delayed capital spending. Additional assumptions will be made for the short-term impact of uncertainty during the negotiation phase and the impact of a reduction in FDI following Brexit, based on recent (post-referendum) official data.

Given the lack of studies on the migration impacts, other sources such as government announcements and targets, are used to inform the assumptions. The impacts on migration will then be carried through to population and productivity, based on the relationship it has with each variable as found in the data and the literature.

3 The Scenarios

3.1 Introduction

Having reviewed briefly the various Brexit options that have been covered in the literature, this chapter looks in more detail at the different versions and model scenarios that have been selected for this study. Section 3.2 presents and describes the various scenarios that were agreed to be modelled. Table 3.1 provides an overview of the scenarios while Figure 3.1 revisits the earlier illustration of the different trading relationships countries have with the EU, and identifies where each scenario is characterised best. Section 3.2 describes each scenario in more detail, while sections 3.3 and 3.4 outline the assumptions being made that enter into the macro-modelling framework. Finally, section 0 highlights the issues each key sector faces and how it affects the trade, investment and productivity assumptions made.

Table 3.1: Scenario overview

Scenario	Two-year 'status quo' transition period from March 2019	Single Market membership	Customs union membership	EU/UK trade deal
1 – Continued SM and CU membership from March 2019	N/A	Y	Y	N/A
2 – Two-year transition followed by SM membership without CU	Y	Y	N	N/A
3 – Two-year transition followed by CU membership without SM	Y	N	Y	N/A
4 – Two-year transition followed by no membership of the SM or CU and falling back to WTO rules	Y	N	N	WTO rules
5 – No transition, no membership of the SM or CU, and no preferential EU/UK trade agreement	N	N	N	WTO rules

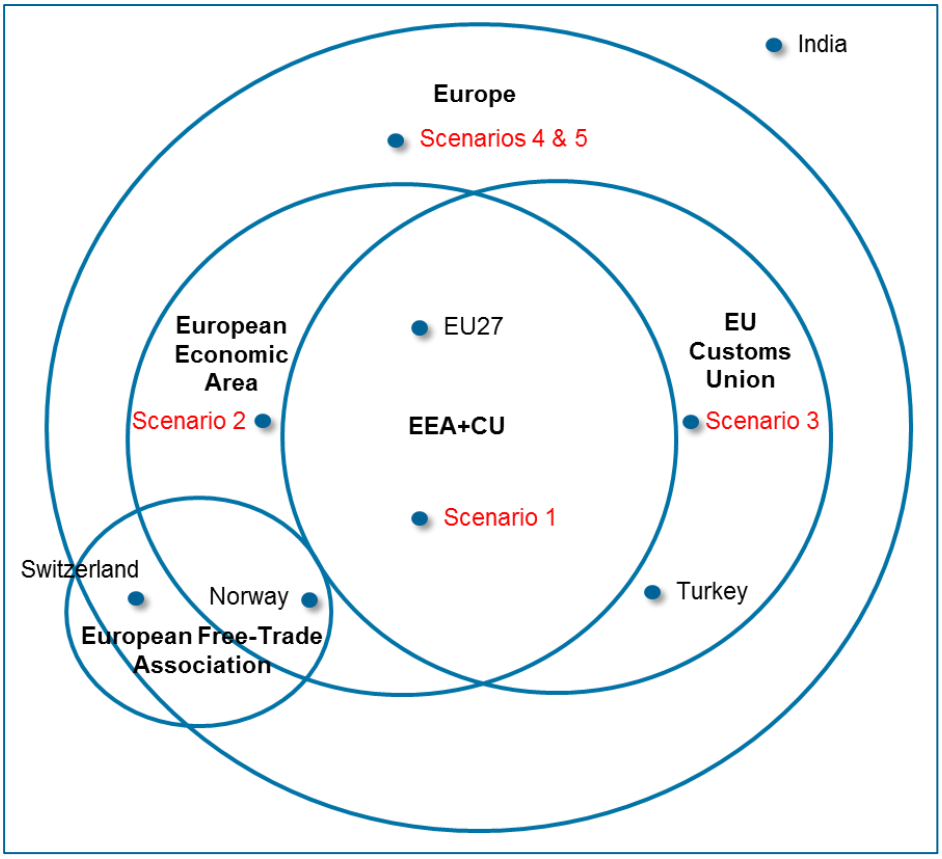
3.2 Scenario descriptions

Scenario 1 (Single Market and Customs Union status quo baseline)

Scenario 1 is effectively the baseline assumption against which all other variants will be assessed, and largely represents business as usual as if the UK remains within the Single Market and Customs Union. As agreed with the GLA, the particular view or forecast to be used as the base case will be one produced by DG EcFin (2015). This study was published before the Brexit referendum, and gives a long-term perspective on government revenues and liabilities pre-Brexit, given demographic trends. It is commonly referred to as the 'ageing report[14] - GDP projections are formed by attaching an estimate of productivity growth to expected changes to the size of the labour force. Population is consistent with the latest GLA projections.

[14] See http://ec.europa.eu/economy_finance/publications/european_economy/ageing_report/index_en.htm.

Figure 3.1: Scenario overview in relation to a selection of other countries



Scenario 2: Two-year transition followed by SM membership without CU

In this scenario, there would be a two-year transition period and from 2021 there would continue to be free movement of goods, services, people and capital within the EEA (Single Market). The UK would abide by the EU's economic rules, including legislation regarding employment, consumer protection, product standards, environmental and competition policy, but the UK would not have any power to decide any legislation.

There would be no tariffs on goods traded between the UK and the EU countries, and the financial sector would retain passporting rights that allow services to be provided in the other countries in the EEA. Non-tariff barriers between the UK and the EU would remain low and there would be no new barriers to trade in services with the EU.

As the UK is no longer part of the Customs Union, it will be able to set its own external tariff and negotiate its own trade deals with non-EU countries. However, there would be some new non-tariff barriers on trade between the UK and EU, as UK exporters would have to satisfy 'rules of origin' requirements when trading with the EU, increasing trading costs, particularly in industries that have large global supply chains, such as the textiles and automotive industries.

The UK will not be able to restrict migration between the UK and the EU, but migration will be lower than in Scenario 1 as the UK becomes a less attractive place for migrants to settle, and the government tries to achieve its tens of thousands migration target.

This scenario is similar to the conditions currently faced by Norway.

Scenario 3: Two-year transition followed by CU membership without SM

In this scenario, there would be a two-year transition period and from 2021 the UK would be part of the Customs Union, but not the EEA. As a result, there would be no tariffs on goods traded between the UK and EU, and the UK would not be able to set its own tariffs or negotiate its own free trade agreements (FTAs) with non-EU countries. The UK could face barriers to trade in services with the EU, and as a result, non-tariff barriers are likely to increase.

As the UK is no longer part of the EEA, it will be able to have control over migration between the UK and the EU, and get closer to achieving the government's tens of thousands migration target. At the same time, countries that are part of the EEA will be able to restrict migration from the UK.

This scenario is similar to the conditions currently faced by Turkey.

Scenario 4: Two-year transition followed by no membership of the SM or CU and falling back to WTO rules

In this scenario, there would be a two-year transition period and from 2021 the UK will no longer be part of the EEA and Customs Union. The UK will have greater political power and will be able to set economic policy and regulatory standards without taking account of the preferences of other EU members.

The UK's trade with most of the rest of the world would be under the WTO rules, resulting in the largest increase in trade costs between the UK and EU across all scenarios. The UK would face the Most Favoured Nation treatment from all WTO members, and would charge the same tariffs to all other WTO members, raising the cost of trade between the UK and the EU. Non-tariff barriers between the UK and EU would also increase, due to divergence in regulation between the UK and the EU. Trade in UK services will also be governed by WTO and so UK service producers would face reduced access to the EEA.

There would be no free movement of people under the WTO rules, enabling the government to meet its tens of thousands migration target, as there would no longer be free labour mobility between the UK and the EU. This would most likely result in a sharp decline in migration.

Scenario 5: No transition and no membership of the SM or CU

This scenario is similar to Scenario 4, except that it is assumed there will be no two-year transition period. The UK will start to experience the trade, investment and migration impacts linked with it no longer being part of the EEA and Customs Union from 2019.

3.3 Scenario assumptions

Moving on from the general descriptions, this section summarises the UK trade, investment and demographic assumptions made in the macro-sectoral modelling for each of the scenarios outlined above.

Trade

The impacts of Brexit on trade mainly result from an increase in trade costs (tariff and non-tariffs) between the UK and the EU, and ultimately between the UK and the rest of the world, as the former no longer benefits from trade agreements negotiated by the EU on behalf of its Member States[15]. A set of assumptions are developed for each scenario, disaggregated by the type of trade costs (tariffs and non-tariff barriers), the flow of trade (import to and export from the UK), and the group of trading partners (EU and non-EU).

As long as the UK remains in either the Single Market or the Customs Union, there is likely to be little change in tariffs, as there are few countries that belong

[15] This study does not consider that following Brexit, the UK might negotiate more preferential trade agreements with non-EU countries than the existing deals between the EU and such countries.

to one but not the other (as shown in Figure 3.1). In addition, these countries are likely to account for a small proportion of UK trade. Therefore, it is reasonable to assume no change in tariffs in Scenario 2 and Scenario 3.

For Scenario 4 and Scenario 5, it is assumed that the WTO's Most Favoured Nation (MFN) tariffs would apply with all trading partners of the UK. To be consistent with the literature, MFN tariff rates calculated by Dhingra et al (2016a) for different types of goods are used for relevant sectors in the E3ME model.

While tariffs are assumed to change only in the hard Brexit scenarios (Scenarios 4 and 5), non-tariff barriers between the UK and the EU are expected to increase in all scenarios. No change is assumed for UK-non-EU trade because of the complexity of modelling non-tariff barriers for each trading partners, and because the most major change in non-tariff barriers is expected to be between the UK and other EU Member States. Non-tariff barrier assumptions for UK-EU trade are based on the results of Berden et al (2009) on tariff equivalents of non-tariff barriers between the USA and the EU, which have been used in the work of Dhingra et al (2016a) and Clayton and Overman (2017), and are as follows:

- Scenario 2: an increase of ¼ of the US-EU reducible non-tariff barriers[16]
- Scenario 3: an increase of ½ of the US-EU reducible non-tariff barriers
- Scenario 4 and Scenario 5: an increase of ¾ of the US-EU reducible non-tariff barriers

The trade-related assumptions for Scenario 2 and Scenarios 4-5 were the same as those used by Dhingra et al (2016a) in the optimistic and pessimistic scenarios, respectively. The increase in Scenario 3 was then assumed to be the mid-point between these two.

Table 3.2 and Table 3.3 show a summary of the assumptions for changes in tariffs and non-tariff barriers (in tariff equivalents) in each scenario compared to Scenario 1 (in which the UK maintains its Single Market and Customs Union memberships). These changes are assumed to have a permanent impact immediately after Brexit (in 2021 for Scenarios 2, 3 and 4, and in 2019 for Scenario 5).

Table 3.2 Tariff assumptions by broad sectors for Scenario 4 and Scenario 5

	UK-EU		UK-non-EU	
	Import	Export	Import	Export
				(%)
Agriculture, Hunting, Forestry and Fishing	5.90	5.63	1.07	4.02
Mining and Quarrying	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	7.26	4.96	6.19	2.08
Textiles and Textile Products; Leather, Leather Products and Footwear	9.49	9.61	10.70	8.73
Wood and Products of Wood and Cork	2.35	3.62	2.74	3.16
Pulp, Paper, Paper Products, Printing and Publishing	0.04	0.10	0.07	0.06
Coke, Refined Petroleum and Nuclear Fuel	2.69	2.81	2.51	3.36
Chemicals and Chemical Products	2.71	2.16	2.47	1.89

[16] Reducible non-tariff barriers are defined as the fraction of the non-tariff barriers which can in principle be eliminated by policy action.

Rubber and Plastics	5.35	5.05	5.25	5.28
Other Non-Metallic Mineral	3.78	3.32	4.80	3.49
Basic Metals and Fabricated Metal	2.05	1.89	1.47	1.00
Machinery, Nec	2.05	2.13	2.34	2.00
Electrical and Optical Equipment	1.97	1.55	1.83	1.70
Transport Equipment	8.09	7.22	5.56	6.26
Manufacturing, Nec; Recycling	1.71	1.69	1.44	1.76

Source: Dhingra et al (2016a).

Table 3.3 Non-tariff barrier assumptions by broad sector

	Scenario 2		Scenario 3		Scenarios 4-5	
	Import	Export	Import	Export	Import	Export
						(%)
Food & beverages	18.3	14.2	36.7	28.4	55.0	42.6
Textiles & clothing	4.2	4.8	8.4	9.6	12.5	14.4
Wood & paper products	1.9	2.8	3.9	5.7	5.8	8.5
Chemicals	5.3	6.0	10.5	12.0	15.8	17.9
Pharmaceuticals	2.4	3.8	4.8	7.7	7.1	11.5
Cosmetics	8.1	8.7	16.2	17.3	24.3	26.0
Metals	4.3	3.0	8.5	6.0	12.8	8.9
Electronics	1.6	1.6	3.3	3.3	4.9	4.9
Office & communications equipment	5.7	4.8	11.5	9.6	17.2	14.3
Automotive	6.7	6.4	13.4	12.8	20.1	19.1
Aerospace	4.8	4.7	9.6	9.4	14.3	14.1
Construction	0.6	1.2	1.3	2.3	1.9	3.5
ICT services	1.0	3.7	2.0	7.5	2.9	11.2
Communications	0.4	2.9	0.9	5.9	1.3	8.8
Financial services	7.9	2.8	15.9	5.7	23.8	8.5
Insurance	4.8	2.7	9.6	5.4	14.3	8.1
Other business services	1.0	3.7	2.0	7.5	2.9	11.2
Personal, cultural & recreational services	0.6	1.1	1.3	2.2	1.9	3.3

Source: Cambridge Econometrics' calculations based on Berden et al (2009).

Investment

Investment can be thought of as being affected by Brexit in three ways:

- driven by trade-related output effects
- short-term uncertainty over eventual outcome
- risk to FDI into the UK

Trade-related output effects have already been taken care of through the trade assumptions and the resulting model inter-connections. While the value of sterling may have some impact on FDI, investment decisions are more likely to be driven by the strategic importance and attractiveness of the location of where the investment is being made. Therefore, no particular assumption has been made for this, and the euro exchange rate has been fixed as explained in section 3.4.

Short-term uncertainty

Uncertainty over the outcomes of the Brexit negotiations and, in particular, over the future trade agreements negotiated between the UK and the rest of the

world, is likely to dampen investment in the short-term, and have already been reported in a CBI survey mentioned in Chapter 2.

Recent changes in investment from the ONS Business investment in the UK dataset were used in order to quantify the potential short-term change in investment due to uncertainty. This showed that the average year-on-year growth in total business investment over the last five quarters since the results of the referendum (2016Q2 to 2017Q2) has fallen to about 1.5% (compared to about 2.5% for the previous five quarters from 2015Q1 to 2016Q1).

This 1.5% growth rate was used in the following way to develop the investment assumptions over 2017-2020:

- The 1.5% growth rate has been used to calculate total investment in 2017.
- Total investment growth between 2018-2020 is then interpolated in order to get back to the 2021 growth in investment in the baseline (Scenario 1), under the assumptions that uncertainty will decrease over time as the outcomes of the negotiations become clearer.
- The total change in investment has been split by sector, based on the sector's share of total investment in the baseline.
- It has been assumed that there is no impact on investment in Government services.

The same assumptions are used across all scenarios, under the assumption that the same degree of short-term uncertainty exists in all scenarios. Table 3.4 shows a summary of the assumptions for the per annum growth in investment by broad sector over 2016-19.

Table 3.4: Investment assumptions by broad sector, 2016-19

	Scenario 1	Scenarios 2-5
		(% pa)
Agriculture etc	0.0	-0.3
Mining & quarrying	-3.0	-3.4
Manufacturing	0.9	0.5
Electricity, gas & water	0.8	0.4
Construction	1.7	1.3
Distribution	1.7	1.3
Transport & storage	1.9	1.6
Accommodation & food services	1.9	1.6
Information & communications	1.9	1.6
Financial & business services	1.9	1.6
Government services	0.4	0.4
Other services	0.4	0.1
Total	1.8	1.5

Longer-term FDI impacts

When the UK leaves the Single Market, UK-based firms could face an increase in costs from an increase in tariffs and non-tariff barriers. This makes it a less attractive place for multinationals to export its goods to the rest of the EU.

Similarly, the movement of component goods needed in the production process and staff between other branches in the rest of the EU may also become more costly and difficult, which may further dampen FDI coming into the UK.

According to Dhingra et al (2017), Brexit is likely to reduce future FDI inflows to the UK by about 22% (2.4% pa). This is in line with other studies that find that UK FDI will be a quarter lower in 2020 because of Brexit (PwC, 2016b), or that there is a positive impact of 25-30% on FDI flows from EU membership (Campos and Coricelli, 2015).

FDI is a measured as a financial flow, but it does also represent a contribution to total investment as the foreign firms owning capital in the UK will invest in assets. However, the link between the FDI figures and investment is far from direct and as a result, it is difficult to translate the FDI impacts found in the studies mentioned above into impacts on total investment[17]. The scenario assumptions for investment are made relative to the baseline trajectory in the form of a slowdown in investment growth. Taking into consideration that growth in total investment in the baseline (Scenario 1) is 1.9% pa over 2021-30, it has been assumed that growth in total investment would fall to 1% pa over 2021-2030 in Scenarios 4 and 5, and assumed that the slowdown would be smaller in Scenarios 2 (1.5% pa) and 3 (1.3% pa). There isn't much literature to base these assumed reductions on, but the variation in the assumptions between the scenarios provide a form of sensitivity testing.

The change in import price in a sector in each scenario has been used as a guideline to split the total change in investment by sector, under the assumption that sectors that are affected by larger changes in tariffs are more likely to be impacted by changes in FDI. As above, it has been assumed that there is no impact on investment in Government services.Table 3.5 shows a summary of the per annum growth in investment assumptions by broad sector over 2021-30. In general, all sectors are assumed to grow progressively more slowly, going from the most optimistic scenario (Scenario 1) to the most pessimistic scenario (Scenario 5). The only exception is Financial & business services which is expected to grow marginally faster in Scenario 5 than in Scenario 4, because the short-run uncertainty effect that delays investment decisions is present for a shorter period of time without the two-year transition.

Table 3.5: Investment assumptions by broad sector, 2021-30

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
					(% pa)
Agriculture etc	0.0	-0.2	-0.2	-3.9	-3.9
Mining & quarrying	-3.3	-3.5	-3.5	-3.6	-3.6
Manufacturing	0.8	-0.8	-2.2	-3.7	-3.7
Electricity, gas & water	0.6	0.4	0.4	0.4	0.4
Construction	1.6	1.2	0.9	0.6	0.6
Distribution	1.6	1.4	1.4	1.4	1.4
Transport & storage	1.8	1.6	1.5	1.5	1.5

[17] Ebell and Warren (2016) established this link as part of their work, but it would be inappropriate to apply their findings directly without a detailed understanding of how they were derived and should be interpreted.

Accommodation & food services	1.8	1.6	1.6	1.6	1.5
Information & communications	1.8	1.2	0.9	0.5	0.5
Financial & business services	1.8	1.2	0.9	0.5	0.6
Government services	0.4	0.4	0.4	0.4	0.4
Other services	0.4	0.1	0.0	-0.2	-0.2
Total	1.9	1.5	1.3	1.0	1.0

Demographics and the labour market

Migration and population

As mentioned in Chapter 2, there isn't much existing literature that considers assumptions directly related to population, migration and the labour market. Following discussions with the GLA, it was decided that Scenarios 4 and 5 would assume that the government's tens of thousands migration target would be achieved. Scenarios 2 and 3 would build up to this from Scenario 1, in which migration is based on the GLA 2016-based projections. These are straightforward assumptions that do not account for the various types of visa systems the UK could adopt after Brexit, as this is politically uncertain and consequently difficult to model. The migration assumptions are then used to develop population assumptions, taking into consideration natural change. The difference in net migration across scenarios is assumed to be driven by changes in both EU and non-EU migration, as it is likely that Brexit will affect both flows. The assumptions do not specifically look at changes in the origins of international migrants, or the impact a change in international migration may have on internal migration (people migrating from one area of the UK to another).

Table 3.6 provides a summary of the migration and population assumptions used in each scenario.

Table 3.6: Summary of migration and population assumptions (2019/21-2030)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Migration	Net migration of 232,000 in 2020, falling to 220,000 in 2030	Net migration of 188,000 from 2020 onwards	Net migration of 144,000 from 2020 onwards	Net migration of 99,999 from 2020 onwards	Net migration of 99,999 from 2020 onwards
Population (over 2019/21-30)	0.6% pa	0.5% pa	0.45% pa	0.4% pa	0.4% pa

Skilled labour

The skills level of the UK labour force is likely to be affected by a change in migration patterns, and in turn is likely to impact the country's productivity. This impact, as opposed to the trade-related impact, is not modelled directly so has been captured through off-model adjustments to productivity. As mentioned in Chapter 2, there isn't much existing literature to use to inform assumptions on how migration might affect productivity levels. The CEP study by Dearden, Reed and Van Reenen (2005), using British firm-level data, estimated that the

elasticity of productivity with respect to the proportion of trained (skilled) workers is 0.6. This elasticity was used in the following way to develop the productivity assumptions:

- While not all working-age migrants are in work, a high proportion are (higher than UK-born people), and so it has been assumed that the reductions in working-age migration in the scenarios are all people who would otherwise come and work in the UK, in order to keep the modelling assumptions straightforward.
- For each scenario, the difference in working-age migration from the baseline is distributed to broad sectors using each sector's share of total (non-UK) workers[18] from the ONS International immigration and the labour market, UK (2016) dataset.
- A percentage difference by broad sector is calculated as the absolute difference divided by employment in the baseline.
- The percentage difference calculated in the previous step is then translated into productivity differences by E3ME sectors using the elasticity of 0.6 from the CEP study mentioned above.
- Productivity differences have been held constant from 2020 onwards (in line with the migration assumptions). This would imply that productivity growth from 2020 onwards is the same in all scenarios and the baseline (but the level will be lower in all scenarios compared to the baseline). This is because the loss in productivity is due to a sudden loss of trained/skilled workers, and this shortage can be addressed in the longer-term by training new, domestic entrants to the labour force. Additionally, long-term productivity growth depends more on other factors, such as technology, and relatively small changes in the workforce (migrants) are not large enough to affect the overall trend.

Table 3.7 shows a summary of the productivity assumptions developed by broad sector. It shows that it is assumed that productivity will be between 0.14-0.31% lower in 2020 in Scenarios 4 and 5 than in the baseline[19].

Table 3.7: Summary of productivity assumptions by broad sector, 2020

	Difference from Scenario 1 in 2020 (%)			
	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Agriculture etc	-0.05%	-0.09%	-0.14%	-0.14%
Energy and water	-0.07%	-0.13%	-0.20%	-0.20%
Manufacturing	-0.10%	-0.21%	-0.31%	-0.31%
Construction	-0.07%	-0.14%	-0.21%	-0.21%
Wholesale and retail trade	-0.07%	-0.14%	-0.21%	-0.21%
Transport and communication	-0.09%	-0.19%	-0.28%	-0.28%
Financial and business services	-0.06%	-0.11%	-0.17%	-0.17%
Public admin, education and health	-0.06%	-0.11%	-0.17%	-0.17%
Other services	-0.06%	-0.12%	-0.17%	-0.17%

[18] As changes in EU and non-EU migration are both expected to contribute to the total reduction in migration.

[19] Boubtane et al (2015) finds that halving the net immigration rate would reduce UK productivity slightly more (-0.32% pa).

3.4 Other assumptions

Other model inputs are held constant between scenarios and therefore do not have a noticeable impact on the model results. Interest rates have been held constant at current rates (i.e. 0.5% base rate) and the euro exchange rate has been fixed at 0.85 euros = 1 pound. No further quantitative easing is added to the model.

It is important to note that government tax rates and expenditure are also fixed. This implies that the fiscal deficit may change in the scenarios. Initially, government balances may improve in the scenarios due to the additional revenues from trade tariffs, but this gain quickly becomes a loss due to lower VAT and income tax receipts that result from weaker economic growth.

E3ME is a global model, and so provides results for other countries as well as the UK. Clearly there are direct and indirect effects from Brexit on other countries, but we have otherwise assumed that policies in other countries remain unchanged (including EU countries).

Other more general assumptions relate to the modelling framework offered by E3ME and its econometric equations. These are discussed further in Section 4.2.

3.5 Key sectors

As part of the analysis, a number of key sectors were identified for more detailed attention. Identifying the impacts of Brexit on these sectors in particular is important in generating an understanding of the overall impact on the London economy. As agreed with the GLA, the sectors that have been chosen are either thought to have a strong influence on the London economy, or likely to be particularly strongly affected by Brexit. This section explores the issues that each key sector faces and how it affects the trade, investment and productivity assumptions made for the macro-sectoral modelling.

Financial & professional services

Countries in the rest of the EU are large consumers of UK financial services. The sector is a major provider of high value and high productivity jobs across the country, and London, in particular, is considered one of the most important financial regions in the world and the financial centre of Europe, accounting for more than 50% of all GVA in the finance and insurance sector in the UK[20].

One of the largest threats to the sector is the potential loss of passporting rights for firms based in the UK that provide financial services to the EU. In 2015, the UK exported £26.1 billion of financial, insurance and pension services to the EU[21]. If the UK fails to negotiate full access to the EU market following Brexit, trade costs could rise and the UK could suffer from a fall in trade in this sector. This is reflected by an increase in import and export prices in the macro modelling assumptions, as the UK is likely to need to continue to comply with EU regulation in order to continue transactions with the EU.

The sector could also suffer from the introduction of the need for EU workers to obtain visas and work permits if the UK tightens its migration policy, reducing the UK's access to high-skilled labour from the EU. This would particularly be

[20] London and Europe: Facts and Figures, GLA (2017).

[21] London and Europe: Facts and Figures, GLA (2017).

felt in London, which accounts for 35% of employment in the finance and insurance sector, and where 12% of its employees in the sector are born in the EEA[22]. This has been reflected as an expected fall in productivity in the macro modelling assumptions.

Over time, if the UK loses its full access to the EU market and its high-skilled labour force, it may lose its competitive advantage as the EU financial hub. This could deter valuable investment and redirect it to other European financial centres. This has been reflected as a decrease in investment in the macro modelling assumptions, where the finance and insurance sector alone is assumed to see a €5.4 billion decrease in investment by 2030, depending on the scenario.

Science and Technology

The main issue facing the science and technology sector in the UK after Brexit is its access to future funds. The sector in the UK has received almost €1.4 billion of European Union resources since 2014[23], and receives almost 16% of all EU science funding from the European Research Council (ERC), compared to the 12% contribution it makes to the overall EU budget. Consequently, the sector could face a loss of investment after the UK leaves the Single Market and it no longer has access to these funds.

In addition, the UK science and technology sector benefits from collaboration and skills from the rest of the EU. For example, in 2013 44% of the almost 1,000 grants the UK received from the ERC went to non-nationals based in the UK, the largest number of any EU country[24]. Depending on the agreements made after Brexit, the UK could experience less benefits from access to research groups and the skills and collaboration opportunities provided by the rest of the EU. This has been reflected by a loss in productivity in the macro modelling assumptions, particularly in the pharmaceutical industry, which is also likely to see a reduction in investment and substantial increases in trade costs.

Creative and Cultural

London's many museums, theatres, music venues, sports venues, galleries, and its abundance of media and product, graphic and fashion design businesses make it a prominent creative and cultural hub, attracting a large number of tourists and a creative labour force. As outlined in the Coadec report[25], the UK tech sector relies heavily on a foreign workforce, and sectors such as Artificial Intelligence (AI), data science and robotics, which the government has identified as potentially high-growth, already demand skills (such as software development, advanced science, technology, engineering and mathematics skills (STEM), and basic skills in literacy and numeracy) that are in short supply. In London, 9% of employees (18,000 jobs) in the arts, entertainment and recreation sectors were born in the EEA[26]. One important question that faces the creative and cultural industries is whether the UK will be able to continue to attract and retain a labour force with relevant high calibre skills from the rest of the world, in order to maintain its reputation in these industries once the UK leaves the Single Market. This is reflected in the

[22] London and Europe: Facts and Figures, GLA (2017).

[23] S Lucas, University of Birmingham, https://www.birmingham.ac.uk/research/perspective/science-and-brexit.aspx

[24] European Research Council (2014). Annual Report on the ERC Activities and Achievements, 2013.

[25] A Global Britain: From local startups to international markets, Coadec (2017).

[26] London and Europe: Facts and Figures, GLA (2017).

productivity assumptions discussed above, where the majority of the industries in the creative and cultural sector are assumed to see up to a 0.5% decrease in productivity by 2030 depending on the scenario, due to a fall in migration levels.

Another major concern the creative and cultural industries face is securing future funding. The UK benefits at the moment from the Digital Single Market[27] and EU funds such as the Creative Europe fund and the Regional Development Fund, which currently fund a large number of creative projects. During its first two years, Creative Europe has supported 230 UK cultural and creative organisations and audio-visual companies as well as the cinema distribution of 84 UK films in other European countries with grants totalling €40 million[28]. In addition, since the referendum, it was announced that the UK will no longer be eligible to have a host city as part of the European Capital of Culture. While host cities don't automatically get money from the EU budget, they can receive funding for specific cultural activities or benefit from EU regional funding. The UK's loss of access to these EU funds may reduce the amount of long term funding available to the UK's creative industries, as it is unlikely that the UK government will be able to replace these. This puts future inward investment at risk and is reflected in the investment assumptions above, where creative and cultural industries, in particular, Computer programming, information services and Motion picture, video, television, are assumed to see large decreases in investment.

Lastly, the EU is a large recipient of UK exports in these sectors. 43% of exports from the UK digital sector alone go to the EU[29]. Trade in these sectors could be adversely impacted if the UK fails to negotiate new trade deals that allow the sector to have full access to the EU market. This is reflected in the trade assumptions made for the creative and cultural sector, where it is assumed that industries within this sector could face up to about 9% increase in their export prices, depending on the scenario and the trade deals agreed.

Food and Drink Manufacturing

The food and drink sector is likely to see the largest trade impacts across the key sectors. The UK currently imports more than 50% of its food, where 70% of its food and non-alcoholic drink imports were from the EU in 2015, and more than 60% of its food and drink exports were to the EU in 2017[30]. This exposes the sector to potentially large increases in trading costs from an introduction of EU tariffs if a favourable trade deal is not negotiated, and could cause supply chain disruptions. Depending on the scenario, the macro modelling parameters assume there could be up to a 48% increase in EU export and import prices (the WTO's average Most Favoured Nation duties on meat is around 48%).

The food and drink sector has a large share of EU workers amongst manufacturing businesses, making it exposed to supply-side constraints if immigration from the EU is controlled too tightly following Brexit. This is reflected in the productivity assumptions, where the sector is assumed to see up to a

[27] The Digital Single Market is a strategy of the European Commission to ensure access to online activities for individuals and businesses under conditions of fair competition, consumer and data protection, removing geo-blocking and copyright issues.

[28] Creative Europe, June 2016, 'Creative Europe Desk UK statement'.

[29] https://www.parliament.uk/business/committees/committees-a-z/commons-select/culture-media-and-sport-committee/news-parliament-2015/brexit-impact-launch-16-17/

[30] The Food and Drink Federation, http://www.fdf.org.uk/home.aspx.

0.5% decrease in productivity by 2030 depending on the scenario, due to a fall in migration levels.

The potential trade and labour supply impacts that the sector may experience following Brexit may affect future investment decisions. Major food companies may reconsider locating in the UK or reducing their operations in the UK and redirect investment to elsewhere in the EU, where they can benefit from the freedom of movement in goods and people. This is reflected in the investment assumptions used in the macro modelling, where the sector is assumed to see up to a €1.4 billion decrease in investment by 2030, depending on the scenario.

Construction

One of the major issues facing the construction sector is the shortage of skills. The sector currently relies heavily on a foreign migrant labour force. Almost 13% of construction workers across the UK were born abroad, and in London and the South East, this proportion increases to 50%. In particular, 25% of employees in the sector in London were born in the EEA[31]. Once the UK leaves the Single Market, it is likely that the skills shortage could get worse, if the new agreements don't allow for free movement of people. This could result in even higher pressures on wages, as labour supply contracts, causing construction firms to face considerably higher project costs. Additionally, this could reduce firms' capacity to deliver new houses to meet the government's housing targets, and further deepen the housing crisis, especially in London. The labour market issues the construction sector faces are reflected as an expected fall in productivity in the macro modelling assumptions.

Once the UK leaves the Single Market, the construction sector is also likely to be affected by trade impacts. A 2010 study by the Department for Business Skills and Innovation highlights how reliant the UK construction sector is on the rest of the EU, estimating that 64% of building materials were imported from the EU, and 63% were exported to the EU. If the UK faces a reduction in access to the EU market following Brexit, construction firms could experience an increase in their costs or a shortage of building materials, as they face an increase in tariffs or limits on quantities imported, which is reflected in the trade assumptions applied to this sector.

At the moment, the UK construction sector benefits from having access to the European Investment Bank (EIB) and the European Investment Fund (EIF), which have invested €7.8 billion in major infrastructure projects, and lent €666 million to SMEs in 2015[32]. A loss of these financial aids could significantly impact the ability of firms to deliver big infrastructure projects such as High-Speed 2 and reduce development opportunities for start-ups. Additionally, foreign investment could dampen due to uncertainty over the UK economy following Brexit, and as investors delay making decisions on the future of projects. This loss of potential future investment has been reflected as a fall of up to €852m in investment in the sector by 2030, depending on the scenario and the severity of Brexit.

Hospitality

The hospitality sector is heavily reliant on foreign workers, with nearly a quarter of all jobs in the sector in the UK carried out by people from the rest of the EU,

[31] London and Europe: Facts and Figures, GLA (2017).

[32] London and Europe: Facts and Figures, GLA (2017).

rising to 32% (79,000 jobs) in London[33]. A report by KPMG for the British Hospitality Association[34] revealed that 75% of waiting staff, 37% of housekeeping staff and 25% of all chefs are from the EU, highlighting the scale of potential negative supply-side impacts the sector could face if immigration from the EU is controlled too tightly following Brexit. If the sector is forced to try to fill the shortfall of EU labour with domestic UK workers, there is a risk that businesses could see a rise in costs if British workers demand higher wages. This has been reflected as an expected fall in productivity in the macro modelling assumptions.

The hospitality sector is assumed to not face an increase in trading costs across all scenarios in the macro modelling stage. This is because the UK already adopts stricter regulation in this sector than the rest of the EU (for example, the UK VAT level is higher than most European countries and above the 5% VAT for labour intensive industries, such as hospitality as stated in EU legislation).

One benefit the sector has experienced since the referendum is the effects of the depreciation of sterling against most currencies. Demand from tourists for accommodation and food services continue to be strong, as international visitors face reduced travelling costs and British visitors substitute going abroad on holiday with staying within the UK on domestic holidays, which are relatively cheaper. Following Brexit, this could reverse if the pound recovers and the UK becomes a less attractive tourist destination, either due to increasing travel costs, more difficult border controls and checks or just being perceived as a less welcoming place. This is particularly a problem for the UK, as according to the ONS International Passenger Survey, 67% of the UK's visitors come from the rest of the EU. It is worth noting, however, that as noted in PwC's 2017 UK hotels forecast[35], London has some of the highest occupancy rates (80% in 2017) and average prices (£142 average room price in 2017), by global standards, and so the hospitality sector in London is likely to be more resilient than in the rest of the country.

3.6 Summary

The scenarios presented move from the most to the least optimistic outlook regarding the expected impact on the UK economy. Scenario 1 reflects a situation where the UK remains in the Single Market and Customs Union (the baseline), and then Scenarios 2 and 3 move from a softer version of Brexit (the UK is part of the EEA, but not the Customs Union in Scenario 2; and is part of the Customs Unions, but not the EEA in Scenario 3), to a harder Brexit in Scenarios 4 and 5 (UK is no longer part of the EEA or the Customs Union).

The range of assumptions used for inputs into the macro-sectoral modelling stage of the work reflects a mix of:

(a) directly borrowing inputs from existing studies (as in the case of the tariff and non-tariff barriers used in the Dhingra et al (2016a) work),

(b) making adjustments based on short-term evidence in the data (for example with the investment uncertainty impact),

[33] London and Europe: Facts and Figures, GLA (2017).

[34] Labour migration in the hospitality sector, KPMG (2017b)

[35] Facing the future: UK hotels forecast 2017, PwC (2017).

(c) using what information exists on government targets and guidelines (for the effect on migration in the hard Brexit outcome), and

(d) making more judgemental assessments using additional literature (such as for the effects of migration on skilled labour and FDI on investment and productivity).

4 Modelling Methodology

4.1 Introduction

This chapter describes the econometric model which has been used to estimate the impacts of Brexit on the UK economy, and the methodology used to localise the effects to the London and sub-regional level and disaggregate the results by key sectors. After illustrating the key features of the model, the focus is switched towards presenting the expected outcomes from the model runs and how these were translated into employment and GVA forecasts by key sector for London and its sub-regions.

4.2 Macro-sectoral method (the E3ME model)

E3ME is a computer-based model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, for forecasting and for research purposes.

Main dimensions of the model

Its main dimensions are:

- 59 countries – all major world economies, the EU28 and candidate countries plus other countries' economies grouped
- 44 or 69 (Europe) industry sectors, based on standard international classifications
- 28 or 43 (Europe) categories of household expenditure
- 22 different users of 12 different fuel types
- 14 types of air-borne emission (where data are available) including the 6 GHG's monitored under the Kyoto Protocol

Although E3ME can be used for forecasting, the model is more commonly used for evaluating the impacts of an input shock through a scenario-based analysis. The shock may be either a change in policy, a change in economic assumptions or another change to a model variable. The analysis can be either forward looking (ex-ante) or evaluating previous developments in an ex-post manner.

Scenarios may be used either to assess policy, or to assess sensitivities to key inputs (e.g. international energy prices). The scenarios represent alternative versions of the future based on a different set of inputs. By comparing the outcomes to the baseline (usually in percentage terms), the effects of the change in inputs can be determined.

E3ME can produce a broad range of economic indicators, including GDP and its aggregate components, sectoral output and GVA, prices, trade and competitiveness effects, international trade by sector, employment, wage rates and labour supply.

Key strength of E3ME

The key strength of E3ME can be summarised as follows:

- the close integration of the economy, energy systems and the environment, with two-way linkages between each component

- the detailed sectoral disaggregation in the model's classifications, allowing for the analysis of similarly detailed scenarios
- its global coverage, while still allowing for analysis at the national level for large economies
- the econometric approach, which provides a strong empirical basis for the model and means it is not reliant on some of the restrictive assumptions common to CGE models
- the econometric specification of the model, making it suitable for short and medium-term assessment, as well as longer-term trends

Limitations of the approach

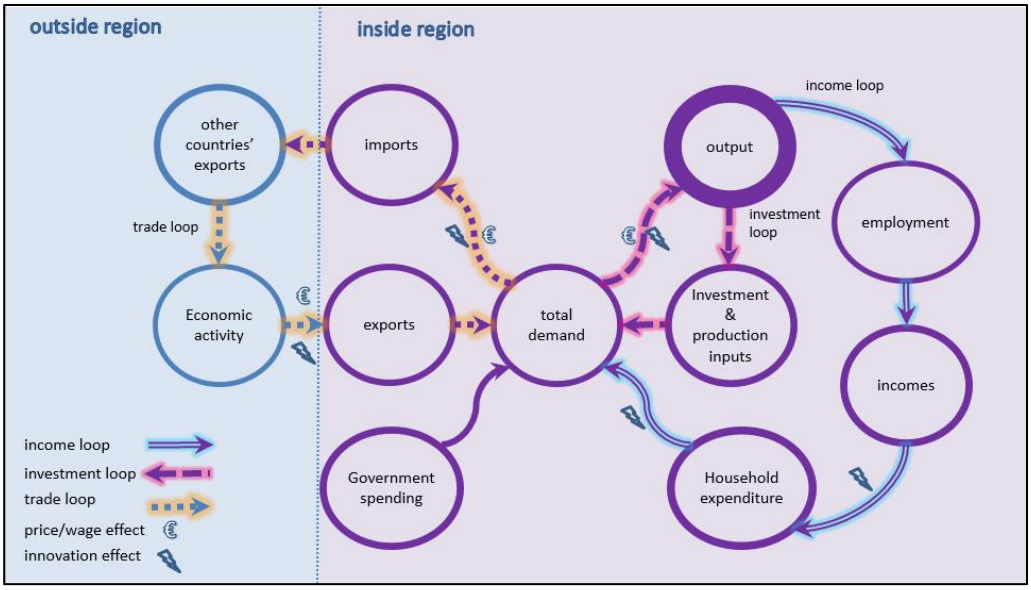
As with all modelling approaches, E3ME is a simplification of reality and is based on a series of assumptions. Compared to other macroeconomic modelling approaches, the assumptions are relatively non-restrictive as most relationships are determined by the historical data in the model database. This does, however, present its own limitations, for which the model user must be aware:

- The quality of the data used in the modelling is very important. Substantial resources are put into maintaining the E3ME database and filling out gaps in the data. However, particularly in developing countries, there is some uncertainty in results due to the data used.
- Econometric approaches are also sometimes criticised for using the past to explain future trends. In cases where there is large-scale policy change, the 'Lucas Critique' that suggests behaviour might change is also applicable. There is no solution to this argument using any modelling approach (as no one can predict the future) but we must always be aware of the uncertainty in the model results.

The economic module in E3ME

Figure 4.1 portrays how E3ME's economic module is solved for each region. Most of the variables mentioned in the chart are solved at the sectoral level. The whole system is solved simultaneously for all industries and all regions, although single-country solutions are also possible.

Figure 4.1: E3ME's basic economic structure



As highlighted above, E3ME entails both an investment and a trade loop. In the former, when firms increase output (and expect higher levels of future output) they must also increase production capacity by investing. This creates demand for the production of the sectors that produce investment goods (e.g. construction, engineering) and their supply chains. In the latter, an increase in demand is met by imported goods and services. This leads to higher demand and production levels in other countries. Hence there is also a loop between countries.

Investment

Gross fixed capital formation is determined through econometric equations estimated on time-series data. Expectations of future output, which are endogenously determined in the model relying on previous 5-years historical data, play an important role in its determination, but investment is also affected by relative prices and interest rates.

Investment is modelled as investment made by industries in E3ME. This is converted in the model (using UK converters) to investment demand received by each industry, which contributes to total final demand of an industry. The level of industry investment can be further adjusted exogenously, if needed. A change in investment feeds through the model to impact on other types of demand. The E3ME model captures both Type I (impacts on other industries) and Type II (impact on labour) multipliers as well as other indirect effects (including prices).

International trade

To estimate international trade, E3ME makes use of the time series of bilateral trade that are available from Comtrade and the OECD. The approach has four stages:

- For each country, total imports are estimated using equations based on time-series national accounts data. Import volumes are determined primarily by domestic activity rates and relative prices.
- Separate bilateral equations for import shares are then estimated for each destination region, sector and origin region.
- Bilateral imports are then scaled so that they sum to the total estimated at the first stage.
- Finally, export volumes are determined by inverting the flows of imports.

Tariffs and non-tariff barriers

A change in tariffs and non-tariff barriers are modelled in E3ME in the following way.

Tariffs barriers

Tariffs are added to export and import prices by industry and can be allocated to bilateral trade relationships (e.g. changes in UK import prices of food exports from France after Brexit, as well as trade from outside the EU). The model then estimates the bilateral import level by product, using the estimated price elasticity from the import price and technology in the exporting country.

Non-tariff barriers

Non-tariff barriers have to be translated to costs e.g. compliance costs of specific regulations and equivalised to tariff/price effects. This can then be modelled in E3ME as an increase in costs to industries or households. This is difficult to measure and there is limited evidence to draw from, so assumptions are made consistent with the methodology of Dhingra et al (2016a), based on the results of Berden et al (2009).

Migration and population

Migration is exogenous in E3ME. A change in migration is modelled as a change in population in the model. Assumptions for population changes by age group and gender need to be developed to input in to the model. Working age population is multiplied by participation rate in the model, which will provide total labour supply. Depending on demand for labour, the additional workforce will either end in employment or unemployment (which will have further impacts in the model).

Productivity

Productivity is an endogenous outcome from many interactions in the E3ME model. An exogenous shock on FDI and R&D directly affects technology indices, which in turn has an impact on a series of key economic variables including prices and demand, bilateral trade, employment, hours worked and sectoral output. All these channels affect productivity.

Key differences from Dhingra et al model

At this stage, it is worth making a comparison between the E3ME methodology and that of Dhingra et al (2017), which is the only other study to date to produce localised results. For this, Dhingra et al (ibid) refer to other papers (Dhingra et al, 2016a and 2016b) which further elaborate on the multi-sector global computable general equilibrium (CGE) model used to produce the necessary (long-run) sectoral GVA results from different assumptions on tariff and non-tariff barriers. Here, the model is described as having the following characteristics:

- a static trade model (this means that it only deals with long-run effects, and as acknowledged in the paper this means it does not account for the dynamic effects of trade on productivity);
- assumes perfect competition (price-taking behaviour) across firms, which it is acknowledged represents a lower bound on the welfare effects from changes to trade barriers;
- accounts for the interdependence across 31 sectors and 35 world regions through complex supply chains (it does this through identification of bi-lateral trade relationships using the COMTRADE database and the inter-sectoral linkages using the latest WIOD input-output tables);
- accounts for fiscal transfers that might occur between the UK and EU under different Brexit scenarios;
- models bilateral trade relationships using a gravity (relative) distance approach, using elasticities based on the literature (i.e. drawn from other studies and situations not necessarily based on the data being used – this includes an average elasticity for services trade based across studies);
- only deals with the trade effects (does not consider effects on investment and FDI, or on population, migration and skilled labour).

In contrast to the model of Dhingra et al (ibid), this study uses the global-sectoral E3ME model. The key features that distinguish the E3ME model are:

- its global geographical coverage, with 59 regions including all Europe's Member States and candidate countries, the world's largest economies and all other economies in groups
- its detailed sectoral disaggregation, with 70 economic sectors in Europe and 44 sectors for the rest of the world

- its econometric specification that provides a strong empirical grounding and means the model is not reliant on many of the rigid assumptions common to other (CGE) modelling approaches.

E3ME is often compared with CGE models and, effectively, it shares many characteristics with the CGE approach. Both types of models rely on the same national accounting framework, use similar national accounts data, and both can be used to answer similar questions. However, underlying this there are important theoretical differences between the modelling approaches. E3ME has the key advantage of relaxing some of the rigid and increasingly questioned assumptions of CGE models. In a typical CGE framework, optimal behaviour is assumed, output is determined by supply-side constraints and prices adjust fully so that all the available capacity is used. In E3ME the determination of output comes from a post-Keynesian framework, and it is possible to have unused labour and capital resources that can be utilised under the right policy conditions. The model is demand-driven, it allows for economies and diseconomies of scale in both production and consumption, technological progress is modelled to allow both product and process innovation and it is not assumed that prices always adjust to market clearing levels. The differences have important practical implications, as they mean that in E3ME regulation and other policy may lead to increases in output if they are able to draw upon spare economic capacity. The econometric specification of E3ME also gives the model a strong empirical grounding. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis.

Summary of differences

The following table summarises the key modelling differences described above that need to be borne in mind when comparing results. Clearly there are many differences between the models, and it would be very difficult, if not impossible, to disentangle which model features are responsible for delivering particular sets of results.

Table 4.1: Summary of key differences between E3ME and the Dhingra et al CGE model

Model features, assumptions and scenarios	Dhingra et al CGE Model	E3ME Model
Model features		
Sector coverage	31 sectors	70 sectors (EU) and 44 sectors (Rest of the world)
Country coverage	35 regions	59 regions
Data sources[36]	WIOD input-output tables, COMTRADE for bilateral trade,	Eurostat, OECD, World Bank, ADB, National sources
Treatment of trade[37]	Gravity approach, with trade depending on geographical distance as well as costs and obstacles to trade.	Bilateral through two-tier econometric equations (see model manual for details)

[36] The historical data in the model are sourced directly from official data sources. These are then used across all scenarios to develop the forecast data within the model.

[37] The Dhingra et al CGE Model only focuses on trade impacts, and does not look at FDI or migration impacts.

Model assumptions		
Firm competition	Perfect competition assumption (all firms are price takers)	Variable, econometrically estimated
Equation parameters	Taken from other empirical studies in the literature	Econometrically estimated (see model manual for details)
Long-run equilibrium	Determined by model closure rules, not a fixed period in time. Although the assumption is that the long-run is represented by a 10-year period, during which non-tariff barriers re-adjust to their new levels.	Moves towards equilibrium following dynamic path. Equilibrium determined by long-run model equations.

4.3 Localisation of effects and key sectors

This section describes how the UK sector level results from the E3ME modelling stage were used to produce employment and GVA forecasts by key sector for London and its sub-regions.

Localisation of effects

The UK employment and GVA results for each scenario from E3ME were disaggregated to London and sub-London areas (see Figure 4.2 for a list of the different geographies). CE have maintained and developed a highly disaggregated database of employment and GVA projections by industry from 1981 for all regions in the UK, and all unitary authorities and local authority districts in Great Britain. The UK E3ME results were used to produced detailed economic forecasts for London under each scenario, in line with CE's method for its regional forecast. This in turn was used to produce forecasts by industry for the London sub-regional areas.

The employment forecasts for London were based on historical growth in London relative to the UK over 1994-2015, on an industry-by-industry basis. For each industry, the relationship between London and the UK can be represented by the following equation:

$$LOEmp_i = \alpha + \beta\, UKEmp_i + \varepsilon$$

Where $UKEmp_i$ and $LOEmp_i$ are the natural logarithms of employment in industry i in the UK and London, respectively, α is a constant term and ε is a residual. The coefficient β reflects the percentage change in London employment associated with a 1% change in UK employment. It was restricted to be between 0.6 and 1.6[38], to avoid London employment collapsing or outgrowing the size of the UK.

It was assumed that those relationships captured by the general equation above continue into the future. Thus, if an industry in London outperformed the industry in the UK as a whole in the past, then it was assumed to do so in the future. Similarly, if it underperformed the UK in the past then it was assumed to underperform the UK in the future.

Population and productivity forecasts for London were estimated using a similar method as the employment forecasts. Productivity was then applied to the employment forecasts for London to calculate GVA forecasts for London.

[38] This range has been selected based on our experience running the same regressions for our local economy forecasting models.

The London sub-regional forecasts were produced using a similar methodology, based on historical growth in the sub-region relative to London or the UK (depending on which area it has the strongest relationship with) over 1994-2015, on an industry-by-industry basis.

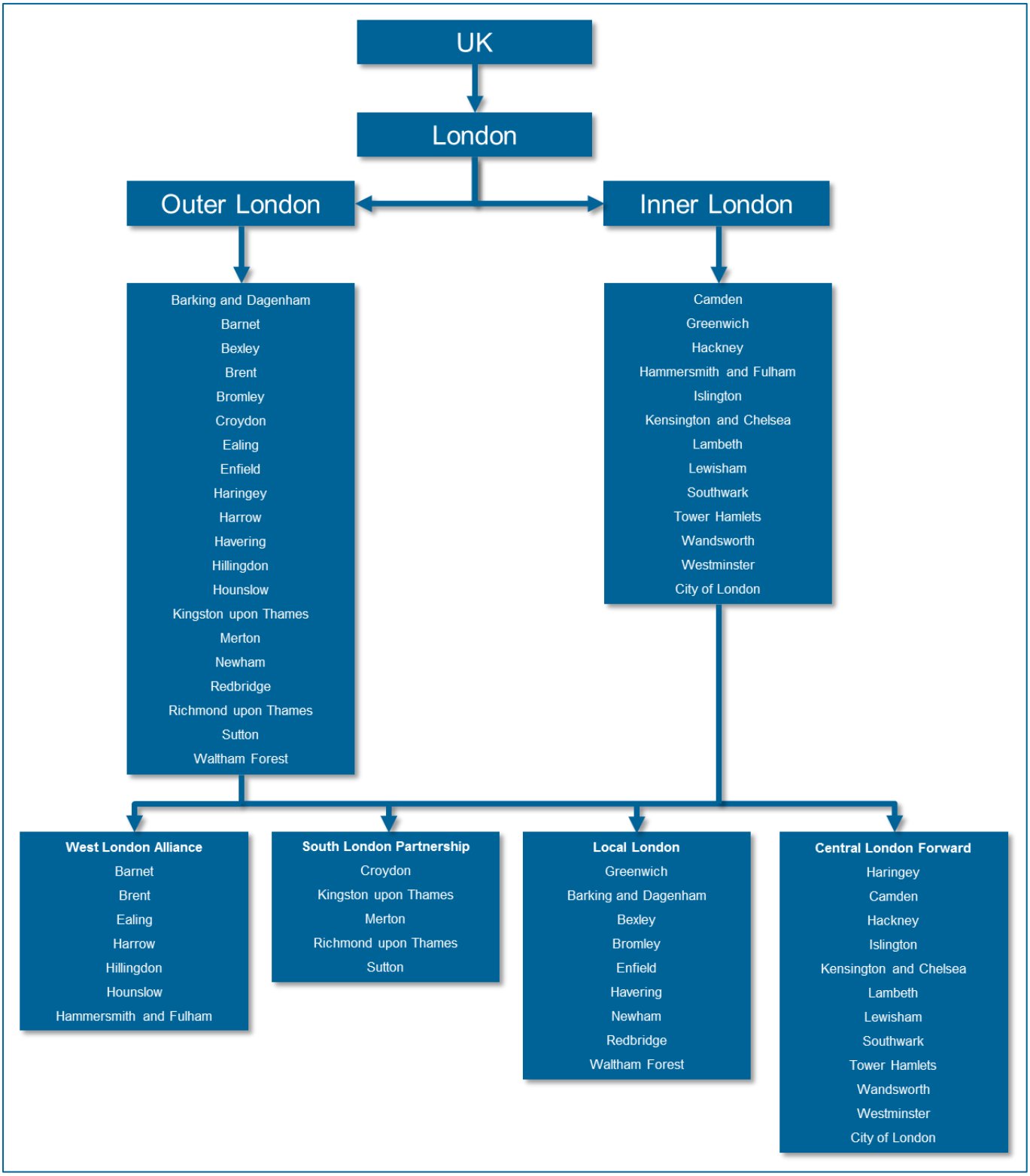
Key sectors

As mentioned in Chapters 1 and 3, a number of key sectors were identified for more detailed attention as part of the analysis. These key sectors were agreed with the GLA and are listed below:

- Financial and professional services
- Science and technology, including the following breakdowns:
  - Digital Technologies
  - Life Sciences and Healthcare
- Creative
- Cultural
- Food and drink manufacturing
- Construction
- Hospitality

Estimates of employment and GVA in the key sectors in each scenario in London and the UK were produced off-model, based on employment shares from the Business Register and Employment Survey (BRES) and a definition of the sectors in terms of the 2007 Standard Industrial Classification (SIC2007), as provided by the GLA (see Appendix B for the definitions).

Figure 4.2: Geographical levels of the modelling stages



5 Scenario Results

5.1 Introduction

This chapter presents the scenario results for the key variables for the UK, London and its sub-regions from the various modelling stages. It also compares the results for the total UK and sectors against those already in the public domain.

5.2 UK

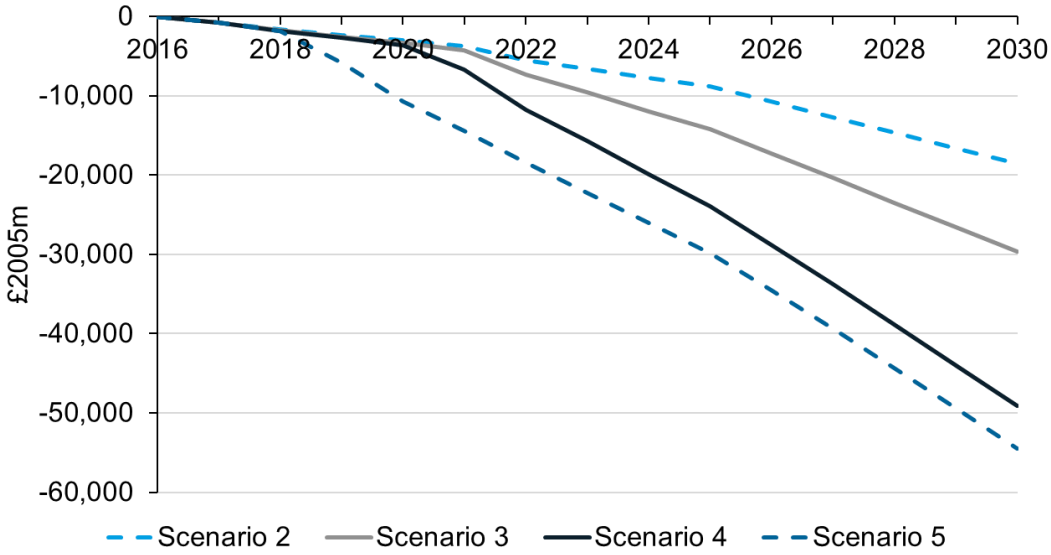
Key macroeconomic results

The impacts of Brexit on the UK can be seen by looking at percentage differences between each scenario and Scenario 1, in which the UK remains in the Single Market and the Customs Union. Table 5.1 shows that Brexit will have a negative impact on the UK economy (compared to what may have happened if the UK remained in the Single Market and Customs Union) across all key indicators, in particular, investment. As expected, the more severe the type of Brexit (going from Scenario 2 to Scenario 5), the greater the negative impact will be on the UK. The GVA differences are also illustrated in Figure 5.1.

Table 5.1 Differences from Scenario 1 for the UK by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
Export to rest of the world	-0.4	-0.6	-2.3	-2.3
Import from rest of the world	-1.5	-2.3	-4.4	-4.6
Population	-0.7	-1.4	-2.2	-2.2
GVA	-1.0	-1.6	-2.7	-3.0
Investment	-6.7	-9.9	-13.8	-15.4
Employment	-0.5	-0.9	-1.4	-1.5
Productivity	-0.5	-0.7	-1.3	-1.5

Figure 5.1 GVA differences from Scenario 1 for the UK



The percentage differences in Table 5.1 are equivalent to a loss of £18.6bn in GVA by 2030, £20.2bn in investment and 176,000 employed people under the

most optimistic scenario (Scenario 2) (compared to what may have happened if the UK remained in the Single Market and Customs Union), and a loss of £54.5bn in GVA, £46.7bn in investment and 482,000 employed people under the most pessimistic scenario (Scenario 5) (see Table 5.2). This implies that the average person in the UK would be between £86 and £203 worse off by 2030 due to Brexit, as measured by GVA per capita across scenarios.

Growth is also likely to slow down, which implies that Brexit will not only reduce the size of the UK economy but also puts it on a slower long-term growth trajectory (i.e. the economy is still growing, but at a slower rate than if the UK remained in the Single Market and Customs Union). This impact is most substantial for investment in which the average annual growth rate over 2019-30 is expected to be between 0.5 and 1.4 percentage points (pp) lower than Scenario 1 across the other four scenarios. The most pessimistic scenario (Scenario 5) even implies a marginal decline in investment in the ten years following Brexit. As a result, Brexit is expected to knock between 0.08 and 0.24 pp off the GVA growth rate each year on average, and between 0.05 and 0.13 pp off the employment growth rate, over 2019-30.

Table 5.2 Summary of results for the UK

		Export to rest of the world	Import from rest of the world	Popula-tion	GVA	Invest-ment	Employ-ment	Product-ivity
		(£2005 bn)	(£2005 bn)	(000s)	(£2005 bn)	(£2005 bn)	(000s)	(£000)
Scenario 1	Level in 2019	534.4	581.4	66898	1595.1	261.7	31034	51.4
	Level in 2030	643.7	694.7	71291	1838.4	302.8	32592	56.4
	Growth (2019-30, % pa)	1.71	1.63	0.58	1.30	1.33	0.45	0.85
Scenario 2	Level in 2019	534.3	580.3	66852	1592.8	258.7	31013	51.4
	Level in 2030	641.2	684.5	70808	1819.8	282.6	32416	56.1
	Growth (2019-30, % pa)	1.67	1.51	0.52	1.22	0.81	0.40	0.81
Scenario 3	Level in 2019	534.4	580.4	66800	1592.6	258.7	31010	51.4
	Level in 2030	639.8	678.6	70272	1808.7	272.9	32288	56.0
	Growth (2019-30, % pa)	1.65	1.43	0.46	1.16	0.49	0.37	0.79
Scenario 4	Level in 2019	534.4	580.4	66741	1592.4	258.6	31007	51.4
	Level in 2030	629.1	664.0	69728	1789.2	261.1	32124	55.7
	Growth (2019-30, % pa)	1.50	1.23	0.40	1.07	0.09	0.32	0.74
Scenario 5	Level in 2019	520.4	563.5	66741	1589.3	258.2	31007	51.3
	Level in 2030	629.1	662.8	69728	1783.9	256.0	32111	55.6
	Growth (2019-30, % pa)	1.74	1.49	0.40	1.06	-0.08	0.32	0.73

Comparison with other macro studies

Around the time of the Brexit referendum, and subsequently as more evidence and information has emerged about the preliminary effects and likely outcome of the Brexit negotiations, a number of model-based studies have been published looking at the expected macroeconomic impacts on the UK.

Notwithstanding the difficulties in comparing models with different priors, assumptions, time frames and baseline comparators, we look briefly at where the results from the current study sit within the outcomes reported thus far. This is not a detailed attempt to disentangle these reported outcomes from the various factors inputting into the models, but rather a brief summary (in chronological order – oldest to most recent) of the background to each result to allow it to be put in a limited context for comparability.

Overview of studies by organisation

- Minford et al (December 2015, and further July 2017)

One of the earliest publications modelling the effects of Brexit, the Minford et al study (also published under the banner 'Economists for Free Trade' but otherwise known as 'Economists for Brexit' also stands out for producing a marked gain in GDP for the UK leaving the EU. The premise is that the UK would be better off by removing all tariffs with the outside world, so that consumers can benefit from the lower prices that result. The huge structural implications of such as shift (eg for agriculture and manufacturing) are seen as a short-run price worth paying, as increased competition (with lower-price international competitors) fosters improved productivity. The modelling approach is based on some questionable assumptions[39], however, and is thus seen as an outlier among model-based studies.

- PwC (2016b)

Published ahead of the Brexit referendum in March 2016, PwC were commissioned by the CBI and ran two scenarios: a free trade agreement with limited uncertainty, and WTO rules with protracted negotiations and difficulties. As with the current study, these scenarios were assessed against a baseline assuming that the UK remained part of the EU. The study uses a CGE model and includes adjustment for trade effects and additional assumptions for migration, FDI/investment and fiscal contributions.

- NIESR (Ebell and Warren, May 2016), also HM Government (April 2016) and OECD (April 2016)

The National Institute make use of their own NiGEM model for analysing Brexit impacts, as do the OECD and HM Treasury (hence why they are grouped together). The NiGEM model is able to capture assumptions for trade and FDI as well as the UK's fiscal contribution to the EU. Three scenarios are considered: the Norway model of EEA membership, the Swiss model of bilateral agreements but no free trade in services, and the default (no agreement) WTO membership option. All sets of results have a central estimate and a range (upper and lower bound). NIESR also comments on the variation of results found between themselves, HM Government and the OECD (using the same model) by attributing the differences to additional productivity adjustments made due to changes in regulation and openness to trade.

- IMF (June 2016)

The IMF used a range of tools (historical evidence, structural model simulations, econometric relationships) to consider two alternative regimes: a *limited uncertainty* world which is broadly consistent with EEA membership and less disruptive to firms and consumers as trading relationships do not change

[39] For example, see http://blogs.lse.ac.uk/brexit/2017/08/23/economists-for-brexit-predictions-are-inconsistent-with-basic-facts-of-international-trade/..

substantially, and an *adverse* view of the world, whereby the UK trades on WTO rules (ie no agreement is reached on a middle ground). Interestingly, in both cases the long-run growth rate of GDP is not affected, and eventually returns to trend, it is the long-run level of GDP that remains lower.

- CPB (July 2016)

The CPB study focusses more on the Netherlands, which as an important European trading partner of the UK stands to lose out more than many other EU Member States from barriers imposed under different Brexit regimes. Two main scenarios are considered: trading under WTO rules (assuming no agreement is reached) and a free trade area (FTA) agreement which would avoid tariff barriers but would impose some degree of non-tariff barrier restrictions. Central estimates are presented with relatively large ranges which reflect the uncertainty being generated by how the knock-on effects of reduced trade will impact on investment, innovation, and productivity.

- RaboBank (October 2017)

Three scenarios are assessed: a soft Brexit where only non-tariff barriers are introduced as the UK remains part of the Single Market and Customs Union, a Free Trade Agreement with larger non-tariff barriers and no freedom of movement of services, and a hard Brexit using WTO rules. These are compared against a baseline scenario of the UK remaining in the EU. As with all other studies being compared, no transition period is assumed. The NiGEM model is again used, alongside additional in-house work to model and adjust total factor productivity which creates a distinctly more negative outlook for the UK economy.

- RAND Europe (December 2017)

RAND use a mix of modelling and game theory analytics to report on five hard Brexit scenarios (WTO, a UK-EU FTA, a UK-US-EU FTA, a UK-US FTA, and a transition period during which non-tariff barriers start to apply) and three soft Brexit scenarios (EEA membership, bilateral arrangements, and remaining in the Customs Union). The model used is the same as that in the Dhingra (2016a) study, with further analysis undertaken for FDI and for the additional scenarios which take into account existing EU trade deals that could affect UK trade costs.

Summary table

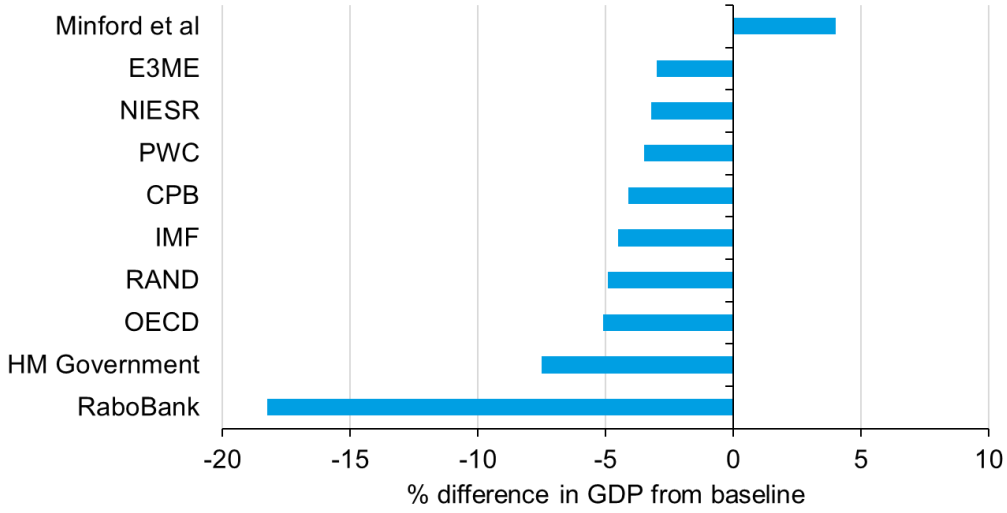
Table 5.3 presents the long-run GDP outcomes (as measured by the % difference of GDP level from baseline) of the above-mentioned studies alongside those generated from the E3ME model, while Figure 5.2 compares the long-run WTO scenarios in a chart to better visualise the differences. Although the studies were produced at different points in times, all seem to have taken account of any effects which might have already been apparent in historic data (over 2016-17) and can be compared without this issue being a concern.

Table 5.3 GDP % differences from base by 2030

Study	EEA Scenario	FTA Scenario	WTO Scenario
Minford et al			+4.0
PWC		-1.2	-3.5
HM Government	-3.8 (-3.4 to -4.3)	-6.2 (-4.6 to -7.8)	-7.5 (-5.4 to -9.5)

Study	EEA Scenario	FTA Scenario	WTO Scenario
OECD[40]		-5.1 (-2.7 to -7.7)	
NIESR	-1.8 (-1.5 to -2.1)	-2.1 (-1.9 to -2.3)	-3.2 (-2.7 to -3.7)
IMF	-1.5		-4.5
CPB		-3.4 (-2.0 to -5.9)	-4.1 (-2.7 to -8.7)
RaboBank	-10 (-8.4 to -11)	-12.5 (-11.3 to -13.7)	-18 to -18.5
RAND[41]			-4.9
E3ME[42]	-1.0	-1.6	-3.0

Figure 5.2: Comparison of the long-run impact of Brexit (Hard Brexit - WTO scenario)



It is clear from the table that the E3ME macro results are at the conservative end of the spectrum when it comes to the magnitude of GDP differences from baseline, and are closest to those obtained by NIESR and PWC. For many of the results analysed, the spread of results (as noted by NIESR) are usually due to how the models deal with the additional effects on productivity caused by changes to FDI, openness to trade, degree of regulation, innovation, and other factors that are not directly captured by the main model structure. This leaves open a wide area of interpretation (and off-model techniques), which then feed through to the GDP outcomes.

Sector results comparison

The other results comparison to make is with the sector-specific results from the Dhingra et al (2017) study. From a modelling perspective this is useful as the national-sector level results are what drive the local results for the hard and soft Brexit scenarios that are reported.

A methodological comparison has already been made in Chapter 4, which highlighted some key properties and assumptions that might lead to variation in

[40] It is not entirely clear what the OECD assumptions are regarding a particular version of Brexit, hence it is assumed to fall somewhere in the FTA/WTO models, as also reported in NIESR (2016).

[41] Only 10-year cumulative effects are reported, whereas most other studies tend to use 2030 as the comparison period. Other scenarios are difficult to assess as they are reported as relative to the WTO scenario.

[42] Within the current study, Scenario 3 is not exactly a FTA model run, but the closest that is produced to this trading environment. Scenarios 4 and 5 are both under WTO rules, but scenario 5 is reported as it does not include the transition period, the same as in other studies.

results, and the difficulty in establishing which particular assumptions might underpin them. Rather than dwell on the individual differences, it is easier to simply compare the outcomes from the two models on the most like-for-like basis. For this reason, the E3ME model was run only using the tariff and non-tariff barrier assumptions for the same soft and hard Brexit scenarios which were reported in the Dhingra et al (2017) study. The table below compares the results (differences from base[43]) for GVA in 2030 for the E3ME model with the long-run differences from the Dhingra et al (2017) study. Table 5.4 presents the sector results (as reported in Table 1 of Dhingra et al (2017)) with equivalent results (aggregated where necessary) from the E3ME model.

Table 5.4: Sector GVA % differences from base by 2030: E3ME (including only assumptions for trade) vs Dhingra et al (2017)

Study	Dhingra et al (2017) (Great Britain)		E3ME Results (UK)	
	Soft Brexit	Hard Brexit	Soft Brexit	Hard Brexit
Total GVA	-1.1	-2.1	-0.2	-0.7
Agriculture, Hunting, Forestry & Fishing	3.3	4.2	-0.6	-2.1
Mining and Quarrying	-7.3	-12.5	0.0	0.0
Food, Beverages and Tobacco	1.4	2.8	0.5	1.2
Textiles and Textile Products; Leather, Leather Products and Footwear	-6.8	-5.2	0.0	-4.7
Wood and Products of Wood and Cork	9.9	15.9	-0.1	-0.3
Pulp, Paper, Paper Products, Printing and Publishing	3.5	6.3	-0.2	-1.0
Coke, Refined Petroleum and Nuclear Fuel	-0.5	-0.8	0.0	-0.1
Chemicals and Chemical Products	-8.9	-15.1	0.1	-0.2
Rubber and Plastics	-0.4	-0.7	-0.1	-2.5
Other Non-Metallic Mineral	0.2	0.2	-0.1	-2.5
Basic Metals and Fabricated Metal	0.5	5.1	-0.1	-1.2
Machine, nec	-0.1	-0.2	-0.2	-1.0
Electrical and Optical Equipment	-9.5	-6.3	0.0	-0.8
Transport Equipment	-0.5	-0.9	0.0	0.0
Manufacturing, nec ; Recycling	0.9	2.5	-0.1	-0.3
Electricity, Gas and Water Supply	-1.1	-2.1	-0.1	-0.5
Construction	-1.4	-2.6	-0.2	-0.6
Retail Sale of Fuel; Wholesale Trade, Commission Trade, including Motor Vehicles & Motorcycles	-0.8	-1.6	-0.2	-0.9
Retail Trade, Except of Motor Vehicles & Motorcycles; Repair of Household Goods	-1.2	-2.3	-0.3	-1.2
Hotels and Restaurants	0.0	-0.2	-0.3	-0.5
Inland Transport	-0.6	-1.2	0.0	-0.2
Water Transport	4.7	9.1	0.0	-0.1
Air Transport	5.2	10.4	0.0	-0.1
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	-1.3	-2.5	-0.2	-0.7

[43] The Dhingra et al (2016a) study refers to their differences as 'the permanent change…that has the same present discounted value effect…as Brexit' which we assume to be the same thing.

Study	Dhingra et al (2017) (Great Britain)		E3ME Results (UK)	
	Soft Brexit	Hard Brexit	Soft Brexit	Hard Brexit
Post and Telecommunications	-1.8	-3.9	-0.2	-0.7
Financial Intermediation	-2.8	-6.2	-0.5	-1.3
Real Estate Activities	-1.4	-2.6	0.0	-0.2
Renting of Machinery and Equipment and Other Business Activities	-1.7	-4.0	-0.2	-0.8
Education	-1.2	-2.2	-0.1	-0.5
Health and Social Work	-1.3	-2.4	-0.1	-0.2
Public Admin, Defence, Social Security and Other Public Services	-1.1	-2.3	-0.2	-0.5

Clearly there are large variations in the results between the two models, with the E3ME differences being, on the whole, more uniform and more conservative. However, Dhingra et al (2017, p5) do note that:

'…we would urge considerable caution in placing strong weight on the estimated impact for any particular sector. We have more confidence in the area level results where the employment share weighting will help 'wash-out' some of the sector-specific prediction errors…'.

Comparison with the sectoral 'risk' from Brexit

As part of an ESRC-funded project (The Impact of Brexit on the UK, Its Regions, Its Cities and Its Sectors) recently-released findings[44] have focussed on the sectoral risks from Brexit, as measured by the exposure of a sector's employment to cross-border (UK-EU) supply-chains. These supply-chain connections are estimated from international input-output linkages with detailed sectoral disaggregation. While the sector-specific Brexit-risk indices cannot be compared directly to the results from this study, the Brexit-risk index can be considered as the difference between the baseline scenario (of no Brexit) and a 'no deal' or 'chaotic' Brexit, in which the legal basis of many international transactions becomes ambiguous, such that defaulting to WTO rules is itself far from straightforward. In this case, the study finds that more than 2.5 million jobs and annually almost £140bn of UK activity are exposed to the trade effects of Brexit. The study also models the opposite extreme case – in which the UK economy is 'hyper-competitive' – whereby UK supply responses are very strong and rapid, and are able to largely compensate for losses of imported input supplies. In this case, UK employment and output increases relative to the baseline scenario, although as the authors point out, the UK productivity statistics suggest that the UK is far from being hyper-competitive, except in a very few sectors and sub-sectors.

5.3 London

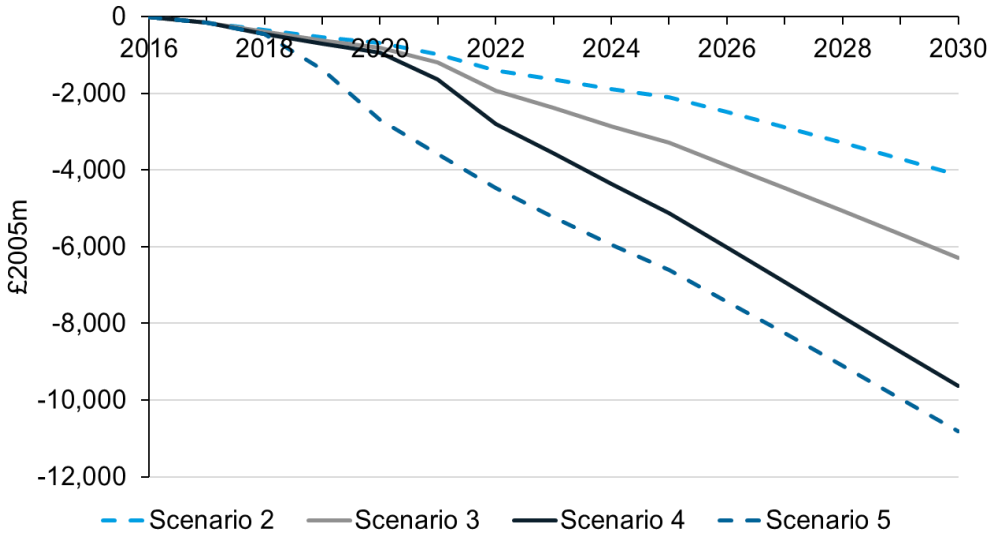
The London results are similar to the UK results in that the impact of Brexit is negative and gets progressively more negative (compared to what may have happened if the UK remained in the Single Market and Customs Union), moving from Scenario 2 to Scenario 5 (see Table 5.5 and Figure 5.3).

[44] See https://blog.bham.ac.uk/cityredi/wp-content/uploads/sites/15/2017/12/City-REDI-Briefing-Template_Sectoral-Analysis-2.pdf.

Table 5.5 Differences from Scenario 1 for London by 2030

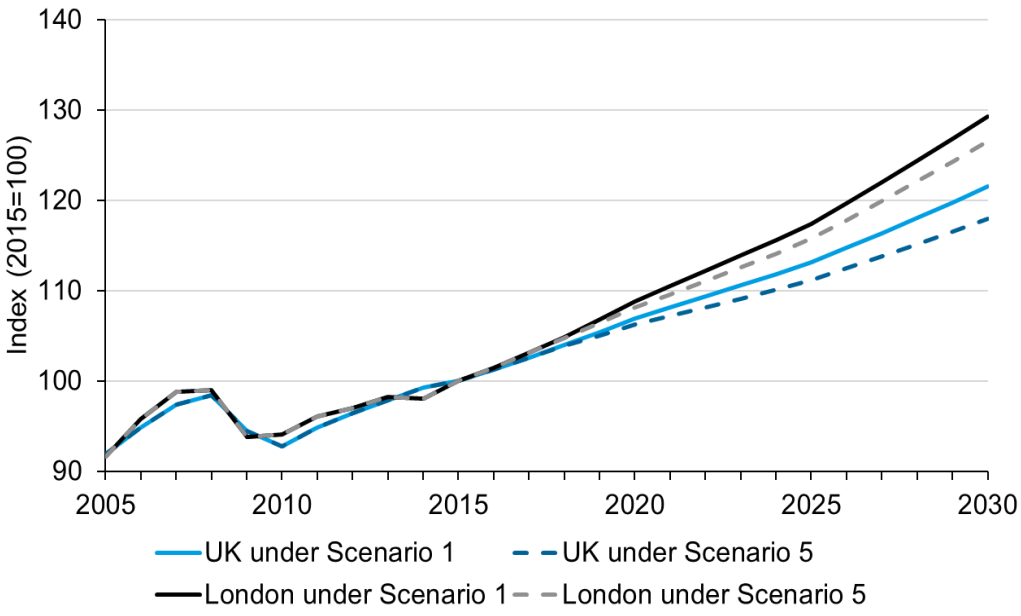
	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
GVA	-0.8	-1.2	-1.9	-2.1
Employment	-0.6	-1.0	-1.6	-1.6
Productivity	-0.2	-0.2	-0.3	-0.5
Population	-1.3	-2.7	-4.2	-4.2

Figure 5.3 GVA differences from Scenario 1 for London



Overall, London is not expected to be affected as much as the UK, in terms of GVA and productivity. Figure 5.4 shows that despite a slowdown, London's GVA would still grow at a much faster rate than the UK's total in all scenarios. This reflects that London has a higher concentration of higher-value sectors, which are able to recover from economic shocks more quickly. As a result, London is likely to account for an increasing share of the UK's GVA.

Figure 5.4 GVA growth in the UK and London



On the other hand, the population (and so employment) impacts in London are noticeably stronger than in the UK. London has a larger proportion of non-UK workers, so border restrictions and a reduction in EU migration are expected to impact London the most. However, London is also more resilient, and so growth in total population and employment is still stronger in London than in the UK across all scenarios (see Figure 5.5 and Figure 5.6)[45].

Figure 5.5 Employment growth in the UK and London

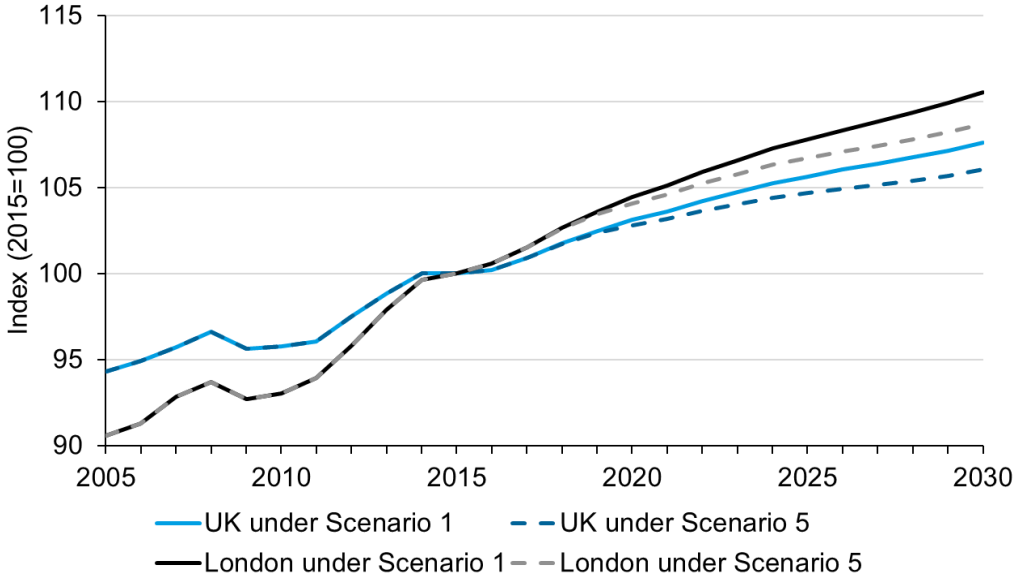
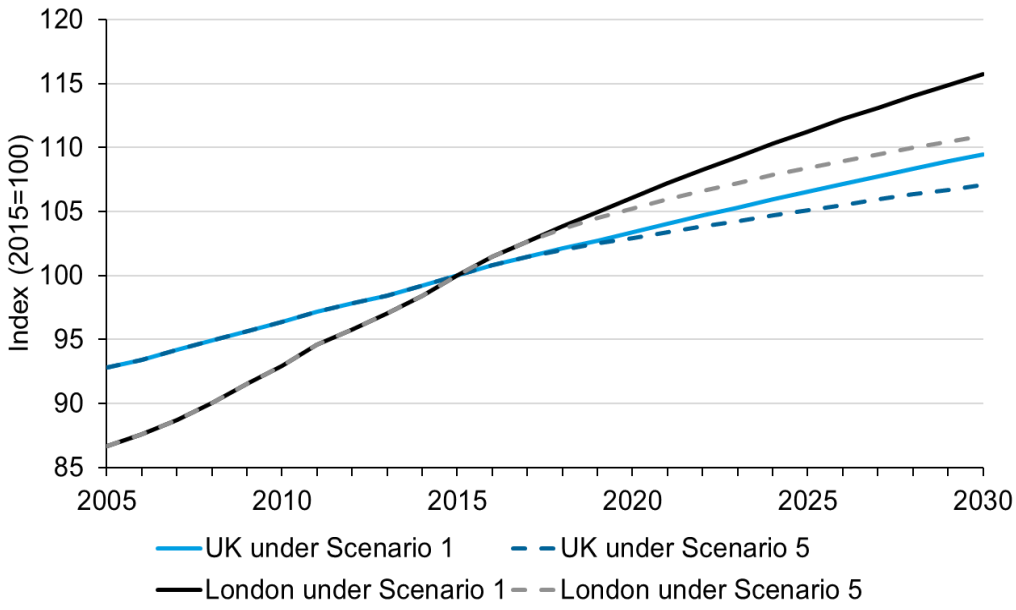


Figure 5.6 Population growth in the UK and London



[45] The population estimates show the potential impact of Brexit based on several simplifying assumptions. They are also static in the sense that they do not consider any wider dynamic effects on future migration trends. Consequently, they are not suitable for long-term planning purposes.

The figures in Table 5.5 also show that the population impact is larger than the employment impact for London, as the gap between Scenario 1 and Scenario 5 is wider, which is not the case for the UK. This can be explained by a number of reasons:

- The employment impact only includes migrant workers who leave or never came to the UK after Brexit, whereas the population impact also includes the departure or non-arrival of their dependents (children and elderly parents). As the concentration of migrants in London is higher than in the UK as a whole, the potential reduction in the number of migrant dependents that is not reflected in the employment impact is likely to be substantial.
- London residents who were unemployed or inactive may be employed following migration restrictions because there is less competition for jobs. As an extreme example, if every vacancy that would have been filled by a migrant from outside the UK is filled by a UK national, employment would be unchanged while population would shrink because the migrant never came.

According to Table 5.6, London would be £4.1bn poorer by 2030 under Scenario 2 and £10.8bn poorer under Scenario 5, as measured by total GVA (compared to what may have happened if the UK remained in the Single Market and Customs Union). This is accompanied by a loss of 30,500 and 87,000 employed people under the two scenarios, respectively. As with the UK, growth is expected to slow down in London across all indicators, but to a lesser extent than for the UK. GVA growth across the other four scenarios is expected to be between 0.07 and 0.17 pp slower per annum than Scenario 1, and employment growth is expected to be between 0.04 and 0.14 pp slower per annum.

These impacts in terms of percentage differences from the baseline are not too dissimilar from the percentages presented for London[46] in The Local Economic Effects of Brexit study by Dhingra et al (2017), where it is estimated that GVA would be 1.3% lower in London under a Soft Brexit and 2.6% lower under a Hard Brexit scenario. However, while the Dhingra study finds that the effects of Brexit in London and the South East are likely to be higher than in most other parts of the UK and the UK as a whole, this study finds that the implications of Brexit are likely to be less for London and the South East than for other parts of the UK and for the UK as a whole, which is more in line with the study by Chen et al (2017a; 2017b).

Table 5.6 Summary of results for London

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	421.5	4940	85.3	9106
	Level in 2030	510.5	5272	96.8	10040
	Growth (2019-30, % pa)	1.76	0.59	1.16	0.89
	Share of the UK in 2019 (%)	26.4	15.9	-	13.6
	Share of the UK in 2030 (%)	27.8	16.2	-	14.1
Scenario 2	Level in 2019	421.0	4936	85.3	9094
	Level in 2030	506.4	5241	96.6	9910

[46] In this study, London is defined in line with the Primary Urban Area definition.

		GVA	Employment	Productivity	Population
	Growth (2019-30, % pa)	1.69	0.55	1.14	0.78
	Share of the UK in 2019 (%)	26.4	15.9	-	13.6
	Share of the UK in 2030 (%)	27.8	16.2	-	14.0
Scenario 3	Level in 2019	420.9	4936	85.3	9081
	Level in 2030	504.2	5218	96.6	9767
	Growth (2019-30, % pa)	1.66	0.51	1.14	0.66
	Share of the UK in 2019 (%)	26.4	15.9	-	13.6
	Share of the UK in 2030 (%)	27.9	16.2	-	13.9
Scenario 4	Level in 2019	420.8	4935	85.3	9066
	Level in 2030	500.9	5188	96.5	9623
	Growth (2019-30, % pa)	1.60	0.45	1.14	0.54
	Share of the UK in 2019 (%)	26.4	15.9	-	13.6
	Share of the UK in 2030 (%)	28.0	16.1	-	13.8
Scenario 5	Level in 2019	420.1	4934	85.1	9066
	Level in 2030	499.7	5185	96.4	9623
	Growth (2019-30, % pa)	1.59	0.45	1.13	0.54
	Share of the UK in 2019 (%)	26.4	15.9	-	13.6
	Share of the UK in 2030 (%)	28.0	16.1	-	13.8

5.4 Rest of the UK

Although the geographical focus of this study is the UK and London, Brexit will certainly affect other parts of the UK as well. Table 5.7 summarises the percentage differences from Scenario 1 by 2030 for the rest of the UK (calculated as the difference between the UK as a whole and London).

Table 5.7 Differences from Scenario 1 for the rest of the UK by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
GVA	-1.1	-1.8	-3.0	-3.3
Employment	-0.5	-0.9	-1.4	-1.4
Productivity	-0.6	-0.9	-1.6	-1.9
Population	-0.6	-1.2	-1.9	-1.9

The ordering of impacts resembles that of the UK and London, but the magnitude is clearly in contrast with London. The impacts on employment and population are slightly smaller, as much of the reduction in migration and population is expected to be in London. On the other hand, the losses in GVA and productivity across all scenarios (compared to what may have happened if the UK remained in the Single Market and Customs Union) are noticeably more severe for the rest of the UK than for London, which implies that the rest of the UK will be much worse off than London following Brexit.

This is more clearly illustrated by the growth rates of key indicators (see Table 5.8). While the slowdown in employment growth is similar to the London results, GVA in the rest of the UK is expected to slow down more than in London, by between 0.09 and 0.27pp each year on average. This means that the welfare

gap between London and other regions would also widen in the longer term, at a faster rate than it would have been without Brexit.

Table 5.8 Summary of results for the rest of the UK

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	1173.6	26094	45.0	57788
	Level in 2030	1327.9	27321	48.6	61029
	Growth (2019-30, % pa)	1.13	0.42	0.71	0.50
Scenario 2	Level in 2019	1171.8	26076	44.9	57754
	Level in 2030	1313.4	27175	48.3	60675
	Growth (2019-30, % pa)	1.04	0.38	0.66	0.45
Scenario 3	Level in 2019	1171.7	26074	44.9	57716
	Level in 2030	1304.5	27070	48.2	60283
	Growth (2019-30, % pa)	0.98	0.34	0.64	0.40
Scenario 4	Level in 2019	1171.6	26071	44.9	57671
	Level in 2030	1288.4	26936	47.8	59883
	Growth (2019-30, % pa)	0.87	0.30	0.57	0.34
Scenario 5	Level in 2019	1169.2	26073	44.8	57671
	Level in 2030	1284.2	26926	47.7	59883
	Growth (2019-30, % pa)	0.86	0.29	0.56	0.34

5.5 Inner and Outer London

The results for Inner and Outer London reflect the results for London, but each part of London is affected in a different way (see Table 5.9 and Table 5.10). Inner London is expected to experience a larger negative impact as a result of Brexit in terms of GVA, employment and population (compared to what may have happened if the UK remained in the Single Market and Customs Union), as this is where the majority of EU-dependent economic activities occur. In particular, sectors in London that are likely to be more exposed to the risks of Brexit, such as Financial & insurance, Media, IT Services, Legal & accounting and Head offices & management consultancy, have a greater presence in Inner London than in Outer London. Together, these sectors account for 44% of total GVA and 29% of total employment in Inner London in 2016, compared to 18% of total GVA and 13% of total employment in Outer London.

However, the loss in productivity is expected to be smaller in Inner London, reflecting the trend that high-value and high-productivity sectors, such as those mentioned above, tend to locate here. The loss in productivity in Outer London is also driven by a number of population-dependent sectors, such as Construction, Education and Health. This is because jobs in these sectors cannot be relocated and must be filled to meet the needs of the population, but Brexit means that some EU nationals who are currently holding such jobs will be replaced by UK and non-EU nationals who may not be as skilled and experienced.

More detailed results for Inner and Outer London and results for the four London sub-regional partnerships are provided in Appendix C.

Table 5.9 Differences from Scenario 1 for Inner London by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
GVA	-0.8	-1.3	-1.9	-2.1
Employment	-0.7	-1.2	-1.9	-1.9
Productivity	-0.2	-0.1	-0.1	-0.2
Population	-1.5	-3.2	-4.9	-4.9

Table 5.10 Differences from Scenario 1 for Outer London by 2030

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
				(%)
GVA	-0.8	-1.2	-1.8	-2.0
Employment	-0.5	-0.8	-1.2	-1.3
Productivity	-0.3	-0.4	-0.6	-0.7
Population	-1.2	-2.4	-3.7	-3.7

5.6 Sector results

Broad sectors

The GVA and employment results for the UK and London are disaggregated into 12 broad sectors in Table 5.11 and Table 5.12. For both areas, the greatest impacts on GVA are expected to be in Agriculture, Manufacturing and Construction. These sectors are most exposed to high tariffs and non-tariff barriers; in addition, manufacturing is assumed to have a substantial slowdown in investment and productivity (see Section 3.3). In comparison, impacts on high-value private sector services, such as Information & communications and Financial & business services are more modest and mostly driven by slower investment growth. The financial & insurance sub-sector is also expected to face higher non-tariff barriers after Brexit, particularly as a result of maintaining equivalence with EU regulations. GVA impacts in all other sectors are either very small in line with the assumptions for that sector, or likely to be linked to the supply chain impacts of sectors mentioned above.

The results for employment show that most sectors will be adversely affected by Brexit (compared to what may have happened if the UK remained in the Single Market and Customs Union), for both the UK and London. More importantly, they show how productivity may be impacted very differently across sectors. The productivity impacts are expected to be strongest in sectors such as Agriculture and Construction, which are highly dependent on trade and skilled labour.

Table 5.11 Differences by broad sectors from Scenario 1 for the UK by 2030

	GVA				Employment			
	S2	S3	S4	S5	S2	S3	S4	S5
								(%)
Agriculture	-1.8	-2.3	-24.7	-33.1	1.1	1.7	9.7	13.2
Mining & quarrying	0.0	0.0	-0.1	-0.4	0.0	0.0	0.0	0.0
Manufacturing	-2.2	-3.4	-5.7	-6.4	-1.5	-2.4	-4.3	-4.7
Electricity, gas & water	0.0	0.1	0.3	0.6	1.2	1.8	3.2	4.1
Construction	-3.5	-5.2	-7.4	-8.2	-0.8	-1.2	-1.7	-1.9
Distribution	-0.7	-1.2	-2.3	-2.5	-0.3	-0.5	-0.8	-1.0
Transport & storage	-0.5	-0.8	-1.2	-1.4	-0.6	-1.1	-2.0	-1.9
Accommodation & food services	-0.3	-0.7	-1.2	-0.8	-0.4	-0.8	-1.4	-1.2
Information & communications	-1.0	-1.5	-2.3	-2.5	-0.6	-1.0	-1.4	-1.6
Financial & business services	-0.9	-1.5	-2.4	-2.6	-0.9	-1.5	-2.4	-2.5
Government services	-0.1	-0.1	-0.3	-0.3	0.0	0.1	0.1	0.1
Other services	-1.3	-2.0	-3.0	-3.2	-1.6	-2.8	-4.3	-4.4

GVA impacts are stronger for most sectors in London than compared to the UK as a whole. However, these impacts are outweighed by the smaller impacts (in percentage terms) in Information & communications, Financial & business services and Government services, the three largest sectors in London in terms of GVA. Financial & business services and Government services are also the two largest sectors in London in terms of employment, employing more than half of London's workforce, and employment in these sectors are expected to be less affected by job losses than other regions. This shows that the larger and higher value part of the London economy would be able to withstand the negative impacts of Brexit better than the UK as a whole.

Table 5.12 Differences by broad sectors from Scenario 1 for London by 2030

	GVA				Employment			
	S2	S3	S4	S5	S2	S3	S4	S5
								(%)
Agriculture	-1.8	-2.0	-28.6	-38.4	2.5	3.7	21.6	29.5
Mining & quarrying	0.0	0.0	-0.2	-0.7	0.0	0.0	0.0	0.0
Manufacturing	-2.3	-3.5	-5.9	-6.9	-1.3	-2.0	-3.7	-4.1
Electricity, gas & water	0.0	0.1	-0.2	-0.2	0.8	1.2	2.2	2.8
Construction	-2.9	-4.4	-6.3	-7.0	-0.9	-1.4	-1.9	-2.1
Distribution	-1.0	-1.7	-3.1	-3.4	-0.3	-0.6	-1.0	-1.2
Transport & storage	-0.2	-0.2	-0.3	-0.5	-0.3	-0.6	-1.1	-1.1
Accommodation & food services	-0.6	-1.2	-2.1	-1.6	-0.6	-1.3	-2.3	-1.9
Information & communications	-0.8	-1.2	-1.7	-1.9	-0.4	-0.5	-0.5	-0.7
Financial & business services	-0.8	-1.1	-1.7	-1.9	-0.8	-1.4	-2.2	-2.3
Government services	-0.1	-0.1	-0.3	-0.3	0.0	0.1	0.1	0.1
Other services	-1.4	-2.2	-3.2	-3.5	-2.0	-3.5	-5.4	-5.6

Key sectors

Table 5.13 and Table 5.14 show the percentage differences from Scenario 1 by key sectors for the UK and London, respectively. As expected, Financial & professional services, Science and Technology, Creative and Construction, which make up a high proportion of economic activity in the UK, particularly in London, are among those hit the hardest by Brexit. Within Science and Technology, most of the impacts are in Digital Technologies, as a large part of Life Sciences and Healthcare is the NHS which may be less exposed to changes in trade and business investment.

The GVA results reflect observations in total GVA that London experiences smaller impacts in percentage terms than the UK. This is also the case for employment in most sectors. However, Construction and Hospitality, which tend to require less skilled labour and employ a larger proportion of EU migrants than other key sectors, are expected to see larger impacts on employment in London than in the UK. As infrastructure and night life are important contributors to London's attractiveness as a place to live and work, there may be negative knock-on effects on other (potentially more skilled, higher value) sectors from a reduction in the Construction and Hospitality labour force in the longer term, including a reduction in new housing supply, which have not been captured in this study.

More detailed results for the broad sectors and key sectors are provided in Appendix C.

Table 5.13: Differences by key sectors from Scenario 1 for the UK by 2030

	GVA				Employment			
	S2	S3	S4	S5	S2	S3	S4	S5
								(%)
Financial & professional services	-0.8	-1.4	-2.2	-2.4	-0.9	-1.6	-2.5	-2.6
Science and Technology	-1.1	-1.7	-2.5	-2.8	-0.5	-0.9	-1.3	-1.4
Digital Technologies	-1.8	-2.8	-4.0	-4.5	-1.3	-2.2	-3.3	-3.6
Life Sciences and Healthcare	-0.2	-0.3	-0.6	-0.6	0.0	-0.1	-0.1	-0.1
Creative	-0.9	-1.4	-2.1	-2.3	-0.7	-1.2	-1.6	-1.8
Cultural	-0.5	-0.8	-1.3	-1.4	-0.8	-1.2	-1.6	-1.8
Food and Drink Manufacturing	-0.2	-0.2	-0.9	-1.3	-0.3	-0.6	-0.8	-0.7
Construction	-3.5	-5.2	-7.4	-8.2	-0.8	-1.2	-1.7	-1.9
Hospitality	-0.3	-0.7	-1.2	-0.8	-0.4	-0.8	-1.4	-1.2

Table 5.14: Differences by key sectors from Scenario 1 for London by 2030

	GVA				Employment			
	S2	S3	S4	S5	S2	S3	S4	S5
								(%)
Financial & professional services	-0.7	-1.0	-1.5	-1.7	-0.8	-1.5	-2.3	-2.4
Science and Technology	-0.8	-1.2	-1.7	-1.9	-0.4	-0.6	-0.9	-1.0
Digital Technologies	-1.5	-2.2	-3.3	-3.6	-1.1	-1.9	-2.8	-3.0
Life Sciences and Healthcare	-0.1	-0.1	-0.3	-0.3	0.0	0.0	0.0	0.0
Creative	-0.8	-1.1	-1.5	-1.7	-0.6	-0.8	-1.0	-1.2
Cultural	-0.2	-0.2	-0.1	-0.3	-0.4	-0.4	-0.1	-0.3
Food and Drink Manufacturing	-0.1	-0.1	-0.5	-0.8	-0.2	-0.4	-0.5	-0.4
Construction	-2.9	-4.4	-6.3	-7.0	-0.9	-1.4	-1.9	-2.1
Hospitality	-0.6	-1.2	-2.1	-1.6	-0.6	-1.3	-2.3	-1.9

6 Business start-ups and scale-ups

6.1 Introduction

This chapter presents an analysis of the impact Brexit may have on business start-ups and scale-ups under the various scenarios. These companies are a significant proportion of UK's economic growth, and it is important to assess the potential impact Brexit may have on these businesses in order to have a fuller understanding of the impact of Brexit on the UK.

6.2 Data availability

There is limited historical data available on business start-ups and scale-ups. While there is detailed 3-digit SIC data for the number of starts-ups in the UK, there is no sector breakdown for London. In addition, there isn't many years of historical data and no national dataset on scale-up businesses. Table 6.1 below outlines the available data sources.

Table 6.1: Sources of data on business start-ups and scale-ups

Dataset	Variable	Lowest level of Geography	Other breakdown	Time period
ONS Business Demography[47]	Business births, deaths and population	Local authorities	Detailed industries (SIC2007) for the UK. No industry breakdown for London	2009-15
UK Business Counts[48]	Business population	Local authorities	By 9 employment size bands, detailed industries (SIC2007) and legal status	2010-16
Centre for Entrepreneurs (based on Company House data)[49]	Business starts	Local authorities		2014-16
Business Population Estimates[50]	Business population, total size of workforce and total turnover	Regions	By 10 employment size bands and broad industry groups	2010-16
The scale-up report on UK economic growth[51]	Total scale-up businesses and additional scale-ups per year	LEPs		2014, 2019 and 2024
ScaleUp Institute lookup[52]	Scale-up businesses	LEPs	By industry, turnover band and employment size band	One year

[47] https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/datasets/businessdemographyreferencetable

[48] https://www.nomisweb.co.uk/articles/764.aspx

[49] https://centreforentrepreneurs.org/cfe-releases/2016-breaks-business-formation-records/?mc_cid=cd53b7970a&mc_eid=0804ec0dee

[50] https://www.gov.uk/government/collections/business-population-estimates

[51] http://www.scaleupreport.org/scaleup-report.pdf

[52] http://www.scaleupinstitute.org.uk/scale-up-businesses/

These data restrictions prevent complex modelling or statistical techniques to be undertaken without large error margins. Therefore, this analysis will place a focus on historical data and a qualitative discussion of impacts based on the literature and modelling results.

6.3 Start-ups

Data for the number of start-ups in the UK over 2010-16 are available at the 3-digit SIC level from the ONS Business Demography dataset. These are then aggregated to CE's 12 broad sectors as presented in Table 6.2.

There is estimated to be just under 415,000 start-ups in the UK in 2016, having almost doubled from the level in 2010, a growth rate of 10% pa. A large proportion (41%) of these is in Financial & business services, followed by Construction (13%), Distribution (11%) and Information & communications (8%). The sectoral distribution of start-ups has changed little in the 7-year period, except for a slight shift from Distribution to Financial & business services and Transport & storage.

Table 6.2: Number of start-ups in the UK by broad sector

	2010	2011	2012	2013	2014	2015	2016	2016
							(units)	(%)
Agriculture	0	0	0	0	0	0	0	0
Mining & quarrying	135	175	210	215	210	240	200	0.0
Manufacturing	9605	10290	11985	15310	14015	15820	15700	3.8
Electricity, gas & water	1190	1725	2055	2375	2510	4260	2500	0.6
Construction	27420	29820	29295	38335	40990	48805	51680	12.5
Distribution	38470	39355	39145	46050	40825	40850	45520	11.0
Transport & storage	7490	8105	8690	12330	15565	20500	27405	6.6
Accommodation & food services	17970	19355	20260	25270	23655	24335	25885	6.2
Information & communications	22865	26435	25630	33535	34125	36800	33625	8.1
Financial & business services	84715	99235	105130	138425	144645	151940	168855	40.8
Government services	11755	11115	12150	16545	16810	20300	26180	6.3
Other services	13530	15760	15015	18095	17240	19225	16805	4.1
Total	235145	261370	269565	346485	350590	383075	414355	100

Source: ONS Business Demography.

Data for London are only available at the total level, so have to be disaggregated to provide a more detailed analysis. The total number of start-ups is first split to CE's 45 sectors using the distribution of micro and small businesses (employing 49 people or fewer) in London in the same period (calculated from UK Business Counts data). These first estimates are then constrained to the UK figure for each sector (from ONS Business Demography) and finally scaled to the total number of start-ups in London. As with the UK, the results are aggregated to 12 broad sectors and presented in Table 6.3.

The number of start-ups in London is over 102,000 in 2016, accounting for almost 25% of start-ups in the UK. The start-up population in London has also grown at a faster rate than the UK as a whole since 2010, at 11.6% pa, giving it an increasing percentage of the UK total. The sectoral distribution and the trend in the distributional shift are both similar to those of the UK, but a noticeably smaller share of start-ups in London is in Financial & business services. The

difference is accounted for by more start-ups in Distribution and Other services (which is mostly made up of recreational and entertainment services). This demonstrates London's role as a transport and cultural hub besides its well-known image as a financial centre, implying that new businesses set up here are more diverse than in other parts of the UK.

Table 6.3: Number of start-ups in London by broad sector

	2010	2011	2012	2013	2014	2015	2016	2016
							(units)	(%)
Agriculture	0	0	0	0	0	0	0	0
Mining & quarrying	30	32	35	49	44	48	47	0.0
Manufacturing	3296	3733	3887	5034	5111	5516	5473	5.4
Electricity, gas & water	169	214	253	366	407	466	498	0.5
Construction	7477	8419	8676	10816	11327	12672	13018	12.7
Distribution	9728	11387	11784	14931	15300	16281	15805	15.5
Transport & storage	1812	2081	2168	2785	3015	3627	3953	3.9
Accommodation & food services	3491	4026	4251	5331	5555	6422	6274	6.1
Information & communications	3939	4720	5208	6934	7596	8562	8901	8.7
Financial & business services	15903	18717	20197	26456	28741	33944	34715	34.0
Government services	2838	3423	3716	4827	5255	6051	6247	6.1
Other services	4069	4640	4921	6074	6231	7331	7205	7.1
Total	52755	61395	65095	83600	88580	100920	102140	100

Source: Cambridge Econometrics' calculations based on data from ONS Business Demography and UK Business Counts.

It is uncertain to what extent the impact on start-ups would be and how long that impact would last, depending on the Brexit scenarios and how other economic variables are affected, but it is likely that the impacts would be negative (compared to what may have happened if the UK remained in the Single Market and Customs Union). On the other hand, it is highly unlikely that entrepreneurial activities would halt following Brexit. New businesses are expected to continue opening in the UK and London, albeit at a slower rate than historically.

It is widely believed that entrepreneurship and economic growth are linked through a two-way relationship. A larger business population generates jobs and profits, introduces technological changes and increases the value of the economy. A high level of economic activity, in turn, creates more demand, which leads to new firms being born to fill the gap in the market. As a result, sectors where the impacts of Brexit on economic activity are the largest are likely to experience the hardest hit on start-ups.

According to the UK results (see Section 5.6), Construction and Financial & business services are expected to have the greatest negative impact on start-ups (compared to what may have happened if the UK remained in the Single Market and Customs Union), because these sectors both account for a large share of total start-ups and are substantially affected in terms of GVA. The next largest impacts are likely to be in Manufacturing, Distribution and Information & communications, where these sectors either account for a large share of total start-ups or are substantially affected by Brexit in terms of GVA.

The impacts are expected to be more adverse and slightly more uniform across sectors for London than for the UK, because of its large share of the UK's total

start-ups and the diversity of its start-up population. The most affected sectors are likely to be the same in London, with the addition of Other services, but the impact may be smaller in Financial & business services and larger in Distribution.

6.4 Scale-ups

According to OECD (2008), a scale-up is a company starting with 10 or more employees and achieving average annual growth of greater than 20% pa over a three-year period (in turnover or employment). It is an alternative measure of business activity to start-ups, which focuses on high-growth businesses and is not restricted to new businesses.

Historical data for scale-ups in the UK and London by 19 sectors are collated from the Scaleup Institute lookup tool, as shown in Table 6.4. This being a live database, the timeliness of the data is uncertain because businesses are included regardless of when they were regarded as scale-ups. Nevertheless, given that this is the only source of detailed data on scale-ups, it is still informative.

Table 6.4: Number of scale-ups by sector

	UK		London	
	(units)	(%)	(units)	(%)
Agriculture, Forestry & Fishing	54	0.6	2	0.1
Mining & Quarrying	81	0.9	22	0.7
Manufacturing	1083	12.4	122	4.0
Electricity, Gas, Steam and Air Conditioning Supply	47	0.5	11	0.4
Water Supply; Sewerage, Waste Management and Remediation Activities	44	0.5	4	0.1
Construction	858	9.8	163	5.3
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	978	11.2	254	8.3
Transport and Storage	253	2.9	60	2.0
Accommodation and Food Service Activities	252	2.9	110	3.6
Information and Communication	843	9.6	421	13.7
Financial and Insurance Activities	882	10.1	455	14.8
Real Estate Activities	205	2.3	74	2.4
Professional, Scientific and Technical Activities	587	6.7	462	15.0
Administrative and Support Service Activities	978	11.2	476	15.5
Public Administration and Defence; Compulsory Social Security	24	0.3	10	0.3
Education	614	7.0	134	4.4
Human Health and Social Work Activities	441	5.0	117	3.8
Arts, Entertainment and Recreation	235	2.7	70	2.3
Other Service Activities	293	3.3	109	3.5
Total	8752	100	3076	100

Source: Scaleup Institute.

It is estimated that there are about 8,800 scale-ups in the UK and just over 3,000 scale-ups in London (more than 35% of the UK total). Unlike for start-ups, there is less similarity in the sectoral distribution of scale-ups between the two areas. Administrative and Support Service Activities and Financial and Insurance

Activities are the only sectors that account for a large share of scale-ups in both the UK and London. In the UK, the other major sectors in terms of scale-ups are Manufacturing and Wholesale and Retail Trade, whereas, in London they are Information and Communication and Professional, Scientific and Technical Activities.

In addition, there is a greater concentration of scale-ups in certain sectors in London, where the largest five sectors account for 67% of the total, compared to 55% in the UK. In particular, 62% of total scale-ups in London are in professional & business services[53], while the UK average is 40%. This implies that the fastest business growth in London is attributable to service sectors, particularly high-value sectors, to a greater extent than growth in the UK as a whole.

Again, taking the GVA results as a guide to the potential impacts on scale-ups, based on the same argument for start-ups, such sectors are expected to be affected more in the UK than in London. On the other hand, sectors that make up a smaller proportion of the scale-up population in London are likely to suffer more from Brexit than their UK counterparts. Based on a comparison of the GVA impacts, it is possible that London may not be as adversely affected as the UK, thanks to the resilience of its high-growth sectors.

[53] Which consists of Information and Communication; Financial and Insurance Activities; Real Estate Activities; Professional, Scientific and Technical Activities; and Administrative and Support Service Activities.

7 References

Baldwin R. E. (2016), Brexit Beckons: Thinking ahead by leading economists.

Berden K. G., Francois J., Thelle M., Wymenga P. and S. Tamminen (2009). Non-Tariff Measures in EU-US Trade and Investment – An Economic Analysis (Annexes). See http://trade.ec.europa.eu/doclib/docs/2009/december/tradoc_145614.pdf

Borchert (2016), Services trade in the UK - What is at stake? UK Trade Policy Observatory Briefing Paper, No. 6, November 2016. See https://www.sussex.ac.uk/webteam/gateway/file.php?name=briefing-paper-6-final.pdf&site=18

Boubtane, E., J-C. Dumont and C. Rault (2015) 'Immigration and Economic Growth in the OECD Countries 1986-2006' CESIFO Working Paper 5392. See https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2622005

Campos N. and F. Coricelli (2015), Some Unpleasant Brexit Econometrics. See http://voxeu.org/article/some-unpleasant-brexit-econometrics

Chen, W., Los, B., McCann, P., Ortega-Argiles, R., Thissen, M., van Oort, F., 2017a, The Continental Divide? Economic Exposure to Brexit in Regions and Countries on both Sides of the Channel, Papers in Regional Science, DOI: 10.1111/pirs.12334

Chen, W., Los, B., McCann, P., Ortega-Argiles, R., Thissen, M., van Oort, F, 2017b, Exposure to Brexit in regions on both sides of the Channel http://voxeu.org/article/exposure-brexit-regions-both-sides-channel, Vox EU, 19-12-2017

Christie E. and G Douglass (2017). London and Europe: Facts and Figures. GLA Current Issues Note, No. 51. See https://www.london.gov.uk/sites/default/files/london-and-europe-cin51.pdf

Clarke S., Serwicka I. and L. A. Winters (2017), Changing lanes: The impact of different post-Brexit trading policies on the cost of living. See http://www.resolutionfoundation.org/app/uploads/2017/10/Changing-Lanes.pdf

Clayton N. and H. G. Overman (2017), Brexit, trade and the economic impacts on UK cities. See http://www.centreforcities.org/wp-content/uploads/2017/07/17-07-26-Brexit-trade-and-the-economic-impacts-on-UK-cities-1.pdf

COADEC (2017), A Global Britain: From local startups to international markets – Tech and digital policy for skills, investment & trade. See http://coadec.com/Coadec-Report-A-Global-Britain.pdf

Cologne Institute for Economic Research (2016). Brexit – The Economic Impact: A Meta-Analysis.

CPB (2016), Brexit Costs for the Netherlands Arise from Reduced Trade. CPB Policy Brief 2016/07. See https://www.cpb.nl/sites/default/files/omnidownload/CPB-Policy-Brief-2016-07-Brexit-costs-for-the-netherlands-arise-from-reduced-trade.pdf

Creative Europe (2016), Update on Creative Europe and the outcome of the EU referendum. Creative Europe Desk UK statement, June 2016. See http://www.creativeeuropeuk.eu/sites/default/files/30%20June%202016%20CED%20UK%20Statement.docx_0.pdf

Dearden L., Reed H. and J. Van Reenen (2005), The Impact of Training on Productivity and Wages: Evidence from British Panel Data. Centre for Economic Performance Discussion Paper, No. 674, February 2005. See http://cep.lse.ac.uk/pubs/download/dp0674.pdf

DG EcFin (2015), The 2015 Ageing Report. See http://ec.europa.eu/economy_finance/publications/european_economy/ageing_report/index_en.htm

Dhingra S., Ottaviano G., Sampson T. and J. Van Reenen (2016a), The consequences of Brexit for UK trade and living standards. Centre for Economic Performance Brexit Analysis, No. 2. See http://cep.lse.ac.uk/pubs/download/brexit02.pdf

Dhingra S., Ottaviano G., Sampson T. and J. Van Reenen (2016b), The impact of Brexit on foreign investment in the UK. Centre for Economic Performance Brexit Analysis, No. 3. See http://cep.lse.ac.uk/pubs/download/brexit03.pdf
Dhingra S., Machin S. and H. G. Overman (2017), The Local Economic Impacts of Brexit. Centre for Economic Performance Brexit Analysis, No. 10. See http://cep.lse.ac.uk/pubs/download/brexit10.pdf

Ebell, M. and J. Warren (2016), The Long-Term Economic Impact of Leaving the EU. National Institute Economic Review, No. 236, May 2016. See https://www.niesr.ac.uk/sites/default/files/publications/National%20Institute%20Economic%20Review-2016-Ebell-121-38.pdf

Economists for Brexit (2016), The Economy After Brexit. See https://issuu.com/efbkl/docs/economists_for_brexit_v2

GLA (2016a), London's Economic Outlook: Autumn 2016 - The GLA's medium-term planning projections. See https://www.london.gov.uk/sites/default/files/leo-autumn-2016_-final.pdf

GLA (2016b). Impact of leaving the EU: Summary of some collected research, surveys and announcements.

Global Futures (2017), Beyond the Highly Skilled: The Needs of Other Stakeholders from Economic Migration. See http://ourglobalfuture.com/wp-content/uploads/2017/07/Global-Future-THE_BREXIT_IMMIGRATION_MYTH.pdf

HM Government (2016) 'HM Treasury analysis: the long-term economic impact of EU membership and the alternatives'. See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/517415/treasury_analysis_economic_impact_of_eu_membership_web.pdf

IMF (2016) 'United Kingdom – Selected Issues', IMF Country Report No. 16/169, June 2016. See https://www.imf.org/external/pubs/ft/scr/2016/cr16169.pdf

KPMG (2017a), Brexit: The impacts on sectors. See https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2017/03/brexit-the-sector-impact.pdf

KPMG (2017b), Labour migration in the hospitality sector. See http://www.bha.org.uk/wordpress/wp-content/uploads/2017/05/BHA-EU-migration-final-report-170518-public-vSTC.pdf

Lavery S., Quaglia L. and C. Dannreuther (2017), The political economy of Brexit and the UK's national business model. Sheffield Political Economy Research Institute Paper, No. 41, May 2017. See http://speri.dept.shef.ac.uk/wp-content/uploads/2017/05/SPERI-Paper-41-The-Political-Economy-of-Brexit-and-the-UK-s-National-Business-Model.pdf

Lawless M. and E. Morgenroth (2016), The Product and Sector Level Impact of a Hard Brexit across the EU. Economic and Social Research Institute Working Paper No. 550, November 2016. See https://www.esri.ie/publications/the-product-and-sector-level-impact-of-a-hard-brexit-across-the-eu/

Migration Watch (2016), UK immigration policy outside the EU. See https://www.migrationwatchuk.org/pdfs/European-Union-MW371.pdf

Minford, P., Gupta, S., Mai Le, V. P., Mahambere, V., and Xu, Y. (2015), Should Britain Leave The EU? An Economic Analysis of a Troubled Relationship, Edward Elgar Publishing. See http://www.e-elgar.com/shop/should-britain-leave-the-eu.

Minford, P. (2017) From Project Fear to Project Prosperity, An Introduction. Economists for Free Trade. See https://www.economistsforfreetrade.com/wp-content/uploads/2017/08/From-Project-Fear-to-Project-Prosperity-An-Introduction-15-Aug-17-2.pdf.

Mulabdic A., Osnago A. and M. Ruta (2017), Deep Integration and UK-EU Trade Relations. World Bank Policy Research Working Paper; No. WPS 7947, January 2017. See http://documents.worldbank.org/curated/en/853811484835908129/Deep-integration-and-UK-EU-trade-relations

OECD (2008), Eurostat-OECD Manual on Business Demography Statistics. See http://www.oecd.org/industry/business-stats/39974588.pdf

OECD (2016), The Economic Consequences of Brexit – A Taxing Decision. OECD Economic Policy Papers. See http://www.oecd-ilibrary.org/economics/the-economic-consequences-of-brexit_5jm0lsvdkf6k-en

Oliver Wyman (2016), Brexit Impact on the UK-based Financial Services Sector. See http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/oct/OW%20report_Brexit%20impact%20on%20Uk-based%20FS.pdf

Pelkmans J. (2017), Economic Impact of Brexit on EU27: Part 2 – Sectoral Consequences. Centre for European Policy Studies presentation at IMCO Workshop on Implications of Brexit, European Parliament.

Portesy J. and G. Fortez (2016), The Economic Impact of Brexit-induced Reductions in Migration. See https://www.niesr.ac.uk/sites/default/files/publications/The%20Economic%20I

mpact%20of%20Brexit-induced%20Reductions%20in%20Migration%20-%20Dec%2016.pdf

PwC (2016a), Brexit Monitor: The impact of Brexit on (global) trade. See https://www.pwc.nl/nl/brexit/documents/pwc-brexit-monitor-trade.pdf

PwC (2016b), Leaving the EU: Implications for the UK economy. March 2016. See https://www.pwc.co.uk/economic-services/assets/leaving-the-eu-implications-for-the-uk-economy.pdf

PwC (2017), Facing the future: UK hotels forecast 2017. See https://www.pwc.co.uk/industries/hospitality-leisure/insights/uk-hotels-forecast-2017.html

RaboBank (2017), Assessing the economic impact of Brexit: background report. See https://economics.rabobank.com/publications/2017/october/assessing-economic-impact-brexit-background-report/

Ramiah V., Pham H. N. A. & I. Moosa (2016). The Sectoral Effects of Brexit on the British Economy: Early Evidence from the Reaction of the Stock Market. Applied Economics, 49(26), pp. 2508-2514.

RAND (2017), After Brexit. Alternative forms of Brexit and their implications for the United Kingdom, the European Union and the United States. See https://www.rand.org/pubs/research_reports/RR2200.html

Appendices

Appendix A Assumptions in the literature

A.1 Trade

Literature	Scenario	Assumptions
The Long-term Economic Impact of Leaving the EU (NIESR, 2016)	The UK has a Norway-type relationship with the EU	• EEA membership allowing access to the Single Market
	The UK has a Switzerland-type relationship with the EU	• Free trade of goods but not services • The UK enters a bilateral trade agreement with the EU
	The UK trades with the EU under WTO rules	• No free trade for goods or services with the EU • No passporting rights • Most Favoured Nation (MFN) tariffs
Deep Integration and UK-EU Trade Relations (World Bank, 2017)	The UK has a Norway-type relationship with the EU	• The UK is part of the Single Market • The UK bargains an agreement with the EU as deep as the EEA, which covers 36 policy areas • The UK has to comply with EU regulations but does not have the power to influence them
	The UK signs a Preferential Trade Agreement (PTA)	• Guaranteed access for goods and some services • The agreement is the average of PTAs the EU has with third countries • The agreement includes about 14 provisions, within the WTO areas
	The UK has no trade agreement with the EU	• No free trade for goods or services with the EU • Most Favoured Nation (MFN) tariffs
The Consequences of Brexit for UK Trade and Living Standards (Centre for Economic Performance, 2016)	Optimistic scenario	• EEA membership allowing access to the Single Market • No Customs Union membership • No trade tariffs • The UK implements policies and regulations to reduce non-tariff barriers • Non-tariff barriers are ¼ of the reducible non-tariff barriers observed in trade between the US and the EU (a 2% increase) • In the ten years following Brexit, intra-EU trade costs fall 20% faster than in the rest of the world (a 5.7% fall in non-tariff barriers within the EU)
	Pessimistic scenario	• UK-EU trade is governed by WTO rules • No trade agreement • Most Favoured Nation (MFN) tariffs

Literature	Scenario	Assumptions
		• Non-tariff barriers are ¾ of the reducible non-tariff barriers observed in trade between the US and the EU (a 6% increase) • In the ten years following Brexit, intra-EU trade costs fall 40% faster than in the rest of the world (a 12.8% fall in non-tariff barriers within the EU)
Changing Lanes - The Impact of Different post-Brexit Trading Policies on the Cost of Living (Resolution Foundation, 2017)	MFN tariffs	• Most Favoured Nation (MFN) tariffs
	No tariffs	• Tariffs with all countries are eliminated
The Local Economic Effects of Brexit, (Centre for Economic Performance, 2017); Brexit, Trade and the Economic Impacts on UK Cities (Centre for Cities, 2017)	Soft Brexit	• The UK joins a free trade agreement • No tariffs • Non-tariff barriers are ¼ of the reducible non-tariff barriers observed in trade between the US and the EU • A 2.77% increase in bilateral trade costs between the UK and the EU
	Hard Brexit	• Most Favoured Nation (MFN) tariffs • Non-tariff barriers are ¾ of the reducible non-tariff barriers observed in trade between the US and the EU (an 8.31% increase)
Brexit Monitor - The Impact of Brexit on (global) Trade (PwC Netherlands, 2016)	Free Trade Agreement (FTA) scenario	• The UK negotiates a FTA with the EU • The negotiation may take between 5 and 10 years • A deal is expected at the earliest in 2024 but may not be ratified until 2029 • Tariffs negotiated to close to zero • The UK would have to adopt EU standards or bear the cost of conforming to two standards • Motor vehicles and parts, electronic equipment and processed foods are expected to have the biggest export impacts because of a high share of EU trade
	WTO scenario	• Most Favoured Nation (MFN) tariffs
The Impact of the UK's Exit from the EU on the UK-based Financial Services Sector (Oliver Wyman, 2016)	Soft Brexit (high access)	• No EEA membership • Access to the Single Market (through a FTA) • Passporting rights and regulatory equivalence
	Hard Brexit (low access)	• The UK has a third country status • No passporting rights and regulatory equivalence
Various sources referenced in Impact of Leaving the EU (GLA, 2016b)	EEA membership	• EEA membership allowing access to the Single Market
	A negotiated bilateral trade agreement	• The UK negotiates a trade agreement with the EU

Literature	Scenario	Assumptions
	WTO membership	• UK-EU trade is governed by WTO rules
Brexit: The Impact on Sectors (KPMG, 2017a)	WTO scenario	• The UK trades with the EU under WTO rules • Large disruptions to banking and insurance • Scope for investment and fund management to continue serving professional investors but access to the retail market will be restricted • Most Favoured Nation (MFN) tariffs • Food manufacturing and produce would be disproportionally hit by high tariffs • Oil and gas would be less affected by tariffs on exports and main imports but may be affected by costs of imported components
The Product and Sector Level Impact of a Hard Brexit across the EU (ESRI, 2016)	WTO scenario	• Most Favoured Nation (MFN) tariffs • High tariffs are expected for food, clothes & tobacco products but not for export-intensive sectors
Brexit – The Economic Impact: A Meta-Analysis (Cologne Institute for Economic Research, 2016)	WTO scenario	• No Single Market membership • Most Favoured Nation (MFN) tariffs • Tariffs would rise significantly for production industries
The Political Economy of Brexit and the UK's National Business Model (SPERI, 2017)	Introduction of trade barriers	• Manufacturing would be affected even with minor increases in non-tariff barriers • Higher costs of importing components may erode the advantage of the cheap pound
Economic Impact of Brexit on EU27 - Part 2 - Sectoral Consequence (CEPS, 2017); London's Economic Outlook (GLA, 2016a); and The Sectoral Effects of Brexit on the British Economy: Early Evidence from the Reaction of the Stock Market (Ramiah, Pham & Moosa, 2016)	WTO scenario	• Most Favoured Nation (MFN) tariffs

Note: Reducible non-tariff barriers are defined as the fraction of the non-tariff barriers which can in principle be eliminated by policy action.

A.2 Investment

Literature	Scenario	Assumptions
Economic Impact of Brexit on EU27 - Part 2 - Sectoral Consequence (CEPS, 2017)	UK-EU trade is governed by WTO rules	FDI is expected to be 22% lower than the baseline (SM and CU membership) in 10 years after Brexit
The Long-term Economic Impact of Leaving the EU (NIESR, 2016)	The UK has a Norway-type relationship with the EU	By 2030, FDI inflow is expected to fall by 8-11.3% (9.7% on average) from the annual average over 2009-13; private sector investment is expected to fall by 1.2-1.7% (1.5% on average) from the 2013 level.
	The UK has a Switzerland-type relationship with the EU	By 2030, FDI inflow is expected to fall by 11.3-22.9% (17.1% on average) from the annual average over 2009-13; private sector investment is expected to fall by 1.7-3.4% (2.6% on average) from the 2013 level.
	The UK trades with the EU under WTO rules	By 2030, FDI inflow is expected to fall by 20.4-26.9% (23.7% on average) from the annual average over 2009-13; private sector investment is expected to fall by 3-4% (3.5% on average) from the 2013 level.
The Impact of the UK's Exit from the EU on the UK-based Financial Services Sector (Oliver Wyman, 2016)	No Single Market membership	The insurance sector would face an in increase in the cost of clearing arising from a shrinking pool of participants in smaller segmented markets (inefficiency), leading some firms to relocate outside the UK
Services Trade in the UK: What Is At Steak? (UK Trade Policy Observatory, 2016)	The UK trades with the EU under rules different to the current Single Market (a FTA or WTO rules)	Investment in manufacturing would be disrupted where a high share of service-related inputs to production are outsourced
Various sources referenced in London's Economic Outlook (GLA, 2016)		Weak investment in construction and business services because of low business confidence (possible outcome, based on "Agents' summary of business conditions – November 2016 Update" by Bank of England, 2016) Less investment in services sectors for training & development (possible outcome) Less investment in manufacturing for plant and machinery (possible outcome)
The Long-term Economic Impact of Leaving the EU (NIESR, 2016)		Investment via EU spending (for agriculture, public investment projects and university research) would likely cease

Literature	Scenario	Assumptions
The Political Economy of Brexit and the UK's National Business Model (SPERI, 2017)		Loss of EU funding for research and innovation, digital technologies, the low-carbon economy, sustainable management of natural resources and small businesses
Impact of Leaving the EU (GLA, 2016)		Changes in business investment of between -£21.1bn and £2.4bn, depending on post-Brexit policies
Brexit – The Economic Impact: A Meta-Analysis (Cologne Institute for Economic Research, 2016)		Euro-denominated wholesale financing, derivatives and currency trading would face lower investment and higher investment premiums
Brexit Beckons: Thinking Ahead by Leading Economists (CEPR, 2016)		The finance sector would still be relatively large and active but firms and financial institutions may direct investment or relocate to the EU
Various sources referenced in London and Europe: Facts and Figures (GLA, 2017)		Construction and production industries would face investment delays because of rising cost, uncertainty and loss of access to the European Investment Bank (EIB) and European Investment Fund (EIF) (possible outcome, based on Economists for Brexit publications) FDI for information & communications may relocate elsewhere (possible outcome, based on "Brexit fallout will damage ICT sector across Europe" by Science|Business, 2016)

A.3 Demographics and labour market

Literature	Scenario	Assumptions
Brexit Beckons: Thinking Ahead by Leading Economists (CEPR, 2016)	No EEA membership	• No free movement of labour • Limited access to a wider pool of skills • Restricted opportunities for UK citizens to work and live in EU countries

	EEA minus scenario	• No free movement of labour
		• EU nationals currently resident in the UK are granted permanent residence
		• Control of EU work-related migration
		  ○ Option 1: EU nationals to apply for a visa to work in the UK, with less restrictive rules than for non-EU nationals
		  ○ Option 2: Cap the number of National Insurance numbers issued to EU nationals each month or year, with no occupation or skill level specific restrictions

Leaving the EU: Impacts on Services and Trade (London First, 2016), referenced in Impact of Leaving the EU (GLA, 2016)	FTA or WTO scenario	• Restrictions on free movement of labour
UK Immigration Policy Outside the EU (Migration Watch UK, 2016)	No free movement of labour after Brexit	• Net EU migration would be on average 65,000 per year (100,000 lower than the 2015 level)
Beyond the Highly Skilled: The Needs of Other Stakeholders from Economic Migration (Global Future, 2017)	No free movement of labour after Brexit	• Net EU migration would be 130,000 per year (compared to 182,000 in 2016), as a result of a 90,000 fall in immigration • Total (EU and non-EU) net migration would fall by 50,000 from 355,000 per year
The Economic Impact of Brexit-induced Reductions in Migration (NIESR, 2016)	Central scenario	• Half of the gain from free movement of labour is reversed • Between 2016 and 2020, net EU migration each year would fall by up to 91,000
	Extreme scenario	• All of the gain from free movement of labour is reversed • Between 2016 and 2020, net EU migration each year would fall by up to 150,000

Appendix B Key sector definitions

Key sector	SIC2007 definition
Financial and professional services	Divisions 64-75
Science and technology	5-digit definition from the ONS science and technology classification. Includes breakdown of the Digital Technologies and Life Sciences and Healthcare subsectors.
Creative	4-digit definition from the DCMS sector definition.
Cultural	4-digit definition from the DCMS sector definition.
Food and drink manufacturing	Divisions 10-11
Construction	Divisions 41-43
Hospitality	Divisions 55-56

Appendix C Detailed results

Table C.1: UK GVA by broad sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)
Agriculture	10.3	10.3	-0.01	10.3	10.1	-0.17	10.3	10.1	-0.21	10.3	7.7	-2.55	10.1	6.9	-3.45
Mining & quarrying	14.1	11.0	-2.29	14.1	11.0	-2.29	14.1	11.0	-2.29	14.1	10.9	-2.30	14.1	10.9	-2.32
Manufacturing	167.6	180.4	0.67	167.1	176.5	0.50	167.1	174.4	0.39	167.1	170.2	0.17	167.2	168.8	0.08
Electricity, gas & water	28.0	29.9	0.61	28.0	29.9	0.62	28.0	30.0	0.62	28.0	30.0	0.64	28.0	30.1	0.66
Construction	98.0	116.7	1.60	97.4	112.6	1.33	97.4	110.6	1.17	97.3	108.1	0.96	97.1	107.1	0.89
Distribution	183.4	218.7	1.61	183.3	217.2	1.56	183.3	216.1	1.51	183.3	213.7	1.40	182.0	213.2	1.45
Transport & storage	66.0	79.2	1.67	66.0	78.8	1.63	66.0	78.6	1.60	66.0	78.3	1.56	66.0	78.1	1.55
Accommodation & food services	51.1	61.6	1.72	51.1	61.4	1.69	51.1	61.2	1.66	51.1	60.9	1.61	51.1	61.1	1.64
Information & communications	133.4	161.6	1.76	133.2	160.0	1.68	133.1	159.1	1.63	133.1	157.9	1.56	132.9	157.5	1.56
Financial & business services	524.6	636.3	1.77	524.0	630.5	1.70	523.8	626.5	1.64	523.6	621.2	1.57	522.5	620.0	1.57
Government services	274.6	286.9	0.40	274.5	286.6	0.39	274.5	286.5	0.39	274.5	286.0	0.37	274.2	285.9	0.38
Other services	44.0	45.7	0.35	43.9	45.1	0.25	43.9	44.8	0.18	43.9	44.4	0.09	44.0	44.3	0.06

Table C.2: UK employment by broad sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)
Agriculture	304	259	-1.45	304	262	-1.35	304	263	-1.30	304	284	-0.61	304	293	-0.34
Mining & quarrying	55	42	-2.29	55	42	-2.29	55	42	-2.29	55	42	-2.28	55	42	-2.28
Manufacturing	2291	2205	-0.35	2287	2171	-0.47	2286	2151	-0.55	2286	2110	-0.73	2298	2101	-0.81
Electricity, gas & water	316	311	-0.15	317	314	-0.06	317	316	-0.01	317	321	0.12	317	324	0.19
Construction	2058	2241	0.78	2055	2223	0.72	2055	2214	0.68	2054	2202	0.63	2053	2198	0.62
Distribution	4627	4693	0.13	4626	4680	0.11	4626	4671	0.09	4626	4654	0.05	4618	4648	0.06
Transport & storage	1416	1407	-0.06	1415	1398	-0.11	1415	1391	-0.16	1415	1379	-0.24	1416	1380	-0.23
Accommodation & food services	2165	2299	0.55	2164	2290	0.52	2164	2280	0.48	2164	2266	0.42	2164	2272	0.44
Information & communications	1295	1355	0.41	1294	1347	0.36	1293	1341	0.33	1293	1336	0.30	1293	1334	0.28
Financial & business services	7003	7817	1.00	6997	7750	0.93	6995	7696	0.87	6992	7630	0.80	6987	7621	0.79
Government services	7899	8220	0.36	7898	8221	0.37	7898	8227	0.37	7899	8232	0.38	7898	8232	0.38
Other services	1606	1743	0.75	1602	1716	0.63	1602	1695	0.51	1601	1669	0.38	1603	1666	0.35

Table C.3: London GVA by broad sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)
Agriculture	0.0	0.0	-0.97	0.0	0.0	-1.11	0.0	0.0	-1.13	0.0	0.0	-3.94	0.0	0.0	-5.01
Mining & quarrying	0.1	0.1	-2.51	0.1	0.1	-2.51	0.1	0.1	-2.51	0.1	0.1	-2.53	0.1	0.1	-2.57
Manufacturing	9.4	9.7	0.29	9.3	9.4	0.10	9.3	9.3	-0.01	9.3	9.1	-0.24	9.4	9.0	-0.36
Electricity, gas & water	2.5	2.8	0.87	2.5	2.8	0.88	2.5	2.8	0.88	2.5	2.8	0.86	2.5	2.8	0.85
Construction	14.7	17.3	1.50	14.6	16.8	1.27	14.6	16.6	1.13	14.6	16.2	0.95	14.6	16.1	0.90
Distribution	31.3	39.7	2.19	31.2	39.3	2.11	31.2	39.0	2.04	31.2	38.4	1.90	31.0	38.3	1.95
Transport & storage	15.9	19.3	1.79	15.9	19.3	1.77	15.9	19.3	1.77	15.9	19.3	1.76	15.9	19.2	1.74
Accommodation & food services	11.3	13.5	1.57	11.3	13.4	1.52	11.3	13.3	1.46	11.3	13.2	1.37	11.3	13.2	1.41
Information & communications	49.5	61.0	1.91	49.5	60.5	1.85	49.5	60.3	1.82	49.5	60.0	1.78	49.4	59.9	1.76
Financial & business services	235.0	292.3	2.00	234.7	290.1	1.94	234.7	289.0	1.91	234.6	287.4	1.86	234.2	286.7	1.85
Government services	42.2	44.9	0.58	42.1	44.9	0.58	42.1	44.9	0.57	42.1	44.8	0.56	42.1	44.8	0.56
Other services	9.5	9.9	0.33	9.5	9.7	0.22	9.5	9.7	0.14	9.5	9.6	0.04	9.5	9.5	0.01

Table C.4: London employment by broad sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)
Agriculture	1	1	-2.98	1	1	-2.76	1	1	-2.66	1	1	-1.24	1	1	-0.68
Mining & quarrying	3	3	-2.51	3	3	-2.51	3	3	-2.51	3	3	-2.50	3	3	-2.50
Manufacturing	117	117	0.02	117	116	-0.08	117	115	-0.15	117	113	-0.31	118	113	-0.39
Electricity, gas & water	27	27	-0.07	28	28	0.00	28	28	0.04	28	28	0.13	28	28	0.17
Construction	246	270	0.87	245	268	0.80	245	267	0.76	245	265	0.71	245	265	0.69
Distribution	584	590	0.10	583	588	0.07	583	586	0.05	583	584	0.01	582	583	0.01
Transport & storage	263	263	0.01	263	263	-0.01	263	262	-0.04	263	260	-0.09	263	261	-0.09
Accommodation & food services	355	391	0.87	355	388	0.81	355	386	0.75	355	382	0.66	355	384	0.70
Information & communications	384	401	0.39	384	399	0.36	383	398	0.35	383	398	0.35	384	398	0.33
Financial & business services	1664	1832	0.88	1662	1818	0.82	1662	1806	0.76	1661	1792	0.69	1660	1790	0.69
Government services	1023	1074	0.44	1023	1074	0.44	1023	1075	0.45	1023	1076	0.46	1023	1076	0.46
Other services	272	302	0.96	272	296	0.80	272	292	0.65	271	286	0.48	272	285	0.45

Table C.5: UK GVA by key sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)
Financial & professional services	431.1	523.1	1.77	430.6	518.7	1.71	430.5	515.6	1.65	430.3	511.6	1.58	429.3	510.8	1.59
Science and Technology	388.8	446.5	1.27	388.2	441.8	1.18	388.2	439.1	1.13	388.1	435.2	1.05	387.6	433.9	1.03
Digital Technologies	87.0	104.9	1.71	86.8	103.0	1.57	86.8	102.0	1.48	86.7	100.6	1.36	86.7	100.1	1.32
Life Sciences and Healthcare	106.8	112.6	0.48	106.7	112.4	0.47	106.7	112.3	0.46	106.7	112.0	0.44	106.2	111.9	0.48
Creative	117.6	141.0	1.66	117.4	139.7	1.59	117.4	138.9	1.54	117.4	137.9	1.48	117.2	137.7	1.48
Cultural	29.5	34.0	1.30	29.5	33.8	1.26	29.5	33.7	1.23	29.5	33.5	1.19	29.5	33.5	1.18
Food and Drink Manufacturing	29.6	29.7	0.03	29.6	29.7	0.02	29.6	29.6	0.01	29.6	29.5	-0.05	30.3	29.3	-0.30
Construction	98.0	116.7	1.60	97.4	112.6	1.33	97.4	110.6	1.17	97.3	108.1	0.96	97.1	107.1	0.89
Hospitality	51.1	61.6	1.72	51.1	61.4	1.69	51.1	61.2	1.66	51.1	60.9	1.61	51.1	61.1	1.64

Table C.6: UK employment by key sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)
Financial & professional services	4222	4631	0.84	4219	4591	0.77	4218	4557	0.70	4217	4515	0.62	4214	4512	0.62
Science and Technology	6162	6599	0.62	6158	6563	0.58	6158	6543	0.55	6157	6515	0.51	6162	6507	0.50
Digital Technologies	855	895	0.42	853	883	0.31	853	875	0.24	852	865	0.14	853	863	0.11
Life Sciences and Healthcare	2463	2768	1.07	2463	2767	1.06	2463	2766	1.06	2463	2765	1.06	2463	2765	1.06
Creative	1446	1528	0.51	1444	1517	0.45	1444	1510	0.41	1444	1503	0.37	1445	1501	0.35
Cultural	435	446	0.24	434	443	0.17	434	441	0.14	434	439	0.10	435	438	0.07
Food and Drink Manufacturing	400	369	-0.73	400	368	-0.75	400	367	-0.78	400	366	-0.80	400	367	-0.79
Construction	2058	2241	0.78	2055	2223	0.72	2055	2214	0.68	2054	2202	0.63	2053	2198	0.62
Hospitality	2165	2299	0.55	2164	2290	0.52	2164	2280	0.48	2164	2266	0.42	2164	2272	0.44

Table C.7: London GVA by key sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)	(£2005 bn)	(£2005 bn)	(% pa)
Financial & professional services	207.4	258.6	2.02	207.2	256.8	1.97	207.1	256.0	1.94	207.0	254.8	1.90	206.7	254.2	1.90
Science and Technology	86.5	103.3	1.63	86.3	102.5	1.57	86.3	102.1	1.53	86.3	101.5	1.48	86.2	101.3	1.48
Digital Technologies	25.2	31.9	2.16	25.2	31.5	2.04	25.2	31.2	1.97	25.2	30.9	1.88	25.1	30.8	1.87
Life Sciences and Healthcare	16.0	17.7	0.93	16.0	17.7	0.93	16.0	17.7	0.92	16.0	17.6	0.91	15.9	17.6	0.92
Creative	48.6	58.7	1.72	48.6	58.2	1.66	48.6	58.0	1.63	48.6	57.8	1.60	48.5	57.7	1.59
Cultural	16.9	19.2	1.16	16.9	19.2	1.15	16.9	19.2	1.15	16.9	19.2	1.16	16.9	19.2	1.14
Food and Drink Manufacturing	2.5	2.5	0.11	2.5	2.5	0.11	2.5	2.5	0.10	2.5	2.5	0.06	2.5	2.5	-0.12
Construction	14.7	17.3	1.50	14.6	16.8	1.27	14.6	16.6	1.13	14.6	16.2	0.95	14.6	16.1	0.90
Hospitality	11.3	13.5	1.57	11.3	13.4	1.52	11.3	13.3	1.46	11.3	13.2	1.37	11.3	13.2	1.41

Table C.8: London employment by key sector

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30	2019	2030	2019-30
	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)	(000s)	(000s)	(% pa)
Financial & professional services	1112	1212	0.79	1111	1202	0.72	1111	1194	0.66	1110	1184	0.58	1109	1183	0.59
Science and Technology	1051	1146	0.79	1050	1141	0.76	1050	1139	0.74	1050	1136	0.72	1051	1135	0.70
Digital Technologies	191	202	0.52	191	200	0.43	190	198	0.36	190	196	0.28	190	196	0.26
Life Sciences and Healthcare	299	348	1.40	299	348	1.40	299	348	1.40	299	348	1.40	299	348	1.40
Creative	497	526	0.52	496	523	0.48	496	522	0.46	496	521	0.44	497	520	0.42
Cultural	177	182	0.24	177	181	0.21	177	181	0.21	177	182	0.23	177	181	0.20
Food and Drink Manufacturing	29	28	-0.44	29	27	-0.45	29	27	-0.47	29	27	-0.48	29	27	-0.47
Construction	246	270	0.87	245	268	0.80	245	267	0.76	245	265	0.71	245	265	0.69
Hospitality	355	391	0.87	355	388	0.81	355	386	0.75	355	382	0.66	355	384	0.70

Table C.9: Summary of results for Inner London

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	276.4	2804	98.6	3297
	Level in 2030	340.6	3025	112.6	3601
	Growth (2019-30, % pa)	1.92	0.69	1.22	0.80
	Share of London in 2019 (%)	65.6	56.8	-	36.2
	Share of London in 2030 (%)	66.7	57.4	-	35.9
Scenario 2	Level in 2019	276.1	2802	98.5	3292
	Level in 2030	337.8	3005	112.4	3546
	Growth (2019-30, % pa)	1.85	0.64	1.21	0.68
	Share of London in 2019 (%)	65.6	56.8	-	36.2
	Share of London in 2030 (%)	66.7	57.3	-	35.8
Scenario 3	Level in 2019	276.0	2802	98.5	3287
	Level in 2030	336.3	2989	112.5	3485
	Growth (2019-30, % pa)	1.81	0.59	1.21	0.53
	Share of London in 2019 (%)	65.6	56.8	-	36.2
	Share of London in 2030 (%)	66.7	57.3	-	35.7
Scenario 4	Level in 2019	276.0	2801	98.5	3281
	Level in 2030	334.0	2968	112.5	3424
	Growth (2019-30, % pa)	1.75	0.53	1.22	0.39
	Share of London in 2019 (%)	65.6	56.8	-	36.2
	Share of London in 2030 (%)	66.7	57.2	-	35.6
Scenario 5	Level in 2019	275.4	2800	98.3	3281
	Level in 2030	333.3	2967	112.3	3424
	Growth (2019-30, % pa)	1.75	0.53	1.22	0.39
	Share of London in 2019 (%)	65.5	56.7	-	36.2
	Share of London in 2030 (%)	66.7	57.2	-	35.6

Table C.10: Summary of results for Outer London

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	145.1	2136	67.9	5809
	Level in 2030	169.9	2246	75.6	6439
	Growth (2019-30, % pa)	1.45	0.46	0.98	0.94
	Share of London in 2019 (%)	34.4	43.2	-	63.8
	Share of London in 2030 (%)	33.3	42.6	-	64.1
Scenario 2	Level in 2019	144.9	2134	67.9	5802
	Level in 2030	168.6	2236	75.4	6365
	Growth (2019-30, % pa)	1.39	0.42	0.96	0.84
	Share of London in 2019 (%)	34.4	43.2	-	63.8
	Share of London in 2030 (%)	33.3	42.7	-	64.2
Scenario 3	Level in 2019	144.9	2134	67.9	5794
	Level in 2030	167.9	2229	75.3	6282
	Growth (2019-30, % pa)	1.35	0.40	0.95	0.74
	Share of London in 2019 (%)	34.4	43.2	-	63.8
	Share of London in 2030 (%)	33.3	42.7	-	64.3
Scenario 4	Level in 2019	144.8	2134	67.9	5786
	Level in 2030	166.9	2220	75.2	6199
	Growth (2019-30, % pa)	1.30	0.36	0.94	0.63
	Share of London in 2019 (%)	34.4	43.2	-	63.8
	Share of London in 2030 (%)	33.3	42.8	-	64.4
Scenario 5	Level in 2019	144.8	2134	67.8	5786
	Level in 2030	166.5	2218	75.1	6199
	Growth (2019-30, % pa)	1.28	0.35	0.93	0.63
	Share of London in 2019 (%)	34.5	43.3	-	63.8
	Share of London in 2030 (%)	33.3	42.8	-	64.4

Table C.11: Summary of results for West London Alliance

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	66.2	929	71.3	2134
	Level in 2030	78.1	980	79.7	2344
	Growth (2019-30, % pa)	1.51	0.48	1.02	0.86
	Share of London in 2019 (%)	15.7	18.8	-	23.4
	Share of London in 2030 (%)	15.3	18.6	-	23.3
Scenario 2	Level in 2019	66.1	928	71.2	2131
	Level in 2030	77.5	975	79.4	2313
	Growth (2019-30, % pa)	1.45	0.45	1.00	0.75
	Share of London in 2019 (%)	15.7	18.8	-	23.4
	Share of London in 2030 (%)	15.3	18.6	-	23.3
Scenario 3	Level in 2019	66.1	928	71.2	2128
	Level in 2030	77.2	972	79.4	2280
	Growth (2019-30, % pa)	1.42	0.42	0.99	0.63
	Share of London in 2019 (%)	15.7	18.8	-	23.4
	Share of London in 2030 (%)	15.3	18.6	-	23.3
Scenario 4	Level in 2019	66.1	928	71.2	2124
	Level in 2030	76.7	968	79.3	2246
	Growth (2019-30, % pa)	1.36	0.38	0.98	0.51
	Share of London in 2019 (%)	15.7	18.8	-	23.4
	Share of London in 2030 (%)	15.3	18.7	-	23.3
Scenario 5	Level in 2019	66.1	928	71.2	2124
	Level in 2030	76.5	967	79.1	2246
	Growth (2019-30, % pa)	1.35	0.37	0.97	0.51
	Share of London in 2019 (%)	15.7	18.8	-	23.4
	Share of London in 2030 (%)	15.3	18.7	-	23.3

Table C.12: Summary of results for South London Partnership

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	33.2	522	63.7	1202
	Level in 2030	38.6	552	70.1	1322
	Growth (2019-30, % pa)	1.38	0.51	0.87	0.87
	Share of London in 2019 (%)	7.9	10.6	-	13.2
	Share of London in 2030 (%)	7.6	10.5	-	13.2
Scenario 2	Level in 2019	33.2	521	63.6	1200
	Level in 2030	38.3	549	69.8	1309
	Growth (2019-30, % pa)	1.32	0.47	0.85	0.79
	Share of London in 2019 (%)	7.9	10.6	-	13.2
	Share of London in 2030 (%)	7.6	10.5	-	13.2
Scenario 3	Level in 2019	33.2	521	63.6	1199
	Level in 2030	38.2	547	69.8	1295
	Growth (2019-30, % pa)	1.29	0.44	0.84	0.70
	Share of London in 2019 (%)	7.9	10.6	-	13.2
	Share of London in 2030 (%)	7.6	10.5	-	13.3
Scenario 4	Level in 2019	33.2	521	63.6	1198
	Level in 2030	38.0	545	69.7	1280
	Growth (2019-30, % pa)	1.24	0.41	0.83	0.61
	Share of London in 2019 (%)	7.9	10.6	-	13.2
	Share of London in 2030 (%)	7.6	10.5	-	13.3
Scenario 5	Level in 2019	33.1	521	63.6	1198
	Level in 2030	37.9	545	69.5	1280
	Growth (2019-30, % pa)	1.22	0.40	0.82	0.61
	Share of London in 2019 (%)	7.9	10.6	-	13.2
	Share of London in 2030 (%)	7.6	10.5	-	13.3

Table C.13: Summary of results for Local London

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	54.4	820	66.3	2659
	Level in 2030	63.6	863	73.7	2973
	Growth (2019-30, % pa)	1.43	0.47	0.96	1.02
	Share of London in 2019 (%)	12.9	16.6	-	29.2
	Share of London in 2030 (%)	12.5	16.4	-	29.6
Scenario 2	Level in 2019	54.3	819	66.3	2656
	Level in 2030	63.1	859	73.4	2938
	Growth (2019-30, % pa)	1.37	0.43	0.94	0.92
	Share of London in 2019 (%)	12.9	16.6	-	29.2
	Share of London in 2030 (%)	12.5	16.4	-	29.6
Scenario 3	Level in 2019	54.3	819	66.3	2652
	Level in 2030	62.8	856	73.3	2899
	Growth (2019-30, % pa)	1.33	0.40	0.93	0.81
	Share of London in 2019 (%)	12.9	16.6	-	29.2
	Share of London in 2030 (%)	12.5	16.4	-	29.7
Scenario 4	Level in 2019	54.3	819	66.2	2648
	Level in 2030	62.4	852	73.2	2861
	Growth (2019-30, % pa)	1.27	0.36	0.91	0.70
	Share of London in 2019 (%)	12.9	16.6	-	29.2
	Share of London in 2030 (%)	12.5	16.4	-	29.7
Scenario 5	Level in 2019	54.2	819	66.2	2648
	Level in 2030	62.2	852	73.1	2861
	Growth (2019-30, % pa)	1.25	0.35	0.90	0.70
	Share of London in 2019 (%)	12.9	16.6	-	29.2
	Share of London in 2030 (%)	12.5	16.4	-	29.7

Table C.14: Summary of results for Central London Forward

		GVA	Employment	Productivity	Population
		(£2005bn)	(000s)	(£000)	(000s)
Scenario 1	Level in 2019	267.7	2669	100.3	3112
	Level in 2030	330.2	2877	114.8	3401
	Growth (2019-30, % pa)	1.93	0.68	1.23	0.81
	Share of London in 2019 (%)	63.5	54.0	-	34.2
	Share of London in 2030 (%)	64.7	54.6	-	33.9
Scenario 2	Level in 2019	267.4	2667	100.2	3107
	Level in 2030	327.5	2858	114.6	3350
	Growth (2019-30, % pa)	1.86	0.63	1.22	0.69
	Share of London in 2019 (%)	63.5	54.0	-	34.2
	Share of London in 2030 (%)	64.7	54.5	-	33.8
Scenario 3	Level in 2019	267.3	2667	100.2	3102
	Level in 2030	326.1	2843	114.7	3293
	Growth (2019-30, % pa)	1.82	0.58	1.23	0.54
	Share of London in 2019 (%)	63.5	54.0	-	34.2
	Share of London in 2030 (%)	64.7	54.5	-	33.7
Scenario 4	Level in 2019	267.2	2666	100.2	3096
	Level in 2030	323.9	2823	114.7	3236
	Growth (2019-30, % pa)	1.76	0.52	1.24	0.40
	Share of London in 2019 (%)	63.5	54.0	-	34.2
	Share of London in 2030 (%)	64.7	54.4	-	33.6
Scenario 5	Level in 2019	266.7	2665	100.1	3096
	Level in 2030	323.2	2821	114.5	3236
	Growth (2019-30, % pa)	1.76	0.52	1.24	0.40
	Share of London in 2019 (%)	63.5	54.0	-	34.2
	Share of London in 2030 (%)	64.7	54.4	-	33.6