London's Economy After Brexit: Impacts and Implications

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Executive Summary

This study was commissioned by the Greater London Authority (GLA) as a follow-up to Cambridge Econometrics' (CE) 2018 'Preparing for Brexit' study. It uses CE's macro-sector model E3ME to model two scenarios:

- **Central**: a scenario that projects the trajectory of the UK economy based on economic and demographic forecasts already published at the time of the Office for Budget Responsibility (OBR)'s March 2023 economic forecast.
- **Counterfactual**: a scenario that estimates what would have happened had the UK not left the EU.

To construct the Counterfactual scenario, we consider how variables such as the UK's investment, trade, and the price of carbon under the emissions trading scheme (ETS) would have differed in the absence of Brexit. Our results present the difference between the two scenarios up to 2035, and can be interpreted as the change in economic outcomes in the London and UK economies for which Brexit is the principal contributor.

We find that while London's economy is more resilient to Brexit's effects than the rest of the UK, Brexit has led to negative impacts in London and the UK in terms of gross value added (GVA) and employment. It has also accelerated the widening productivity gap between London and the rest of the UK. This report presents the methods, assumptions, and findings of this study.

Key findings

1

GVA in the UK and London to be lower due principally to Brexit

Annual GVA growth over 2023-35 is expected to be 0.4 percentage points (pp) slower in the UK and 0.3 pp slower in London than if the UK remained in the EU. As a result, GVA is projected to be 10.1% and 7.5% lower by 2035 in the UK and London respectively, than in a scenario in which Brexit had not occurred.

2

Brexit to stifle employment growth in the UK and London

Slower output growth leads to fewer jobs. The UK is projected to have nearly 3 million fewer jobs post-Brexit by 2035, approximately 500,000 of which would have been in London.

3

Strong negative impacts on investment

Brexit has contributed to slow investment growth. By 2035, investment in the UK is projected to be more than 32% lower than it otherwise would have been, which will lead to lower output. The impacts of weak investment would considerably affect London's economy as well.

4

Imports to fall more than exports

By 2035, UK imports are projected to be 15.8% lower and exports 4.6% lower than if the UK remained in the EU. Net trade is set to become positive, but only because the volume of imports falls more than that of exports.

5

Productivity in London to remain similar

London's productivity is projected to remain similar to what it would have been had the UK remained in the EU. However, employment and GVA in London would have been higher by 2035 in the absence of Brexit.

6

Brexit to widen the gap between London and rest of the UK

The productivity gap between London and the rest of the UK is projected to further widen following Brexit. This is because, compared to London, the slowdown in GVA growth is larger outside of London, while the slowdown in employment growth is about the same.

Summary of UK results

- Overall, by 2035, UK output, investment, exports, imports, employment and productivity are all expected to be lower than if the UK remained in the EU.
- New trade barriers are reducing EU businesses' desire and ability to trade with the UK, while import costs are increasing. This lowers business confidence in the UK and, in turn, will negatively impact investment and GVA.
- Brexit is expected to lead to net trade becoming positive by 2035; this means export volumes will exceed import volumes, but at the cost of both volumes being lower.
- Employment is also expected to be lower, as growth is impacted by lower investment and trade volumes.

Table 1.1 presents a summary of the differences between the Central and Counterfactual scenarios by variable and over time.

Table 1.1: Summary of UK results

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/Range	2023	2035	growth p.a.	2023	2035	growth p.a.	2035
GVA (£2019bn)	2,207.0	2,771.2	1.9%	2,346.9	3,082.7	2.3%	-10.1%
Employment (millions)	35.3	37.2	0.4%	37.1	40.2	0.7%	-7.4%
Productivity (£2019k / job)	62.5	74.5	1.5%	63.2	76.8	1.6%	-3.0%
Investment (£2019bn)	520.9	620.0	1.5%	635.3	917.3	3.1%	-32.4%
Exports (£2019bn)	648.2	691.8	0.5%	683.9	725.2	0.5%	-4.6%
Imports (£2019bn)	708.8	673.6	-0.4%	773.5	800.3	0.3%	-15.8%

By 2035, the UK would expect...

£311bn Less GVA | **3m** Fewer jobs | **32%** Lower investment | **5%** Lower exports | **16%** Lower imports

...than had it remained in the EU.

Summary of London results

- By 2035, London's output and employment are expected to be lower than if the UK remained in the EU.
- Productivity is not expected to be negatively impacted by Brexit, though Brexit is expected to lead to lower absolute levels of both GVA and employment in London.
- Of the total UK Brexit impacts by 2035, 20% of the GVA impacts and 17% of the employment impacts are expected to be in London. The productivity impacts are expected to chiefly occur outside of London.
- Brexit is expected to cause the productivity gap between London and the Rest of the UK to widen further.

Table 1.2 presents a summary of the differences between the Central and Counterfactual scenarios by variable and over time.

Table 1.2: Summary of London Results

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/Range	2023	2035	growth p.a.	2023	2035	growth p.a.	2035
GVA (£2019bn)	599.5	780.2	2.2%	629.6	843.1	2.5%	-7.5%
Employment (millions)	5.9	6.3	0.5%	6.2	6.8	0.8%	-7.5%
Productivity (£2019k / job)	101.2	123.9	1.7%	101.3	123.9	1.7%	0.0%

By 2035, London would expect...

£63bn Less GVA | **500k** Fewer jobs

...than had the UK remained in the EU.

1. Introduction

1.1. Background

Following the European Union (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 vote to leave the EU ('Brexit') is likely to have had and to continue having economic impacts on both the London and UK economies, in both the short and long run, as has been highlighted by research published by a number of organisations prior to and after the June 2016 referendum. However, the magnitude of these effects remains disputed, with the source of such disputes ranging from methodological differences to difficulty in disentangling the effect of Brexit from other important events that have impacted the UK economy in recent years, such as the COVID-19 pandemic and the cost-of-living crisis.

1.2. Scope of the study

The aim of the study is to model the impact on the UK and London economies of the UK leaving the EU Customs Union and Single Market.

This study is a follow-up to analysis that was completed in 2018 by Cambridge Econometrics (CE) for the Greater London Authority (GLA), which focused on developing scenarios for post-Brexit arrangements between the UK and the EU and forecasting their potential impacts. The 2018 study presented the results of five scenarios, which modelled the potential economic outcomes under different forms of an exit deal, which at that time had not yet been agreed. The current study models two scenarios: a central forecast that is based on information available primarily from the Office for Budget Responsibility (OBR)'s Economic and Fiscal Outlook (EFO) at the time of the 2023 March Budget, as well as information on the Brexit deal in place and other global developments; and a counterfactual scenario that models what would have happened had the UK not left the EU. By comparing these two scenarios, we estimate the impact that Brexit has had and will have on the UK and London economies.

1.3. Modelling stages

The study begins with a review of the existing literature, focusing on the observed impacts in the run-up to and following the UK voting to leave the European Union (Section 2). The focus of the review was not to undertake a wide-ranging review of Brexit, but rather to locate research that looks at the impacts on the UK and London economies to inform our model assumptions on trade, investment, and other economic and demographic variables.

Following the literature review, the scenario assumptions were developed and modelled. The scenarios were developed using CE's macro-sectoral model, E3ME, a global model that includes coverage of all of the EU'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. Section 4 provides a

more detailed description of E3ME and the economic relationships within the model.

The UK results for each scenario from E3ME were then disaggregated to London, based on historical growth in the local area relative to the UK, on a sector-by-sector basis. See section 4.3 for more information.

1.4. Report structure

This report describes the methodology and findings of this study. Section 2 gives an overview of the literature review. Section 3 describes each of the scenarios developed as part of this study and provides a summary of the key assumptions made for each scenario. Section 4 describes the macro-sectoral model used to model the scenarios at the UK-level, and describes the methodology used to localise the effects to London. The key scenario results by geography and sectors are provided in Section 5.

2. Literature review

2.1. Introduction

This literature review aims to:

1. Provide an overview of existing analyses of Brexit's effects on the UK and London economies.
2. Determine whether the forecasts (from the OBR and the Office for National Statistics [ONS]), to which this report's Central Scenario will be calibrated, account for the effect of Brexit on certain variables such as trade and investment.
3. Account for other global events – beyond Brexit – that are significant to the economy, to inform the assumptions used to model the Counterfactual Scenario.

We also provide an overview of the Brexit timeline below, which informs our modelling assumptions on the timing of impacts.

On 23rd June 2016, the UK voted in a referendum to leave the EU, making it the first Member State to leave the union. Following the UK invoking Article 50 of the Treaty on European Union on 29th March 2017, the Withdrawal Agreement was signed on 24 January 2020 and became effective on 31 January 2020 at 23:00 GMT. EU law still applied to the UK until the end of the transition period on 31st December 2020, when the UK effectively left the union.

On 30 December 2020, the EU and the UK signed a Trade and Cooperation Agreement (TCA) that provisionally applied from 1 January 2021 (it formally entered into force on 1 May 2021). While the TCA includes free trade in goods and limited trade and access in services, it is a relative downgrade from the customs union and single market membership the UK enjoyed before Brexit. Moreover, it introduced a customs and regulatory border between the UK and the EU.

2.2. Trade

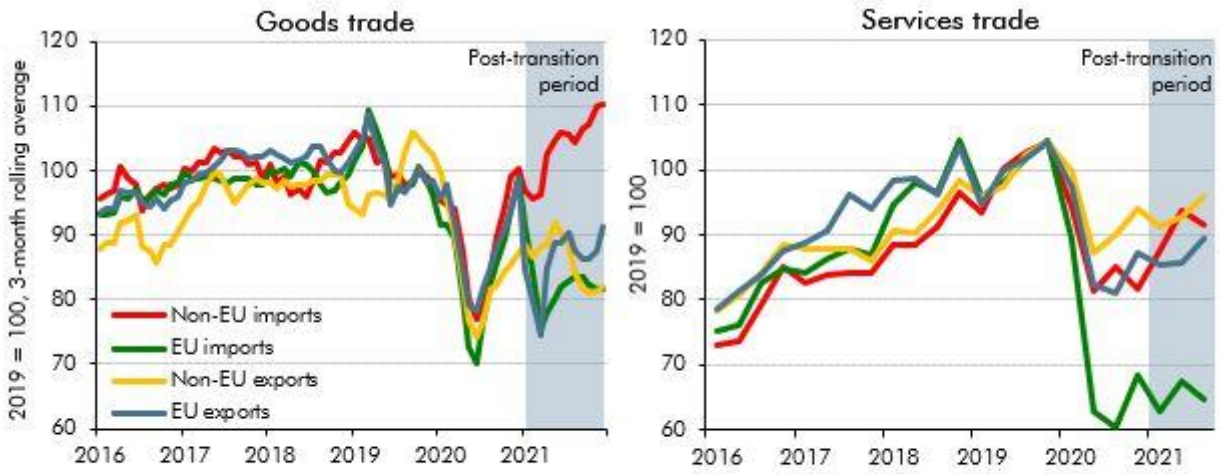
Research has suggested that policy uncertainty, starting even months before the referendum (Graziano et al. 2021; Douch & Edwards 2021), has had negative impacts on trade with the EU (Crowley et al. 2018), acting as a barrier to trade that is equivalent to a tariff of between 1.7% to 8.7% (Osnago et al. 2015; Ahmad et al. 2020; Douch & Edwards 2021). In addition, the customs and regulatory border introduced following Brexit resulted in non-tariff barriers such as customs checks and restrictions on traded products. Overall, research suggests that Brexit depressed UK-EU trade by 10% during the referendum phase and 15% during the transition phase (Buigut & Kapar 2023), with greater effects on UK imports from the EU (15-20%) than UK exports to the EU (10-16%) (Freeman et al. 2022; Kren & Lawless 2022).

The OBR estimates that the volume of UK imports and exports will both be 15% lower in the long run (10 years after referendum) than if the UK had remained in the EU. The OBR claims that this assumption has been validated by recent data that have been published since the signing of the TCA between the UK and the EU. The OBR cites research by Springford (2022), which argues that net trade in goods was 7% lower in June 2022 than it would have been had the UK remained in the EU, but there was less definitive evidence

on the impact on net trade in services.

Figure 2.1 shows clear substitution effects from EU to non-EU imports of goods and services. The UK constitutes a small market for the rest of the EU, meaning EU firms are much more likely to conduct business as usual without needing to complete additional new paperwork or comply with new regulations to sell to the UK. Goods exports to EU have somewhat recovered in comparison to non-EU exports, but this is not the case for services exports. To the best of our knowledge, only one research paper (Springford 2022) discusses the empirical differences in Brexit impacts on goods and services trade. However, the results of that study are reporting in terms of net trade, not broken down by exports and imports. Thus, there is insufficient conclusive evidence on the difference in the impact on exports relative to imports of goods and services following Brexit.

Figure 2.1: Goods and services trade in post-Brexit UK



Note: Goods excludes unspecified goods. Services data is only available to the third quarter of 2021.
Source: ONS

Source(s): OBR Economic and fiscal outlook - March 2022 Box: 2.6.

2.3. Investment

There is a consensus that Brexit has had a negative impact on UK investment levels since 2016, supported by both observed data and survey evidence. The Office for National Statistics (ONS) (2023a) reports that business investment in the UK fell sharply from the middle of 2016 onwards (i.e., from the point of the referendum). This decline in investment has been attributed to factors such as increased uncertainties, higher trading costs and reduced access to talent for businesses.

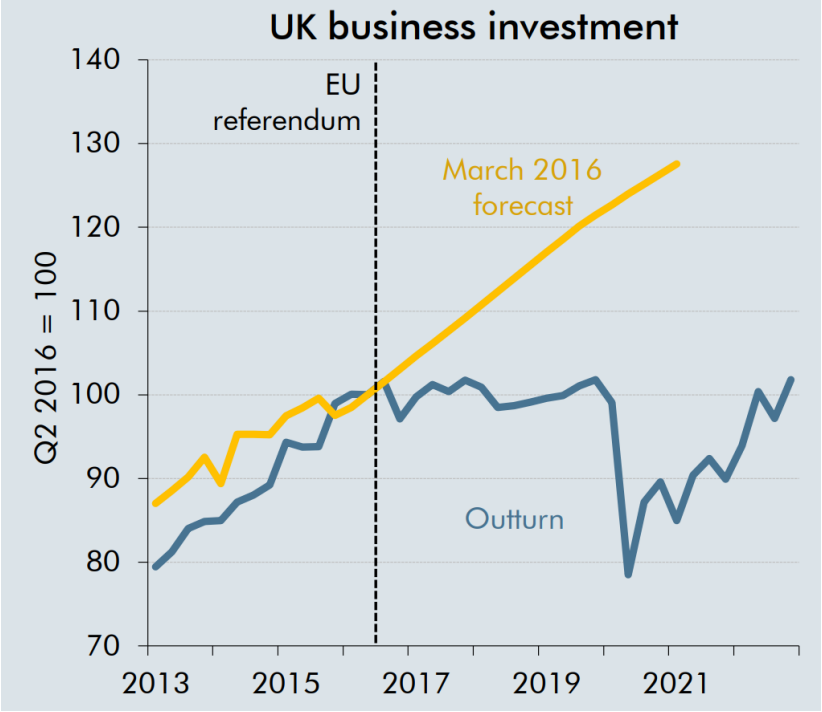
Several papers attempted to estimate the effects of Brexit on investment: Haskel and Martin (2023) used a projected growth rate of 0.5% per quarter (averaged from 1997 to 2016), while Springford (2022) conducted a 'doppelgänger' analysis (projected a combination of other countries that best match the set of economic variables for the UK before the referendum). They estimated investment was 10% lower in Q2 2022 than what it would have been in the absence of Brexit. Both accounted for the effects of the COVID-19 pandemic, which caused a sharp decline and rebound in business investment, an outcome that is most likely to have

happened even in the absence of Brexit. Using a large survey of businesses in the UK, the Bank of England estimated investment to be 23% lower in 2020/21 than what it would have been in the absence of Brexit.

The OBR assumes that Brexit has affected levels of investment in two ways: first due to uncertainty about the future of the UK's trading relationships, and second due to resources being diverted from more productive investment towards Brexit preparations. Additionally, the OBR consistently lowered its medium-term investment growth expectations between late 2016 and early 2020, reflecting the idea that Brexit might have a longer-term effect on the attractiveness of the UK as a destination for investment.

Relative to the OBR's last forecast before the Brexit referendum (in March 2016), business investment in November 2019 was 16.2% lower than previously forecasted, just before the COVID-19 pandemic (see Figure 2.2 below). This difference between forecasted investment and observed investment over 2016-19 likely reflects the short-term effect Brexit had on investment growth.

Figure 2.2: UK business investment, OBR 2016 forecast versus outturn



Source(s): OBR; Box 2.4 of March 2023 EFO.

2.4. Demographics and labour market

The OBR notes, as others, that net migration in the UK is higher in the immediate post-Brexit period than originally anticipated. EU net migration is now negative, but this has been offset by in-migration from non-EU countries. In its 2023 Budget forecasts, the OBR assumes the same level of migration as the January 2023 ONS 2020-based population projections, international migration variant, namely, that net migration will level off at approximately 245,000 people a year from 2026-27 onwards.

However, it should be noted that more recent data from the ONS (2023b) (e.g., its May 2023 update that showed net migration for the 2022 calendar year at 606,000, then revised in November 2023 even higher to 745,000) shows that such forecasts (made only earlier in the same year) do not reflect recent UK migration trends.

It is too early to tell how much of these higher net migration flows will be sustained or how many of the new migrants will ultimately enter the workforce. In particular, some of the recent increase in net migration is likely to reflect temporary factors that could subsequently be reversed, such as:

- the resumption of international travel following the pandemic, especially among foreign students, with student visas reaching a record high of 490,000 in 2022;
- the post-Brexit immigration regime that began in 2021 and issued 800,000 visas in its first year of operation (only 50,000 of which were for EU citizens who did not require a visa under the previous regime);
- 129,000 British National Overseas visas to Hong Kong nationals;
- 210,000 visas to Ukrainian nationals; and
- other visa programmes pertaining to refugees from Syria and Afghanistan.

Focusing on post-Brexit immigration, Portes and Springford (2022) found that in lower-skilled sectors, work-related migration under free movement does not appear to have been replaced by additional visa issuance under the new system. Meanwhile, the authors find that in higher skilled sectors, visa issuance has increased, and does appear to be consistent with levels of migration that are broadly in line with the pre-pandemic and pre-Brexit trend.

2.5. Long-term impacts of Brexit

There is limited research on the long-term impact of Brexit. In 2023, the National Institute of Economic and Social Research (NIESR) revisited their previous studies on the impact of Brexit. Using available economic data, the report suggested that the UK has experienced slower economic growth following its exit from the EU. The authors estimate GVA to be 2-3% lower in 2023 than had Brexit not occurred. This negative impact is expected to gradually increase to 5-6% by 2035, while labour productivity, measured by output per hour worked, is expected to be 5.5% lower than in the absence of Brexit. Overall, NIESR estimates that it will take fifteen years for the trade and productivity impacts attributable to Brexit to fully materialise in the UK economy.

Meanwhile, this report contributes to the literature by estimating the impact of Brexit on the UK and London by 2035 using a macro-level econometric model.

3. Scenarios

3.1. Introduction

As part of this study, we developed two economic scenarios and used the difference between them to assess the impact of Brexit on the UK economy. The Central Scenario represents the current trajectory of the UK economy based on the UK-EU Trade and Cooperation Agreement, and is based on the OBR's March 2023 EFO.[1] The Counterfactual Scenario is the alternative trajectory (in which the UK would have stayed in the European Union Customs Union and Single Market). Our approach to develop the Counterfactual Scenario seeks to isolate and subtract the "Brexit effect" on parameters such as trade and investment from the Central Scenario – effectively modelling a scenario in which other factors (e.g., the COVID-19 pandemic and the war in Ukraine) took place but Brexit did not.

Table 3.1 provides an overview of the assumptions for UK trade, investment, and emission trading schemes in both scenarios.

Table 3.1: Overview of assumptions

	Central Scenario	Counterfactual scenario
Trade	Imports and exports in line with OBR's March 2023 Economic and fiscal outlook (EFO).	Decreased trade costs (tariff and non-tariff barriers) as in Dhingra et al. (2016).
Investment	Investment in line with OBR's March 2023 EFO.	Continuation of trends in OBR's March 2016 EFO (last forecast published before the Brexit referendum vote).
Emission trading schemes	UK ETS to follow trend projected for EU ETS in EU PRIMES 2020 Reference Scenario.	Same as EU ETS.

3.2. Central scenario

The assumptions developed for the Central Scenario are based on the March 2023 EFO published by the OBR. The March 2023 EFO is a medium-term economic forecast for the UK economy, which provided projections of key variables out to 2028. The OBR also publishes accompanying long-term assumptions for certain variables, which go out to 2073. For variables without a long-term projection, we substitute them using growth rates from other relevant variables. See Appendix D for the table of variables with published projections.

When reviewing the assumptions in the March 2023 EFO, we found that the OBR assumes that Brexit has affected the UK economy in three main ways: through migration, trade, and investment. These are the same variables we made assumptions for in the 2018 'Preparing for Brexit' study for the GLA. The EFO accounts

[1] The modelling does not include the ONS (2023c) revision to GDP growth published in October 2023.

for these factors when considering the effect Brexit has had and will have on the UK economy.

3.3. Counterfactual scenario

Assumptions in the Counterfactual Scenarios reflect trends before the 2016 EU membership referendum. The following sub-sections discuss the assumptions for the key variables.

Trade

The impacts of Brexit on trade mainly result from an increase in trade costs (tariff and non-tariff) 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. However, since Brexit, the UK has signed a number of "roll-over" trade deals with non-EU countries that replicate the trade terms the UK had when it was a member state of the EU (Edginton, 2022).

Consistent with our previous study (Cambridge Econometrics, 2018), Most-Favoured Nations (MFN) tariff rates calculated by Dhingra et al. (2016) for different types of goods are used for relevant sectors in the E3ME model.

Additionally, non-tariff barriers between the UK and the EU are assumed to have increased in the Central Scenario. No change is assumed for UK-non-EU trade because of the complexity of modelling non-tariff barriers for each trading partner, and because the most major change in non-tariff barriers is expected to be between the UK and other EU Member States. Assumptions for non-tariff barriers 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 by Dhingra et al. (2016) and Clayton & Overman (2017), and are assumed to be an increase of ¾ of the US-EU reducible non-tariff barriers.

The trade-related assumptions correspond to the 'pessimistic' scenarios in Dhingra et al. (2016).[2] Appendix E provides a summary of the assumptions for changes in tariffs and non-tariff barriers (in tariff equivalents) in the Central Scenario compared to Counterfactual Scenario. These changes are assumed to have a permanent impact starting in 2020, when the details of the TCA were finalised.

The OBR (2023) assumes that the volume of UK imports and exports will both be 15% lower in the long run than if the UK had remained in the EU. Our trade assumptions correspond to an increase in trade costs (see Appendix D), which are then translated into a change in trade volumes in the model. See Section 5.2 for the modelling results, which present import and export volumes for both scenarios.

Investment

Our investment assumptions are based on two vintages of the OBR's EFO: the March 2016 vintage (the last EFO published before the Brexit referendum was passed), and the March 2023 vintage. Table 3.2 summarises our investment assumptions and from which particular vintage of the EFO these assumptions are drawn.

[2] Two scenarios were modelled in Dhingra et al. (2016): optimistic and pessimistic. The pessimistic scenario is more closely aligned to the Central Scenario, and hence, was used as the basis of the trade assumptions in the Central Scenario.

Assumptions for investment growth over 2016-19 and 2026-35 in the Counterfactual scenario are based on OBR's pre-Brexit forecasts of investment growth from 2016. To account for fluctuations over the COVID-19 pandemic period (2020-21) and the current period of elevated inflation rates (2021-25), we used the historical and projected growth rates of investment over 2020-25 from OBR's March 2023 vintage. To adjust for the "Brexit effect" on investment during the pandemic period, the quarterly growth rate is increased by 0.9pp (the average difference in the quarterly growth rates over 2016Q1-2021Q1 between the OBR forecasts published in 2016 and the OBR data outturn published in 2023).

Table 3.2: Summary of investment assumptions

Period - description	Period – year(s)	Assumption
Counterfactual		
Pre-pandemic period	2016-2019	Growth rates from OBR March 2016 EFO (pre-Brexit Referendum)
Pandemic period	2020	Growth rates from OBR March 2023 EFO plus adjustment for the average 'Brexit effect' (0.9pp increase in quarterly growth rate)
Recovery, Ukraine war, high inflation	2021-2025	Growth rates from OBR March 2023 EFO
Post-recovery period	2026-2035	4.3% annual growth rate (average annual growth rate over the forecast period in OBR March 2016 EFO)
Central		
Short-term	2023-2027	Growth rates from OBR March 2023 EFO
Long-term	2028-2035	Growth rates from OBR March 2023 EFO adjusted by the long-term projections for GDP (see Appendix D for more detail)

Emissions trading schemes

Carbon prices in the Counterfactual scenario (for both the UK and other EU countries) are assumed to follow the EU PRIMES 2020 Reference Scenario projections for the EU ETS (European Commission, 2021, p43). This Reference Scenario was designed to accommodate Phase IV of the EU ETS (2021-30), which focused on meeting the EU's 2030 emission reduction targets and the commitments made in the Paris Agreement[3]. The prices are derived endogenously with model iterations, accounting for factors such as emission reductions in ETS sectors as a response to changing prices, risk-averse behaviour of market agents, and other price assumptions and policy drivers, while also meeting the cumulative ETS cap and respecting the terms of the Market Stability Reserve.

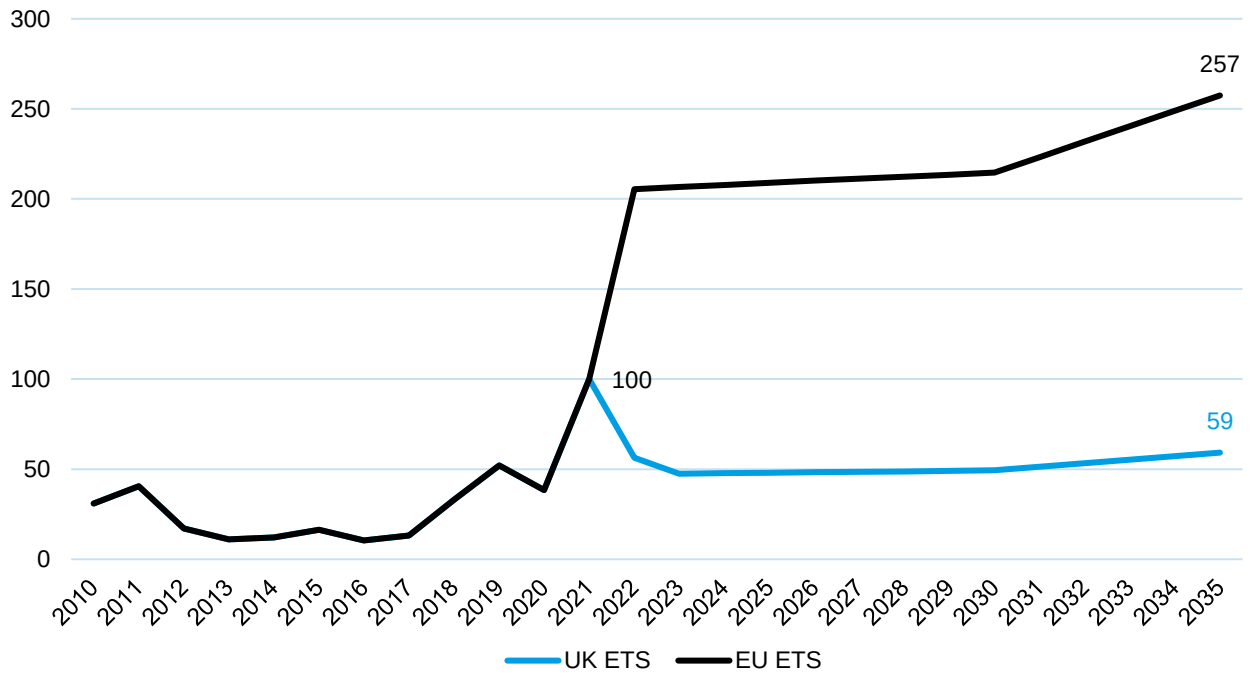
The EU carbon price is the same in the two scenarios. The carbon price for the UK in the Central scenario,

[3] The Reference Scenario prices were calculated using the ETS policy framework for 2030 as of the end of 2019, and as such does not take into consideration the new target of reducing the EU's net GHG emissions by at least 55% in 2030.

however, takes account of the UK switching to the UK ETS in 2021. The historical data for the UK ETS were taken from the World Bank and forecasted using the growth rate projected for the EU ETS in the PRIMES Reference Scenario, maintaining consistency across scenarios.[4]

Figure 3.1 illustrates the disparity between the two scenarios. Despite both growing at the same rate, the UK's prices are considerably suppressed due to their lower chosen prices in the early years of its ETS.

Figure 3.1: Projections of carbon prices under EU ETS and UK ETS (index 2021=100)



Source(s): European Commission, the World Bank, and Cambridge Econometrics.

3.4. Other assumptions

Most other model inputs are held constant between scenarios and therefore do not have a noticeable impact on the model results. 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).

Some of the other modelling assumptions are discussed below. General assumptions related to the modelling framework offered by E3ME and its econometric equations are discussed further in Section 4.2.

[4] The use of the EU ETS growth rate to project the future of the UK ETS should not be impacted by the UK's decision to not target net zero emissions by 2030. The trajectory of the EU ETS is used as a benchmark for how the UK ETS price will grow and is not significantly impacted by the different emissions aims of the two regions.

Government tax and expenditure

It is important to note that government tax rates and expenditure are also fixed. However, the absolute amount of tax revenues would be influenced by economic feedbacks (to income and consumption), which implies that the fiscal deficit may change in the scenarios.

Productivity

Productivity is calculated after obtaining modelling results. As such, there are no explicit productivity assumptions made in either scenario. Productivity is reported in terms of real GVA per job.

Migration and population

In line with the March 2023 OBR forecast, we assumed that annual net migration (international) will reach approximately 245,000 people in the long term in the Central Scenario. This assumption aligns with the ONS international migration variant of the 2020-based population projections, published in January 2023, which the March 2023 EFO is based on.

Our assumptions did not factor in recent data that shows that EU migrant outflows were more than offset by non-EU migration. As our modelling was based on earlier forecasts, we assumed that the decrease in EU migration due to the end of freedom of movement will not be fully replaced by migration from non-EU countries over time. In the Counterfactual scenario, we assumed that annual net migration would reach 377,000 in the long term (see Appendix F for more detail).

This assumption regarding long-term migration coincides with ONS projections. In other words, while the inflow of non-EU migrants has more than offset the outflow of EU migrants in 2022 for example, the trend is unlikely to continue at existing levels over the long term. Moreover, the labour force participation and employment statuses of non-EU migrants generally differ from those of EU migrants. For example, when the focus shifts particularly to migrants in employment, there remain acute labour supply shortages in sectors that previously relied heavily on EU workers (European Central Bank 2023). Some of these sectors (e.g., hospitality, retail, and construction) happen to be important to London's output and its labour market.

Meanwhile, the more recent announcement by the Home Secretary (made in early December 2023) to further reduce net migration into the UK could considerably decrease non-EU migration and affect long-term trends. Finally, as Appendix F explains, even the ONS revisions to published historical migration data from 2022 would not significantly impact the study's projected long-term economic consequences (e.g., on GVA and employment) of Brexit due to the demand-driven nature of employment in E3ME and the constraint it imposes on supply-side parameters pertaining to population growth.

4. Approach

4.1. Introduction

This section describes the econometric model that has been used to estimate the impacts of Brexit on the UK economy, and the methodology used to localise the effects to London. After describing the key features of the model, the expected outcomes from modelling the scenarios are presented.

4.2. E3ME

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, forecasting and research purposes.[5]

Structure and data

The structure of E3ME is based on the system of national accounts, with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, government spending and international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

The E3ME model includes historical data and projects forward annually to 2050, taking into account potential effects of Covid-19 and the Ukraine war. The main data sources for European countries are ONS, Eurostat and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. For regions outside Europe, additional sources for data include the UN, OECD, World Bank, IMF, ILO and national statistical agencies. Gaps in the data are estimated using customised software algorithms.

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 is often compared to Computable General Equilibrium (CGE) models. In many ways the modelling approaches are similar; they are used to answer similar questions and use similar inputs and outputs. However, underlying this there are important theoretical differences between the modelling approaches. In a typical CGE framework, optimising 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

[5] For more information, see https://www.e3me.com/

from a post-Keynesian, demand-driven accounting framework and it is possible to have spare capacity in the economy. 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 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 and rebound effects, which are included as standard in the model's results.

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 strengths 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 the economy and energy system.
- 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 (71 regions in total).
- 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:

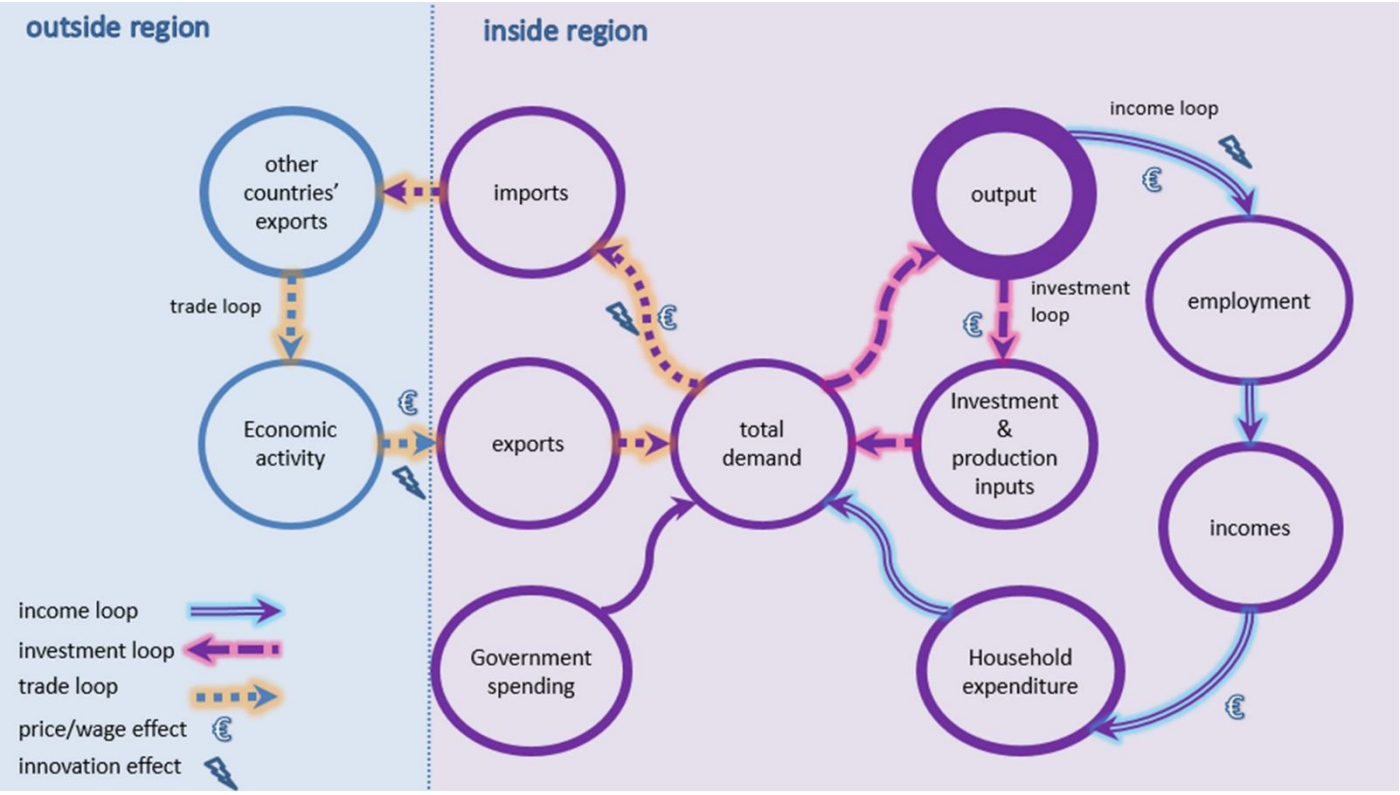
- The quality of the data used in the modelling is very important. Substantial resources are put into maintaining the E3ME database and filling gaps in the data. However, there is some uncertainty in results due to the data used.
- Econometric approaches are also sometimes criticised for using the past to explain future trends. While the E3ME parameters are based on long timeseries to provide sufficient data points for robust estimations, in cases where there is large-scale policy change, the 'Lucas Critique', which suggests behaviour might change, can be applicable. There is no solution to this argument using any modelling approach (as no one can predict the future or behavioural responses by economic agents), but we must always be aware of the uncertainty in the model results.

The other main limitation to the E3ME approach relates to the dimensions of the model. In general, it is very difficult to go into a level of detail beyond that offered by the model classifications. This means that sub-national and detailed sub-sectoral analysis is difficult (section 4.3 describes how this was achieved for this study). Similarly, although usually less relevant, attempting to assess impacts on a monthly or quarterly basis would not be possible.

The economic module in E3ME

Figure 4.1 shows how E3ME's economic module is solved for each region, illustrating the main flows in the model. Most of the economic variables shown in the chart are solved at the sectoral level. The whole system is solved simultaneously for all sectors and all regions, although single-country solutions are also possible.

Figure 4.1: E3ME 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

Investment demand (measured as Gross Fixed Capital Formation) is determined through econometric equations estimated on time-series data. Expectations of future output are a key determinant of investment, but investment is also affected by relative prices and interest rates.

Shocks to investment would directly impact the level of demand, output, employment and GDP, following the investment loop described above. There would also be implications for labour productivity, as investment represents technological progress in E3ME, with substitution and complementary effects on employment across different sectors.

Due to data limitations, investment is not disaggregated by asset in E3ME. Stockbuilding is treated as exogenous in the model.

Given the demand-driven nature of the model, savings (by households, firms and the government) are not measured explicitly. The endogeneity of the money supply in E3ME implies that consumption and investment are driven by effective demand in the economy and relative prices, and can be financed through borrowing and not restricted by savings.

International trade

Trade in E3ME makes use of the time-series data for 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.

The fossil fuel sectors trade commoditised products and so the bilateral trade specification (which assumes differentiated production) is not appropriate. Cost-supply curves are instead used to determine the source of fuel supply.

A shock to the costs of trade, as a result of Brexit, would lead to demand responses in the opposite direction, which are reflected in the value of trade. In addition, such changes to trade costs would be passed on to consumers through changes to industry prices, thus affecting the overall level of purchasing power and household consumption. The extent to which each sector is affected by trade costs depends on their dependency on import and comparative advantage in export, which are captured implicitly in the model parameters.

Population and labour markets

Population is an exogenous assumption to E3ME, disaggregated by gender and age.

E3ME includes econometric equation sets for employment, average working hours, wage rates, and participation rates. The first three of these equations are disaggregated by economic sector while participation rates are disaggregated by gender and five-year age band. The labour force is determined by multiplying labour market participation rates by population. Unemployment (including both voluntary and involuntary unemployment) is determined by taking the difference between the labour force and employment.

In the econometric representation in E3ME, employment is determined as a function of real output, real wage costs, hours-worked, the oil import price (used as a proxy for energy prices) and the measures of technological progress. The power sector has a special treatment which determines operational employment for that sector based on the capacity mix and fixed technology-specific employment factors.

Carbon pricing

Carbon pricing is a core energy and environmental policy in E3ME. It is set at the regional level and represented by a flat rate per unit of emissions and the sectoral coverage.

An increase in the effective rate of carbon pricing leads to two main effects. First, the tax makes carbon-emitting energies and technologies (such as fossil fuels) more expensive to operate, which creates an incentive (among other policy instruments) for investors and energy users to switch to less polluting or zero-carbon options. This leads to a redistribution of jobs from fossil fuel supply industries to industries typically associated with the renewable energy supply chain (such as construction and manufacturing), since E3ME assumes that jobs are mobile between sectors. In countries that are large producers and exporters of fossil fuels, the reduction in fossil fuel supply jobs is likely to outweigh the increase in renewable energy jobs. On the other hand, countries with strong manufacturing bases and lower fossil fuel dependency may see net job gains from this transition. Secondly, at least in the medium term when many industries and regions are still reliant on fossil fuels, the carbon price represents an increase in the cost of production which is passed on to other industries and consumers through higher prices, thus leading to a reduction in non-transition spending and the jobs associated with it. This effect eases over time as the share of fossil fuels becomes increasingly small in the energy mix whereas low-carbon technologies benefit from cost reductions linked to faster deployment and endogenous learning-by-doing effects.

4.3. Localisation of results

This section describes how the UK sector results from the E3ME modelling stage were used to produce employment and GVA forecasts for London.

CE have maintained and developed a highly disaggregated database of employment and GVA forecasts by sector from 1971 for all regions in the UK. The UK E3ME results were disaggregated to produce detailed economic forecasts for London under each scenario, in line with CE's method for its regional forecast.

The employment and GVA forecasts for London were based on historical growth in London relative to the UK, on a sector-by-sector basis. In the Central Scenario, the results for London were based on the relative historical performance until 2022 for employment and 2020 for GVA[6], while in the Counterfactual Scenario, this was based on the relative historical performance until 2015 (to reflect the relative performance in the pre-Brexit period). It is assumed that those historical relationships continue into the future. Thus, if a sector in London outperformed the sector in the UK as a whole in the past, it will be 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.

Using employment as an example, the relationship between London and the UK for each sector can be represented by the following equation:

$$LOEmp_s = \alpha + \beta UKEmp_s + \varepsilon$$

Where $UKEmp_s$ and $LOEmp_s$ are the natural logarithms of employment in sector s 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,[7] to avoid London employment collapsing or outgrowing the size of the UK.

GVA by sector was divided by employment by sector to then calculate productivity by sector (expressed as GVA per job).

[6] This reflects the last year of ONS published data for London at the time CE's regional database was updated in February 2023.
[7] This range has been selected based on our experience running the same regressions for our local economy forecasting models.

5. Results

5.1. Introduction

In this section, we present the results of the modelled scenarios to 2035, comparing differences between the Central and Counterfactual scenarios to identify the impacts of Brexit on the UK. At the UK level, we present GVA, employment, productivity, investment, and export to and import from rest of the world. We also present the GVA, employment and productivity results by sector. Lastly, we present the forecasted GVA, employment and productivity impacts on London compared to the rest of the UK.

5.2. Impacts of Brexit on the UK

By 2035, UK output, investment, exports, imports, employment and productivity are all expected to be lower than if the UK had remained in the EU. Imports are expected to be considerably impacted due to new trade barriers reducing EU businesses' desire to sell to the UK and complicating UK businesses' ability to import final products or production inputs. This lowers business confidence in the UK and, in turn, will negatively impact investment and GVA. Brexit is expected to lead to net trade becoming positive by 2035, but that also happens with absolute levels of both exports and imports being lower. Employment is also expected to be lower. Table 5.1 presents a summary of the differences between the Central and Counterfactual scenarios by variable and over time.

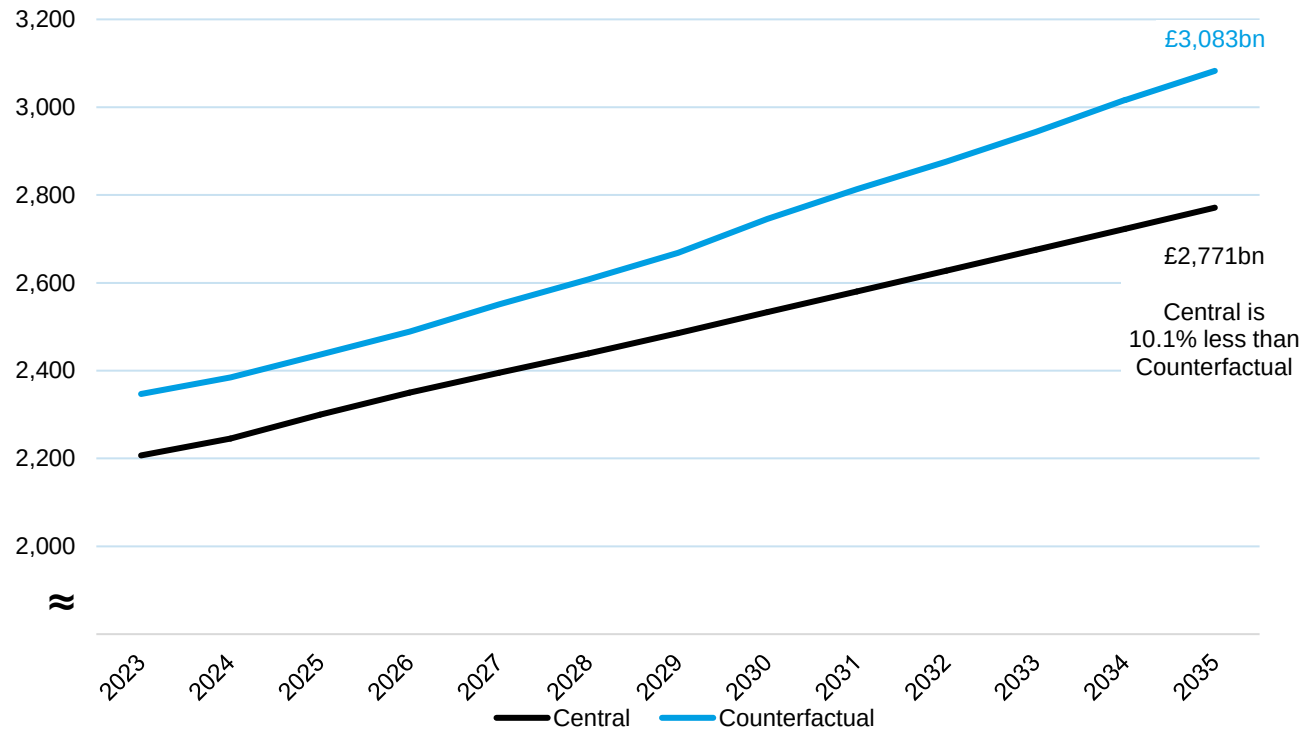
Table 5.1: Summary of UK results

Scenario	Central			Counterfactual			Diff. from CF
Year/Range	2023	2035	growth p.a.	2023	2035	growth p.a.	2035
GVA (£2019bn)	2,207.0	2,771.2	1.9%	2,346.9	3,082.7	2.3%	-10.1%
Employment (millions)	35.3	37.2	0.4%	37.1	40.2	0.7%	-7.4%
Productivity (£2019k / job)	62.5	74.5	1.5%	63.2	76.8	1.6%	-3.0%
Investment (£2019bn)	520.9	620.0	1.5%	635.3	917.3	3.1%	-32.4%
Exports (£2019bn)	648.2	691.8	0.5%	683.9	725.2	0.5%	-4.6%
Imports (£2019bn)	708.8	673.6	-0.4%	773.5	800.3	0.3%	-15.8%

GVA

Brexit has already impacted the UK's economic output. In 2023, GVA is estimated to be £140bn or 6.0% lower than if the UK had remained in the EU. By 2035, GVA is expected to be more than £311bn or 10.1% lower due to Brexit. The average per annum GVA growth over 2023-35 in the Central Scenario is expected to be 1.9% (0.4pp lower than in the Counterfactual scenario). Figure 5.1 shows the difference in real GVA (£2019bn) between the two scenarios over 2023-35. These findings are similar to NIESR (2023), which estimates that the negative impact of Brexit gradually escalates, reaching 5-6% of GDP by 2035.

Figure 5.1: UK GVA impact (£2019bn)

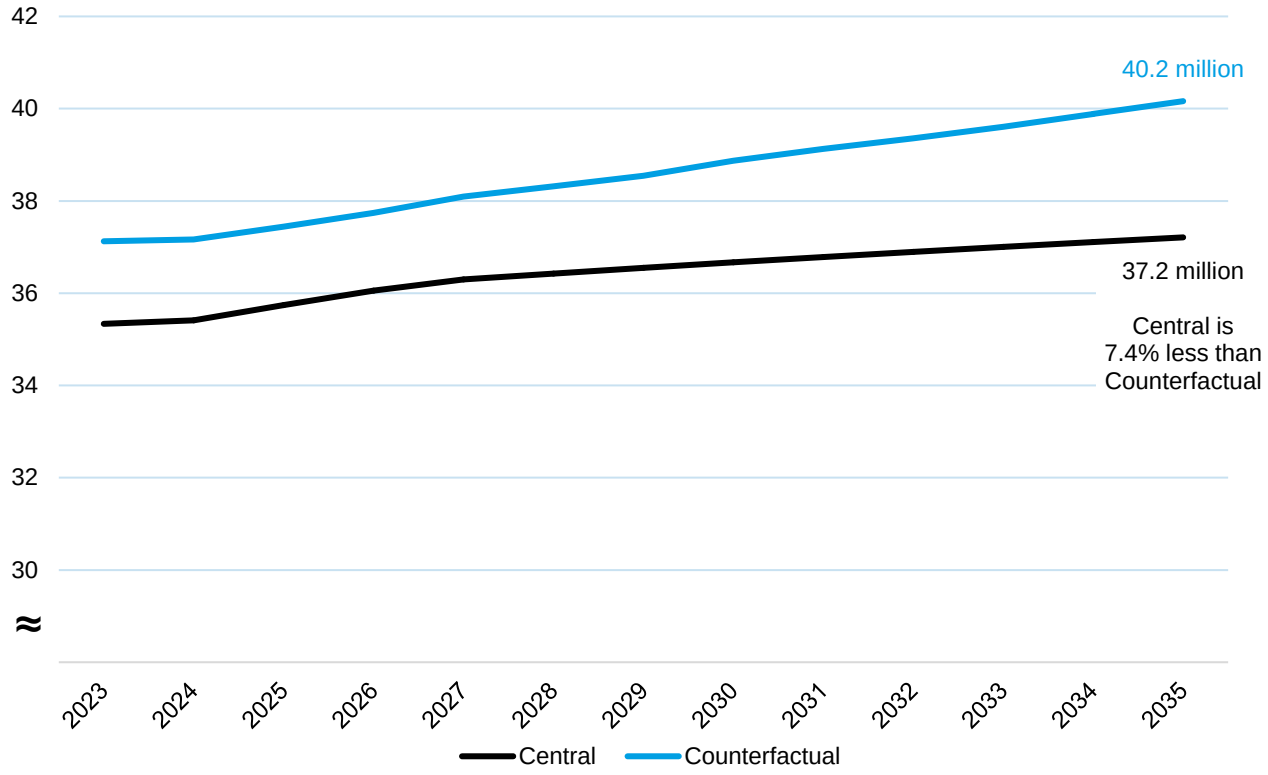


Employment

In 2023, it is estimated that there are 1.8m fewer jobs in the UK than if Brexit didn't happen, representing a 4.8% difference from the Counterfactual. By 2035, there are expected to be nearly 3 million fewer jobs in the UK due to Brexit, representing a 7.4% difference from the Counterfactual. The average per annum growth in employment over 2023-35 is expected to be 0.4% in the Central scenario, a 0.3pp difference from the Counterfactual scenario. Figure 5.2 shows the difference in employment (million jobs) between the two scenarios over 2023-35.

For both GVA and employment, some of these impacts are already felt by 2023. However due to slower growth out to 2035, these impacts continue to grow and, in the case of GVA, compound, leading to hundreds of billions of pounds of unrealised output in the UK economy.

Figure 5.2: UK employment impact (millions)



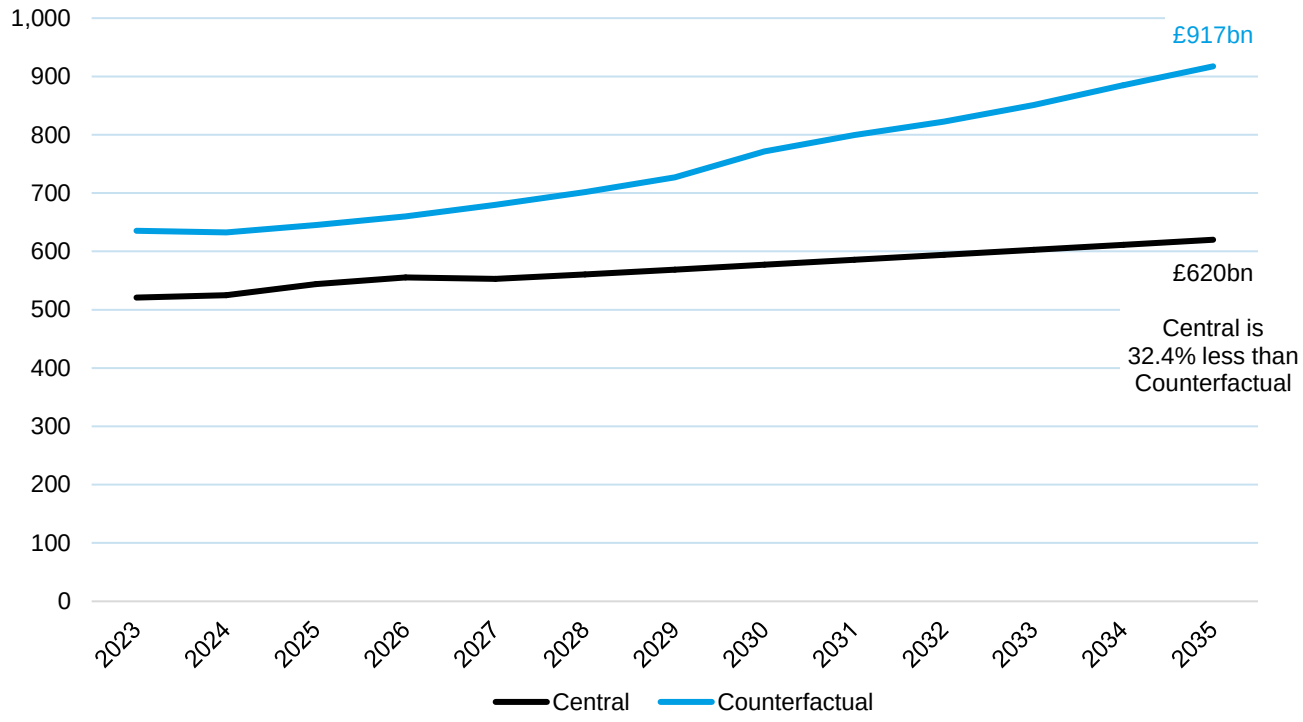
Productivity

We define productivity as GVA per job (£2019k per job). In 2023, productivity was estimated to be £800 per job (1.2%) lower than if the UK remained in the EU. By 2035, productivity is expected to be more than £2,300 per job (3.0%) lower due to Brexit, which is comparable to the NIESR (2023) estimate of 5.5%. The average per annum productivity growth over 2023-35 in the Central Scenario is expected to be 1.5% (0.1pp lower than in the Counterfactual scenario). While productivity does not differ substantially between the two scenarios, this hides that Brexit will contribute to lower levels of GVA and employment than otherwise would have been the case.

Investment

In line with literature on the topic (see Section 2), we assume that the main impacts Brexit has had on the UK economy are on trade, investment, and migration. Of these, Brexit has had and is expected to have a large effect on investment. In 2023, investment is estimated to be 18.0% lower than if Brexit did not happen. This is comparable to NIESR (2023), which estimated business investment in 2023 to be 12.4% lower than if the UK had not left the EU. By 2035, investment in the Central Scenario is expected to be 32.4% lower due to Brexit. Figure 5.3 shows the difference in investment (£2019bn) between the two scenarios over 2023-35.

Figure 5.3: UK investment impact (£2019bn)



Trade

Brexit has increased the UK's trade costs for both exports and imports, as the EU is one of the UK's largest trading partners. However, the impact that Brexit will have on the UK differs between exports and imports.

In 2023, exports are estimated to be 5.2% lower and imports 8.4% lower than if the UK remained in the EU. By 2035, the impact on exports is expected to decrease (to be 4.6% lower than the Counterfactual scenario), while the impact on import is expected to increase (to be 15.8% lower than Counterfactual scenario). Figure 5.4 shows the expected difference in import and export volumes (£2019bn) between the two scenarios over 2023-35.

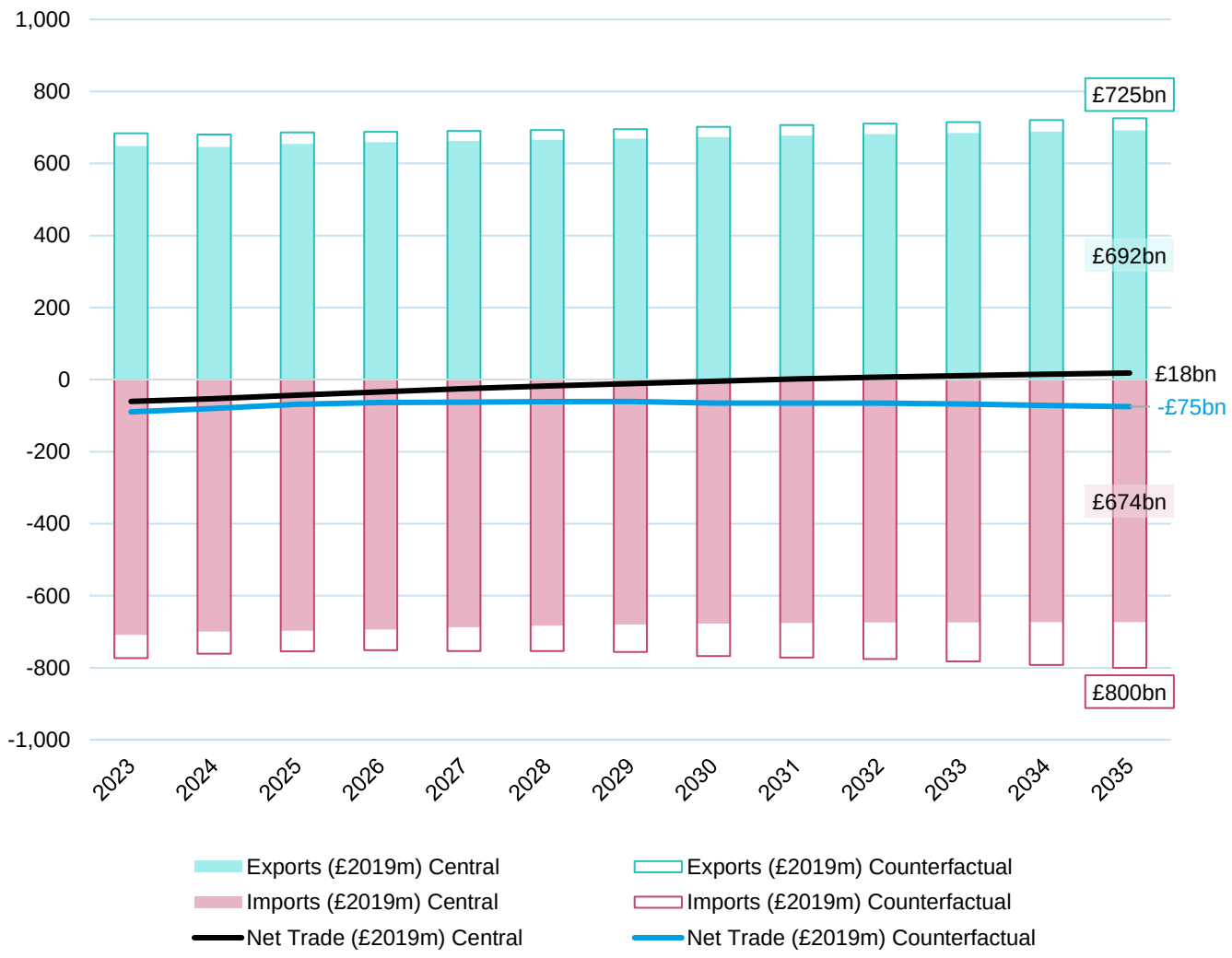
Before Brexit, a greater share of UK imports came from the EU compared to the share of UK exports sent to the EU. UK imports are, therefore, more exposed to changes from Brexit than UK exports. Imports to the UK tend to be raw commodities (e.g., food) that are more difficult to import from trade partners located farther away. Whereas UK exports tend to be services and products that require advanced manufacturing, which are easier to export globally. Thus, the UK is expected to import less as commodity prices rise with an increase in trade barriers, but the UK is expected to continue to export its goods and services to other trade partners besides the EU without facing much higher export costs.

Additionally, the fall in investment due to Brexit affects imports more than exports. In the Counterfactual scenario, the additional investment includes domestic business investment, which is funded by UK firms. This business investment increases costs of these firms' production, which may lead to an increase in imports of production inputs. That is another reason why imports would be much higher under the Counterfactual scenario.

Figure 5.4 also shows the level of net trade in the UK in both scenarios. For the Central scenario, in 2035, total UK exports amount to £692bn, compared to £674bn for imports. This means that the UK runs a trade surplus of £18bn. However, under the Counterfactual scenario, while total exports are higher than under the Central (£725bn), imports are also much higher than they are under the Central (£800bn). For that reason, the UK would actually be expected to run a trade deficit of £75bn in 2035 had it remained in the EU. Nevertheless, the UK would export and import more under the Counterfactual than Central scenario, which shows that Brexit undermines trade activity in general.

These results are roughly in line with the OBR's March 2023 EFO assumptions, namely that both imports and exports will fall by 15% in the long run. However, our modelling suggests that Brexit will not impact exports as much as imports for the reasons stated above.

Figure 5.4: UK trade impacts (£2019bn)



Results by sector

This section presents the UK results of the modelled scenarios by broad sector for GVA, employment, and productivity. Table 5.2 presents the difference from the Counterfactual scenario by sector for each of these three variables in 2035. See Appendix A for detailed results tables by sector, and Appendix C for definitions of the broad sectors in terms of the UK's Standard Industrial Classification (SIC).

The employment results represent employment demand in terms of workplace jobs. E3ME does not model the origin of workers within the labour market, and so employment differences by sector between the two scenarios do not necessarily reflect a shortage of workers due to changes in migration rules. The differences are driven by changes in investment, trade, and carbon price assumptions in the Counterfactual Scenario, which either increase or decrease labour demand within a particular sector relative to the Central Scenario.

Table 5.2: UK impacts by broad sector, 2035

Variable	GVA	Employment	Productivity
Units	% difference from Counterfactual	% difference from Counterfactual	% difference from Counterfactual
Agriculture	-14.7%	-8.1%	-7.2%
Mining & quarrying	-3.3%	-18.9%	19.3%
Manufacturing	-17.4%	-15.5%	-2.3%
Electricity, gas & water	-10.6%	-1.7%	-9.1%
Construction	-31.7%	-29.6%	-3.0%
Distribution	-8.5%	-1.8%	-6.8%
Transport & storage	-13.4%	2.3%	-15.4%
Accommodation & food services	-5.3%	2.9%	-7.9%
Information & communications	-9.0%	-10.7%	1.9%
Financial & business services	-7.4%	-8.6%	1.4%
Government services	-2.2%	-2.2%	0.0%
Other services	-4.0%	-7.7%	4.0%

Note(s): Figures are reported as the differences between the values in 2035 in the Central scenario relative to the Counterfactual scenario.

For GVA, Brexit is expected to have a negative impact across all sectors, with the largest differences in 2035 expected in Construction (31.7% lower than the Counterfactual scenario) and Manufacturing (17.4% lower than the Counterfactual scenario). This is likely because output in these two sectors is sensitive to shocks in investment, which is expected to be negatively affected by Brexit. There are also expected to be strong negative employment impacts in these two sectors, with employment in Construction in 2035 expected to be 29.6% lower than in the Counterfactual scenario, and 15.5% lower in Manufacturing. This follows the GVA impacts, as a decrease in investment and output contributes to lower employment demand.

Employment in Mining & quarrying is 18.9% lower than in the Counterfactual, while GVA is 3.3% lower. The negative impact of Brexit in this sector is also driven by the negative investment shocks. However, the employment impact is relatively strong due to low levels of employment demand, given that the sector is

capital-intensive and has been on a long-term decline due to decarbonisation. As a result, this sector has higher productivity in the Central Scenario relative to the Counterfactual Scenario.

Transport & storage and Accommodation & food services are expected to have higher employment in the Central scenario (2.3% and 2.9% higher than the Counterfactual scenario, respectively), despite the fact that GVA in these sectors is expected to be lower. In E3ME, higher demand for workers is expected to lead to higher wages (i.e., the cost of labour) paid by firms as workers gain bargaining power. Over time, this would lead to an inverse effect on employment demand, suppressing it when wages are high and increasing it when wages are low. These two sectors are particularly sensitive to wage changes in line with changes in demand, as they employ a high share of low to medium-skilled and casual workers. Hence, over time, Brexit would lead to an increase in employment demand in these sectors at lower pay, resulting in lower productivity (measured as GVA per job), given that output (GVA) in these sectors is lower than in the Counterfactual scenario.

Most sectors are expected to have lower productivity by 2035 compared to the scenario in which the UK remained in the EU (with few exceptions, notably in Mining & Quarrying).

5.3. Impacts of Brexit on London

This section presents the results for London, which include GVA, employment, and productivity. The impacts of Brexit are expected to follow similar trends in London as in the UK as a whole, with some notable differences, as discussed below. Table 5.3 summarises the results for London and the rest of the UK for both scenarios.

Table 5.3: Summary of Brexit impacts in London and the Rest of the UK

Scenario	Central			Counterfactual			Diff. from CF
Year/Range	2023	2035	growth p.a.	2023	2035	growth p.a.	2035
London							
GVA (£2019bn)	599.5	780.2	2.2%	629.6	843.1	2.5%	-7.5%
Employment (millions)	5.9	6.3	0.5%	6.2	6.8	0.8%	-7.5%
Productivity (£2019k / job)	101.2	123.9	1.7%	101.3	123.9	1.7%	0.0%
Rest of the UK							
GVA (£2019bn)	1,607.5	1,991.0	1.8%	1,717.3	2,239.7	2.2%	-11.1%
Employment (millions)	29.4	30.9	0.4%	30.9	33.4	0.6%	-7.3%
Productivity (£2019k / job)	54.7	64.4	1.4%	55.6	67.1	1.6%	-4.1%

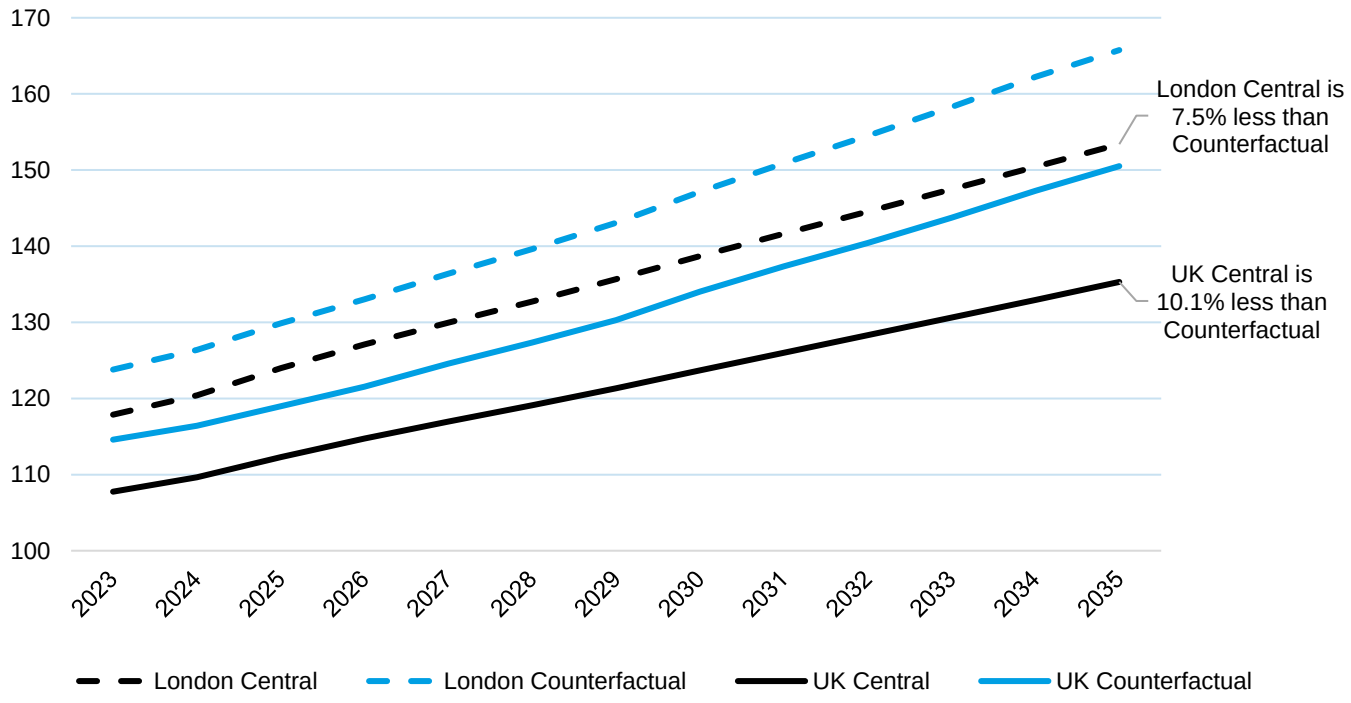
In 2023, GVA in London is estimated to be £30bn or 4.8% lower than if Brexit did not happen. This is expected to increase to £63bn or 7.5% lower than the Counterfactual scenario by 2035. It is estimated that

there are 290,000 fewer jobs in London in 2023 than had the UK remained in the EU, representing a 4.7% difference from the Counterfactual scenario. By 2035, it is expected that there would be more than 500,000 fewer jobs in London than there otherwise would have been if Brexit did not happen, representing a 7.5% difference from the Counterfactual scenario.

London impacts relative to the UK as a whole

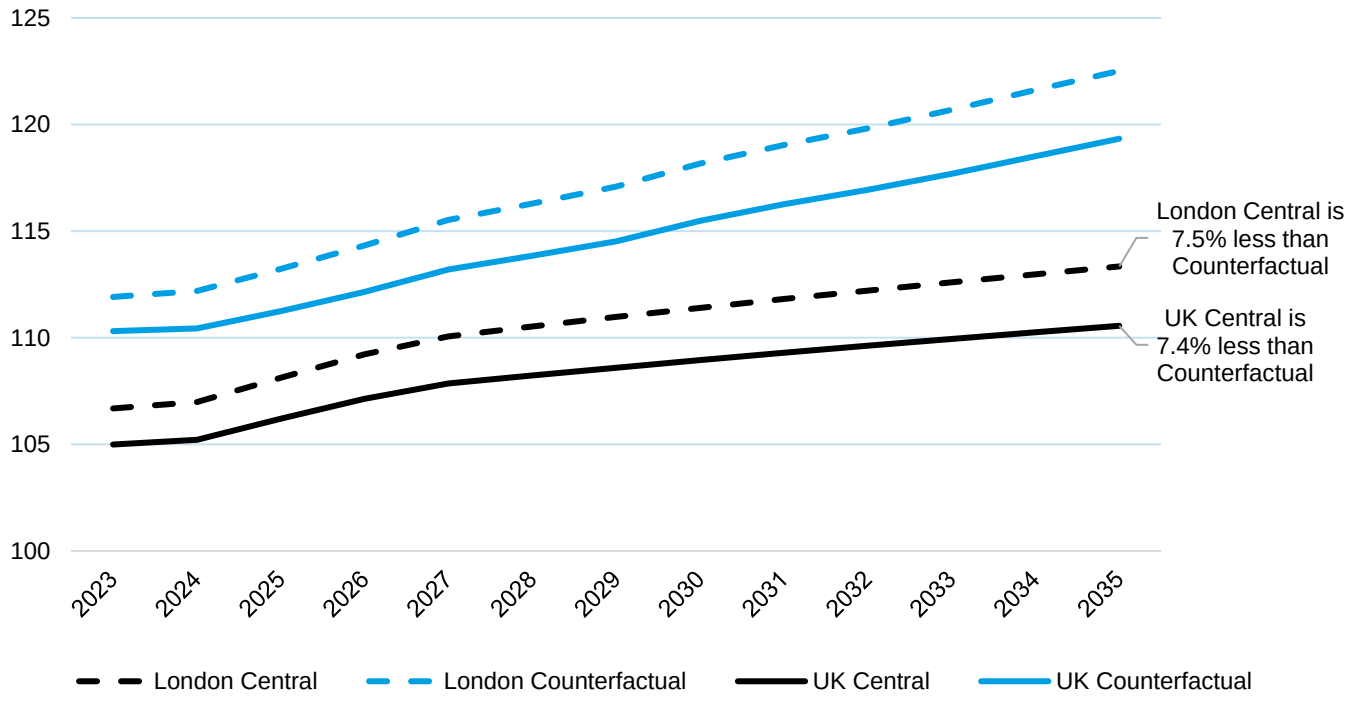
The figures in this section present the expected impacts of Brexit for London and compare these to the impacts expected for the UK as a whole. GVA growth in London is expected to be stronger than the UK's in both scenarios (see Figure 5.5), while employment growth in London is expected to be similar to the UK as a whole in both scenarios (see Figure 5.6). As a result, productivity growth is expected to be stronger in London than the UK as a whole, but it is not expected to differ in London between the two scenarios (whereas productivity growth in the UK as a whole is expected to be higher in the Counterfactual Scenario) (see Figure 5.7).

Figure 5.5: GVA impacts in London and the UK (index 2015=100)



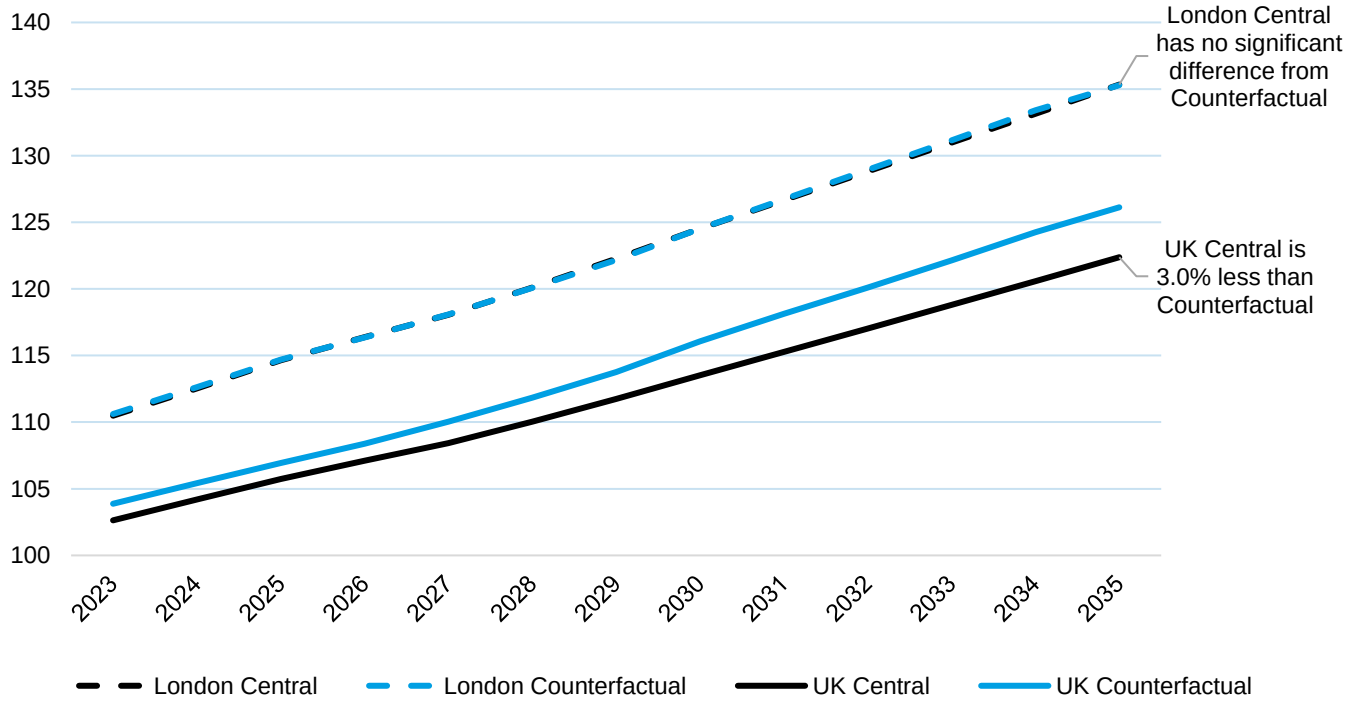
Note(s): 2015 is selected as the base year as it is the last complete calendar year before the Brexit referendum.

Figure 5.6: Employment impacts in London and the UK (index 2015=100)



Note(s): 2015 is selected as the base year as it is the last complete calendar year before the Brexit referendum.

Figure 5.7: Productivity impact in London and the UK (index 2015=100)



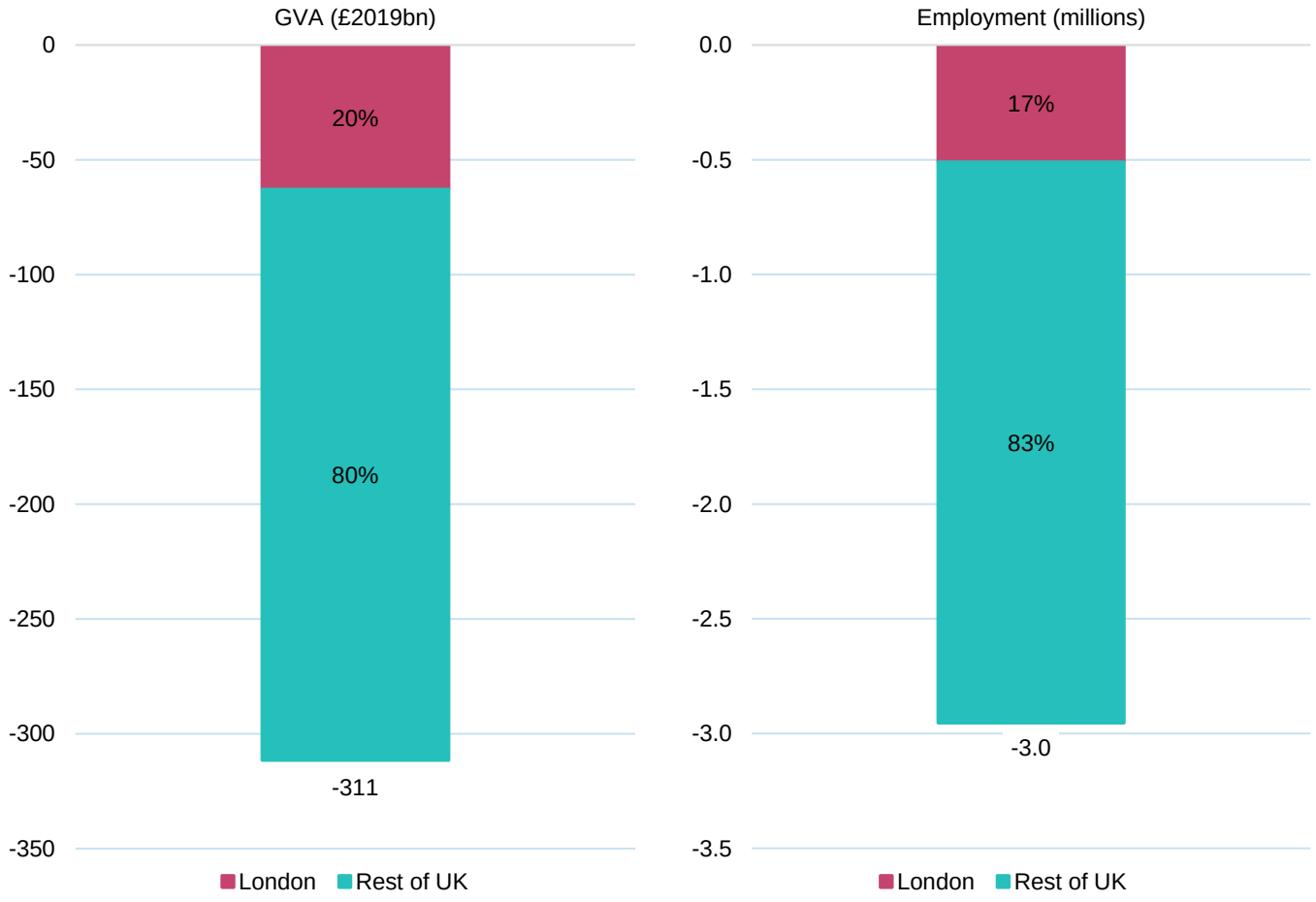
Note(s): 2015 is selected as the base year as it is the last complete calendar year before the Brexit referendum.

London relative to the rest of the UK (i.e., UK regions outside of London)

GVA and employment are expected to be impacted to the same degree in London by 2035 (7.5% lower than the Counterfactual scenario), while in the rest of the UK, GVA impacts are expected to be larger (11.1% lower than the Counterfactual scenario) than employment impacts (7.3% lower than the Counterfactual scenario). Productivity in London is expected to be the same in both scenarios, while Brexit is expected to lead to lower productivity in the rest of the UK in 2035 than it otherwise would have been if Brexit did not happen (4.1% lower than in the Counterfactual scenario).

Figure 5.8 shows the UK GVA and employment impacts expected in London in 2035 relative to the rest of the UK. By 2035, GVA in London is expected to be nearly £63bn lower than if the UK remained in the EU, which represents 20% of the total GVA impacts expected in the UK. London is expected to have more than 500,000 fewer jobs by 2035 compared to if Brexit did not happen, which is 17% of the total employment impacts expected in the UK.

Figure 5.8: Proportion of UK impacts in London and rest of the UK, 2035

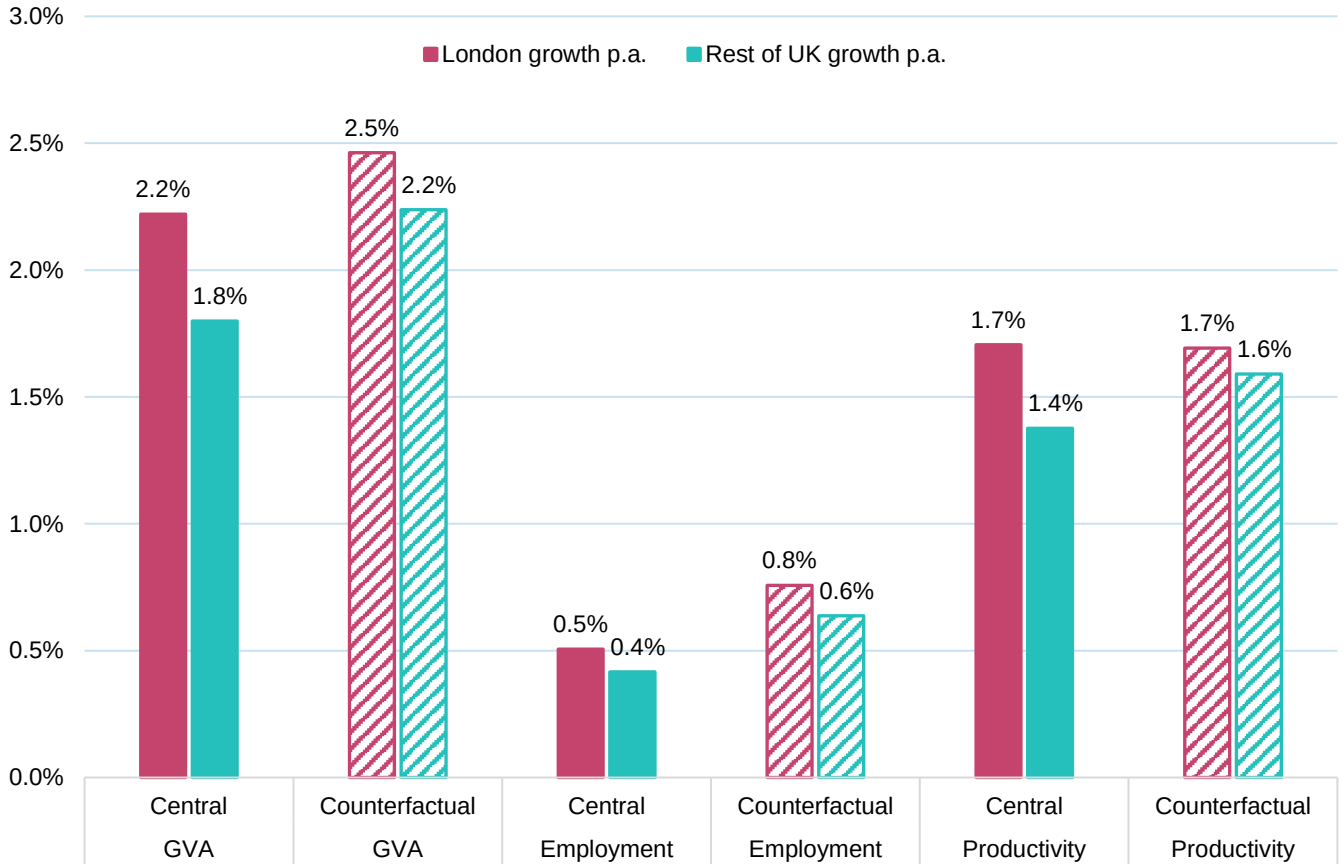


Note(s): Figures are reported as the difference between the values in 2035 in the Central scenario relative to the Counterfactual scenario.

Brexit is expected to affect the annual growth of GVA and employment in London over 2023-35 (see Figure 5.9). GVA and employment growth in London are both expected to be 0.3pp lower than if the UK remained in the EU. Productivity in London, however, is expected to grow by 1.7% p.a. in both scenarios.

London's economy is expected to be more resilient and experience relatively less damage from Brexit than the rest of the UK. Brexit is expected to have a bigger impact on GVA and productivity growth in the rest of the UK than London, and as a result, the productivity gap between London and the rest of the UK is expected to widen faster than if Brexit did not happen. In particular, while the average annual growth in productivity in the rest of the UK in the Counterfactual Scenario is expected to be only 0.1pp slower than London, it is expected to be 0.3pp slower than London in the Central Scenario.

Figure 5.9: Impacts in London versus the rest of the UK, 2023-35



Note(s): Figures are average per annum growth rates over 2023-35.

Results by sector

This section presents the GVA, employment, and productivity results for London by broad sector. Table 5.4 presents the difference from the Counterfactual scenario by sector for each of these three variables in 2035. See Appendix B for detailed results tables by sector and Appendix C for definitions of the broad sectors in terms of the UK's Standard Industrial Classification (SIC).

As with the UK results, the London employment results represent demand for workers, and are not affected by the change in labour supply between the two scenarios. Rather, employment differences are driven by the investment, trade, and carbon price assumptions in the Counterfactual Scenario.

Table 5.4: London impacts by broad sector, 2035

Units	GVA	Employment	Productivity
Variable	% difference from Counterfactual	% difference from Counterfactual	% difference from Counterfactual
Agriculture	-15.9%	-12.6%	-3.8%
Mining & quarrying	-3.7%	-22.4%	24.1%
Manufacturing	-12.9%	-17.8%	5.9%
Electricity, gas & water	-9.7%	-1.6%	-8.2%
Construction	-19.4%	-32.3%	19.1%
Distribution	-6.3%	-2.8%	-3.7%
Transport & storage	-12.4%	1.5%	-13.7%
Accommodation & food services	-7.5%	4.7%	-11.6%
Information & communications	-7.5%	-9.7%	2.4%
Financial & business services	-7.3%	-8.2%	1.0%
Government services	-1.4%	-2.8%	1.5%
Other services	-2.7%	-9.5%	7.5%

Brexit is expected to have a negative impact on GVA growth across all sectors, with the largest differences in 2035 expected in Construction (19.4% lower than in the Counterfactual scenario) and Agriculture (15.9% lower than in the Counterfactual scenario). In addition, GVA in Financial & business services is expected to be £40bn lower in London by 2035 than if the UK remained in the EU. While this is a smaller difference from the Counterfactual Scenario in percentage terms (-7.3%) compared to some of the other sectors, it represents 64% of the expected total GVA impacts by 2035, given that Financial & business services is London's largest sector (accounting for over 60% of London's economy in terms of GVA); it should be clarified that this sector goes beyond Financial & insurance and also includes Real estate, Legal & accounting, Head offices & management consultancies, and other professional and business services - hence its considerable magnitude in terms of London impacts.

The largest employment impacts in 2035 are expected to occur in Construction (32.3% lower than in the Counterfactual scenario), Mining & quarrying (22.4% lower than in the Counterfactual Scenario) and Manufacturing (17.8% lower than in the Counterfactual Scenario). Transport & storage and Accommodation & food services are expected to have higher employment in the Central Scenario in 2035 for the same reasons as in the UK (see Section 5.2 above).

Some sectors are expected to have higher productivity in 2035 than they would have had if the UK remained in the EU. However, London's total productivity across the whole economy (aggregate of all sectors) remains the same between the two scenarios, and total productivity outside of London is expected to be lower than if the UK had remained in the EU.

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Appendices

Appendix A Detailed UK sector results

Table A.1: UK GVA by sector (£2019bn)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	£2019bn	£2019bn	% p.a.	£2019bn	£2019bn	% p.a.	%
Agriculture	13.9	14.2	0.2%	15.6	16.7	0.5%	-14.7%
Mining & quarrying	18.9	15.4	-1.7%	19.3	15.9	-1.6%	-3.3%
Manufacturing	221.9	250.0	1.0%	248.3	302.6	1.7%	-17.4%
Electricity, gas & water	62.4	68.4	0.8%	65.3	76.5	1.3%	-10.6%
Construction	135.2	177.9	2.3%	163.5	260.5	4.0%	-31.7%
Distribution	191.3	245.7	2.1%	204.0	268.5	2.3%	-8.5%
Transport & storage	66.8	85.8	2.1%	72.0	99.0	2.7%	-13.4%
Accommodation & food services	55.9	72.8	2.2%	58.9	76.9	2.3%	-5.3%
Information & communications	139.0	180.9	2.2%	146.8	198.8	2.6%	-9.0%
Financial & business services	903.3	1,189.1	2.3%	949.4	1,283.9	2.5%	-7.4%
Government services	338.0	385.6	1.1%	341.8	394.4	1.2%	-2.2%
Other services	60.3	85.4	2.9%	61.9	89.0	3.1%	-4.0%

Table A.2: UK Employment by sector (millions)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	million	million	% p.a.	million	million	% p.a.	%
Agriculture	0.4	0.4	0.0%	0.4	0.4	0.2%	-8.1%
Mining & quarrying	0.1	0.1	-0.1%	0.1	0.1	1.0%	-18.9%
Manufacturing	2.6	2.7	0.3%	3.0	3.2	0.5%	-15.5%
Electricity, gas & water	0.4	0.4	0.3%	0.4	0.4	0.3%	-1.7%
Construction	2.3	2.4	0.5%	2.8	3.5	1.8%	-29.6%
Distribution	4.8	5.1	0.5%	4.9	5.2	0.4%	-1.8%
Transport & storage	1.9	2.0	0.6%	1.9	2.0	0.3%	2.3%
Accommodation & food services	2.4	2.6	0.5%	2.5	2.5	0.1%	2.9%
Information & communications	1.6	1.7	0.7%	1.7	1.9	1.0%	-10.7%
Financial & business services	8.2	8.8	0.6%	8.6	9.6	1.0%	-8.6%
Government services	8.9	9.0	0.2%	8.9	9.2	0.3%	-2.2%
Other services	2.0	2.1	0.5%	2.0	2.2	0.8%	-7.7%

Table A.3: UK Productivity by sector (£2019k per job)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	£2019k per job	£2019k per job	% p.a.	£2019k per job	£2019k per job	% p.a.	%
Agriculture	37.9	38.5	0.1%	39.9	41.5	0.3%	-7.2%
Mining & quarrying	354.4	289.7	-1.7%	330.8	242.7	-2.5%	19.3%
Manufacturing	85.8	93.6	0.7%	83.7	95.8	1.1%	-2.3%
Electricity, gas & water	163.3	173.5	0.5%	169.2	190.8	1.0%	-9.1%
Construction	58.8	72.6	1.8%	58.0	74.9	2.2%	-3.0%
Distribution	39.8	48.3	1.6%	41.5	51.8	1.9%	-6.8%
Transport & storage	35.8	42.6	1.4%	37.9	50.3	2.4%	-15.4%
Accommodation & food services	22.9	28.0	1.7%	23.7	30.4	2.1%	-7.9%
Information & communications	89.7	107.9	1.6%	88.4	105.9	1.5%	1.9%
Financial & business services	110.6	135.1	1.7%	110.9	133.3	1.5%	1.4%
Government services	38.2	42.7	0.9%	38.2	42.7	0.9%	0.0%
Other services	30.8	41.4	2.5%	30.5	39.8	2.2%	4.0%

Appendix B Detailed London sector results

Table B.1: London GVA by sector (£2019bn)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	£2019bn	£2019bn	% p.a.	£2019bn	£2019bn	% p.a.	%
Agriculture	0.1	0.1	0.2%	0.1	0.1	0.6%	-15.9%
Mining & quarrying	0.2	0.2	-2.0%	0.2	0.2	-1.8%	-3.7%
Manufacturing	9.4	9.9	0.5%	10.2	11.3	0.9%	-12.9%
Electricity, gas & water	5.2	5.6	0.7%	5.4	6.2	1.2%	-9.7%
Construction	23.1	27.1	1.3%	25.8	33.6	2.2%	-19.4%
Distribution	32.6	39.6	1.6%	34.2	42.3	1.8%	-6.3%
Transport & storage	14.2	17.8	1.9%	15.2	20.3	2.5%	-12.4%
Accommodation & food services	13.3	19.5	3.2%	14.4	21.1	3.2%	-7.5%
Information & communications	53.9	71.8	2.4%	56.5	77.6	2.7%	-7.5%
Financial & business services	375.8	507.5	2.5%	395.3	547.8	2.8%	-7.3%
Government services	55.6	61.6	0.9%	56.1	62.5	0.9%	-1.4%
Other services	16.1	19.5	1.6%	16.4	20.1	1.7%	-2.7%

Table B.2: London Employment by sector (000s)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	000s	000s	% p.a.	000s	000s	% p.a.	%
Agriculture	1.6	1.6	0.0%	1.7	1.8	0.3%	-12.6%
Mining & quarrying	2.9	2.8	-0.1%	3.2	3.7	1.2%	-22.4%
Manufacturing	115.1	117.4	0.2%	133.7	142.7	0.5%	-17.8%
Electricity, gas & water	30.0	30.9	0.3%	30.2	31.4	0.3%	-1.6%
Construction	316.4	339.3	0.6%	397.3	501.3	2.0%	-32.3%
Distribution	638.6	685.2	0.6%	656.6	704.7	0.6%	-2.8%
Transport & storage	302.5	315.6	0.4%	306.9	310.8	0.1%	1.5%
Accommodation & food services	424.9	470.8	0.9%	438.5	449.8	0.2%	4.7%
Information & communications	487.1	533.4	0.8%	517.9	590.4	1.1%	-9.7%
Financial & business services	2,011.6	2,150.7	0.6%	2,103.7	2,343.8	0.9%	-8.2%
Government services	1,239.7	1,268.4	0.2%	1,255.7	1,305.6	0.3%	-2.8%
Other services	356.0	380.2	0.6%	371.3	420.0	1.0%	-9.5%

Table B.3: London Productivity by sector (£2019k per job)

Scenario	Central			Counterfactual (CF)			Diff. from CF
Year/ Period	2023	2035	2023-35	2023	2035	2023-35	2035
Units	£2019k per job	£2019k per job	% p.a.	£2019k per job	£2019k per job	% p.a.	%
Agriculture	37.0	37.6	0.1%	37.9	39.1	0.3%	-3.8%
Mining & quarrying	67.9	54.1	-1.9%	62.4	43.6	-3.0%	24.1%
Manufacturing	81.2	84.1	0.3%	76.3	79.4	0.3%	5.9%
Electricity, gas & water	173.1	181.6	0.4%	178.2	198.0	0.9%	-8.2%
Construction	73.1	79.8	0.7%	64.9	67.0	0.3%	19.1%
Distribution	51.1	57.9	1.0%	52.0	60.1	1.2%	-3.7%
Transport & storage	46.8	56.5	1.6%	49.4	65.4	2.4%	-13.7%
Accommodation & food services	31.4	41.4	2.3%	32.8	46.8	3.0%	-11.6%
Information & communications	110.7	134.6	1.6%	109.1	131.5	1.6%	2.4%
Financial & business services	186.8	236.0	2.0%	187.9	233.7	1.8%	1.0%
Government services	44.9	48.6	0.7%	44.6	47.9	0.6%	1.5%
Other services	45.2	51.4	1.1%	44.2	47.8	0.7%	7.5%

Appendix C Sector definitions

Table C.1: Broad sector definitions (SIC2007)

Broad Sector	SIC2007 Classification
Agriculture	01-03
Mining & quarrying	05-09
Manufacturing	10-33
Electricity, gas & water	35-39
Construction	41-43
Distribution	45-47
Transport & storage	49-53
Accommodation & food services	55-56
Information & communications	58-63
Financial & business services	64-82
Government services	84-88
Other services	90-96

Note(s): SIC2007 refers to the UK's Standard Industrial Classification 2007 edition.
For employment, Government services includes jobs in HM Forces.

Appendix D Central Scenario growth assumptions

Table D.1: OBR growth forecast used in UK assumptions

Model Variable	OBR MT Variable	OBR LT Variable	Comment
GDP		Real GDP	
Output		Real GDP	
GVA		Real GDP	For both GVA at factor price and GVA market price
Household consumption	Household consumption	Real GDP	GDP components scaled to LT-Growth of Real GDP
Government spending	Government consumption	Real GDP	GDP components scaled to LT-Growth of Real GDP
Investment	Investment	Real GDP	GDP components scaled to LT-Growth of Real GDP
Imports	Imports	Real GDP	GDP components scaled to LT-Growth of Real GDP
Exports	Exports	Real GDP	GDP components scaled to LT-Growth of Real GDP
Non-EU imports	Imports	Real GDP	Sum of EU and Non-EU are scaled to Total
Non-EU exports	Exports	Real GDP	Sum of EU and Non-EU are scaled to Total
EU imports	Imports	Real GDP	Sum of EU and Non-EU are scaled to Total
EU exports	Exports	Real GDP	Sum of EU and Non-EU are scaled to Total
Population		Population	
Employment	Employment	Working Age Population	Working Age (16-64) Population is estimated using ONS 2020-based population projections published in 2022
Import prices		CPI	
Export prices		CPI	
Domestic prices		CPI	
GVA deflator		CPI	
Nominal GDI		Nominal GDP	
Wages	Wages and salaries	Average earnings	LT-growth in wages is calculated by the sum of growth rates in average earnings and employment

Note(s): All Medium-term (MT) and Long-term (LT) variables are in annual growth rates in 2010 million euros, unless otherwise stated.
Our forecast uses annual growth rates based on the calendar year. While the long-term OBR forecasts are based on fiscal years (beginning in Q2), the difference in growth rates are negligible because the long-term forecast growth rates are stable.

Appendix E Trade cost assumptions

Table E.1: Central scenario tariff assumptions - difference from Counterfactual scenario (%)

	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
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(s): Dhingra et al. (2016).
Note(s): Figures represent a percentage difference from the Counterfactual Scenario.

Table E.2: Central scenario non-tariff assumptions - difference from Counterfactual scenario (%)

	Difference from Counterfactual scenario (%)	
	Import	Export
Food & beverages	55.0	42.6
Textiles & clothing	12.5	14.4
Wood & paper products	5.8	8.5
Chemicals	15.8	17.9
Pharmaceuticals	7.1	11.5
Cosmetics	24.3	26.0
Metals	12.8	8.9
Electronics	4.9	4.9
Office & communications equipment	17.2	14.3
Automotive	20.1	19.1
Aerospace	14.3	14.1
Construction	1.9	3.5
ICT services	2.9	11.2
Communications	1.3	8.8
Financial services	23.8	8.5
Insurance	14.3	8.1
Other business services	2.9	11.2
Personal, cultural & recreational services	1.9	3.3

Source(s): Cambridge Econometrics' calculations based on Berden et al. (2009).
Note(s): Figures represent a percentage difference from the Counterfactual Scenario.

Appendix F Population assumptions

Migration assumptions

In our 2018 Brexit study, the 2020 net migration level in Scenario 1 (a scenario in which Brexit did not occur, i.e., similar to the Counterfactual in this study) is estimated to be 132,000 greater than that in Scenario 4 (a scenario in which a relatively similar 'hard' Brexit (i.e., similar to this study's Central Scenario) did occur), primarily reflecting the loss of EU migrants due to the end of freedom of movement. In this study, we assume that same level of difference between the Counterfactual and Central scenarios from 2026 to 2035 (i.e., over the long term). This assumes that the loss of EU migrants is not fully replaced by migration from non-EU countries in the long run.

In this study, we assumed that the migration impacts of Brexit began in 2018 (to reflect when the transition period was agreed and that there would be a time lag in migration impacts as labour is generally less mobile than capital), with the full effects being realised in 2026, resulting in net migration of 245,000 and 377,000 people by 2026 in the Central and Counterfactual scenario, respectively. The year 2026 was chosen for consistency with the January 2023 ONS population projections, which assume that net migration reaches 245,000 by 2026 and remains constant for all future years.

Population in E3ME

Population is an exogenous input to E3ME and varies between scenarios only if such a deviation is accounted for in scenario assumptions. Given that E3ME is a demand-driven model, the presence of population in the equation sets is mainly to capture potential labour supply constraints.

Population features as an explanatory variable in three out of the 28 econometric equation sets in E3ME:

- Population enters the denominator of the labour force calculations as noted above. Labour force is also influenced by average wage rates, the level of output, benefit rates and unemployment, most of which (with the exception of benefit rates) are likely to be visibly impacted in a scenario after secondary feedbacks have been taken into account. In contrast, population does not contain any feedback loop, thus the labour force is much more likely to be influenced by the other factors previously mentioned than by changes in population. In other words, the extent to which the labour supply responds to changes in population would remain relatively limited. The only exception is under major restructuring of the benefits and pay systems, which are matters of national policy and have not been associated with Brexit (i.e., they are not relevant to this study).
- In the household consumption equations, variables covering child and old-age dependency rates are also included in an attempt to capture any change caused by an ageing population. Higher dependency rates can result in either higher or lower levels of consumption, assuming everything else is held constant. However, in a scenario where changes in population are proportioned across age bands (i.e., no implied change in the population structure is assumed), there is no significant impact on the overall economic results as the dependency ratios would remain unchanged. Therefore, for the purposes of this study, we hold the child and old-age dependency rates constant.
- Similarly, dependency ratios are also an explanatory variable in the investment in dwellings equation (alongside household income and dwelling prices). Investment in dwellings makes up

around a quarter of total investment in the UK and is equivalent to 5% of total UK GVA. Given that dependency ratios are held constant between scenarios, observed scenario impacts relating to investment in dwellings reflect the outcomes of other assumptions (for investment and trade) and their associated economic feedbacks.

Most parameters in E3ME are expressed in terms of elasticities (i.e., the proportion of change in a variable that can be explained by proportionate changes in another). For all equations listed above, the parameters concerning population for the UK are less than 1, which means that, other things equal, a 1% change in the population-related driver in each equation would lead to less than a 1% change in the dependent variable.

The relationship between population on the one hand, and GVA and employment on the other, is significantly less direct than the ones mentioned above. Population-induced effects on household consumption (as described above) are reflected in GVA because consumption is a component of output, and labour market interactions between unemployment, participation rates and average wages are reflected in employment through the employment-wage relationship. Because these effects are often observed as part of wider economic impacts (only fully materialising after several rounds of economic adjustments to the initial shock), the GVA and employment results are typically much less sensitive and responsive to population changes than to other policy inputs that directly affect aggregate demand (such as exogenous shocks to investment). While it is not possible to quantify exactly the elasticities of GVA and employment to population changes because of the high complexity of feedbacks, there are upper bounds on their likely values, because the model parameters suggest that in the UK:

- Participation rates and average wages are insensitive to unemployment rates (a proxy of potential strain on labour supply, given the population and demand for labour), with elasticity values of less than 0.15 on average. This means a 10% reduction in unemployment leads to a less than 1.5% increase in participation rates and average wages after the economy has fully adapted (i.e., a decrease in the unemployment rate will not necessarily lead to a substantial increase in people entering the labour market).
- Pressure on the labour supply has no statistically significant impact on household consumption, both in the short and long runs. Rather, consumption is strongly influenced by income and price effects.
- In the vast majority of sectors, employment is less sensitive to average wage changes (due to labour market interactions) than to demand-side effects, both in the short run and in the long run. On average, a 10% increase in output would lead to a 7% increase in employment in the long run, whereas the same change in employment would require almost a 12% change in average wages.

Finally, the magnitude of change expected is strongly driven by the relative scale of the shocks being modelled. For the purposes of this study, the magnitude of difference in the population assumptions between the Central and Counterfactual Scenarios is lower than the magnitude of differences in the investment and trade assumptions between the two scenarios. Based on how the model envisages economic linkages as well as its parameters and assumptions, the impact of any revisions or changes to population flow data on aggregate and sectoral GVA and employment results over the long term (as developed in this study) would be minimal.