Office for
Budget
Responsibility

Fiscal risks and sustainability

July 2022

CP 702

Office for Budget Responsibility

Fiscal risks and sustainability

Presented to Parliament by the
Chief Secretary to the Treasury by
Command of Her Majesty

July 2022

CP 702

This publication is available at www.gov.uk/official-documents

Any enquiries regarding this publication should be sent to us at obr.enquiries@obr.uk

ISBN 978-1-5286-3375-8

E02748612 07/22

Printed on paper containing 40% recycled fibre content minimum.

Printed in the UK by HH Associates Ltd. on behalf of the Controller of Her Majesty's Stationery Office.

Contents

Foreword

The Office for Budget Responsibility (OBR) was established in 2010 to examine and report on the sustainability of the public finances. A central feature of our efforts to meet that remit has been finding better ways to capture and communicate economic and fiscal risks. Ever since our first *Economic and fiscal outlook* (*EFO*) in 2010, we have emphasised the degree of uncertainty around our central economic and fiscal forecasts by using probabilistic ranges ('fan charts'), alternative scenarios and sensitivity analysis. Our *Fiscal sustainability reports* (*FSRs*) that include long-term fiscal projections have also included sensitivity analysis to changes in demographic, macroeconomic and other assumptions. And since 2017 we have produced a biennial *Fiscal risks report* (*FRR*) setting out the main risks to the public finances, including macroeconomic and specific fiscal risks.

In the January 2022 update to the *Charter for Budget Responsibility*, Parliament amended the OBR's remit to give us greater discretion to determine the content of our annual sustainability report, which has previously alternated each year between the *FSR* and the *FRR*. We have therefore chosen to combine the *FRR* and *FSR* into our inaugural *Fiscal risks and sustainability* report (*FRS*). This edition of the *FRS* includes fully updated long-term fiscal projections for the first time since 2018, and a detailed discussion of two specific fiscal risks: the rise in geopolitical tensions as manifest by the Russian invasion of Ukraine, and the impact of higher energy prices, which have risen dramatically in recent months. Future editions of the *FRS* will be flexible in their content, but we will continue to update our long-term projections periodically (typically following the release of updated ONS population projections) and track developments against the broader spectrum of fiscal risks identified in our fiscal risk register. The updated *Charter* requires the Treasury to respond formally to this report at a subsequent fiscal event, so we would hope to see the Treasury to address the analyses and issues raised in this report in its forthcoming response.

The analysis and projections in this report represent the collective view of the independent members of the OBR's Budget Responsibility Committee. We take full responsibility for the judgements that underpin the analysis and projections, and for the conclusions we have reached. We have been supported in this by the full-time staff of the OBR, to whom we are as usual enormously grateful.

We have also drawn on the help and expertise of officials across numerous government departments and agencies, including HM Treasury, the Bank of England, the Climate Change Committee, Department for Business, Energy & Industrial Strategy, Department for Digital, Culture, Media & Sport, Department for Education, Department for Health and Social Care, Department for Work and Pensions, the Government Actuary's Department, the Government Security Group, HM Revenue and Customs, Ministry of Defence, National Infrastructure Commission, the Office for National Statistics and the UK Health Security Agency. We are very grateful for their insight.

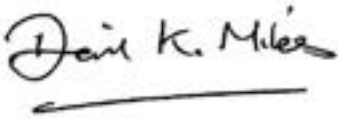
In addition, we have benefitted from discussions with experts from outside government. In particular, we would like to thank Dr Eddy Bekkers at the World Trade Organisation, Professor Brian Bell and

colleagues at the Migration Advisory Committee, Pepijn Bergsen, Alice Billon-Galland, Hans Kundnani, Creon Butler and Peter Watkins at Chatham House, James Black and Erik Silfversten at RAND Europe, Professor Malcolm Chalmers at the Royal United Services Institute, Anita Charlesworth and colleagues at the Health Foundation, Professor Meredith Crowley and Professor Jonathan Portes at UK in a Changing Europe, Tim Gould and Jonathan Coppel at the International Energy Agency, Professor Sir Dieter Helm at the University of Oxford, Dr Fiona Hill at the Brookings Institute, Professor Stephen Kinsella at the University of Limerick, Professor Michael Gasiorek and Dr Ingo Borchert at the UK Trade Policy Observatory, the Institute for Government, Professor Ciaran Martin at the University of Oxford, the National Institute of Economic and Social Research, Professor Danny Ralph at the Cambridge Centre for Risks Studies, the Resolution Foundation, Dr Mattia Romani at the London School of Economics, Simon Ruffle at Risilience Limited, Madeleine Sumption at the Migration Observatory, Ben Zaranko and colleagues at the Institute for Fiscal Studies, and Pool Re. We would also emphasise that despite the valuable assistance received, all the judgements and interpretation underpinning the analysis and conclusions of the *FRS* are ours alone.

We provided the Chancellor of the Exchequer with a provisional summary of our main conclusions on 27 June, and an updated version on 1 July. Given the importance of the report to the Treasury in managing fiscal risks and sustainability, we have engaged with Treasury officials throughout the process. The Prime Minister's announcement on 30 June that the UK will spend 2.5 per cent of GDP on defence by 2030 has not been reflected in our analysis of defence spending risks in Chapter 2 because the Treasury was not able to provide us with information about it in sufficient time to do so. Nevertheless, the announcement is consistent with the scenarios discussed in Chapter 2. We provided an advance pre-release copy on 4 July and a full and final copy 24 hours prior to publication, in line with the pre-release arrangements in the *Memorandum of Understanding between the Office for Budget Responsibility, HM Treasury, Department for Work and Pensions and HM Revenue & Customs*. At no point in the process did we come under any pressure from Ministers, special advisers or officials to alter any of our analysis or conclusions.

We would be pleased to receive feedback on any aspect of the content or presentation of our analysis. This can be sent to feedback@obr.uk.

Richard Hughes



Professor David Miles CBE

Andy King

The Budget Responsibility Committee

Executive summary

Overview

1 In little more than two years, the UK economy and public finances have felt the consequences of a global health crisis caused by Covid-19, a global security crisis sparked by Russia's invasion of Ukraine, and a global energy crisis brought about by both. In a little over a decade, we have also felt the economic and fiscal consequences of a global financial crisis and the uncertainty created by the UK's decision to leave the EU and the ensuing negotiations on how to go about it. And in the decades ahead, governments in the UK and around the world face perhaps the still greater economic and fiscal challenges of addressing climate change, dealing with the fiscal costs of ageing, and managing all these pressures and risks against a backdrop of potentially weaker productivity growth, higher levels of public debt, and rising interest rates.

2 It is hard to escape the conclusion that the world is becoming a riskier place. And for fiscal policy makers, the costs associated with those risks seem to be rising too. Discretionary fiscal support for households, firms, and public services during the pandemic was unprecedented in scale, reaching 10.4 per cent of GDP at its peak in the UK, and may have raised expectations regarding the role of government in future crises. The UK Government has so far spent as much this year (1¼ per cent of GDP) to help households to cope with the sharp rise in the cost of living as it did supporting the economy through the financial crisis. It is largely as a consequence of successive shocks, and the Government's response to them, that, at over 90 per cent of GDP, public debt is now more than triple its level at the start of the century and more than double the around 40 per cent of GDP projected by the Treasury in the UK's first pioneering *Long-term public finance report* published two decades ago.[1]

3 It is to provide a more comprehensive understanding of the interplay between the near-term threats to the fiscal outlook and the long-term health of the public finances that we are publishing this inaugural *Fiscal risks and sustainability* report (*FRS*). The *FRS* brings together the analysis previously found in our biennial *Fiscal risks reports (FRRs)* and *Fiscal sustainability reports (FSRs)* into a single annual report. In addition to surveying the universe of smaller fiscal risks, previous *FRRs* have looked in depth at a number of potentially major shocks to the economic and fiscal outlook including a severe recession, a 'no deal' Brexit, Covid, climate change, and rises in the cost of debt. Previous *FSRs* have provided regular 50-year fiscal projections and assessed the long-run sustainability of the public finances based on the latest demographic, economic, and fiscal policy developments.

[1] HM Treasury, *Long-term public finance report: an analysis of fiscal sustainability*, November 2002.

4 In this first combined *FRS*, we focus on three more significant threats to the public finances:

- **Rising geopolitical tensions (Chapter 2).** The Russian invasion of Ukraine has prompted many to reassess the risks from both conventional and cyber security threats and the sustainability of current historically low levels of defence spending across Western countries. Rising geopolitical tensions have also manifested themselves in the economic sphere with the breakdown of multilateral trade negotiations, the US-China tariff war, and a slowdown, and partial reversal, in international trade and investment flows potentially auguring a retreat from the global economic integration that has brought significant economic gains over the past 70 years.

- **Higher energy prices (Chapter 3).** The recent more than doubling of gas and oil prices and the rise in inflation to rates not seen since the energy crises of the 1970s have underscored the economic and fiscal risks associated with the UK's continued dependence on fossil fuel imports. It has also brought into sharper focus the fiscal choices and trade-offs involved in shifting the UK's energy mix to one that is compatible with getting to net zero emissions by 2050.

- **Long-term fiscal pressures (Chapter 4).** The pandemic has had remarkably little impact on the medium-term fiscal position (with debt marginally higher but the primary balance slightly stronger), thanks in part to the substantial tax rises announced in its wake. Since our 2018 *FSR*, demographic pressures have eased somewhat in the near-term thanks to a lower birth rate and slower improvements in life expectancy, reducing age-related spending as a share of GDP, while lower migration levels bring some fiscal offsets. But in the long run the pressures of an aging population on spending and the loss of existing motoring taxes in a decarbonising economy leaves public debt on an unsustainable path in the long term.

5 Given the experience of the past two decades, this slightly more benign baseline fiscal projection for the coming two decades needs to be seen in the context of the risks discussed in this report. And these emergent geopolitical and energy challenges add to, rather than replace, the risks we studied in previous *FRRs*. Many threats remain, with rising inflation potentially tipping the economy into recession, continued uncertainty about our future trading relationship with the EU, a resurgence in Covid cases, a changing global climate, and rising interest rates all continuing to hang over the fiscal outlook.

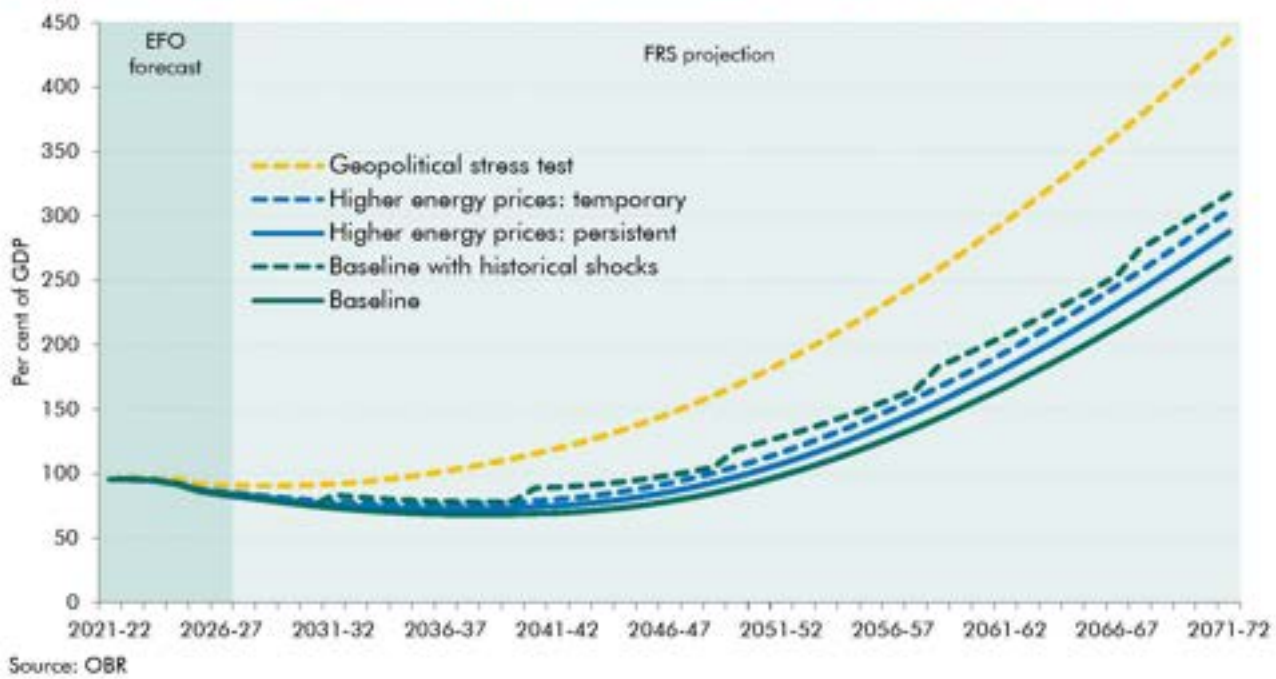
6 Taken together, they add up to a challenging outlook for this and future governments as they steer the public finances through inevitable future shocks, while managing multiple slow-building pressures. Our long-term projections show debt rising to over 100 per cent of GDP by 2052-53 and reaching 267 per cent of GDP in 50 years if upward pressures on health, pensions and social care spending, and the loss of motoring taxes, are accommodated (Chart 1). Bringing debt back to 75 per cent of GDP – the level at which it stabilised in the Government's pre-pandemic March 2020 Budget – would need taxes to rise, spending to fall, or a combination of both, amounting to a 1.5 per cent of GDP additional tightening (£37 billion a year in today's terms) at the beginning of each decade over the next 50 years.

7 Factoring in a stylised estimate of the asymmetric costs associated with inevitable periodic shocks would push debt up to 100 per cent of GDP by 2047-48 and nearly 320 per cent of GDP in 50 years. These figures are based on a simple reading of post-war UK fiscal history. This *FRS* also explores the potential fiscal costs associated with two specific risks:

- **Geopolitical stress test.** If geopolitical tensions continue to rise, with threats to both security and economic integration crystallising, the fiscal outlook could be materially weaker – as illustrated in this year's 'fiscal stress test'. It includes: a future Government increasing defence spending from just over 2 to 3 per cent of GDP, at a cost of £24 billion in today's terms; a major cyber-attack that delivers a short, sharp recession in 2024 that pushes public debt higher, but leaves no lasting scars; and a global trade war that escalates over time and eventually subtracts 5 per cent from UK GDP. This simultaneous crystallisation of several risks adds 28 per cent of GDP to public debt in 2036-37 and leaves debt at over 430 per cent of GDP in 2071-72.

- **Near- and medium-term energy price shocks.** What if energy prices were to spike even higher or to persist at current high levels? In our 'temporary spike scenario' gas prices more than double next year and oil prices spike too, keeping inflation in double digits. The associated recession leaves public debt higher in the medium term, and it reaches over 300 per cent of GDP in 2071-72. In our 'persistent shock scenario', high gas and oil prices weigh on the economy's productive potential. The fiscal impact of this also raises public debt in the medium term and leaves it at under 290 per cent of GDP in 2071-72. Asymmetries in the welfare system explain the temporary price shock being fiscally more costly than the persistent one. Additional fiscal support for households of the type seen this year would dampen the short-term hit to household incomes, but only at the expense of passing a higher public debt burden onto future households.

Chart 1: Public debt: baseline projection with historical and specific shocks

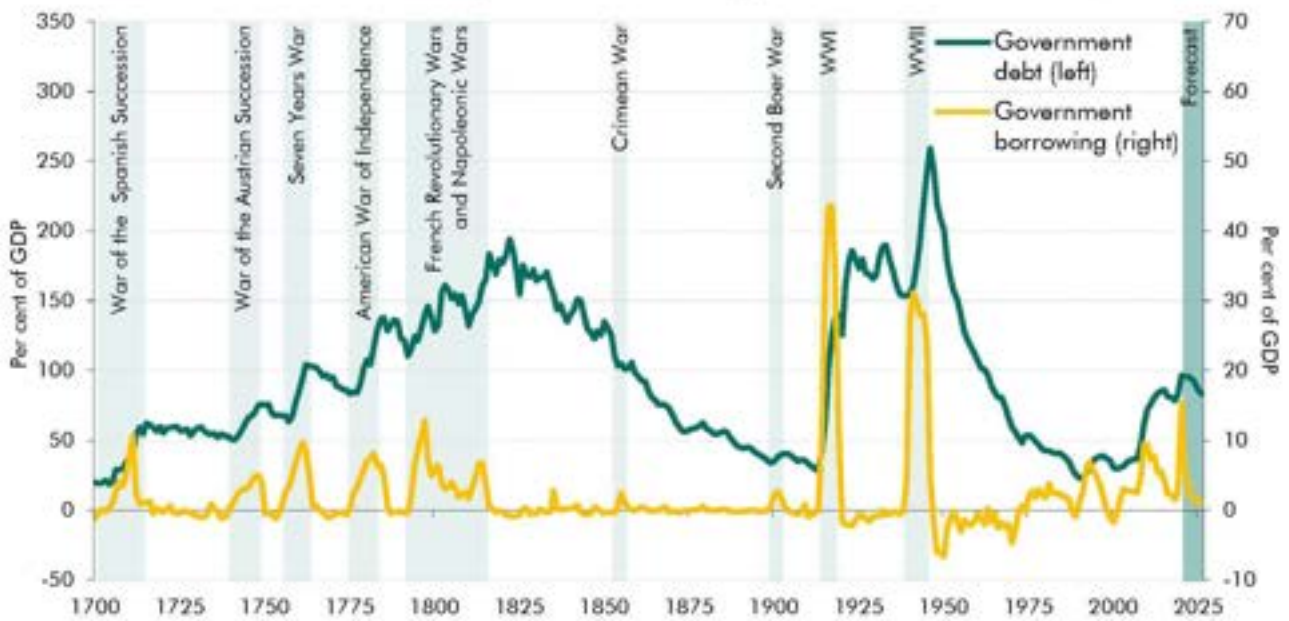


Source: OBR

Rising geopolitical tensions (Chapter 2)

8 Historically, geopolitical tensions, and the armed conflicts arising from them, have been the most important drivers of fiscal outcomes in the UK. Before the Covid pandemic, the highest deficits and largest increases in debt had been associated with three periods of armed conflict that directly threatened the security of the British mainland (Chart 2). The Napoleonic, First, and Second World Wars all saw annual borrowing exceed 10 per cent of GDP and each added more than 70 per cent of GDP to the stock of debt. Outside of these episodes of total war, the geopolitical environment has been a key driver of the level and composition of tax and spending. The easing of Cold War tensions over the latter half of the 20th century allowed for a gradual reduction in UK defence spending. It fell from nearly 7 per cent of GDP on the eve of the Korean War in 1949, to just over 3 per cent by the time the Berlin Wall fell in 1989, and to a 150-year low of around 2 per cent in 2020. This growing 'peace dividend' created fiscal space for a steady reduction in debt and expansion of the NHS and the wider welfare state. Over a similar period, the UK economy and public finances also benefited from the progressive liberalisation of global trade and investment, which rose from 5 to 21 per cent of GDP and from 2 to 4 per cent of GDP respectively.

Chart 2: Government borrowing and debt during periods of conflict and peace

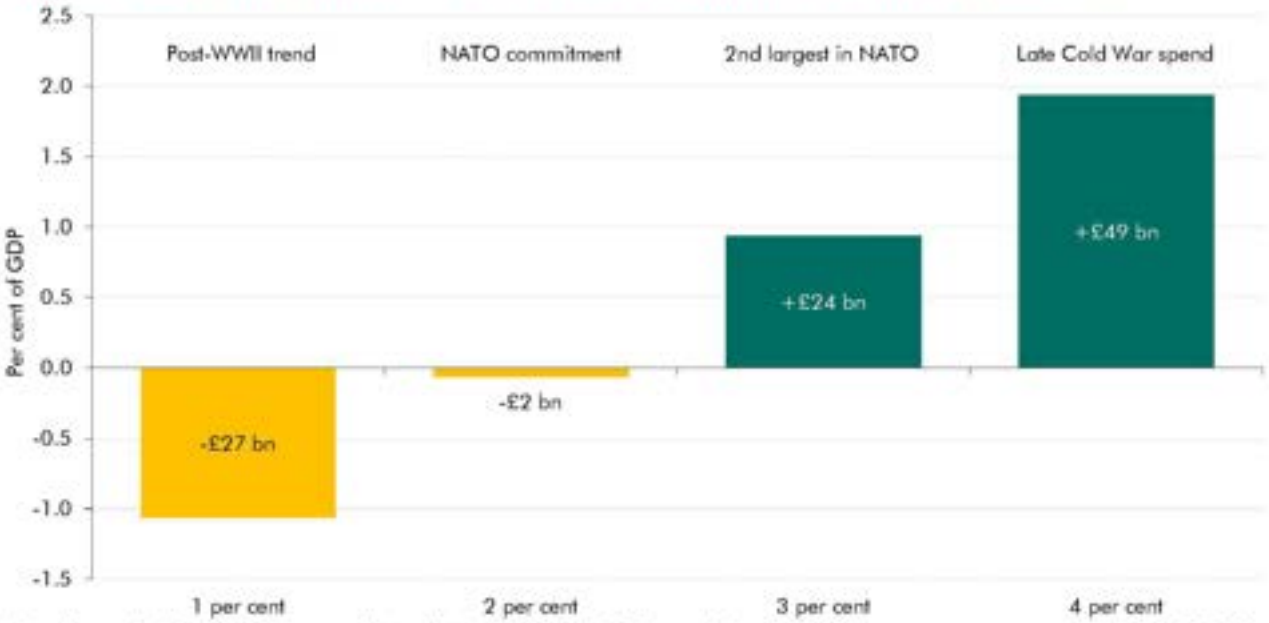


Note: Financial year data used from 2016-17.
Source: Bank of England, OBR

9 The Russian invasion of Ukraine has prompted a reappraisal of levels of defence spending across Western countries. So far, many of our European allies, most notably Germany, have committed to increase their military spending to the NATO minimum of 2 per cent of GDP (or more). Over the longer term, the Government is committed to spending at least 2 per cent of GDP on defence, meeting its NATO commitment, and that would already see the long-term post-war decline in defence spending come to an end. Increasing our defence spending from 2.1 to 3 per cent of GDP by the mid-2030s would cost an additional £24 billion in today's terms and comfortably maintain our position as the second-largest defence

spender in NATO (after the US) in absolute terms, even after the German commitment to reach 2 per cent is fulfilled. Were rising geopolitical tensions to require a return to Cold War levels of resource mobilisation, increasing defence spending to the 4 per cent of GDP it averaged during the 1980s would cost an additional £49 billion in today's terms. On the other hand, if the failure of Russia to secure a swift victory in Ukraine plus the increased defence spending by our NATO allies reduces the pressure on the UK defence budget and allows it to continue its long-run downward trend as a share of GDP to 1 per cent, this could save £27 billion in today's terms, though it would not be consistent with the NATO commitment (Chart 3).

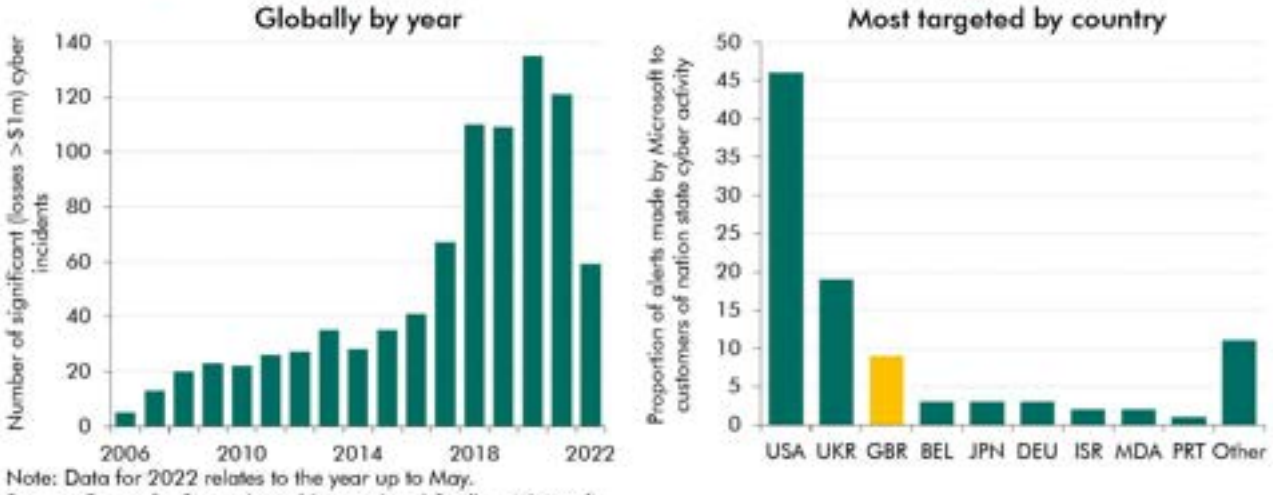
Chart 3: Fiscal risks from different defence spending scenarios in 2036-37



Note: Figures in £ billion are expressed in today's terms i.e. the £ billion equivalent of each percentage as a per cent of 2022-23 GDP.
Source: OBR

10 In addition to possible pressures on defence spending discussed above, the UK also faces the growing threat of unconventional warfare in the form of cyber-attacks. Over the past 15 years, the number of serious incidents rose 24-fold from five in 2006 to 122 in 2021 and the UK ranked third behind the US and Ukraine in terms of malicious cyber-activity linked to nation states between July 2020 to June 2021 (Chart 4). While most of these incidents have been relatively modest in scale, a few recent attacks have cost other economies billions and governments hundreds of millions. These incidents have typically been backed by hostile state actors (most notably Russia and North Korea), targeted other states' institutions or critical national infrastructure, and had significant unintended consequences. Based on a Cambridge Centre for Risk Studies (CCRS) scenario modelling the implications of a major cyber-attack on the UK electricity grid, we estimate that such an attack could result in a 1.6 per cent of GDP shock in the year that it occurs and add £29 billion to borrowing in both direct and indirect effects.

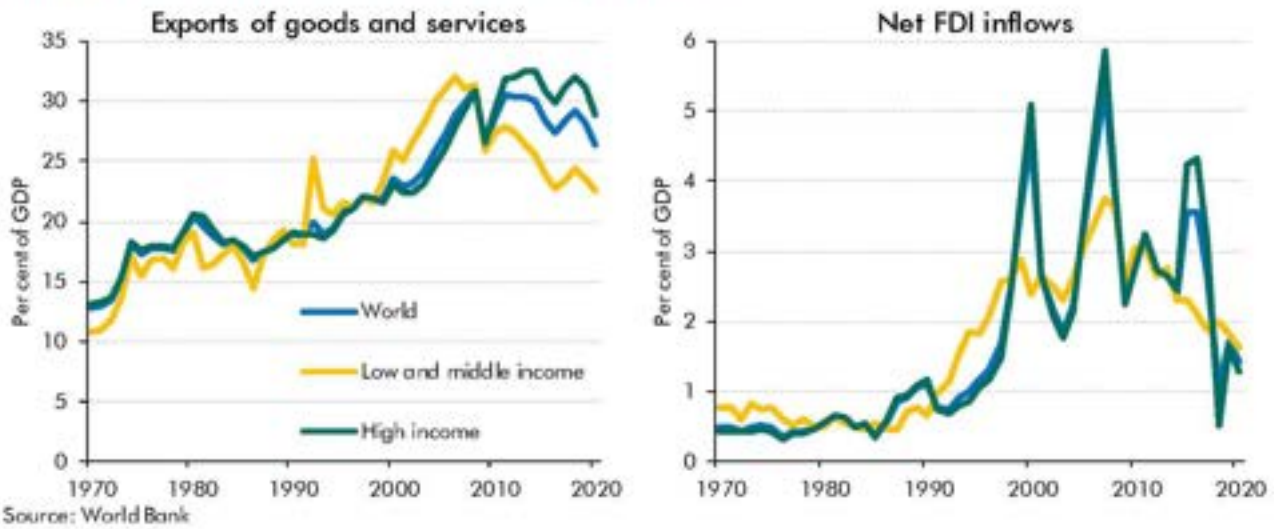
Chart 4: Significant cyber-attacks from 2006-22 and country targets in 2020-21



Note: Data for 2022 relates to the year up to May.
Source: Centre for Strategic and International Studies, Microsoft

11 On top of the potential fiscal costs associated with rising conventional and cyber-security threats, rising geopolitical tensions could also put at risk the gains from deepening global economic integration over the past 70 years. The pace of global integration has stalled on some measures and reversed on others since the global financial crisis in 2008. Having grown rapidly in the early 2000s, global trade as a share of GDP has declined from a peak of 31 per cent in 2008 to 26 per cent in 2020. Global foreign direct investment flows (FDI) peaked in 2007 at 5 per cent of GDP and have since fallen back to 1.4 per cent in 2020 (Chart 5). Having been historically one of the most open of the major advanced economies, the fall in both trade intensity and inward FDI has been particularly pronounced in the UK in recent years. Drawing on a World Trade Organisation scenario to illustrate the economic and fiscal risks from escalating trade tensions, rising global protectionism could reduce global trade volumes by 17 per cent and reduce real GDP by a little more than 5 per cent over 15 years. In addition, declining holdings of UK debt causes interest rates to rise by one percentage point. Together these add 2.3 per cent of GDP to borrowing and over 20 per cent of GDP to public debt by 2036-37.

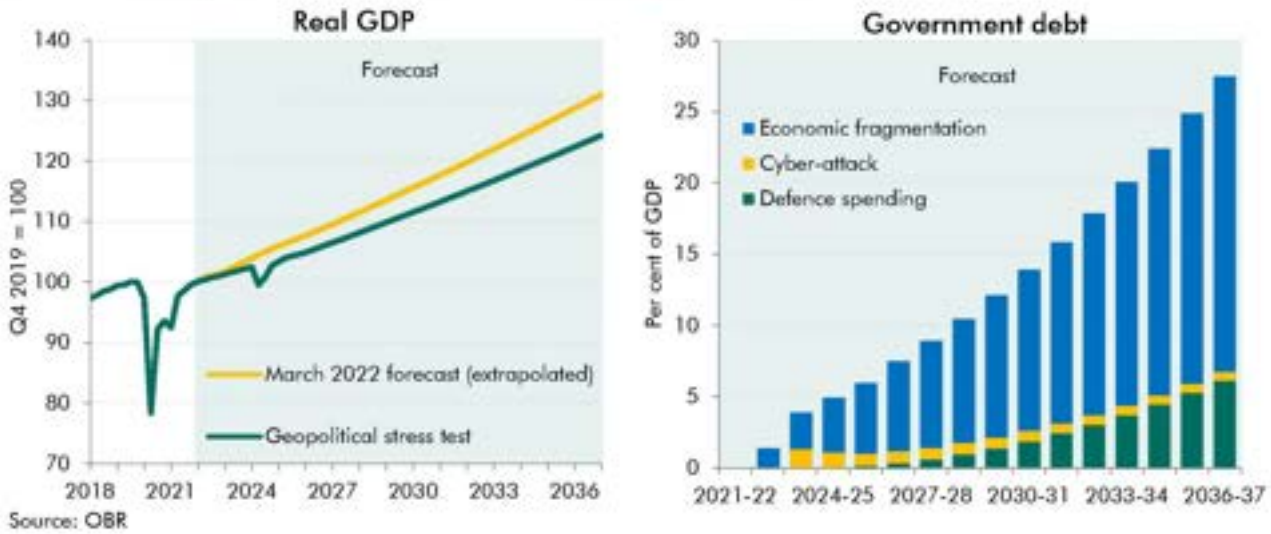
Chart 5: Trade and investment intensity of GDP



Source: World Bank

12 History has shown that geopolitical risks are also highly correlated, with periods of rising security tensions between the major powers coinciding with breakdowns in global cooperation in the economic sphere. We therefore produce a geopolitical stress test in which: (i) a major cyber-attack occurs in the mid-2020s; (ii) rising conventional security threats prompt a future Government to increase defence spending to 3 per cent of GDP by the mid-2030s, maintaining its position as the second largest contributor to NATO; and (iii) a global trade war reduces cross-border trade and investment over the next 15 years, damaging prospects for the UK economy's supply potential. This results in a 2.4 per cent of GDP hit in 2024-25 (of which 1.6 per cent of the hit relates to the short-term cyber shock), which then gradually increases to an over 5 per cent hit to GDP by 2036-37 driven mainly by global economic fragmentation. This results in government debt reaching nearly 28 per cent of GDP above baseline by 2036-37 (Chart 6), the majority of which is also driven by global economic fragmentation and the damage done to nominal tax bases by the large hit to the productive potential of the economy.

Chart 6: Geopolitical stress test: GDP and government debt

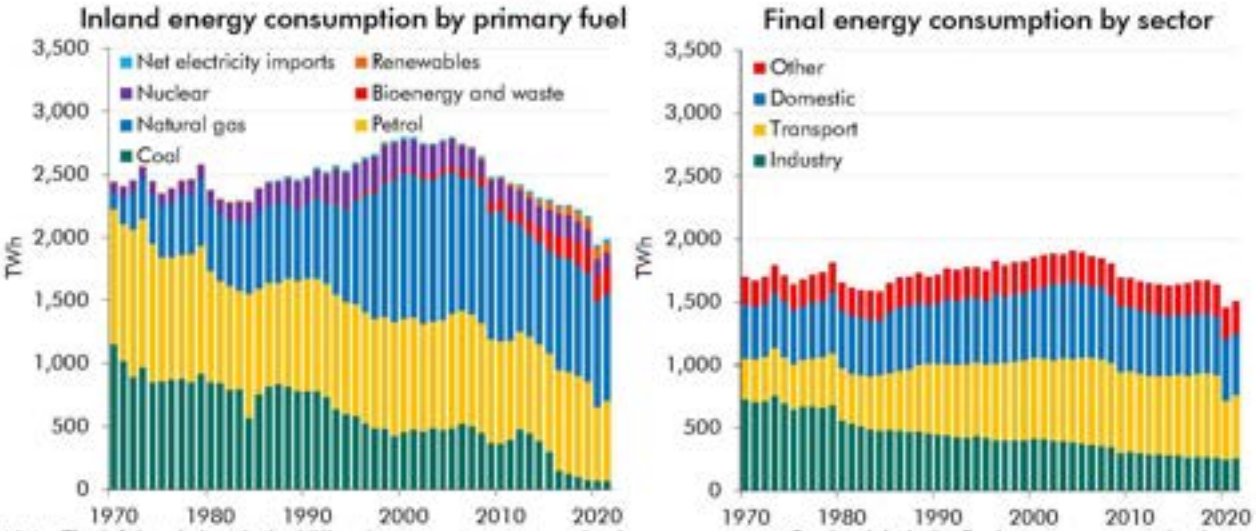


Source: OBR

Higher energy prices (Chapter 3)

13 Recent months have underscored the economic and fiscal risks associated with the UK's continued dependence on fossil fuel imports to meet its energy needs. High and volatile energy prices raise economy-wide inflation, erode real incomes and consumption, and, if sustained, can also weigh on potential output and thereby adversely affect long-term fiscal sustainability. Gas and oil prices had already begun to rise as economies reopened in the wake of the pandemic in the second half of 2021 before surging to all-time highs in sterling terms in response to Russia's invasion of Ukraine in February 2022. While the overall energy intensity of the UK economy has fallen by around two-thirds since the last major energy price shock in the late 1970s, the share of gas and oil in the energy mix has increased from around 50 per cent in 1970 to around 75 per cent in 2000, due to declining coal and nuclear power, and has remained fairly constant at around 70 to 75 per cent since 2000 (Chart 7). Geopolitical, demographic and environmental factors could mean that these commodities' prices could remain high and volatile over the medium term.

Chart 7: Sources and uses of energy in the UK since 1970



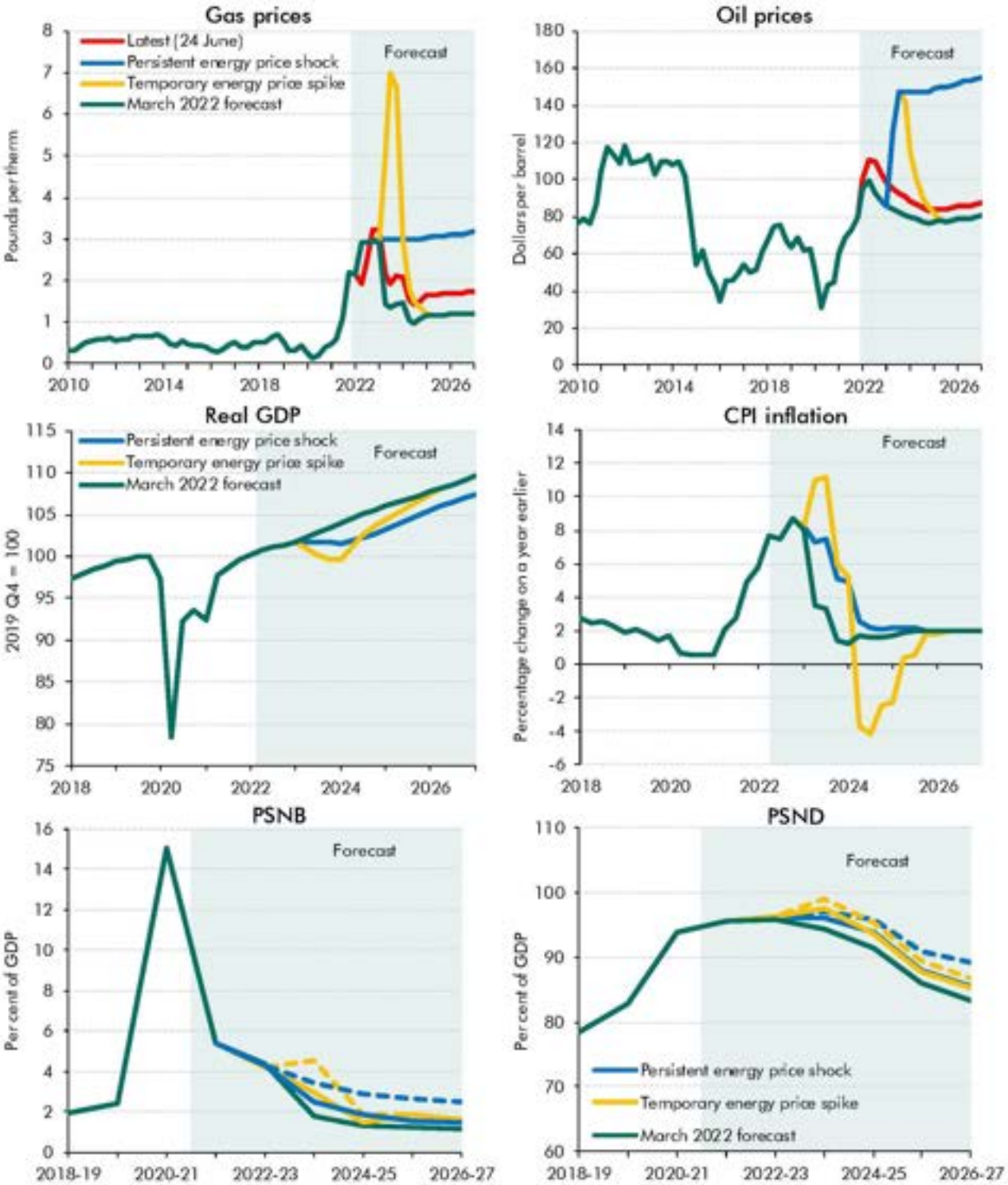
Note: The left hand chart is the UK's primary energy consumption by energy source. On the right is the final energy consumption by sector. The disparity is due to inefficiencies within the power system.
Source: BEIS

14 In the medium term, high and volatile fossil fuel prices can be very disruptive economically and fiscally, as they were during the late 1970s and early 1980s. Based on a scenario in which gas prices temporally spike to £7 per therm (over twice the peak in our March forecast) and oil prices to $147 a barrel (their 21st century peak), inflation would peak at 11 per cent, 8 percentage points above our March forecast, before falling well below zero as energy prices fall. The economy would fall into recession as GDP drops 4 per cent below our baseline but then quickly recovers as prices fall, with no long-term scarring to the economy. Real household disposable incomes would fall by just over 4 per cent next year. This scenario would add £30 billion (1.2 per cent of GDP) to government borrowing in 2023-24 and £63 billion (1.8 per cent of GDP) to debt by 2026-27. If, for illustration, the government were to extend a level of fiscal support in proportion to that provided for energy bills and the price of oil so far this year, it would add a further £40 billion (1.5 per cent of GDP) to borrowing in 2023-24 and £50 billion (1.7 per cent of GDP) to debt by 2026-27. Providing more support, however, merely pushes the cost of higher energy on to future households as the Government cannot make the costs of more expensive energy go away, merely adjust who pays it and when.

15 In a scenario in which gas prices remain at the peak assumed in our March 2022 *Economic and fiscal outlook* (*EFO*) of £3 per therm and oil prices rise to and then remain at around their 21st century peak of $147 a barrel over the next five years, inflation peaks at 8 per cent (and averages around 4 percentage points above our March 2022 forecast across 2023-24). GDP falls around 1 percentage point below our March 2022 forecast in 2023 and, because energy prices remain high, the economy is 2 per cent of GDP smaller in the medium term. Government borrowing is around £13 billion (0.5 per cent of GDP) higher in every year and debt £50 billion (2.2 per cent of GDP) higher by 2026-27. The fall in real household disposable income in 2023-24 would be around 2½ per cent. If the Government were to extend the level of fiscal support in proportion to the rise in energy bills and the price of oil so far this year, this would add a further £25 billion (1.0 per cent of GDP) to

borrowing in 2023-24 and £112 billion (3.8 per cent of GDP) to debt by 2026-27. However, this degree of insulation of the current generation from the impact of what are sustained rises in the cost of energy would bequeath a higher stock of debt to future generations but with no expectation that they face lower prices.

Chart 8: Energy price scenarios



Note: Latest is the average over the 5 days to 24 June. For PSNB and PSND, the solid lines exclude the illustrative policy risk, whilst the dotted lines include it.
Source: Datastream, ONS, OBR

16 Over the long term, the UK has more flexibility to alter its energy mix to reduce its dependence on fossil fuels and meet its ambition to reach net zero carbon emissions by 2050. However, in facilitating this transition, the Government faces a trade-off between its goals of an energy system that is cheap, reliable, and clean – as highlighted in its April British energy security strategy (BESS).[2] Until recently fossil fuels have provided cheap and reliable energy but at the expense of the global climate. Nuclear power emits almost no carbon but brings with it a significant risk that the Government is called upon to cover some or all of the cost of constructing and decommissioning the reactors. Renewable energy of the kind currently available in the UK (wind and solar) is cheap and effectively zero carbon but is also intermittent and seasonal, and therefore could require significant public investment in storage technologies to make it a reliable source of baseload energy.

17 Economic and policy developments since our 2021 *FRR* have put both upward and downward pressures on the fiscal risks associated with getting to net zero by 2050:

- Higher market prices for gas and oil have increased the **economic incentive to shift away from fossil fuels** toward zero-carbon alternatives. Relative to the Government's *Net Zero Strategy* assumptions, the medium-term gas prices from our most recent *EFO* reduce the marginal cost of getting to net zero relative to continuing to consume fossil fuels and emit carbon by more than a third by raising the operating costs of fossil fuel-powered vehicles, heating systems, and power generation.

- The same higher gas prices would reduce the scope for the Government's use of the UK emissions trading scheme (ETS) or other **carbon taxes** to create those incentives and benefit from the resulting revenue in respect of gas use. But updating our 2021 *FRR* analysis for the latest gas prices only modestly reduces the scope for additional carbon tax revenues by around a sixth over the period to 2050-51 (2.7 per cent of GDP). The greater fiscal risk would come if future governments were to choose not to significantly expand and increase carbon taxes and were instead more reliant on **subsidies and regulation** to deliver net zero.

- Greater focus on **energy security** could result in greater calls on government to invest in more system-wide reliability than the private sector would deliver based on price signals alone. Maximising future use of domestic natural gas – more secure than imported supplies – could mean more public investment in carbon capture and storage infrastructure, which doubles both construction and operating costs for new gas plants. Supporting the transition to nuclear – which is both secure and green – could require more public investment in constructing and decommissioning new nuclear facilities, with the construction costs of the additional capacity targeted in the BESS potentially approaching £170 billion over the coming decades if the cost of Hinkley Point C were a reasonable guide. And relying more on renewables could require more public investment in economy-wide storage capacity to overcome intermittency in wind and solar power generation, at a potential cost of tens of billions.

[2] Department for Business, Energy & Industrial Strategy, *British energy security strategy – Secure, clean and affordable British energy for the long term*, April 2022.

18 Our baseline long-term projections have been updated to reflect some of the fiscal costs associated with the transition to net zero (notably the loss of motoring tax revenues). We will return to some of the issues raised above in future *FRSs*, as and when further relevant information is published by the Government and the Climate Change Committee.

Long-term fiscal pressures (Chapter 4)

19 These emergent geopolitical and energy risks, and all of those analysed in our previous *FRRs*, need to be managed in the context of a set of longer-term demographic, environmental, and other structural pressures on the public finances. These are the largest, and most certain, threats to long-term fiscal sustainability – with every assessment we have published over the past decade having shown debt on an unsustainable path over the next 50 years as a result of these pressures. We have made only modest changes to the main demographic and economic assumptions underpinning our latest long-term projections, but some have significant fiscal implications. Specifically, relative to the demographic assumptions underlying our 2018 *FSR*, our latest projections assume:

- **Fewer births.** The birth rate has been revised down from 1.84 to 1.59, reflecting a drop in outturn that largely pre-dates the pandemic. This contributes to a material downward revision to the 'young-age dependency ratio' (the population aged 15 and under as a percentage of the population aged 16 to 64) from roughly 30 per cent to around 25 per cent, as shown in the left panel of Chart 9. This reduces spending as a share of GDP on health, education, and child-related welfare payments.

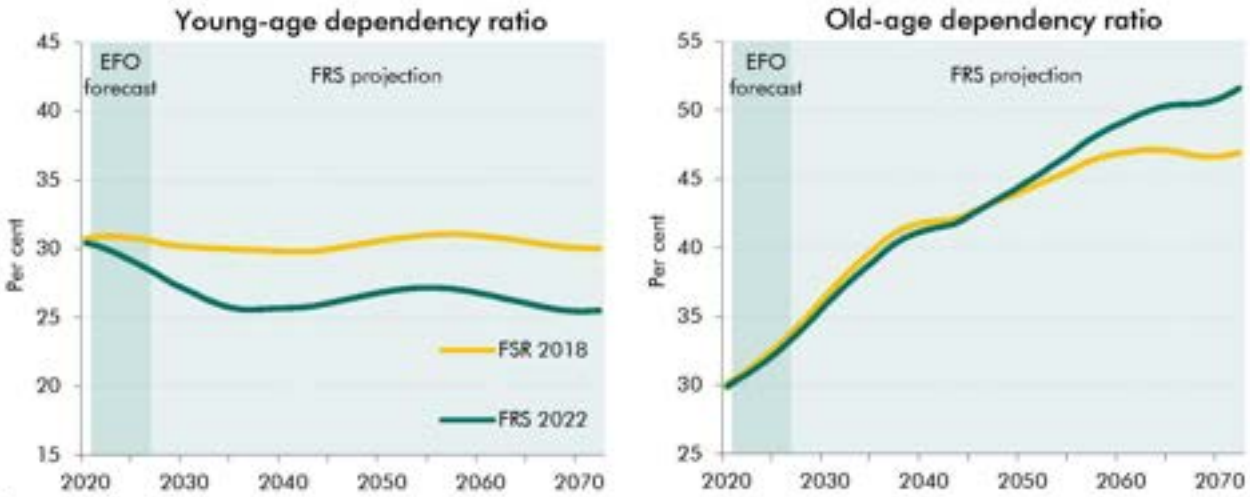
- **Slower improvements in life expectancy.** Cohort life expectancy (the average age that each birth cohort is expected to live to) has been revised down – for example, from 95.6 to 92.6 years for females born in 2045. This also largely reflects trends that pre-date the pandemic, although the projections do assume some modest ongoing effects of the pandemic on mortality in the near term. On its own, this reduces the 'old-age dependency ratio' (the population aged 65 and over as a percentage of the population aged 16 to 64) in the long term from 47 to 44 per cent.[3] Although, as shown in the right panel of Chart 9, the long-run effect of fewer births and lower net migration are sufficient to outweigh the impact of higher mortality on this ratio from the 2040s onwards. The net result is to reduce spending as a share of GDP on health, social care and pensions in the first half of the projection, but raise it from 2047 onwards when the old-age dependency ratio is higher than in our 2018 projections.

- **Lower net migration.** Consistent with our medium-term assessment of the impact of the new post-Brexit migration regime on net inward migration numbers, our projections assume these net inflows settle at 129,000 a year rather than the 165,000 assumed in our 2018 projections.[4] This is also lower than the 205,000 a year assumed in the ONS's own interim 2020-based projections. The difference between our assumption and the ONS one builds up over time to leave the population almost 6 million smaller

[3] Compared to FSR 2018.
[4] See Box 2.4 of our March 2020 *Economic and fiscal outlook* for a description of this assessment and the uncertainties around it.

in 2072, compared to the ONS's interim projection. As migrants are more likely than the resident population to be of working age when they arrive, this raises both dependency ratios for some decades relative to our previous assumption. Over that period, it therefore raises age-related spending as a share of GDP since it reduces real GDP by a somewhat greater margin than it reduces age-related public spending.

Chart 9: Young- and old-age dependency ratios: latest versus previous projections



Source: OBR

20 Taken together these three changes reduce population growth from an average of 0.3 per cent a year over the next 50 years in our 2018 projections to minus 0.1 per cent a year in these latest projections.[5] Indeed, the population peaks in 2044 at 68.4 million and falls to 65.9 million by 2072, the first time our projections have been based on a declining population. From the perspective of fiscal sustainability, the overall size of the population is not hugely significant – the burden of previously accumulated debt will be somewhat greater per person than if it were being serviced by rising numbers of taxpayers. But the cost of most public services, with the possible exception of defence, is proportionate to the size of the population. And a modestly declining population puts less pressure on energy and other natural resources, so could contribute to achieving net zero and other environmental goals. Rather, fiscal sustainability depends more on the age structure of the population.

21 Our long-term projections begin in 2027-28, jumping off the fiscal position at the end of our latest medium-term forecast presented in our March 2022 *EFO*. The primary balance – the overall budget deficit adjusted for net interest spending – in 2026-27 is forecast to be in surplus by 0.2 per cent of GDP, compared with a deficit of 0.5 in the starting year for our 2018 *FSR*. Our long-term projections then show the primary balance deteriorating steadily from that point onwards as the ageing population puts upward pressure on health, social care, and pensions spending, while other non-demographic cost pressures in the health and social care systems are accommodated. For the first time, our long-term projections also factor in the loss of motoring taxes associated with the shift to electric vehicles as the

[5] This excludes the forecast horizon. If we include the forecast period, then population falls a little with an average population growth of zero.

economy transitions to net zero carbon emissions by 2050. Overall, the primary balance deteriorates by 11.4 per cent of GDP (£287 billion in today's terms) between 2026-27 and 2071-72 (left panel of Chart 10), with higher health spending contributing 6.7 per cent of GDP, higher social care spending 1.1 per cent of GDP, higher pensions spending 3.0 per cent of GDP, and lower motoring taxes 1.5 per cent of GDP.

22 The primary deficit at the end of the 50-year projection is 2.6 per cent of GDP higher than our 2018 *FSR* projections, thanks to several changes. As Chart 10 shows, that reflects:

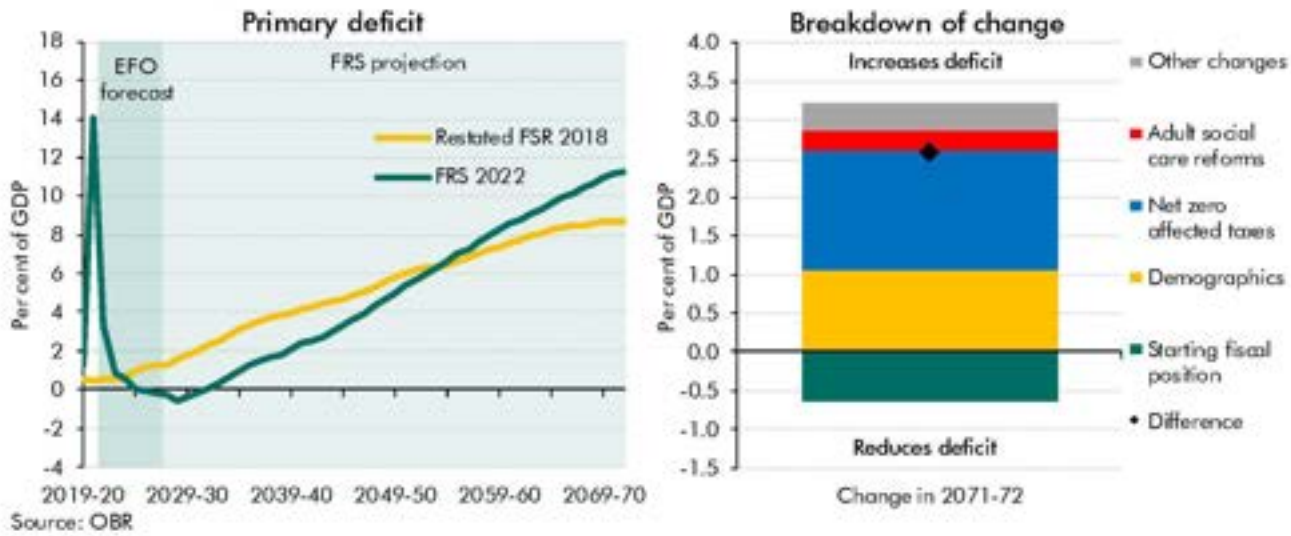
- **The starting primary deficit** at the end of the medium term has improved by 0.7 per cent of GDP. This reflects both policy, in the form of net tax increases, and forecasting changes from a more tax-rich economy.

- **Demographic changes** that reduce the primary deficit in the near future but increase it in the long term, the cumulative effect of which is to reduce debt in 2071-72. This reflects the profile of revisions to dependency ratios flowing from the updated demographic assumptions. Lower migration reduces the working population and so increases young- and old-age dependency ratios, while increased mortality reduces the old-age dependency ratio. The lower birth rate reduces the young-age dependency ratio throughout, but eventually results in fewer working-age adults and so increases the old-age dependency ratio in the long run.

- **The loss of net-zero-affected revenues** – most notably fuel duty and vehicle excise duty – reduces revenues by 1.6 per cent of GDP a year from 2050-51 onwards relative to our 2018 projections, which did not factor in the goal of getting to net zero emissions by 2050.

- **Other long-term policy changes** have a modest effect on the primary deficit, with adult social care reforms raising primary spending somewhat.

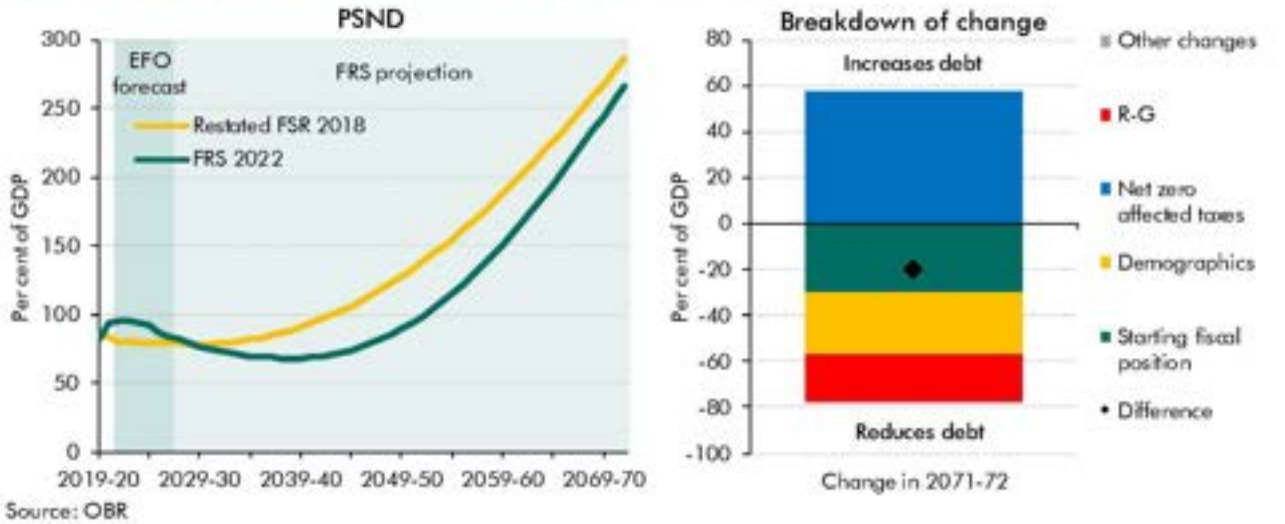
Chart 10: Long-term projections for the primary deficit: *FRS* 2022 versus *FSR* 2018



Source: OBR

23 The continuously rising primary deficit means that net debt increases from 84 per cent of GDP in 2026-27 to 100 per cent in 2052-53 and then rises rapidly to 267 per cent of GDP by 2071-72. Despite this unsustainable path, this is 20 per cent of GDP lower than in our 2018 *FSR* projections. This partly reflects the improved starting primary deficit, as well as the more favourable interest rates relative to economic growth ('R-G') at the end of our latest medium-term horizon. Despite increasing the primary deficit by 2071-72, the cumulative effect of revised demographics across the projection period is to reduce debt as the more favourable near-term position outweighs the less favourable one in the longer term. These sources of downward revision are largely offset by the removal of net zero affected taxes.

Chart 11: Long-term projections for public sector net debt



Source: OBR

24 We consider several sustainability metrics in assessing the long-term fiscal position, including fiscal gaps that would need to be filled to stabilise debt at a pre-determined figure and measures of the intertemporal or comprehensive fiscal balance. Perhaps the most pertinent of these to the way policy evolves in reality is the decade-by-decade fiscal tightening that would be necessary to offset the underlying pressures from ageing, net zero and other factors such that debt stood at 75 per cent of GDP at the end of the projection – the level it reached in the Government's pre-pandemic Budget in March 2020. This shows that an ongoing policy tightening of 1.5 per cent of GDP over every decade would be sufficient, although debt would initially fall, troughing at 32 per cent around 2050 before rising up to and through 75 per cent in 2071-72. As such, further adjustment beyond the projection horizon would be required to stabilise debt-to-GDP over the very long run.

25 A fiscal adjustment to the level of spending or tax of 1.5 per cent of GDP every decade would be equivalent to £37 billion in today's terms – a significant sum, but over the space of a decade not an inconceivable one. This would mean a cumulative adjustment of 7.4 per cent of GDP by 2071-72, or £185 billion in today's terms. To give some context:

- Each decade's adjustment is roughly twice the size of the 0.7 per cent of GDP **improvement in the medium-term primary balance over the four years between the 2018 *FSR* and this latest *FRS***. This adjustment has been more than explained by the

1.1 per cent of GDP in medium-term tax increases that the Government has put in place in the wake of the pandemic, which partly finance a rising path for health and social care spending that is itself broadly consistent with the pace at which those items rise in our long-term projections.

- A decade's adjustment is roughly equal to the **loss of motoring tax revenues due to decarbonisation**. So if the Government ensures *"that revenue from motoring taxes keeps pace with this change"* as it has said it will need to,[6] it would deliver around a fifth of the total adjustment required.

- The total adjustment is somewhat smaller than the 8.8 per cent of GDP of **fiscal consolidation delivered in the decade following the financial crisis**, over four-fifths of which was delivered by reductions in spending.[7] Of course, this consolidation was delivered in the context of a roughly 15 per cent shortfall in output relative to the pre-crisis trend (and which underpinned pre-crisis spending plans) rather than in response to slow-building demographic and other cost pressures.

26 More generally, the degree of fiscal adjustment required to address the long-term pressures captured in our projections should be viewed alongside the nearer-term risks that this report also covers. The experience of the past two decades makes it hard to escape the conclusion that the world is becoming a riskier place, with emergent geopolitical and energy challenges adding to, rather than replacing, risks we have explored in previous reports. The result is a challenging combined picture for current and future governments, as they steer the public finances through both slow-building pressures and inevitable future shocks. Governments need to anticipate and manage these risks if they are to meet their fiscal objectives and ensure fiscal sustainability over the long term.

[6] HM Government, *The Ten Point Plan for a Green Industrial Revolution*, November 2020.
[7] See Box 3.1 in our October 2021 *Economic and Fiscal Outlook*.

1 Introduction

Background

1.1 The 2011 Budget Responsibility and National Audit Act (BRNA) that OBR set as our main duty *"to examine and report on the sustainability of the public finances"*. In doing so, the Act requires us to explain *"the main assumptions made"* and *"the main risks which [we] consider to be relevant"*. The principal means by which we do this is through our twice-yearly *Economic and fiscal outlooks* (*EFO*s), which we publish alongside the Government's Autumn Budgets and Spring Statements. These reports routinely provide not only our central, medium-term forecasts of the economy and public finances but also: (i) an illustration of the degree of uncertainty around our forecasts (fan charts); (ii) analysis of the sensitivity of those forecasts to changes in key assumptions (sensitivity analysis); and (iii) an exploration of the most important sources of risks and shocks to the outlook (risk and scenario analysis).

1.2 While critical to supporting effective fiscal policy making and informing the public about economic and fiscal prospects, our medium-term *EFO* forecasts can only ever provide a partial picture of the overall sustainability of the public finances and the risks surrounding the fiscal outlook. This is because those forecasts:

- cover only a five-year horizon, while many of the most important drivers of economic and fiscal sustainability unfold over much longer periods – including demographic trends, climate change, and the impact of new technologies or investments; and
- do not routinely consider the risks from high-impact events that have a low probability of occurring in any given year but a high probability of occurring at some point. These 'tail risks', which can have significant consequences for long-term sustainability, include recessions, financial crises, pandemics, energy price shocks, and wars.

1.3 To provide a more comprehensive account of the factors affecting the sustainability of the public finances, we have explored those that lie outside the scope of our semi-annual *EFO*s in two biennial publications. Since 2011, our *Fiscal sustainability reports* (*FSR*s) have provided 50-year projections for the public finances and analysed the underlying trends affecting their sustainability over the long term. And beginning in 2017, our *Fiscal risks reports* (*FRR*s) have considered the key sources of potential shocks to the fiscal outlook over the medium term and threats to the sustainability of the public finances over the long term.

Integrating fiscal risk and sustainability reporting

1.4 The succession of shocks that have buffeted the global and UK economies in recent years have highlighted the challenges of separating consideration of medium-term fiscal risks

from the analysis of long-term fiscal sustainability. This is partly because many of the biggest of these shocks have not only delivered large near-term hits to the economy and public finances but may also have left longer-term scars on the productive potential of the economy and the level of government debt. Evaluating their near-term and longer-term implications in separate publications would fail to capture the full economic and fiscal consequences of these shocks.

1.5 More generally, shocks, by definition, happen at unexpected times, and it is important to good policy making to be able to evaluate their economic and fiscal implications quickly rather than sticking to the timing of biennial *FRR*s and *FSR*s. This latter point was brought home in 2020 when the pandemic required a reorientation of the July 2020 *FSR* towards an initial assessment of the near- and medium-term fiscal risks from the Covid pandemic. The UK's hosting of the 26th UN Climate Change Conference of Parties (COP26) and publication of the Government's *Net Zero Strategy* the following year prompted us to focus on the long-term economic and fiscal implications of the net zero transition in our July 2021 *FRR*.

1.6 Recognising the interplay between fiscal risks and sustainability, the Government has, through the most recent amendments to the *Charter for Budget Responsibility* underpinning the BRNA, reinterpreted the BRNA requirement on us to *"produce an annual sustainability report"* such that it *"will analyse the sustainability of the public finances and the risks thereto"*. This new formulation enables us to combine the biennial *FSR* and *FRR* into a single, annual *Fiscal risks and sustainability* (*FRS*) report and take a more flexible approach to determining its content. In doing so, however, we will continue to track developments affecting both long-term sustainability and medium-term risks by: (i) producing long-term fiscal projections every two years (in line with the ONS release of updated population projections); and (ii) reporting progress against the full 94-item fiscal risk register from the last *FRR* in alternating years.

Context for this report

1.7 Our 2021 *FRR* noted that, in contrast to the relatively benign economic environment which advanced economies enjoyed towards the end of the 20th century, the start of this century has been marked by a succession of major global shocks including, at that time, the financial crisis and the pandemic. At their peak in the UK, these shocks brought about the two largest post-war falls in output (of 4.2 per cent in 2009 and 9.3 per cent in 2020) and largest budget deficits (of 10.1 per cent of GDP in 2009-10 and 14.5 per cent of GDP in 2020-21). Together they contributed to a more than doubling of government debt from below 40 to over 90 per cent of GDP, although the additional burden that this debt has placed on the public finances has been greatly mitigated by a more than halving in the average interest rate on that debt from 5.9 per cent in 2007-08 to 2.4 per cent in 2021-22.

1.8 The Russian invasion of Ukraine has delivered a third major shock to the UK and global economies and public finances in the first quarter of this century. Gas prices are at all-time highs, real oil prices are at relatively similar levels to the late 1970s and early 1980s, and inflation has risen to levels last seen the early 1980s. Governments across advanced

countries have once again provided large-scale and novel fiscal support to cushion the impact of this latest shock on households. In the UK, the £30 billion net cost of discretionary fiscal support extended by the Government in February, March and May of this year is, at around 1.3 per cent of GDP, similar in size to the fiscal support extended at the height of the financial crisis, although still a fraction of the 3.5 per cent of GDP in support to households at the height of the pandemic.[1] And like both the financial crisis and the pandemic, the Russian invasion could also have longer-term implications for the productivity of the UK economy and sustainability of the public finances if it augurs a period of permanently higher energy prices or a more hostile geopolitical environment.

1.9 In their efforts to steer their economies and public finances through these more turbulent waters, governments across advanced economies also had to contend with rising economic and fiscal headwinds. These come from a range of long-term trends including, in the UK:

- an **ageing population** with the peak of the baby-boom population retiring in the early 2030s and the birth rate reaching an all-time low last year;
- **declining productivity growth**, which has averaged less than 1 per cent a year so far this century compared to nearly 2 per cent in the final two decades of the last century;
- **recently rising interest rates** after a sustained period of declines, with 10-year gilt rates having risen from 0.2 per cent in mid-2020 to 2.5 per cent in the middle of this year; and
- the costs of tackling **climate change** and meeting our commitments to reaching net zero carbon emissions by 2050, which our 2021 *FRR* estimated could cost the Government over 2 per cent of GDP a year over the next three decades.

Structure of this report

1.10 In the wake of this latest global shock to the UK economy and public finances, and in the context of these burgeoning fiscal pressures, this first combined *FRS* explores three major threats to fiscal sustainability.

1.11 Chapter 2 considers the economic and fiscal risks associated with **rising geopolitical tensions**. The Russian invasion of Ukraine has seen the tragedy of armed conflict return to the European continent for the first time in this century. It has already prompted a number of Western European countries to commit to reversing the half-century trend of falling defence spending as a share of national income. It has also led advanced economies to impose a wide array of economic sanctions on Russia, which has responded with its own

[1] Comparing the cost of policy decisions at Spring Statement 2022 and the Government's estimates of the May cost of living package for the four quarters of 2022-23 (excluding student loans) with the cost of net fiscal giveaways in 2008-09 and 2009-10 covered by the 2008 Pre-Budget Report and Budget 2009 over the five quarters from the first quarter of 2009 up to the first quarter of 2010. The latter excludes the cost of balance sheet interventions to support the financial system, which mostly took the form of loans and equity stakes – and have subsequently been largely recouped (as set out in Annex B of our March 2022 *EFO*). Pandemic support has been calculated based on 'support for households' in Table 3.27 of our October 2022 *EFO*. Total pandemic support, including that provided for business and public services, amounted to 10.4 per cent of GDP.

retaliatory measures on Western countries. This 'economic warfare' represents perhaps the most dramatic illustration of a more general slowdown in the pace of global economic integration and subordination of economic interests to geopolitical and national security objectives. And it comes on the back of post-pandemic initiatives to 'reshore' activities that were previously outsourced to other countries so as to shorten supply chains and improve their resilience. In this context, the chapter considers the potential pressures on conventional UK defence spending in the wake of the Russian invasion, economic and fiscal threats from new forms of warfare in the form of cyber-attacks, and risks to the UK economy and public finances from a reversal of globalisation.

1.12 Chapter 3 analyses the economic and fiscal consequences of **higher energy prices**. The most immediate economic consequence of the Russian invasion of Ukraine for the UK has been the dramatic increase in global oil and gas prices, which had already risen as a result of pent-up demand pressures and supply bottlenecks following the lifting of pandemic-related restrictions last year. Tackling climate change and successfully transitioning to net zero carbon emissions is also likely to require a sustained increase in fossil fuel prices and a shift away from natural gas as the UK's principal energy source. The chapter explores the economic and fiscal consequences of both oil and gas prices spiking higher and also of an alternative scenario where they remain elevated for a longer period than assumed in our March 2022 *EFO* forecast. It also looks at the fiscal challenges associated with making the transition away from fossil fuels to more sustainable and secure energy sources.

1.13 Chapter 4 looks at **long-term fiscal pressures**. It updates our 50-year economic and fiscal projections for changes in the medium-term fiscal position and our expectations for key long-run demographic and other determinants in the aftermath of the pandemic. Our first full update of these projections since 2018, it incorporates the ONS's 2022 long-term population projections and increases in the tax burden and size of the post-pandemic state, and examines their impact on various metrics for fiscal sustainability. It also considers how the risks discussed in earlier chapters could affect the public finances over the longer term.

1.14 This report does not attempt to cover the universe of potential threats to the public finances or provide updates on developments in managing risks identified in previous reports. Our next *FRS* in 2023 will provide a more comprehensive overview of developments against the wider range of 94 fiscal risks highlighted in our last *FRR*. However, with Covid continuing to claim lives and disrupt economic activity around the globe and infections once again on the rise in the UK, Box 1.1 discusses the economic and fiscal risks posed by the potential emergence of a vaccine-escaping variant of the virus.

Box 1.1: Pandemic risk scenario: the emergence of a vaccine-escaping variant

The pandemic was the largest shock to the UK economy in a century. While successful vaccines have enabled much of our economic lives to return to normal, the emergence of new vaccine-escaping Covid variants remains a key downside risk. Over the past two years, the UK has seen four major waves of infections caused by different variants, and public health experts have warned that Omicron is unlikely to be the last.[a]

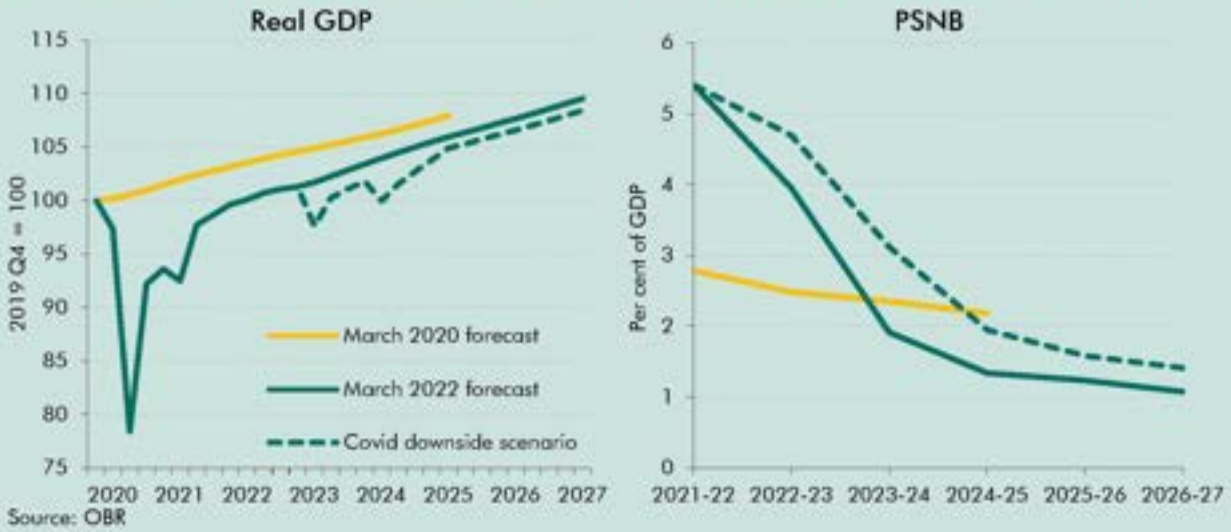
As of the middle of June, Covid infections in the UK had doubled on a month earlier, albeit from a low base, with the ONS estimating that over 2 per cent of the population had Covid. In common with other European countries, the US and South Africa, this has been caused by the growing prevalence of new Omicron variants (especially BA.4 and BA.5). Thankfully, as yet, deaths remain low though hospitalisations have risen, suggesting current vaccines remain effective in combating serious illness.

However, to illustrate the ongoing economic and fiscal risks associated with the potential emergence of a new, vaccine-escaping variant of covid, our March 2022 *EFO* included a Covid downside scenario that assumes:

- A new, vaccine-escaping Covid variant emerges in winter 2022-23 with a **health impact** broadly between the Alpha and Omicron waves.[b]
- The variant is **as contagious as Omicron** but causes more severe illness and requires existing vaccines to be adapted, then manufactured and rolled out.
- Adapting **vaccines** takes three-to-four months with rollout to the majority of the adult population taking another three months.[c] The first wave of infections peaks before the adapted vaccines can be rolled out, but they help to limit the health impact of the following winter's second wave.
- A fall in **mobility** that is broadly between the Alpha and Omicron waves, due to a combination of additional public health restrictions and greater voluntary social distancing, that eases by the end of the first quarter of 2023 as infections fall.
- The **GDP** impact of this fall in mobility is calibrated to 2021 outturns rather than 2020, to reflect the adaptation of the economy to public health restrictions during the pandemic.[d] Greater adaptation would further lessen the economic impact.
- Government **fiscal support** is proportionate to the economic impact of previous waves of infections.

Under these assumptions, GDP falls 3.5 per cent in the first quarter of 2023, then recovers from the second quarter as infections fall and the vaccine is rolled out. The second wave of infections causes GDP to fall by 1.8 per cent in the first quarter of 2024, around half as bad as the first wave. Sectors most affected by previous waves, such as transport, travel and hospitality, drive the fall in GDP. In the medium term, there is an additional 1 percentage point scarring to potential output compared to our central forecast (Chart A). The additional scarring is caused by lower labour supply (for example due to greater long-term sickness) and a larger fall in productivity (for example because firms face further production inefficiencies from continuing to operate under the pandemic).

Chart A: Real GDP and government borrowing in the Covid downside scenario



Source: OBR

The scenario increases borrowing by 0.8 per cent of GDP in 2022-23 and by 1.4 per cent of GDP in 2023-24 relative to our central forecast, falling to 0.3 per cent above the central forecast by 2026-27. The effect in 2022-23 is mostly due to the assumption of further discretionary fiscal support that is proportionate to the fall in GDP. Tax receipts move broadly in line with GDP (with some delayed effect due to the time lags in self-assessment payments). But spending as a share of GDP remains higher than our central forecast in every year due to the 1 per cent scarring of nominal GDP, which raises spending as a share of GDP in 2026-27 by 0.4 percentage points. Debt is 3.6 per cent of GDP higher by 2026-27, largely as a result of higher cumulative borrowing, as well as the smaller denominator.

[a] For example, see New and Emerging Respiratory Virus Threats Advisory Group, *Long term evolution of SARS-CoV2*, February 2022.
[b] Our scenario is similar to the 'Scenario 3: Central Pessimistic' in: Scientific Advisory Group for Emergencies, *Viral Evolution Scenarios*, February 2022.
[c] We assume a similar rollout pace to booster vaccines in the final quarter of 2021, which reached around 60 per cent of those aged 12 and over in three months.
[d] See Box 2.5 of our March 2021 *EFO*.

Management of fiscal risks

1.15 Our previous *FRR*s have included discussions of how the Government manages fiscal risks. Since our last report there have been several significant developments:

- The Government has formally recognised the desirability of **monitoring a broader range of fiscal indicators** in addition to the measures covered by its fiscal targets. In its updated *Charter for Budget Responsibility* the Government states its intention to monitor the evolution of the broader public sector balance sheet and the affordability of public debt. To facilitate this monitoring, we show how a variety of balance sheet measures (including public sector net worth) and affordability metrics (including debt interest payments as a share of revenue) perform over the medium term in our *EFO*s. In Chapter 4 of this report we project these measures over the long term.

- The Government has created a new role (Head of the Government Risk Profession) responsible for driving the Government's **risk management strategy and delivery plan**, which sets out actions to better integrate high-quality, effective risk management into wider government processes over the next two-to-three years, including training for both risk professionals and non-specialists. In addition, the Government's Risk Centre of Excellence has published a number of pieces of guidance to help officials deliver specific aspects of risk management (for example, guidance on risk appetite, published in August 2021) and has recently moved into HM Treasury to increase alignment with planning and performance management.

- **Contingent liabilities** have become an increasingly popular tool for Government to achieve policy objectives, but management and oversight has historically been weak. In recent years the Government has made a number of improvements in the area including conducting and publishing a *Balance sheet review*, and introducing new guidance under the contingent liability approval framework. In 2021, the Government went further by launching the Contingent Liability Central Capacity (CLCC) within UK Government Investments. The CLCC has three strategic objectives that aim to ensure the Government understands and manages its contingent liabilities effectively. These are to: (i) review and report on existing contingent liabilities; (ii) provide advice and analysis on new and existing contingent liability proposals; and (iii) provide guidance and promote sharing of best practice. On 23 June the CLCC produced a report of its first year and laid out plans for the future.[2]

1.16 More broadly, the Government continues to maintain a National Risk Register. One lesson we drew from the experience of the pandemic was to ensure that our risk analysis took account of this broader risk assessment, as discussed in Box 1.2.

Box 1.2: National Risk Register

The National Risk Register (NRR) provides the Government's assessment of the likelihood and potential impacts of a range of risks to the safety and security of the UK.[a] It covers a broad range of risks arising from: malicious attacks, serious and organised crime, environmental hazards, human and animal health, major accidents and societal risks. As we do in our fiscal risk reporting, the NRR places risks in a matrix of impact and likelihood (Table A).

Most of the risks listed in the NRR (32 of the 38 risks in total) have indicative economic impacts under £1 billion and so are unlikely to be large enough to merit a specific focus in our work. Where risks, such as crime, are common, and the fiscal consequences covered by departmental budgets, they may be thought of as already in our baseline and so do not represent additional fiscal risks. That said, a growing number of major risks on the NRR have now been explicitly covered in our work. Looking at the largest NRR risks (those with an indicative economic impact greater than £1 billion):

[2] UK Government Investments, *The contingent liability central capability*, June 2022.

- Our first *FRR* in 2017 included a stress test looking at the fiscal implications of another major financial crisis.
- Our 2019 and 2021 *FRRs* looked at the fiscal risks from unmitigated climate change, which encapsulate some of the environmental hazards included in the NRR, including increased coastal and river flooding.
- Our 2021 *FRR* also reviewed the lessons from the Covid pandemic, and this report summarises the potential risks of a vaccine-escaping variant.
- Chapter 2 of this *FRS* covers the growing risks from cyber-attacks and rising geopolitical tensions which are the source of several risks of malicious attacks identified in the NRR.
- Chapter 3 of this *FRS* discusses the fiscal risks associated with the construction of new nuclear power plants, but does not explicitly address the risks of a major nuclear accident – a high-impact but very low-likelihood risk identified on the NRR.

The NRR will be updated later this year and we will continue to use it to inform our risk reporting.

Table A: The National Risk Register's risk assessment matrix

Impact	Likelihood				
	<1 in 500	1 to 5 in 500	5 to 25 in 500	25 to 125 in 500	>125 in 500
Level A			- Undermining the democratic process - Earthquakes	- System failures	
Level B	- Major transport accidents	- Wildfires	- Industrial incidents - non nuclear	- Cyber attacks - Smaller-scale CBRN attacks[1] - Serious and organised crime[2] - Environmental disaster overseas - Commercial failures - Industrial action	- Attacks on accessible locations
Level C		- Droughts - Animal diseases - Systematic financial crisis - Major fires	- Surface water flooding - Severe space weather - Poor air quality - High-consequence infectious disease outbreak - Antimicrobial resistance - Widespread public disorder	- Attacks on infrastructure - Attacks on transport - Medium-scale CBRN attacks - Storms - Low temperatures - Heatwaves - Volcanic eruptions	
Level D	- Industrial accidents - nuclear		- Costal flooding - River flooding - Widespread electricity failure		
Level E			- Larger-scale CBRN attacks - Pandemics		

[1] CBRN attacks stands for chemical, biological, radiological and nuclear attacks.
[2] Serious and organised crime includes vulnerabilities, prosperity and commodities.
Note: The placement of risks comes from the Risk Matrix in the 2020 NRR. A likelihood depends on the risk of the reasonable worst-case scenario occurring in the next year. The impact level is determined by the NRR's impact indicators, with Level A being the smallest impact and Level E being the largest impact.

[v] HM Government, *National Risk Register 2020*, December 2020.

2 Rising geopolitical tensions

Introduction

2.1 This chapter explores the economic and fiscal risks associated with rising geopolitical tensions. Armed conflict has been the largest single source of fiscal risk in the UK over the past three centuries. And various forms of conventional, unconventional, and cyber-attacks have consistently featured among the top risks identified in the Government's National Risk Register.[1] The Russian invasion of Ukraine in February 2022 has served as a stark reminder of the seriousness and immediacy of these security threats. And rising geopolitical tensions have also manifested themselves in a slowdown in global economic integration, both in the scope and ambition of global and regional trade agreements and in the pace of growth in cross-border trade and investment since the start of the century. The US-China trade war, UK departure from the EU, and supply chain disruptions wrought by the pandemic have further contributed to this trend toward global economic fragmentation.

2.2 To explore the potential fiscal risks presented by rising geopolitical tensions, this chapter

- assesses the **historical impact of geopolitical conflict** on the UK's public finances over the past three centuries;
- discusses the **pressures on defence expenditure** in the UK and other countries in the wake of the Russian invasion of Ukraine;
- considers the threats to the economy and public finances associated with a new mode of warfare, in the form of **cyber-attacks**;
- reviews trends in global economic integration and risks to the UK from a return to **global economic fragmentation**; and
- estimates the potential economic and fiscal costs that could result from a combination of rising global security risks and declining global economic cooperation through a **geopolitical stress test**.

[1] The Government's updated *National Risk Register 2020* includes eight types of malicious attack including cyber and 'CBRN' (chemical, biological, radioactive and nuclear) attacks of different scales, and various forms of terrorist attacks.

Geopolitical tensions and fiscal outcomes through history

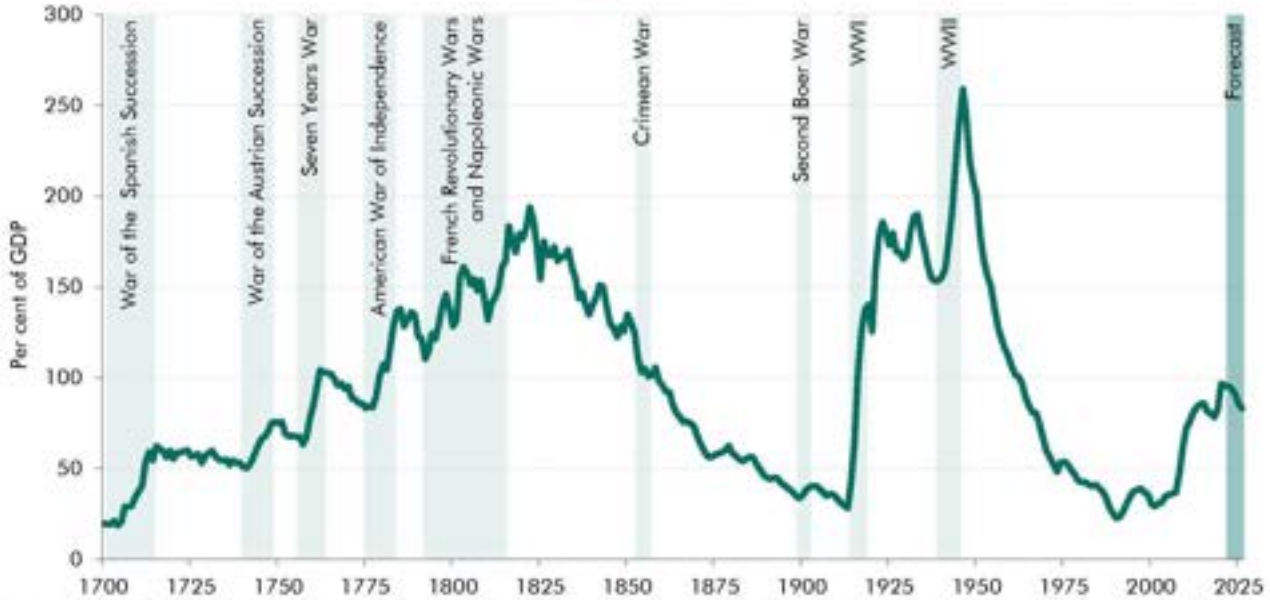
2.3 Historically, geopolitical tensions and the armed conflicts arising from them have been the most important drivers of fiscal performance in the UK. Over the past three centuries, the geopolitical environment has shaped levels of government spending, revenues, borrowing, and debt in three distinct channels:

- periods of **total war** have required dramatic increases in government borrowing to finance the associated military expenditure and left behind a legacy of significantly higher government debt that often persists for decades;
- periods of **heightened geopolitical tensions** have required sustained higher levels of military expenditure and, often, taxation; and
- periods of **global economic fragmentation** have, by reducing trade, investment, and growth, entailed significant indirect fiscal costs, which have typically outweighed any associated fiscal opportunities.

Periods of total war

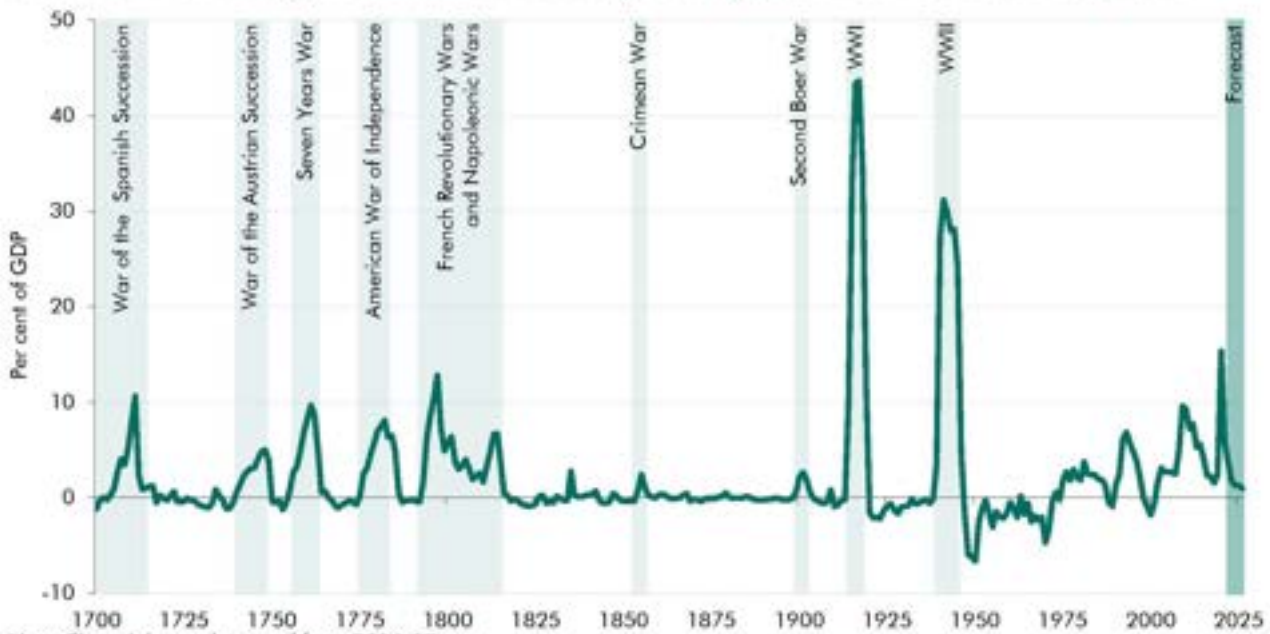
2.4 Periods of total war in which large parts of the economy are mobilised to meet an existential threat have had the most dramatic and lasting fiscal consequences, especially for the level of government debt. Prosecuting the war requires enormous increases in military expenditure funded by similarly dramatic increases in government borrowing, with the costs of servicing the resulting stock of debt falling on present and future generations. Over the past three centuries, the largest increases in government debt have all been associated with periods of armed conflict on the continent of Europe and around the world (i.e. the Napoleonic Wars, World War I (WWI), and World War II (WWII)) that directly threatened the security of the British mainland (Chart 2.1). These conflicts each saw annual borrowing exceed 10 per cent of GDP and added more than 70 per cent of GDP to the stock of debt. It was only with the advent of Keynesianism and growth of the welfare state in the second half of the twentieth century, that peacetime shocks (Black Wednesday in 1992, the financial crisis in 2008, and the pandemic in 2020) supplanted wars as a factor driving government borrowing above 5 per cent of GDP in any given year (Chart 2.2).

Chart 2.1: Public sector net debt during periods of conflict and peace



Note: Financial year data used from 2016-17. Highlighted periods represent conflicts where annual central government borrowing exceeded 2 per cent of GDP in any one year.
Source: Bank of England, OBR

Chart 2.2: Central government borrowing during periods of conflict and peace



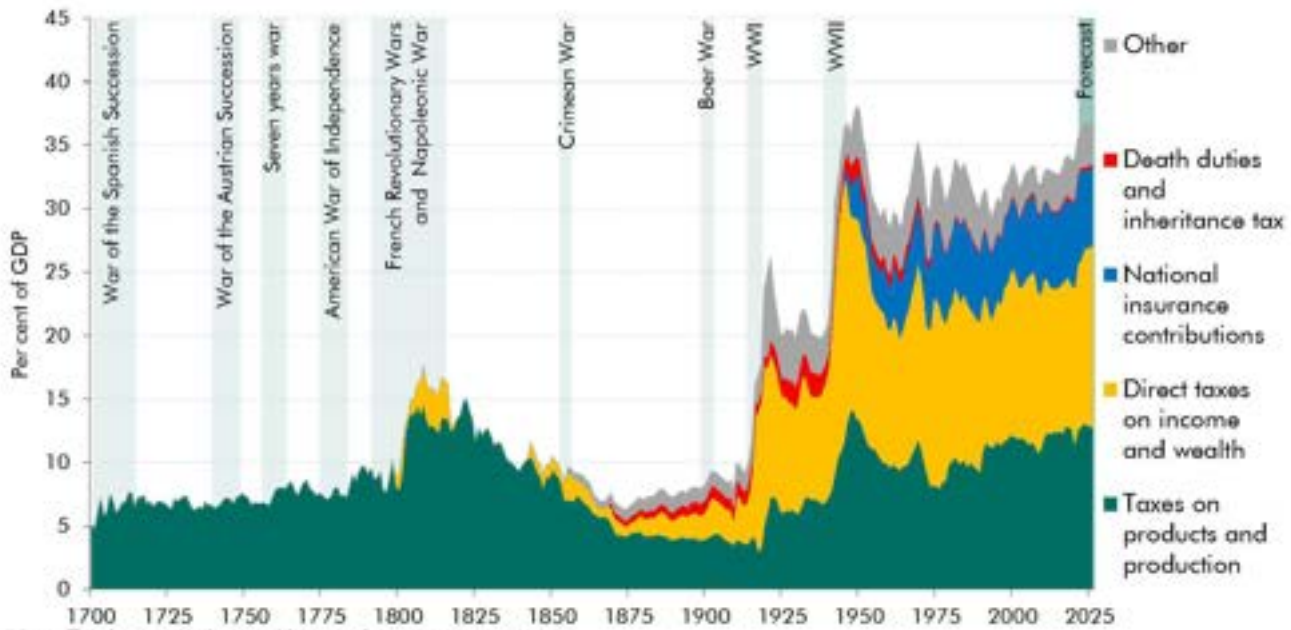
Note: Financial year data used from 2016-17.
Source: Bank of England, OBR

2.5 These periods of total war have often required governments to find new sources of revenue to finance the prosecution of the war itself, a higher post-war debt stock, and a larger post-war state. The Napoleonic, First, and Second World Wars were associated with increases in the tax burden of 7, 14, and 17 per cent of GDP respectively between the start and end of these conflicts, although with some fall-back after each. Indeed an income tax was first introduced in the UK in 1799, when Britain was at war with revolutionary France, in order to

finance the large outlay on the army and navy.[2] Although initially unpopular, with public pressure leading to its abolition in 1816, it was later reintroduced in 1842 as a temporary measure, in order to allow for the removal of import and export duties.[3] The Crimean War of 1853-56, however, led to government once again seeking new sources of revenue, and income tax thereafter became a mainstay of government tax policy. Formally, it remains a temporary tax that must be renewed by Parliament in each year's Finance Act.

2.6 WWI saw a significant expansion of the income tax with the standard rate rising from 6 per cent to 30 per cent between the beginning and end of the war, and the number of people paying income tax almost trebling from around 1 million in 1914 to 3 million in 1920.[4] These factors combined led to it supplanting taxes on products and production – e.g. excise duties – as the main source of government revenue (Chart 2.3). WWII, once again, saw tax rates rise, with the introduction of the purchase tax in 1940 – the predecessor to VAT – and the PAYE (pay-as-you-earn) system in 1944.[5] National Insurance contributions were introduced in 1948 to fund the creation of the NHS and expansion of the welfare state in the aftermath of WWII, but also helped to service the over 250 per cent of GDP in debt it left behind.

Chart 2.3: Government revenue during periods of conflict and peace



Note: Totals are consistent with central government revenue.
Source: Bank of England, OBR

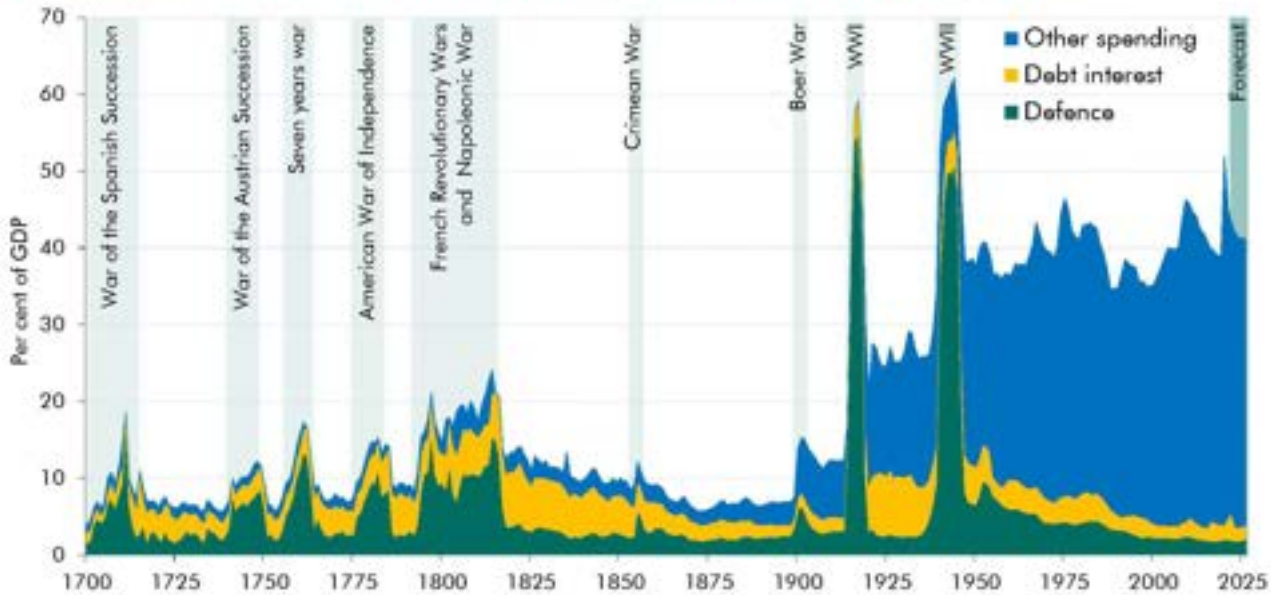
Periods of heightened geopolitical tensions

2.7 Periods of heightened geopolitical tensions that fell short of total war have also been an important driver of the level and composition of tax and spending. Outside periods of armed conflict (both total wars and more limited ones like the American Revolutionary,

[2] UK Parliament, *War and the coming of income tax*, accessed 23 June 2022.
[3] UK Parliament, *Income tax abolished and reintroduced*, accessed 23 June 2022.
[4] UK Parliament, *Taxation during the First World War*, accessed 23 June 2022.
[5] UK Parliament, *The cost of war*, accessed 23 June 2022.

Crimean, and Boer Wars), UK defence spending has only exceeded 4 per cent of GDP on a sustained basis during the four decades of the Cold War (Chart 2.4). Between the outbreak of the Korean War in 1950 and fall of the Berlin Wall in 1989, the UK spent around 5 per cent of GDP on average to maintain a sizable military presence in Europe, the Middle East, and Asia.[6] By contrast, the relatively large armed forces that Britain maintained throughout the 19th century period of imperial expansion were funded in part by taxes and other levies on countries colonised by Britain, with the resulting revenue and expenditure falling outside the definition of UK government revenue and expenditure.

Chart 2.4: Government spending during periods of conflict and peace

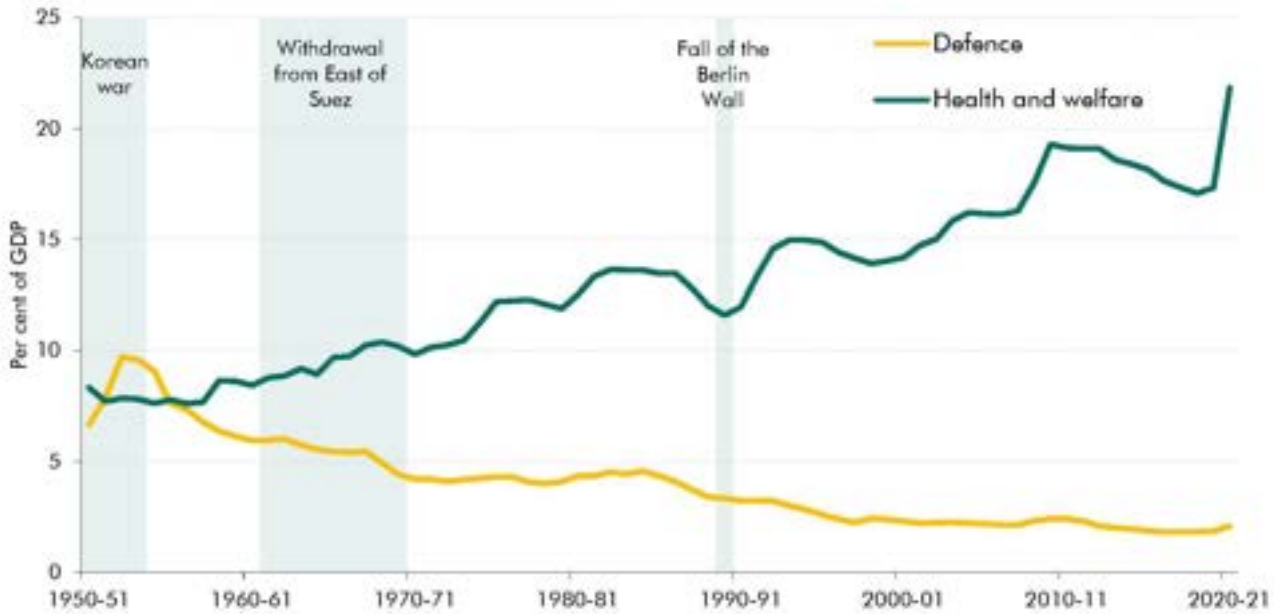


Note: Financial year data used from 1955-56. Totals are consistent with central government spending pre-1900 and total managed expenditure thereafter.
Source: Bank of England, HM Treasury, IFS, Mitchell, OBR

2.8 The gradual reduction in the size of the UK's conventional and nuclear forces in the years after the Korean war, alongside a rising tax burden, helped to fund the gradual expansion of the welfare state over the second half of the 20th century. Between 1952 and 2005, defence spending fell from just under 10 per cent of GDP to 2 per cent (Chart 2.5). In an arithmetic sense, the 8 per cent of GDP reduction can be thought of as funding the entire increase in health and welfare spending over the same 53-year period, which increased from 8 to 16 per cent of GDP. The changes in UK defence policy behind the gradual reduction in the size of the armed forces over the latter part of the 20th century are discussed in more detail below.

[6] The Cold War period also included direct conflicts such as the Falklands War, which raised defence spending.

Chart 2.5: Post-WWII defence, health and welfare spending

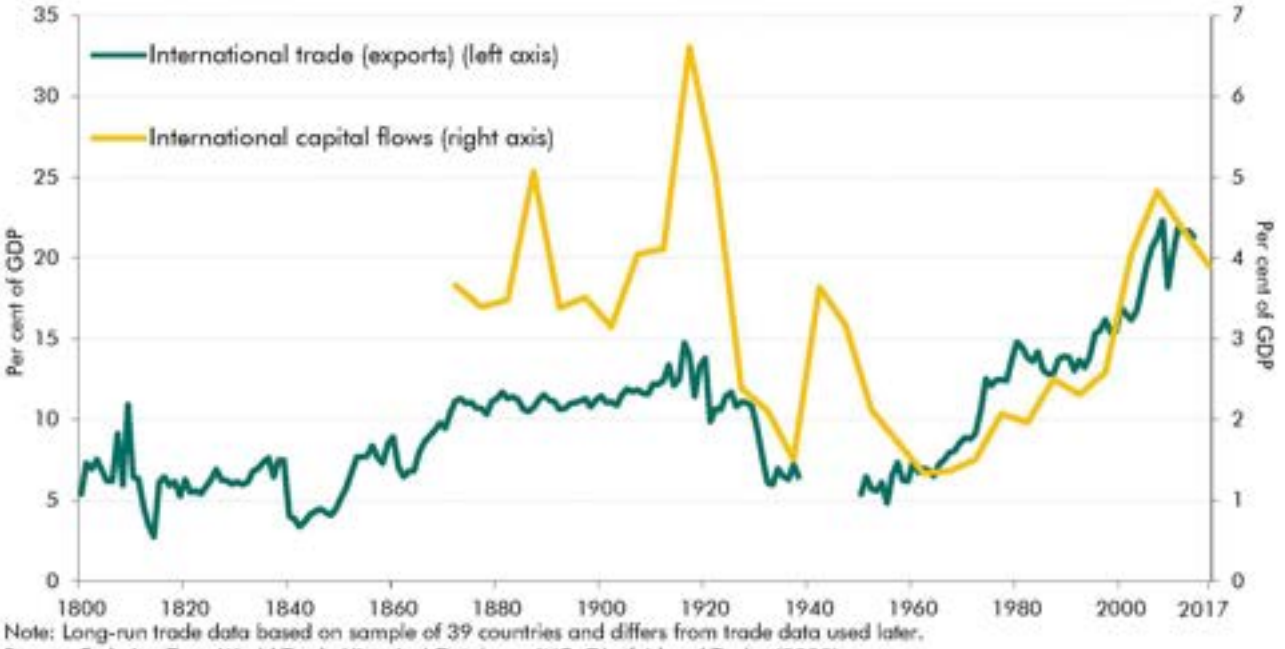


Note: Calendar year data used from 1950 to 1954.
Source: Bank of England, HM Treasury, IFS, OBR

Periods of economic fragmentation

2.9 In addition to their direct impact on the level of defence spending, geopolitical tensions have also affected UK fiscal outcomes indirectly, though no less profoundly, via their impact on the UK economy. The UK has, historically, been one of the most open of the major advanced economies and is therefore more exposed than many to global economic developments, be they positive and negative. Aided by improving transportation technology, Britain was the driving force behind, and one of the principal beneficiaries of, the first wave of global economic integration in the second half of the 19th century. This saw the volume of global trade flows peak at close to 12 per cent of world GDP and global investment flows peak at 4 per cent of GDP in the early 1900s (Chart 2.6). Expanding trade flows created opportunities for UK firms to realise economies of scale, boosting productivity, incomes, and tax receipts. Deepening international capital markets enabled UK firms to access capital required to expand production and the UK government to access the finance to rollover its maturing war debts and fund the occasional deficits at declining real interest rates.

Chart 2.6: Global trade and capital flows as a share of world GDP: 1800 to 2014



Note: Long-run trade data based on sample of 39 countries and differs from trade data used later.
Source: Federico-Tena World Trade Historical Database, IMF, Obstfeld and Taylor (2005)

2.10 However, global economic integration has not been a steady, or indeed unidirectional, process. Instead, the degree of global openness has waxed and waned throughout history, shaped by the geopolitical situation and policy choices of major economic powers of the day. From its pre-war peak of 13 per cent in 1913, trade as a share of global GDP fell back to 5 per cent after WWII and only sustainably passed its pre-WWI peak in 1994 before reaching an all-time high of 22 per cent on the eve of the global financial crisis in 2008. Global capital flows reached a peak of 7 per cent of GDP in 1917 before collapsing to 2 per cent in the aftermath of the two World Wars and only recovering to 5 per cent of GDP on the eve of the global financial crisis.

2.11 The two great waves of global economic integration over the past two centuries were each driven by a single hegemonic economic and military power – either through direct coercion or through the establishment of international institutions designed to promote and manage a more liberal economic order:

- **The UK in the latter half of the 19th century**. In the 19th century, the UK employed a combination of: unilateral tariff removal after the repeal of the Corn Laws in 1846; trade with countries within the British Empire (which by 1914 governed about a quarter of the world's population), a significant part of which was enforced; and military interventions ('gunboat diplomacy') to open up trade, including the two Opium Wars against China in the mid-19th century.

- **The US in the latter half of the 20th century**. This involved the establishment of the General Agreement on Tariffs and Trade (GATT) in 1947 (which became the World Trade Organization (WTO) in 1995) and the Bretton Woods institutions (the International Monetary Fund (IMF) and the World Bank) in 1944. The accession of

former communist countries (including Russia and China) to these institutions, and the forging of regional trade arrangements including the European Union, NAFTA, Mercosur, and ASEAN, added further momentum to global economic integration in the latter part of the 20th century.

2.12 Major world wars have been the biggest disruptors of global trade and investment flows over the past two centuries. During WWI and the decade that followed, world trade fell by 11 per cent, while cross-border capital flows fell 42 per cent during the same period. World trade declined by 20 per cent following WWII, though the damage was somewhat smaller given the significant trade barriers that had already been erected in the inter-war period.[7] This reduction in cross-border trade accounted for a substantial part of the economic cost of the two World Wars – one that has been estimated to have been roughly equal to their 'direct' economic cost in the form of lost lives and physical capital.[8]

2.13 Much of the indirect economic costs of these wars derived not from the conflict itself but from the maintenance, and in some cases enhancement, of trade and investment restrictions in their aftermath. The two World Wars, and the Great Depression in between, saw a retreat from globalisation and a significant fall in global trade. While global exports had recovered to their pre-war levels of 12 per cent of GDP, the Great Depression and rising trade barriers (such as the Smoot-Hawley Tariff Act of 1930, which raised average US tariff rates from 40 to 47 per cent) sent exports plunging to just 6 per cent of global output by 1938.[9] Other countries also made other policy choices that inhibited global trade. With the UK turning towards the Empire and away from the rest of the world under the 'Imperial preference' system, the Empire's share in Britain's imports rose by over 10 percentage points during the 1930s alone.[10]

2.14 As well as substantial trade restrictions, the inter-war period was also characterised by restrictions on the movement of capital. The late 19th to early 20th century saw a significant expansion in the movement of capital particularly from major lenders in Europe such as Britain, Germany, and France to emerging market economies. By 1914, Britain's national savings peaked at 16 per cent of GDP, in large part due to finance investments abroad.[11] After wartime capital controls were lifted, most countries returned to the gold standard, which allowed for considerable capital mobility to return until around 1930.[12] However, economic depression led to the abandonment of the gold standard, and many countries, particularly in central and eastern Europe, Latin America and Japan, chose to introduce their own limits on capital movements including *"administrative controls, with the government centralizing exchange dealings, setting official exchange rates, and hindering the transfer of capital abroad by private citizens to stop capital flight and curb*

[7] Federal Reserve Bank of San Francisco, *Collateral damage: trade disruption and the economic impact of war*, August 2005.
[8] Federal Reserve Bank of San Francisco, *Collateral damage: trade disruption and the economic impact of war*, August 2005.
[9] Irwin, D. A., *From Smoot-Hawley to reciprocal trade agreements: changing the course of U.S. trade policy in the 1930s*, NBER, January 1998.
[10] LSE Business Review, *When Britain turned inward*, December 2018.
[11] Ghosh, A. R., and M. S. Qureshi, *What's in a name? That which we call capital controls*, IMF working paper, February 2016.
[12] Obstfeld, M., and A. M. Taylor, *The Great Depression as a watershed: international capital mobility over the long run*, NBER, January 1998.

speculation."[13] Capital controls remained widespread, particularly on outflows from advanced economies after WWII; indeed the "*original drafts of the IMF's Articles envisaged capital controls as a permanent, structural element of the international financial landscape.*"[14] Capital account liberalisation only became the norm in the 1970s and 1980s, after the US ended convertibility of the dollar to gold.

2.15 In the UK, the interwar years were characterised first by slow growth and rising debt amid high interest rates to return to the gold standard at pre-WWI exchange rates from 1925. The debt burden only began to fall after 1933, after the UK came off the gold standard and the government engaged in debt refinancing (in effect defaulting on some of its US war debt and negotiating interest rate reductions from 5 to 3.5 per cent with some war bond holders in 1932). This period of falling interest rates coincided with declining openness to trade, with the UK introducing the general tariff of 10 per cent on goods in 1932, and reorienting trade towards the Empire. The UK's policy choices are thought to account for a fall in the value of British imports of around 10 per cent in the early 1930s; though overall imports fell by 45 per cent in this period due to collapsing global demand.[15] Trade in goods and services as a proportion of GDP did not return to its 1929 level until 1952. The net result was a squeeze on UK government finances between the wars from (i) a high debt burden; (ii) sluggish growth amid deglobalisation; and (iii) very high interest costs – which only began to ease as the storm clouds of the next World War were gathering in the mid-1930s.

Geopolitical tensions and fiscal risks today

2.16 Having explored how geopolitical tensions have shaped economic and fiscal outcomes over the past, this section considers how the rapidly changing geopolitical environment might affect the UK's economy and public finances in future. While rhetoric has become more heated recently, the UK's membership of NATO and independent nuclear deterrent means that the risk of another conventional total war that directly threatens the UK mainland remains remote. And seeking to estimate the devastating economic and fiscal cost of a nuclear attack on the UK would be both highly speculative and of little practical value to a government and society that would be profoundly altered by such an attack. We therefore focus on three potential ways in which rising geopolitical tensions could impact the UK economy and public finances:

- First, Russia's invasion of Ukraine and more aggressive posture with regard to NATO, as well as ongoing tensions in the Pacific, could create pressure to increase our conventional **defence spending** so as to meet future threats to the UK and our allies.

- Second, while the probability of nuclear or conventional military attack on the UK mainland is remote, the UK's digital connectivity with the rest of the world has created new opportunities for disruption to economic activity within the UK from a distance via **cyber-attacks**. And while most attacks thus far have comprised theft of data and

[13] Mitchener, K. J., and K. Wandschneider, *Capital controls and recovery from the financial crisis of the 1930s*, Journal of International Economics, June 2013.
[14] Ghosh, A. R. and M. S. Qureshi, *What's in a name? That which we call capital controls*, IMF working paper, February 2016.
[15] LSE Business Review, *When Britain turned inward*, December 2018.

relatively minor breaches, the prospect of a large-scale, disruptive cyber incident with major economic and fiscal repercussions is a plausible tail risk.

- Third, the recent slowdown and partial reversal of global trade and investment flows, rising global trade policy tensions, and the increasing use of trade restrictions including sanctions to achieve wider foreign policy aims, have revived fears of a return to **global economic fragmentation** and a reversal of the gains from the deepening of trade and investment links between economies over the past three-quarters of a century.[16]

Defence spending

UK defence spending in the 20th century

2.17 For most of the seven decades following WWII, a steady decline in defence expenditure has, alongside falling interest costs, provided a rare source of 'fiscal space' that successive governments have used to reduce debt and increase spending on other civilian programmes (notably health care). In the UK, this 'peace dividend' came in three waves:

- **Post-WWII demobilisation in the 1940s.** Defence spending fell sharply following the end of WWII from a high of 51 per cent of GDP in 1944 to 7 per cent in 1949. This was accompanied by increased spending on the welfare state with the establishment of non-contributory means-tested income support, the basic state pension and the National Health Service in 1948.[17] The fall in defence spending was interrupted by the brief rise that resulted from the Korean War, with defence spending as a share of GDP peaking at around 10 per cent in 1952. Nevertheless, by the end of the 1950s defence spending had fallen to around 6 per cent of GDP.

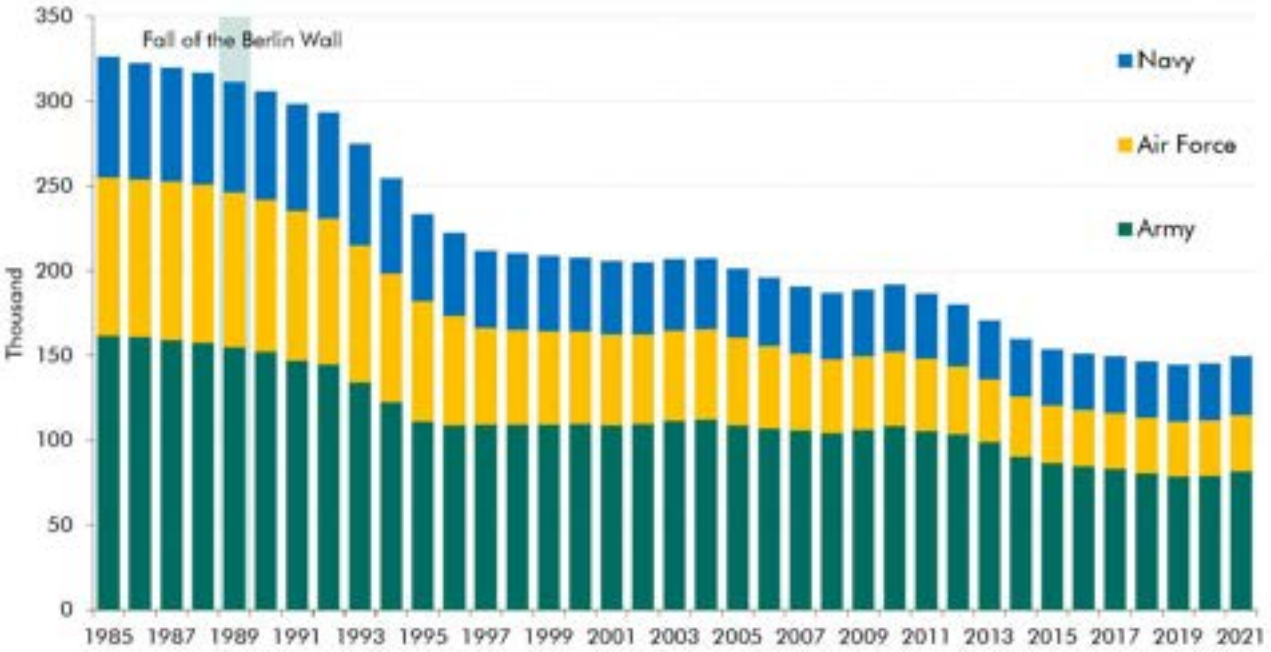
- **Withdrawal from East of Suez in the 1960s.** The late 1950s and 1960s marked a rapid period of decolonisation and realignment of the UK's defence posture towards Europe and NATO with the removal of British troops from overseas military bases in Singapore, Malaysia, the Maldives, and the Persian Gulf.[18] The associated reduction in the size of the armed forces allowed defence spending fall to around 4 per cent of GDP from the beginning of the 1970s to the late 1980s.

- **End of the Cold War in the 1990s.** The end of the Cold War led to a large restructuring of the armed forces, initiated by the 'Options for Change' review in 1990, which sought to reduce spending on defence. There were significant cuts to personnel (Chart 2.7), which fell by around a quarter between 1990 and 1995. Cuts were broadly distributed across the armed forces with reductions to the Royal Naval fleet as well as the removal of army ground forces and closure of Royal Air Force bases in Germany following the fall of the Berlin Wall, collapse of the Soviet Union,

[16] See, for example, Gourinchas, P. O., *Shifting geopolitical tectonic plates*, IMF Finance & Development, June 2022.
[17] UK Parliament, *The benefits of Britain*, accessed 23 June 2022.
[18] Jordan, D., *The Defence Review Dilemma: The British Experience*, 2019.

and accession of former Warsaw Pact countries into the European Union and NATO.[19] This decline in personnel continued throughout the 2000s and 2010s. By 2021, the number of regular armed forces personnel had fallen to almost half the level in 1989.

Chart 2.7: UK regular armed forces personnel since the Cold War



Source: Ministry of Defence

Post-Cold War defence spending in an international context

2.18 The winding down of defence spending relative to GDP following the end of the Cold War was a phenomenon experienced by other major economies. Chart 2.8 shows post-Cold War defence spending as a percentage of GDP for the major advanced economies – France, Germany, Japan, Italy, Canada, the US, and the UK – as well as for Russia and China. According to the Stockholm International Peace Research Institute (SIPRI), the US experienced the largest fall in defence spending as a proportion of GDP between 1989 and 2000, falling by 2.8 percentage points, but rising thereafter reflecting conflicts in Afghanistan and Iraq. The UK meanwhile had the second-largest Cold War peace dividend, with defence spending falling by 1.7 percentage points over the same period. Other G7 countries saw an average post-Cold War peace dividend of 0.6 percentage points reflecting their lower starting points.

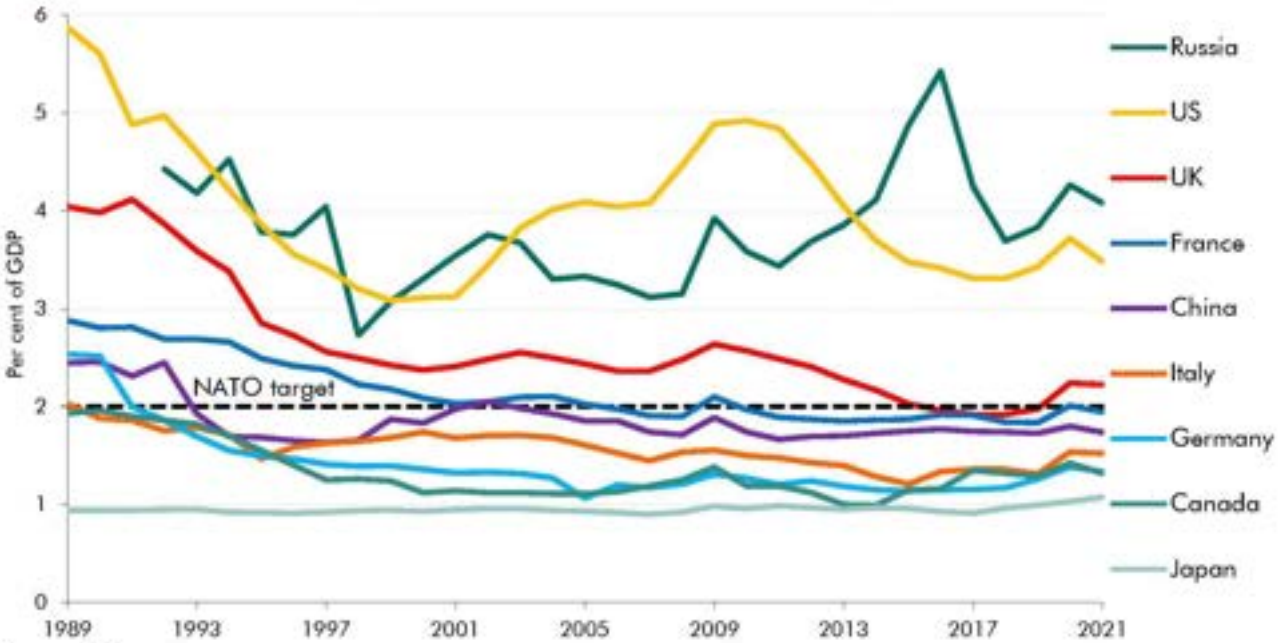
2.19 As a share of GDP, Russia and China's spending on defence has remained broadly stable between the 1990s and today. However, rapid growth of the Chinese economy in that period means this has translated into an almost 13-fold increase in defence spending between 1989 and 2020 (in constant 2020 US dollars).[20] In contrast, US defence spending

[19] House of Commons Library, *A brief guide to previous British defence reviews*, 2020.
[20] Russian and Chinese defence spending is an estimate from SIPRI (2021).

over the same period has risen by 16 per cent on the same metric, UK defence spending has fallen by 2 per cent, and spending by other G7 countries has risen by 3 per cent.[21]

2.20 Despite being the second-largest military spender in NATO in absolute terms, the UK military is the sixth largest in terms of personnel with about 156,000 in uniform in 2022. This compares to 189,000, 207,000 and 1.3 million in Germany, France, and the US respectively.[22] As a proportion of total expenditure, the UK spends comparatively less on personnel and infrastructure compared to other NATO countries and relatively more on military equipment and other expenditure.[23] As a nuclear power, £4.5 billion (over 10 per cent) of the UK's defence budget was used for nuclear deterrence, meaning that £37.9 billion (about 90 per cent) was used for conventional capability in 2020-21.[24]

Chart 2.8: Defence expenditure as a percentage of GDP for G7 economies, Russia and China



Source: SIPRI

Current UK defence spending and policy

2.21 As set out above, reduced demands on UK military capacity since WWII have meant that UK defence spending now stands close to a 150-year low of 2 per cent of GDP.[25] However, spending plans announced in November 2020 signalled an increase in defence spending, with the Government pledging additional funding of over £24 billion over the next four years in cash terms, *"making the UK the largest European spender on defence in NATO and the second largest in the Alliance"*.[26] This spending plan exceeded the Conservative

[21] SIPRI, *SIPRI Military Expenditure Database*, accessed 23 June 2022.
[22] NATO, *Defence Expenditure of NATO Countries (2014-2022)*, June 2022.
[23] NATO, *Defence Expenditures of NATO Countries (2014-2022)*, June 2022.
[24] Ministry of Defence, *Annual Report and Accounts 2020-21*, January 2022.
[25] This is based on comparing current defence spending as a percentage of GDP from HMT PESA tables to historical defence spending and GDP estimates from Bank of England, *A millennium of macroeconomic data*.
[26] HM Treasury, *Spending Review 2020*, November 2020.

manifesto commitment to increase defence spending by 0.5 percentage points above inflation for every year of the Parliament and kept UK defence spending above the 2 per cent of GDP NATO minimum. The Spending Review of November 2020 set out the year-on-year profile of this funding, rising to £47.6 billion in 2024-25, with an implied and average real growth rate between 2019-20 and 2024-25 of 1.8 per cent based on inflation expectations at the time. Despite a modest further cash uplift in the October 2021 Spending Review – to £48.6 billion in 2024-25 – higher forecast inflation meant the settlement was consistent with 1.5 per cent a year real growth on average, down 0.3 percentage points from what had been envisaged in November 2020.

2.22 In March 2021, the Government's Integrated Review of Security, Defence, Development and Foreign Policy (published alongside the Defence Command Paper, the Defence and Security Industrial Strategy, and the National Space Strategy) set out the Government's more detailed plans for this spending, and outlined the UK's defence policy and strategy to 2025. The Review sets out a range of policy aims including to *"adapt to a more competitive and fluid international environment"* referencing challenges in the Indo-Pacific, while remaining clear that the Government's *"commitment to European security is unequivocal"*.[27] It also reaffirmed the UK's commitment to exceed the NATO 2 per cent of GDP spending minimum and to *"remain the largest European spender on defence in NATO"*.

2.23 High inflation in 2022-23 is likely to place further pressure on the defence budget, given it was set in cash terms in the October 2021 Spending Review when inflation was expected to be much lower. In our March 2022 forecast, we revised up CPI inflation by 4.3 percentage points and GDP deflator growth by 1.3 percentage points relative to our October forecast. Although the GDP deflator is the standard metric for measuring public spending in real terms, higher CPI inflation is also likely to impact the Ministry of Defence's (MoD's) budget, given it spends around £600 million a year on energy and fuel (1.4 per cent of the total budget).[28] Using our March 2022 forecasts for the GDP deflator and CPI inflation implies cost pressures of between £0.6 billion and £2.1 billion on the MoD's budget for 2022-23.

2.24 In response to the Russian invasion of Ukraine in February 2022, the Government has since pledged more than £1.55 billion of military equipment (including missiles, and anti-tank and high-explosive weapons) and funding for the Ukrainian military, as part of a support package of over £2.8 billion including both humanitarian and economic aid, £4.1 million to further fund the BBC World Service and tackle disinformation, and further support for the International Criminal Court's investigation into war crimes.[29] This support has been funded from the Treasury's contingency reserve, funds such as the Conflict, Stability and Security Fund, as well as contributions from departments such as the Department for Digital, Culture, Media and Sport (DCMS), and Foreign, Commonwealth & Development Office (FCDO) relating to the BBC World Service. This illustrates a broader point that while in the rest of this chapter we often refer to the MoD's budget as a short-hand for defence

[27] Cabinet Office, *Global Britain in a competitive age: the Integrated Review of Security, Defence, Development and Foreign Policy*, March 2021.
[28] Ministry of Defence, *Annual Report and Accounts 2020-21*, January 2022 and see IFS, *Heightened uncertainty and the spectre of inflation hang over the Spring Statement*, March 2022.
[29] Ministry of Defence, *PM announces major new military support package for Ukraine: 24 March 2022*, March 2022.

spending, in practice 'defence spending' has a far broader definition that cuts across government departments.

Pressures on defence spending

2.25 The implications of the Russian invasion of Ukraine for the UK's public finances depend on what it implies about the severity of future security threats relative what was assumed when spending plans were set, and the extent to which any change in the security environment prompts this or future governments to change spending plans. The range of possible outcomes for future security threats may be two-sided – it could be that the failure of Russia to secure a swift victory plus the increased funding for defence in many NATO countries (see below) means that the UK is more secure now than was expected two years ago. But it could also be that geopolitical threats are greater and likely to remain more elevated than expected and could even return to something approaching Cold War levels of tension between major powers. In either case, the *fiscal* risk associated with potential future changes in defence spending is made more one-sided due to the Government's commitment to meeting the NATO minimum of spending 2 per cent of GDP on defence (Chart 2.9).

2.26 We therefore consider four longer-term scenarios for defence spending, varying from a low of 1 per cent of GDP to a high of 4 per cent by the middle of the next decade. Reflecting the time it would take to ramp up spending that is often subject to long-term contracts and long lead times, these scenarios assume the ultimate level of spending will be reached in a straight line over a decade from the end of the period covered by the existing spending settlement. These four paths roughly equate to two downside and two upside pressures, in which the Government by 2036-37:

- reduces spending down to **1 per cent of GDP**, which would represent a continuation of the long-run post-WWII decline in defence spending and be consistent with a situation in which the Russian threat proved to be less serious than feared and the UK's allies bear more of the financial burden of defending NATO – but would not be consistent with continuing to meet the NATO minimum spending guideline;

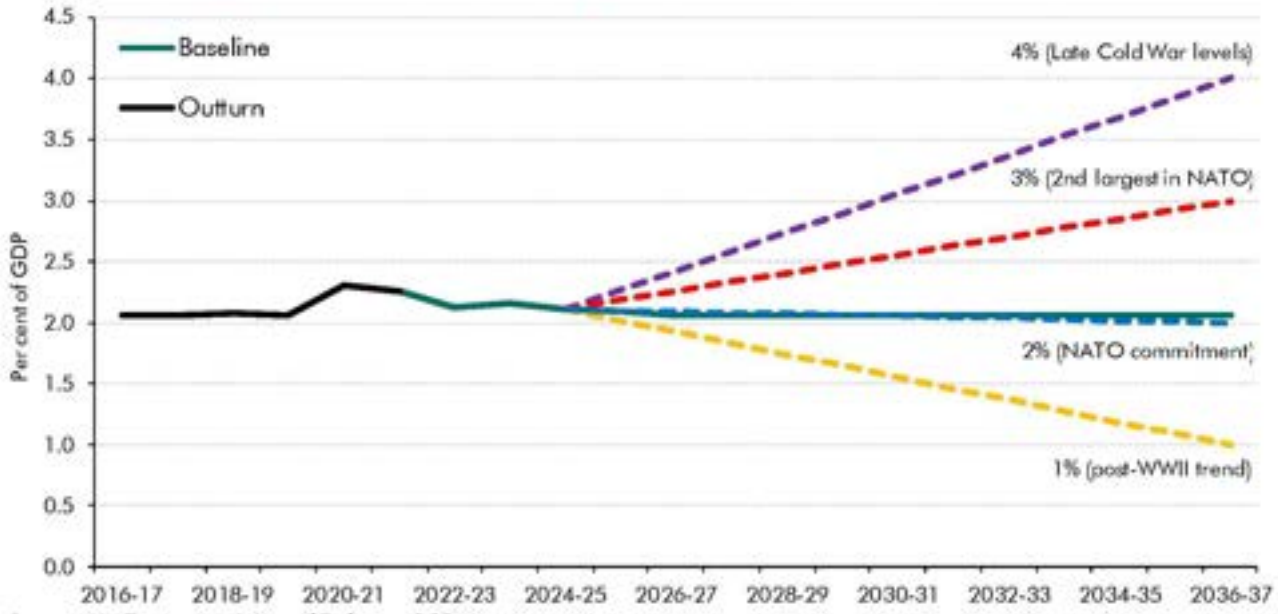
- keeps to the NATO commitment of spending **2 per cent of GDP**, which Government policy currently states acts as a 'floor' on defence spending policy and is exceeded slightly by current Spending Review plans;[30]

- increases spending to **3 per cent of GDP**, which would be consistent with a heightened perceived threat and also maintain our position as the second-largest spender in NATO once the latest commitments of other members are taken into account; and

- increases spending to **4 per cent of GDP**, returning to Cold War levels of resource mobilisation as proxied by a return to average levels of spending over that period.

[30] There are differences between Ministry of Defence budget allocations and the NATO metric of defence spending relevant to the 2 per cent target (which also includes Armed Forces pensions, and other costs of operations that don't form part of the Ministry of Defence budget). To construct a baseline roughly consistent with the NATO metric of defence spending in Chart 2.9, we have added the average historical difference between the two measures to existing Spending Review plans (roughly 0.3 per cent of GDP per year). This baseline then rises in line with DEL assumptions (excluding health and education) in our March 2022 *Economic and fiscal outlook* forecast for 2025-26 and 2026-27, and is then held constant as a percentage of GDP to the forecast horizon in 2036-37.

Chart 2.9: Long-term defence spending scenarios

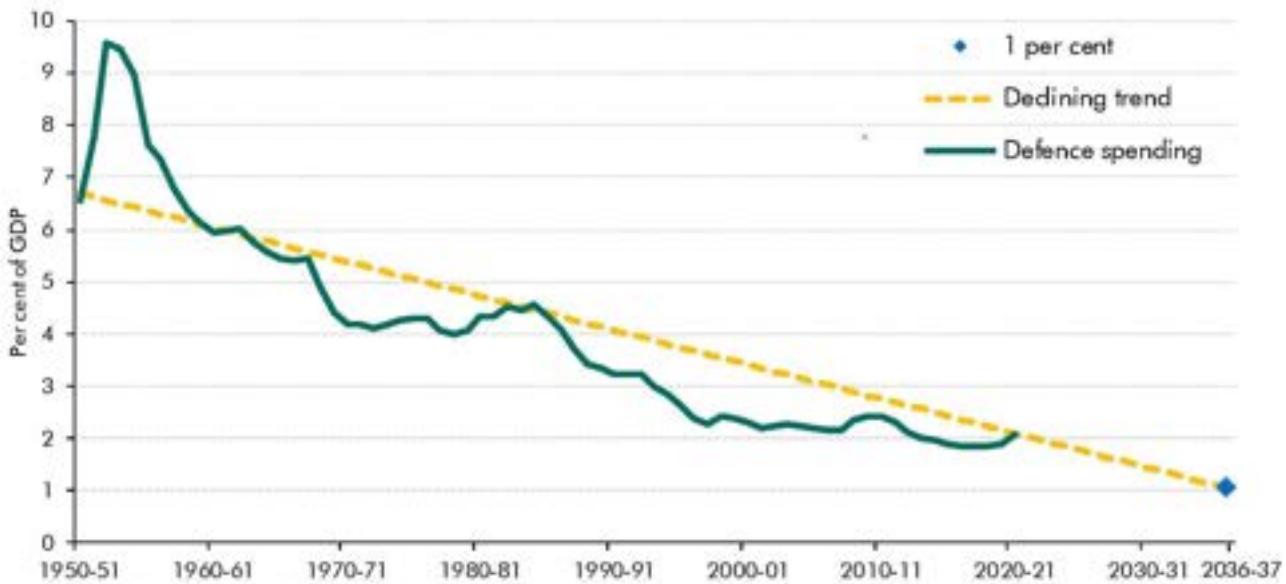


Source: HM Treasury, Ministry of Defence, OBR

1 per cent scenario (continuation of post-WWII trend)

2.27 Extrapolating the historical trend in defence spending from the end of WWII forwards would imply spending falling below the 2 per cent NATO guideline to near to 1 per cent by the middle of the 2030s (Chart 2.10). In today's terms, spending falling to 1 per cent would imply a reduction of £27 billion in defence spending. This could represent a scenario in which the increased spending by other NATO members reduces the burden on UK defence expenditure, or an optimistic scenario in which geopolitical tensions significantly reduced over the next decade. But it would not be consistent with current Government policy of meeting the NATO minimum.

Chart 2.10: Post-WWII trend in defence spending



Note: Calendar year data used from 1950 to 1954.
Source: Bank of England, HM Treasury, OBR

2 per cent scenario (NATO commitment)

2.28 The current defence spending settlement is framed by the NATO 2 per cent minimum, which is over-achieved modestly over the next three years with spending on the NATO definition averaging 2.1 per cent of GDP. The threat assessment underpinning that was set out in the Integrated Review and associated documents. So this scenario would be consistent with the Russian invasion being a development of the type envisaged in the Review, and the resources allocated to defence over the subsequent decade being on a similar scale to now. Since the NATO minimum is currently being over-achieved, spending 2 per cent of GDP would represent a modest 0.1 per cent of GDP saving by 2036-37 (£2 billion in today's terms).

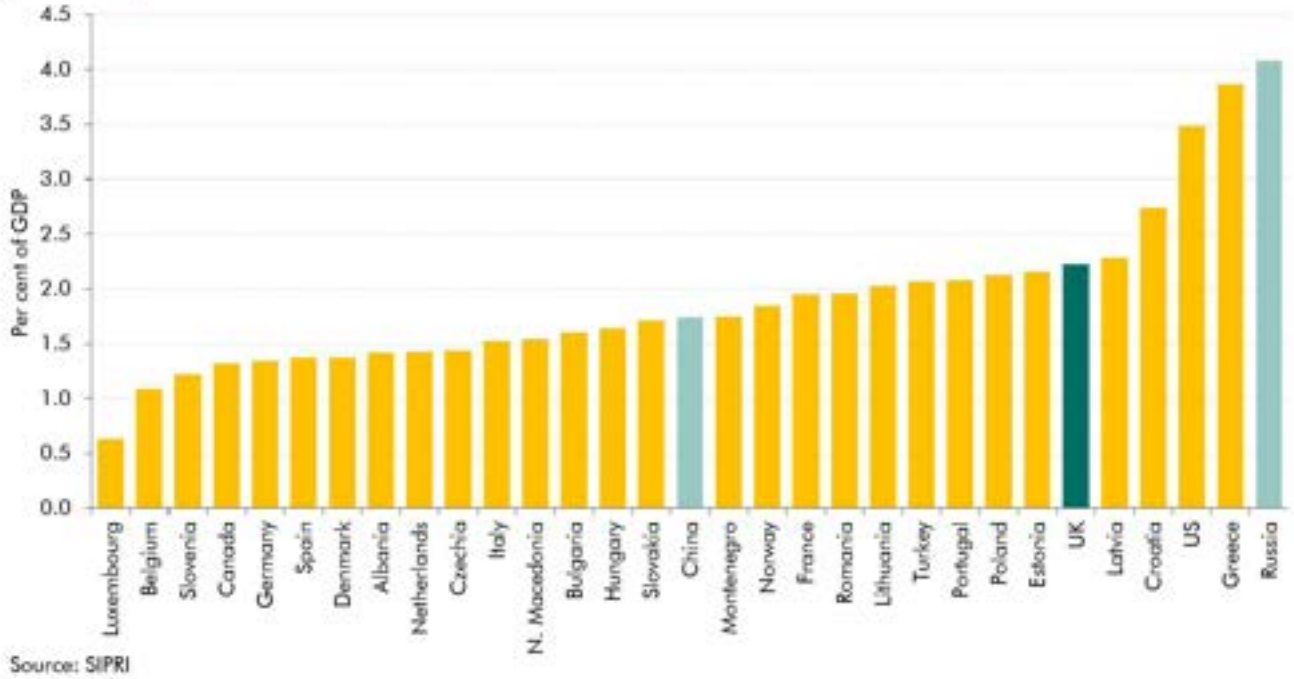
3 per cent scenario (second-highest spending in NATO)

2.29 The UK currently spends more on defence in absolute terms than any other NATO country other than the US. According to NATO estimates, the UK spent $72.2 billion on defence in 2022, compared to $62.7 billion and $55.9 billion spent by Germany and France respectively, the next largest NATO defence spenders.[31] The Government's 2021 Integrated Review highlighted the fact that the UK was *"the second highest defence spender in NATO and highest in Europe"* as a *"UK strength"*. A few smaller NATO members were estimated to spend more than the UK in per cent of GDP terms in 2020 (including Greece), but their smaller economic size means their absolute spending is a fraction of that in the UK.

2.30 Measured in purchasing power parity terms (correcting for different price and wage levels in different countries), only six countries in the world currently spend more on defence than the UK, as derived using data from SIPRI. The US, China, India and Russia spend 12, six, four and three times more respectively than the $64.7 billion that the UK spent in 2020 in purchasing power parity terms, while Saudi Arabia spends twice as much.[32] Expressed as a percentage of GDP, SIPRI estimates that the UK is the fifth-highest defence spender across NATO countries in 2021 (Chart 2.11). It is, however, worth noting that when making international comparisons of defence spending, estimates often vary substantially between organisations due to definitional differences.[33]

[31] NATO, *Defence Expenditure of NATO Countries (2014-2022)*, June 2022.
[32] Ministry of Defence, *International defence expenditure: 2021*, November 2021.
[33] In 2019, the Ministry of Defence's total DEL spending amounted to 1.76 per cent of GDP; the Treasury estimates that the spending on defence in functional terms (i.e. classifying spending by what it does rather than which department delivers it) was 1.87 per cent of GDP; SIPRI estimates that UK defence spending was 1.98 per cent of GDP; and NATO puts it at 2.06 per cent of GDP. These differences will largely relate to what items are captured within each definition (although GDP denominators could also differ). For example, NATO defines defence spending as *"payments by a national government made, or to be made, during the course of the fiscal year to meet the needs of its armed forces, those of Allies or of the Alliance"*, while SIPRI includes expenditure on armed forces, defence ministries and other government agencies engaged in defence projects, paramilitary forces available for military operations, and military space activities in its definition.

Chart 2.11: Defence spending by NATO members, Russia and China, as a percentage of GDP in 2021



Source: SIPRI

2.31 The Russian invasion of Ukraine has changed the international context for defence spending. In the days following the invasion, countries across Europe pledged to reverse decades of cuts and increase defence spending to meet or exceed the 2 per cent of GDP NATO target. These included:

- Four days after the beginning of the Russian invasion, the German Chancellor, Olaf Scholz, pledging to increase **Germany**'s defence spending from 1.5 per cent to more than 2 per cent of GDP by proposing plans to boost spending from a fixed €100 billion fund.[34]
- On 25 February, **Belgium** pledging to increase its defence budget from 1.2 per cent of GDP to 1.5 per cent of GDP by 2030.[35]
- On 1 March, **Romania** announcing plans to increase defence budget from 2.0 per cent of GDP to 2.5 per cent of GDP in 2023. [36]
- On 3 March, **Poland** committing to increase defence budget from 2.1 per cent of GDP to 3 per cent of GDP starting in 2023.
- On 10 March, **Sweden** committing to raising defence spending from 1.3 per cent of GDP to 2 per cent *"as soon as is practically possible"*.

[34] SIPRI, *Explainer: The proposed hike in German military spending*, March 2022.
[35] Reuters, *Belgium to inject another billion euros into its army - L'Echo*, March 2022.
[36] Breaking Defense, *Seven European nations have increased defense budgets in one month. Who will be next?*, March 2022.

- On 16 March, the Parliament in **Italy** voting to raise defence spending from around 1.4 per cent of GDP to 2 per cent of GDP, to be achieved by 2028.
- On 18 March, **Norway** announcing an additional 3 billion Norwegian Krone of defence spending (around 0.1 per cent of Norwegian GDP) for this year.
- In April, **Finland** increasing defence spending by about 0.8 per cent of GDP (€2.2 billion) over the next four years.[37]
- In May, the **Netherlands** pledging to increase defence spending by €5 billion in 2022 and nearly €15 billion by 2025 to meet NATO's 2 per cent of GDP target.[38]

2.32 This increased NATO funding for defence forces should improve the overall capability of the Alliance as a whole relative to previous plans and, all things being equal, reduce pressure on the UK to provide that capability. But from the perspective of maintaining the UK's relative standing as the second-largest defence spender in NATO, it would make that more expensive – in particular due to the German pledge to meet the NATO 2 per cent minimum which would be equivalent to $85 billion in today's terms. As outlined in the Integrated Review, the Government's *"priority actions will be: To reaffirm our commitment to leadership in NATO, supporting its adaptation to threats above and below the threshold of war under international law. We will increase our defence budget by over £24 billion over the next four years and remain the largest European spender on defence in NATO…"*.[39]

2.33 Reaching 3 per cent of GDP would cost an additional £24 billion in today's terms. This would comfortably maintain the UK's position as the second-largest spender in NATO. To match Germany's commitment to spending 2 per cent of GDP in absolute terms, the UK would need to increase its defence budget by £11.5 billion in today's terms based on comparisons of GDP at market rates (to around 2.5 per cent of GDP), or £18.7 billion if comparing in purchasing power parity terms (2.8 per cent of GDP).[40]

4 per cent scenario (returning to Cold War levels of expenditure)

2.34 Matching the latest spending commitments of our European allies would still leave UK defence spending as a proportion of GDP below the levels prevailing over the past half-century. Were Russia's invasion of Ukraine and subsequent events to augur the return to a global security environment more akin to the Cold War, this could see still higher levels of resource mobilisation for defence. For example, returning to the average level of defence expenditure in the last decade of the Cold War would imply spending rising to around 4 per cent of GDP. The evolution of technology and the nature of military, political and economic threats faced by the UK today obviously differ to those in the last decade of the Cold War,

[37] Ministry of Defence of Finland, *National defence budget to be increased significantly*, April 2022.
[38] Dutch News, *Defence boost is 'biggest investment' since end of the Cold War*, June 2022.
[39] Cabinet Office, *Global Britain in a competitive age: the Integrated Review of Security, Defence, Development and Foreign Policy*, March 2021.
[40] NATO comparisons of defence spending in absolute terms are published in current (and constant) US dollars. However, wider international comparisons are often made on a purchasing power parity basis. These comparisons are based on the sterling-euro market and PPP exchange rates used by the IMF's World Economic Outlook, a yearly average updated in April 2022. Exchange rate movements over the projection period would likely have a material effect on the actual figures.

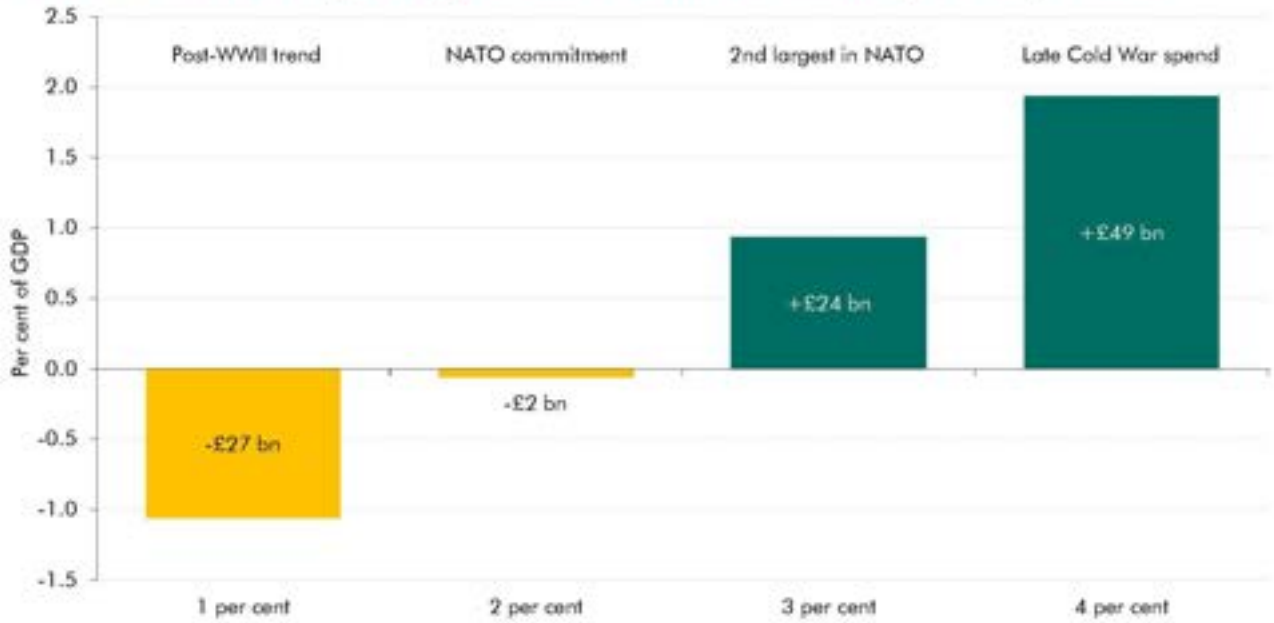
so this period is simply used to illustrate a scenario in which tensions between major powers were significantly greater (Chart 2.10). This would require an increase in spending in 2036-37 of 1.9 per cent of GDP, or £49 billion in today's terms.

Summary of defence spending scenarios

2.35 As summarised in Chart 2.12, how the level of defence expenditure responds to changes in the geopolitical environment over the coming years has important implications for the degree of fiscal space available to future governments to cope with other shocks and pressures. Relative to the 2.1 per cent of GDP of defence expenditure (on the NATO definition) assumed in our long-term fiscal projections and expressed in today's terms:

- were defence spending to continue its long-run post-WWII trend decline to 1 per cent of GDP, this would save £27 billion;
- just meeting the NATO two per cent of GDP commitment would save £2 billion given the current modest over-achievement that is rolled forward in our projections;[41]
- increasing spending to 3 per cent of GDP would maintain our position as the second-largest defence spender in NATO even after the latest commitments by Germany, but would cost an additional £24 billion; and
- increasing spending to 4 per cent of GDP would return us to late Cold War levels of resource mobilisation but cost an additional £49 billion.

Chart 2.12: Defence spending scenarios relative to baseline, in today's terms



Note: Figures in £ billion are expressed in today's terms i.e. the £ billion equivalent of each percentage as a per cent of 2022-23 GDP.
Source: OBR

[41] Our baseline is the Spending Review 2021 settlement to 2024-25, increased in line with the growth of the overall DEL envelope (excluding health and education spending) in our March 2022 forecast from 2025-26 to 2026-27, then held constant from this point onwards as a share of GDP to the forecast horizon, at 2.1 per cent of GDP.

Cyber risks

2.36 In addition to the pressures on conventional defence spending discussed above, the UK also faces the changing nature of warfare and, in particular, the growing threat of cyber-attacks. 'Cyber risk' can encompass a broad range of threats to online devices and services, with a diverse range of potential impacts on national security, the economy, and the public finances. This includes cyber-attacks directly targeting the public sector, as well as those levelled at private sector firms across the economy. It also encompasses the impact of financially motivated cyber-crime, as well as state-sponsored or terrorism-related attacks with a broader set of political, economic, and strategic motives.

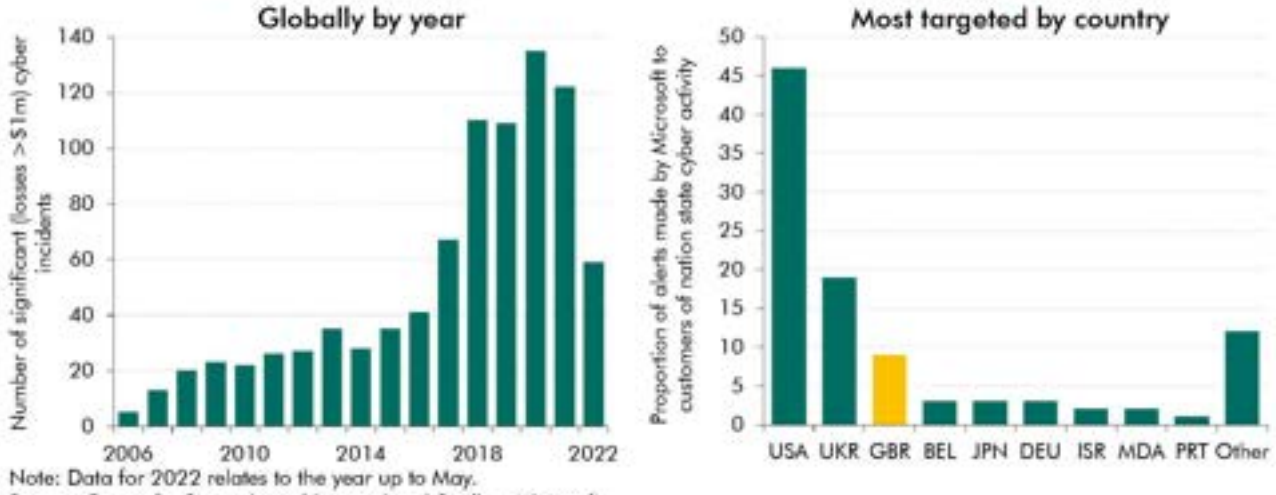
Rising frequency and cost of cyber-attacks

2.37 Cyber-attacks are a rapidly growing threat globally, and the UK has been a major target to date. Over the past 15 years, the number of cyber incidents recorded by the Centre for Strategic and International Studies globally that were classed as 'significant' (i.e. resulting in losses of more than $1 million) rose more than 24-fold from five in 2006 to 122 in 2021 (Chart 2.13).[42] In a recent study by Microsoft, the UK ranked third after the US and Ukraine in terms of malicious cyber-activity linked to nation states from July 2020 to June 2021.[43] According to DCMS's Cyber Breaches Survey, 39 per cent of UK businesses identified a cyber-breach or attack in 2022,[44] and the UK's National Cyber Security Centre (NCSC) dealt with 777 cyber incidents affecting both the private and public sectors between September 2020 and August 2021.[45]

2.38 These figures may not tell the whole story, with some businesses likely experiencing breaches they have not yet identified, or some private businesses (or other governments) potentially unwilling to report cyber-attacks and associated vulnerabilities publicly. However, given the UK's role as a major global financial centre, the international reach of many of its companies, and its active role in foreign affairs, it arguably experiences a higher threat of cyber threats than many other advanced economies.[46] The UK Government's National Risk Register places cyber-attacks in its second-highest 'likelihood' category, but in its second-lowest 'economic impact' category, with attacks typically costing millions rather than billions of pounds.

[42] Centre for Strategic and International Studies, *Significant cyber incidents*, accessed 23 June 2022.
[43] Microsoft, *Special Report: Ukraine*, April 2022.
[44] DCMS, *Cyber Security Breaches Survey 2022*, March 2022.
[45] NCSC, *NCSC Annual Review 2021*, November 2021.
[46] Global Connectivity Index, *Country rankings*, January 2021.

Chart 2.13: Significant cyber-attacks from 2006-21 and country targets in 2020-21



Note: Data for 2022 relates to the year up to May.
Source: Centre for Strategic and International Studies, Microsoft

2.39 While most incidents to date have been relatively modest in scale, some recent ones have underscored the potential economic risks posed by large-scale cyber-attacks. The dominance of high-frequency, low-impact incidents such as 'phishing' attacks means that the average costs to businesses from cyber incidents over the past year was just £4,200.[47] However, the past few years have also witnessed several significant cyber-attacks around the world (including those targeting critical national infrastructure), with large financial impacts. These include:

- **NotPetya (2017)**. Initially targeting Ukrainian businesses and government entities, NotPetya exploited a vulnerability in Microsoft operating systems. This encrypted the data on infected devices, causing widespread disruption in Ukraine (including by disabling the radiation monitoring system at the Chernobyl Power Plant), and spread to other global companies including Maersk shipping, resulting in wider supply-chain disruption. While initially appearing financially motivated, the attack also sparked allegations of Russian state involvement, and total costs incurred by the attack are estimated at nearly $10 billion globally.[48]

- **WannaCry (2017)**. WannaCry was a ransomware attack, exploiting a vulnerability that Microsoft had already identified, but that many companies had failed to patch or were using legacy software that remained vulnerable. The virus affected more than 200,000 computers across 150 countries, including causing major disruption to NHS computer servers in the UK. The attack was formally attributed to North Korea and had estimated financial impacts of $4 to $8 billion across affected organisations.[49]

[47] DCMS, *Cyber Security Breaches Survey 2022*, March 2022. This figure relates to the cost of cyber incidents that had a material impact – e.g. loss of money or data, and may represent an underestimate as it relies on firms' own assessment of the cost of breaches, and does not capture the top 1 per cent of incidents by cost to avoid a heavily skewed distribution.
[48] Wired, *The untold story of NotPetya, the most devastating cyber-attack in history*, August 2018.
[49] Reinsurance News, *Re-insurance to take minimal share of $8 billion WannaCry economic loss*, May 2017 and Broadcom Software, *WannaCry: Lessons learned 1 year later*, May 2018.

- **SolarWinds (2020)**. SolarWinds was an attack on a major US IT firm, which spread to the firm's clients through software updates to a system widely used to manage IT resources. This allowed hackers to access sensitive information in over 18,000 customers' computers, including high-profile private companies such as Microsoft and Intel, as well as several agencies of the US government. The attack was officially attributed to hackers linked to the Russian state by US and UK officials and had significant security implications, as well as indirect costs relating to the investigation of data accessed during the breach and security mitigations, estimated to amount to billions of dollars.[50]

- **Attack on the Irish Health Service (2021)**. Ireland's healthcare system was hit by a ransomware attack in May 2021, leading to the Health Service Executive of Ireland taking its IT systems offline and resulting in major disruption to healthcare across the country. The attack resulted from a 'phishing' email, and spread through the Irish healthcare system's IT, encrypting and disabling systems and accessing sensitive personal data. While the perpetrators of the attack reacted to the ensuing public outcry and provided the decryption key, the disruption it caused was estimated to have cost the Irish government up to €100 million, with further unquantified effects on public health relating to the attack.[51]

2.40 Those cyber-attacks that have entailed the largest costs have shared several common features:

- Suspected, or explicitly attributed, involvement of **state actors** from hostile states such as North Korea and Russia. Small-scale cyber-attacks are a widespread phenomenon and often perpetrated by private actors with financial motivations. However, the level of complexity and expertise required to conduct a large-scale cyber-attack remains considerable, and often is only held by actors working with nation states, or in tacit co-operation with them. These attacks often have wider motivations than purely financial, such as the intention to access sensitive data, or cause widespread disruption, which can make them significantly more disruptive and expensive to resolve.

- Targeting of a **state's institutions or critical national infrastructure.** Many of the above attacks were particularly damaging as they either directly targeted, or indirectly affected, public bodies or critical national infrastructure. In many of the above cases legacy IT infrastructure made these bodies more vulnerable to attacks targeting weaknesses in software systems.

- Significant **unintended consequences** flowing from the attack. Widespread disruption outside the intended impacts of a cyber-attack is a common feature of many of the above incidents. NotPetya was specifically targeting Ukraine but had global impacts through contagion to multinational corporations with Ukrainian clients, while WannaCry had significant unintended impacts on the UK healthcare system. Most

[50] IT World Canada, *Experts say worldwide cost of investigating SolarWinds Orion hack could be in the billions*, January 2021.
[51] RTE, *HSE cyber-attack cost hits €43m, could rise to €100m*, February 2022.

clearly, the perpetrators of the attack that affected the Irish healthcare system were alleged to face public pressure relating to the impact the attack had on patients, leading to the sharing of a decryption key.[52]

2.41 The Russian invasion of Ukraine has heightened cyber risk globally and may have increased the threat of further serious attacks on the UK (see Box 2.1). This comes on top of an environment of increasing cyber risk before the invasion, with the UK, US and Australia's cybersecurity authorities making a joint statement in February 2022 through the US's Cybersecurity and Infrastructure Security Agency (CISA), recognising an increase in 2021 in *"sophisticated, high-impact ransomware incidents against critical infrastructure organizations globally"*.[53] Post-invasion, both the FCDO in the UK and CISA in the US have published research attributing cyber-attacks on critical national infrastructure in the UK, Europe, and the US to the Russian Intelligence services.[54]

Box 2.1: Cyber-attacks during the Russian invasion of Ukraine

The period following the annexation of Crimea by Russia in 2014 was characterised by sustained cyber-attacks against key Ukrainian infrastructure by Russian-linked groups. In November 2015, the Ukrainian power grid was hacked by groups allegedly linked to Russia, leaving an estimated 230,000 customers in Western Ukraine without power for up to six hours.[a] The successful attack in 2015 was followed up by the NotPetya ransomware attack of 2017 (discussed above), where the total cost of the attack was estimated at nearly $10 billion globally. The White House dubbed the attacks as the *"most destructive and costly cyber-attack in history"*.[b] The 'NotPetya' attack was also the first time Western officials publicly attributed a cyber-attack to groups linked to the Russian government, with the National Cyber Security Centre (NCSC) in the UK releasing a statement to this effect in 2018.[c]

The run-up to the next Russian invasion of Ukraine in early 2022 also saw continued cyber-attacks from Russian-linked groups, though at a much smaller scale in comparison to the major attacks witnessed in 2015 and 2017. Ukrainian government officials reported in January 2022 that an estimated 288,000 cyber-attacks were recorded in the first 10 months of 2021, on top of the 397,000 attacks that had been recorded in 2020.[d]

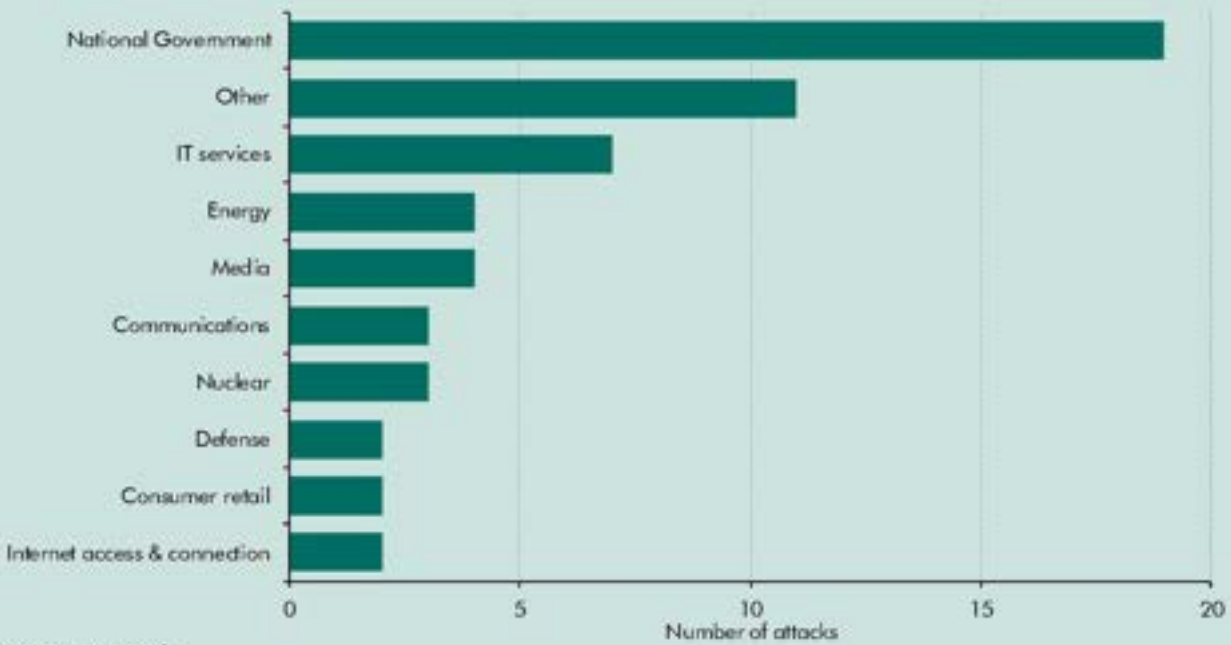
Against this backdrop, many analysts had expected cyber-attacks to feature heavily in the conflict following the full-scale invasion of Ukraine in February 2022. It has been argued by some commentators that Russia has so far refrained from large-scale cyber-attacks against Ukraine because the Russian military were also making use of the infrastructure in the country.[e]

Despite the war remaining largely conventional to date, it appears that cyber-attacks have played more of a role in the conflict than initially realised. There have been reported cases of Russian cyber activity just before the invasion, including attacks on Ukrainian and European satellite communication systems in late February.[f] And in March there were more attacks as the war intensified, including the hacking of a Ukrainian nuclear power plant and the breach of a

[52] RTE, *State did not pay ransom for decryption key*, May 2021.
[53] CISA, 2021 *Trends show increased globalised threat of ransomware*, February 2022.
[54] Gov.uk, *Russia's FSB malign activity: factsheet*, April 2022 and CISA, *Russian State-Sponsored and Criminal Cyber Threats to Critical Infrastructure*, May 2022.

Kyiv-based media agency that had its data stolen by Russian-linked hackers.[g] More recent analysis by Microsoft suggests a correlation between military advances and cyber activity (Chart A sets out the number of these attacks, by sector of the economy targeted).[h] Another indirect aspect of cyber risk that has played a role in the conflict is in the form of disinformation. Although many Russian state outlets were banned on Facebook and Twitter, there are continued allegations of the promotion of false narratives online, through social networks and video platforms.[i]

Chart A: Cyber-attacks on Ukraine by Russia since the invasion began, by sector



Source: Microsoft

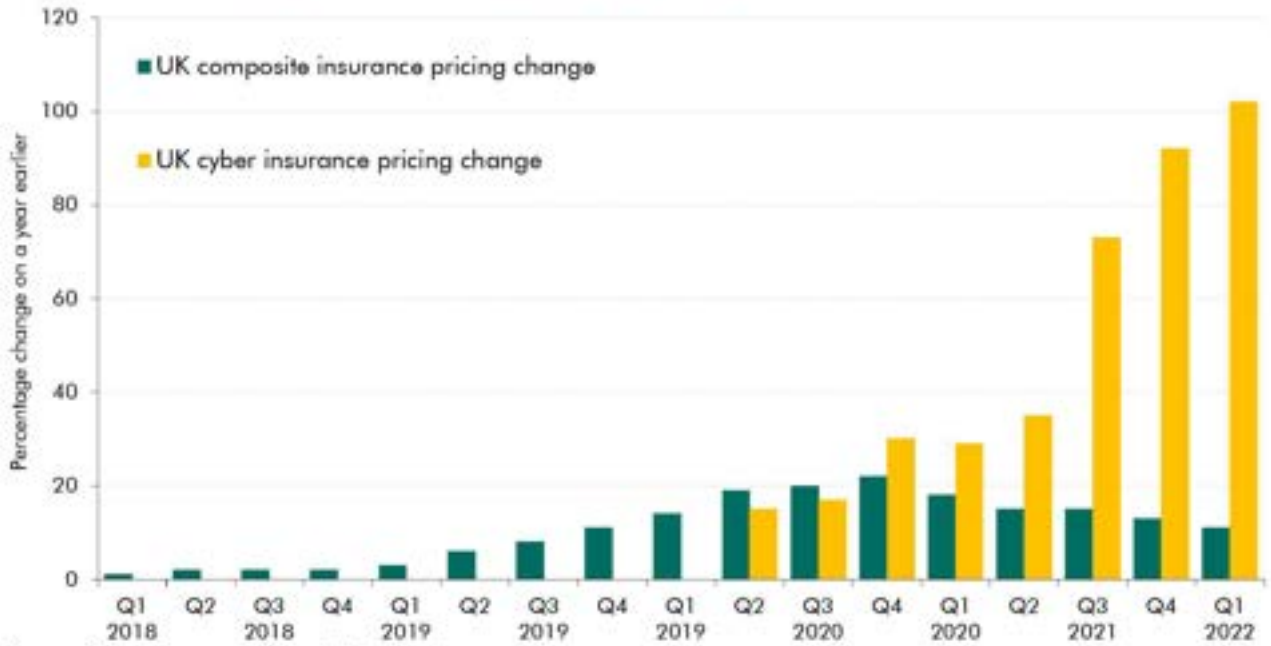
It remains unclear whether the lack of a catastrophic cyber-attack related to the conflict stems from Russia's choice of offensive tactics, Ukraine's defensive capability, or evidence that such attacks are harder to mount or less impactful than previously thought. However, as this is a report focused on risks to the outlook, and in the absence of more information to substantiate the first two hypotheses, it takes as its starting assumption that a major, successful cyber-attack on the UK remains a material threat and looks to estimate its potential economic and fiscal consequences later in this chapter.

[g] The Economist, *Cyber-attacks on Ukraine are conspicuous by their absence*, March 2022.
[h] The White House, *Statement from the Press Secretary*, 15 February 2018.
[c] NCSC, *Russian military 'almost certainly' responsible for destructive 2017 cyber-attack*, February 2018.
[d] The Guardian, *Ukraine hit by 'massive' cyber-attack on government websites*, January 2022.
[e] The Economist, *Cyber-attacks on Ukraine are conspicuous by their absence*, March 2022.
[f] Reuters, *the cyber war between Ukraine and Russia: An overview*, May 2022.
[g] The Economist, *Russia is swaying Twitter users outside the West to its side*, May 2022.
[h] Microsoft, *Special Report: Ukraine*, April 2022.
[i] Politico, *As war in Ukraine evolves, so do disinformation tactics*, March 2022.

2.42 From a fiscal perspective, the likely impact of a major cyber-attack could include indirect fiscal costs from economic disruption or direct claims on government spending to maintain critical national infrastructure or support affected businesses. Cyber risk is currently largely borne by the private sector, with many firms using cyber insurance to mitigate potential

financial losses (43 per cent of businesses reported being insured against cyber risks in some way according to the DCMS Cyber Breaches Survey).[55] However, the cyber insurance industry faces renewed challenges in the face of a riskier cyber landscape given the rise in ransomware, a less stable geopolitical situation, and growing risks of globally correlated incidents. This is coupled with existing challenges relating to the sector's relatively short lifespan thus far, and so lack of contextual data to aid pricing of insurance policies.[56] Chart 2.14 uses Marsh's Global Insurance Pricing Index to illustrate the significant increases in cyber insurance premiums that have taken place over the past two years, with pricing increasing by 102 per cent in the first quarter of 2022 alone.[57] The insurance broker and risk advisor notes that this increase has been *"driven by ransomware claims; with continued market deterioration and reduction in capacity"*, causing it to diverge significantly from falling pricing elsewhere in the market (as evidenced by the declines in the composite insurance series).

Chart 2.14: Changes in insurance pricing for cyber insurance



Source: Global Insurance Pricing Index, Marsh

2.43 Previous experience suggests that, while the private sector may continue to bear the risk and associated costs of cyber-attacks without the input of government, a failure of the insurance sector to keep pace with levels of risk could put pressure on the public purse. One example of the Government facing fiscal exposure due to a lack of available insurance is the creation of Pool Re to address a lack of a terrorism insurance sector during the IRA bombing campaign of the 1990s (Box 2.2). This addressed a market failure in the face of a risk that was difficult to quantify given a lack of available precedent and that could potentially be very significant in value – both features that are common to cyber risks.

[55] DCMS, *Cyber Security Breaches Survey 2022*, March 2022.
[56] Harvard Business Review, *Cybersecurity insurance has a big problem*, January 2021.
[57] Marsh, *Global Insurance Market Index – Q1 2022*, accessed June 2022.

Box 2.2: Government-guaranteed insurance against systemic risk (Pool Re)

Faced with risks seen to be too large, too uncertain, or too highly correlated for private companies to offer insurance against, the Government has previously extended guarantees to private insurers, 're-insuring' the risks they take onto their balance sheet and seeking to take on the 'systemic risk' element that would overwhelm any individual insurer.[a] For example, during the pandemic temporary reinsurance schemes were introduced to deal with the high levels of Covid-related risk in certain sectors – including the Live Events Reinsurance Scheme and the broader Trade Credit Reinsurance Scheme.[b] The Government also intervened in the market for flooding insurance on homes through the 'Flood Re' scheme. This was set up in the aftermath of the damaging 2012 floods and allows insurers to offer flooding insurance on homes at much lower prices than would be commercially viable, funded by a government levy on the sector instead of a guarantee.[c]

The longest-running government-guaranteed reinsurance scheme (and most relevant as a comparator to the cyber insurance market) is Pool Re. Pool Re was set up in 1993, in the wake of the 1992 Baltic Exchange bombing by the IRA which, alongside other attacks perpetrated by the IRA throughout the early 1990s, had destabilised the market for terrorism insurance on commercial properties. Given both the potentially very high costs associated with terrorist attacks on commercial property and the high degree of uncertainty associated with predicting the frequency and severity of those attacks, many insurers had withdrawn from the terrorism insurance market. Given the damaging impact on the wider economy should commercial properties become uninsurable, government intervention was deemed necessary.

Pool Re functions as a 'pooled reinsurance' scheme, through which around 95 per cent of the UK's terrorism commercial property insurance market operates. The scheme covers insurance on nearly £2 trillion of assets in the UK in respect of physical damage (and associated business interruption) relating to conventional terrorist attacks and chemical, biological, radiological and nuclear attacks, as well as physical damage relating to cyber-attacks. Since April 2018, Pool Re has provided cover for insurers of 'remote digital interference', which relates to terrorist attacks with a cyber trigger, but specifically those resulting in physical damage. This is different from the broader cyber risks quantified throughout this chapter, which often include impacts on revenue and intangible assets.

Insurers pay premia to Pool Re, which are then invested to create pooled reserves that can be drawn on by members when a terrorist event occurs. These reserves now amount to over £6.9 billion (Chart B), in addition to which Pool Re holds further reinsurance from the global insurance sector worth £2.5 billion. Pool Re pays part of the premia it receives (around half), and some of its investment returns (around a quarter) to the Treasury, in exchange for an unlimited guarantee should Pool Re require additional funding to meet its members' needs after a terrorist event. These payments have resulted in a further £1.4 billion 'buffer' to costs incurred by the scheme, above which the Treasury guarantee would take over. Therefore, taking into account the 'excess' paid by members, Pool Re is in total able to absorb £9.5 billion of losses from its own balance sheet, and £11 billion before needing to call on the guarantee and hitting the public finances.[d]

Chart B: Pool Re hierarchy of obligations

Source: HM Treasury, OBR

Fiscally, while an unlimited guarantee is a significant exposure on the part of the Government, Pool Re has thus far been self-contained in absorbing terrorist risk in respect of commercial property damage. The scheme has paid out over £1.25 billion in relation to 17 terrorist attacks since its formation but has never called on the government guarantee. However, this is not to suggest that in the event that signs of weakness in the cyber insurance prompted a similar intervention, a parallel scheme would be equally resilient. Given Pool Re has had nearly 30 years to amass the reserves now able to absorb significant future losses, the more imminent threat of cyber risks, and the potentially high impact of a catastrophic attack could combine to make an unlimited exposure to this risk more fiscally challenging than terrorism risk has proved to date.

[a] HM Treasury, *Government as insurer of last resort: managing contingent liabilities in the public sector*, March 2020.
[b] The Live Events Reinsurance Scheme was announced in August 2021 and offered government reinsurance for insurers providing cover against the cancellation, postponement, relocation or abandonment of live events due to new government restrictions in response to Covid-19. The Trade Credit Reinsurance Scheme was announced in June 2020 and provided reinsurance for insurers providing insurance to businesses for situations in which customers owe money for products or services but cannot pay their debts, or pay them late.
[c] Flood Re, *How is Flood Re funded?*, accessed 23 June 2022.
[d] HM Treasury, *HM Treasury's review of Pool Reinsurance Company Limited: Final Report*, March 2022.

2.44 Fiscal costs arise too from the mitigation of cyber risk, although these serve to lessen the possibility of a major cyber-attack crystallising and reduce its costs when it does. The Government pledged £2.6 billion over the 2021 Spending Review period for cyber and legacy IT, in addition to funding for the UK's National Cyber Force.[58] In its 2022 National Cyber Strategy, the Government set out priorities for this funding, including investing in building expertise in cyber risk, aiding businesses in improving their cyber protection, working on technologies relevant to cyber-security, as well as working directly to mitigate

[58] The National Cyber Force is a partnership between the UK's defence and intelligence operations, responsible for countering cyber threats.

threats to the UK and international partners. While a world of heightened cyber risk may put pressure on these commitments, this pressure can be considered as implicit in our higher defence spending scenarios. Government spending on cyber resilience is also in addition to mitigation occurring elsewhere in the public sector, with the Bank of England becoming one of the first central banks to run cyber stress tests on the financial sector. Its pilot in 2019, and its full 2022 cyber stress test, invited major banks to assess the impact of a significant cyber-attack on their systems to better understand potential vulnerabilities and improve the resilience of what is the UK's most profitable, and internationally connected sector.[59]

Cyber-attack scenario

2.45 In order to quantify the potential fiscal impact of a major cyber-attack for our geopolitical stress test, we present an illustrative scenario of a significant attack on critical national infrastructure that draws on estimates of the economic impact of an attack from the literature. Table 2.1 sets out a range of academic estimates of the economic impact of a cyber-attack, the majority of which focus on large-scale global attacks with some level of contagion. In line with the common factors shared by the costliest attacks of recent years (set out above) we use a Cambridge Centre for Risk Studies (CCRS) scenario from 2016 that is based on an attack on the UK electricity grid, of the sort of scale where perpetration by a state, or state-funded, actor would be likely.[60] An attack of this complexity and scale remains unlikely, given the high level of expertise required, and the significant time likely required to prepare an attack of this type (attacks on the Ukrainian electricity grid in 2015 and 2016 took an estimated 19-31 months to prepare, and were still quickly discovered and neutralised).[61] However, the impact of this type of attack does resemble cyber-related disruption that has occurred in practice, such as the Colonial Pipeline cyber-attack in May 2021, a ransomware attack on the US's largest oil pipeline that resulted in major disruption to fuel supplies across the south-eastern United States.[62]

[59] Bank of England, *Prudential Regulation Authority statement on the 2022 cyber stress test: Retail payment system*, December 2021.
[60] Kelly, S., E. Leverett, E. J. Oughton, J. Copic, S. Thacker, R. Pant, L. Pryor, G. Kassaro, T. Evan, S. J. Ruffle, M. Tuveson, A. W. Coburn, D. Ralph, and J. W. Hall, *Integrated Infrastructure: Cyber Resiliency in Society, Mapping the Consequences of an Interconnected Digital Economy*, Cambridge Centre for Risk Studies, January 2016.
[61] Maschmeyer, L., *The subversive trilemma: why cyber operations fall short of expectations*, International Security, October 2021.
[62] Reuters, *Cyber attack shuts down U.S. fuel pipeline 'jugular', Biden briefed*, May 2021.

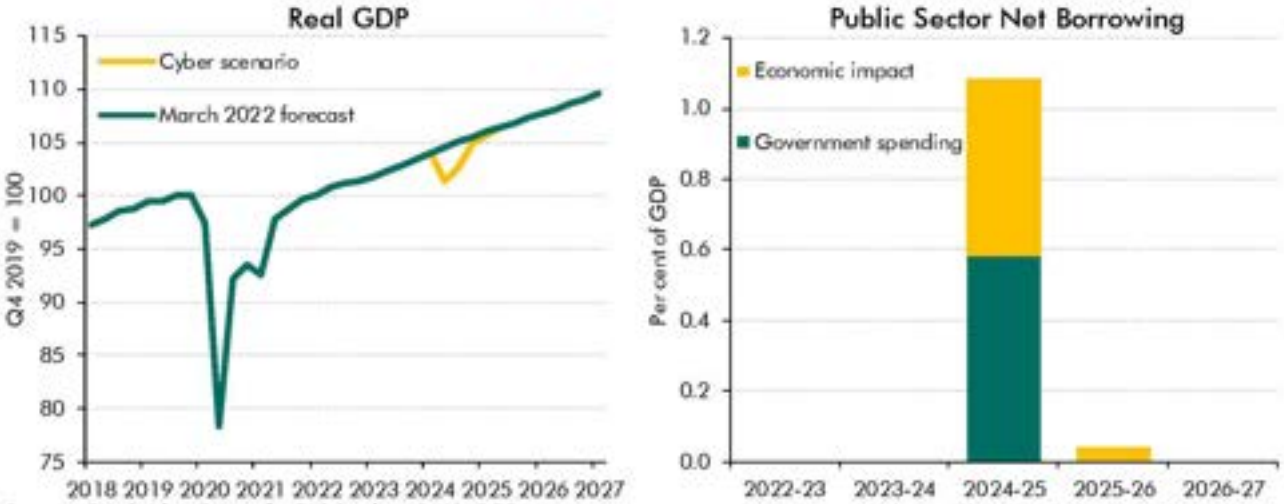
Table 2.1: Academic estimates of the impact of a major cyber-attack

Organisation	Year	Type of attack	Quantification
Cambridge Centre for Risk Studies	2016	Cyber-attack on electrical power transformers	Between £49 - £442 billion impact on the UK economy (over five years)
IMF	2018	Aggregate cost of cyber-attacks on the financial sector in an 'extreme' scenario where major attacks are frequent, with a high degree of contagion	Between $270 - $350 billion cost to the global financial sector annually
Lloyd's	2019	Ransomware attack on a global corporation, that has contagion effects on other businesses across the world, with an average of a week's system outage	Between $85 - $193 billion cost to the global economy depending on number of infected companies
Lloyd's	2021	Major cloud service provider suffers a total system outage (due to malicious code), meaning all users of the provider experience business interruption	Between $4.6 - $53.1 billion cost to the US economy depending on duration of outage
New York Federal Reserve	2021	Cyber-attack on US financial system, impacting payment systems	Up to $122 billion cost to the US economy for a one-day outage

2.46 The CCRS scenario describes a cyber-attack causing severe disruption to electricity distribution in the South East of the UK, including London. The attack involves power blackouts caused by the mass distribution of malicious software across the electricity network, allowing the disabling of multiple electricity substations, and causing 'rolling blackouts' as new substations are inhibited just as others are repaired or brought back online. We use the paper's central scenario for our fiscal modelling, which involves the compromising of 95 electricity substations with malicious software, causing a rolling power outage for three weeks affecting up to 11.3 million customers a day, as well as broader disruption to digital communications, and water supply and treatment.

2.47 Overall, the paper involves a peak-to-trough GDP shock of just over 3 per cent in one quarter, or a fall of 1.6 per cent in financial year 2024-25 (left panel of Chart 2.15). While the paper assumes a return to trend over a two-year horizon, we assume a shorter recovery within a year. This reflects the experience of the pandemic, in which the economy rebounded rapidly from disruption to particular activities, aided by fiscal support from the Government. A significant cyber-attack on the UK could also have longer-term effects on productivity and GDP, for example due to higher overheads faced by businesses to maintain higher cyber resilience (e.g. updating computer systems more often), or just increased disruption from more frequent, smaller attacks. However, the high level of uncertainty over how to quantify the cost of such additional resilience in a higher-risk world has led us not to attempt to include this longer-term impact in our scenario.

Chart 2.15: GDP impact of electricity grid cyber-attack scenario

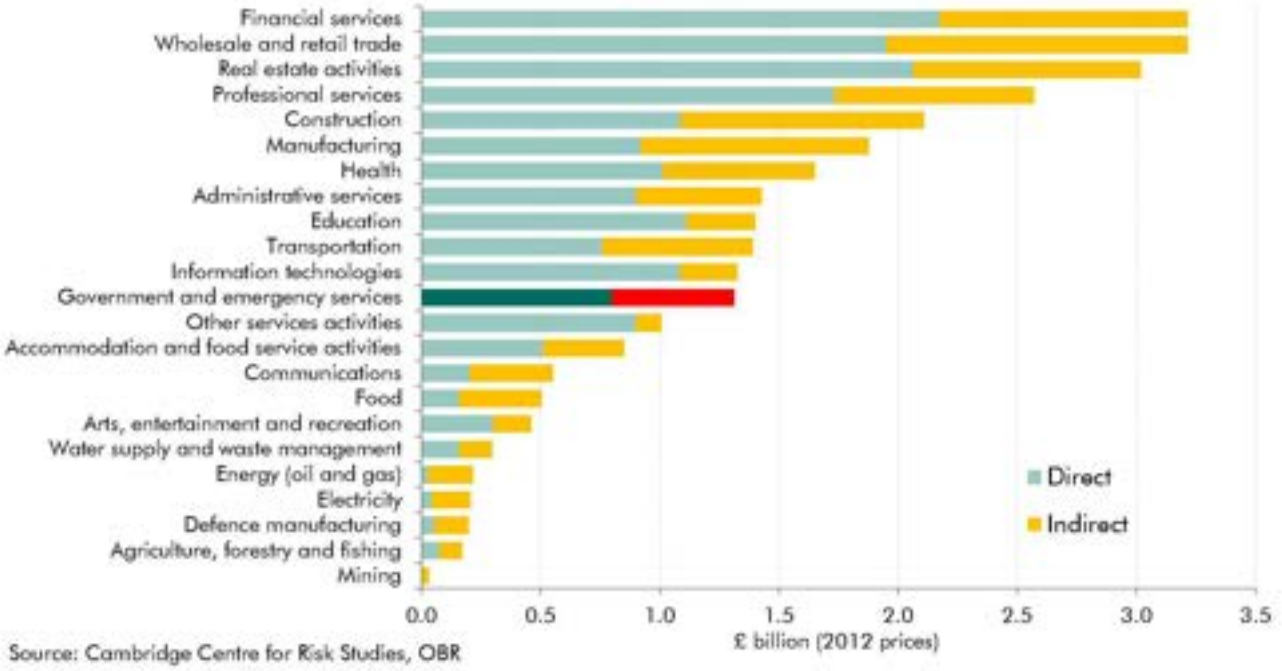


Source: Cambridge Centre for Risk Studies, ONS, OBR

2.48 Our scenario includes both the indirect fiscal impacts associated with this economic shock, as well as direct costs from the Government providing further support to affected sectors. Based on the experience of the financial crisis, the pandemic, and this year's cost of living crisis, successive UK governments have intervened to mitigate and socialise the impact of large, temporary, exogenous shocks to the economic activities of households and firms, at significant cost to the public finances. The CCRS scenario provides a disaggregation of the sectoral impact of the crisis (Chart 2.16), which we use to calibrate the value of fiscal support that might be delivered. Our stylised scenario assumes the Government bears the cost of all direct and indirect effects on 'government and emergency services' (£2 billion in 2024-25 terms), as well as around half the direct impact on the private sector, coming to a total of £16 billion of support during the crisis period.[63] In practice this might be concentrated on sectors relating to critical national infrastructure (e.g. water and waste management). And while large in absolute terms, it would be small relative to the hundreds of billions of support extended during both the financial crisis and the pandemic.

[63] Here, 'direct' effects relate to economic damage incurred by the power-outage itself, with 'indirect' effects illustrating the impact of the longer-lasting macroeconomic consequences of the attack.

Chart 2.16: Economic impact of electricity grid cyber-attack scenario by sector



Source: Cambridge Centre for Risk Studies, OBR

2.49 Taken together, the direct and indirect effects of the cyber-attack scenario add nearly £29 billion (1.1 per cent of GDP) to public sector net borrowing in 2024-25 (right panel of Chart 2.15), split nearly equally between government spending and wider macroeconomic effects that add £16 billion and £13 billion respectively. The macroeconomic impact of the cyber-attack continues into 2025-26, adding £1 billion to borrowing. This contributes to our stress test scenario later in the chapter.

Economic fragmentation

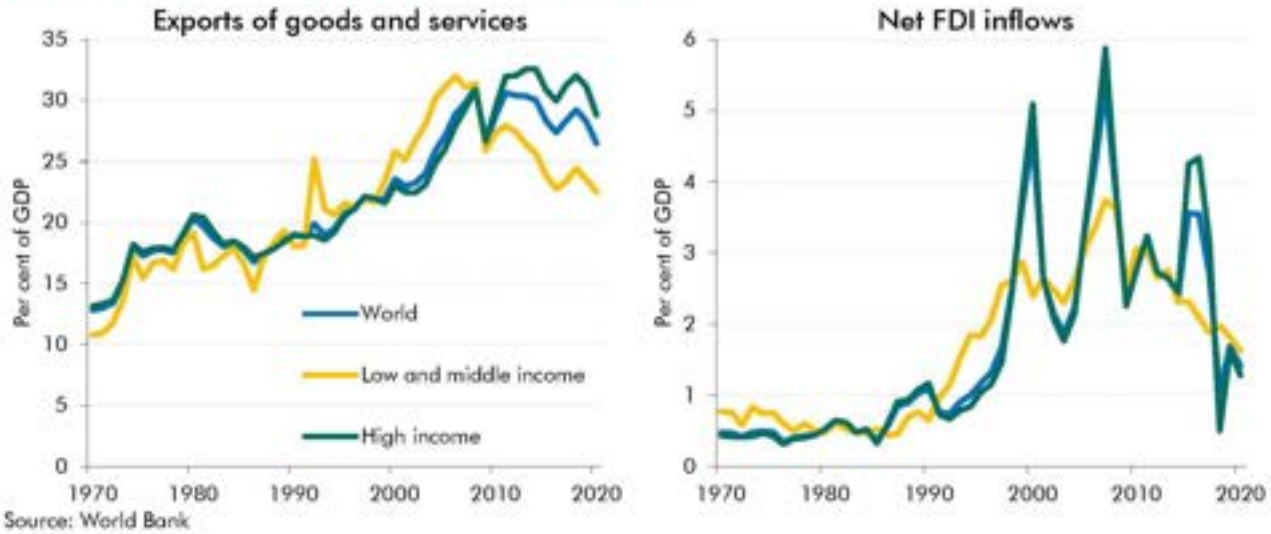
2.50 In addition to the potential fiscal costs associated with rising conventional and cyber-security threats, rising geopolitical tensions could also put at risk the gains from deepening global economic integration that we have witnessed over the past 70 years. As witnessed during the interwar and Cold War years, countries could become more inclined to subordinate economic openness to domestic or international security policy aims. Larger economies and trading blocs such as the US, China and the EU could set domestic trade and investment regulations to match their perceived 'competitive' interest, without regard to multilateral agreements. As discussed below, there are some initial indications that such a retreat from global economic integration is already underway.

Current outlook for global economic integration

2.51 Having accelerated rapidly around the turn of the century, there are signs that the pace of global integration has stalled on some measures and reversed on others since the global financial crisis in 2008. After growing rapidly in the 2000s, global trade as a share of GDP has declined from a high of 31 per cent in 2008 to 26 per cent in 2020, with trade intensity falling faster among low- and middle-income countries (Chart 2.17). Global foreign direct

investment (FDI) peaked at 5 per cent of GDP in 2007 before falling back to 1.4 per cent in 2020, with investment falling faster from a higher (albeit more volatile) peak among high-income countries. While on most measures the levels of these cross-border flows remain at or near the hundred-year highs they reached at the end of the last century, it is their continued growth that matters for continued improvements in global productivity resulting from increasing specialisation and returns to scale.[64] And there are growing risks of a change not just in the pace but also in the direction of global economic integration. We discuss the implications of integration for the economy and public finances in Box 2.3.

Chart 2.17: Global trade and investment flows



Source: World Bank

Box 2.3: Why interconnection matters for the economy

Growing interconnection between economies has been a significant factor in spurring economic growth, increasing average income levels, and reducing absolute poverty levels across the globe over the past two centuries.[a] Interconnection between countries can be facilitated through multiple channels including trade in goods and services and movements of capital.

Trade in goods and services. Economic theory and empirical evidence suggest that greater trade intensity increases productivity and real GDP over the long run. There are several different channels through which this happens. First, trade can boost the level of productivity by allowing countries to specialise in their areas of comparative advantage – through opening up exporting opportunities for products that a country is relatively more efficient at producing, and allowing a country to import products that it is less relatively less efficient at producing. Increased trade intensity can also have dynamic effects on productivity (longer-lasting effects on growth rates) by allowing countries to access new technologies and knowledge that supports innovation and more efficient modes of production.[b] It can also enhance welfare by increasing the choice of products that consumers have access to or by lowering prices.[c] Increased trade intensity has been fuelled by the progressive liberalisation of global trade policies. Stronger economic growth as a result of

[64] Static returns to productivity increase with growth in integration; but the level of volumes also matters for dynamic productivity impacts through technology and knowledge spillovers.

greater trade intensity boosts the public finances by increasing growth in domestic tax bases and thus government revenue, often by more than is lost from the lowering of tariffs on trade.

International capital flows. Access to international financial markets allows for greater diversification of investments, improved risk-sharing, and a more efficient allocation of global resources.[d] Increased foreign direct investment is also found to have a positive impact on GDP through human capital transfer and the development of financial markets.[e] The broadening and deepening of international capital flows have also helped to reduce long-term interest rates in advanced economies.[f] Movement of capital can therefore support the public finances by boosting real GDP and tax revenue, as well as potentially by reducing debt interest costs.[g]

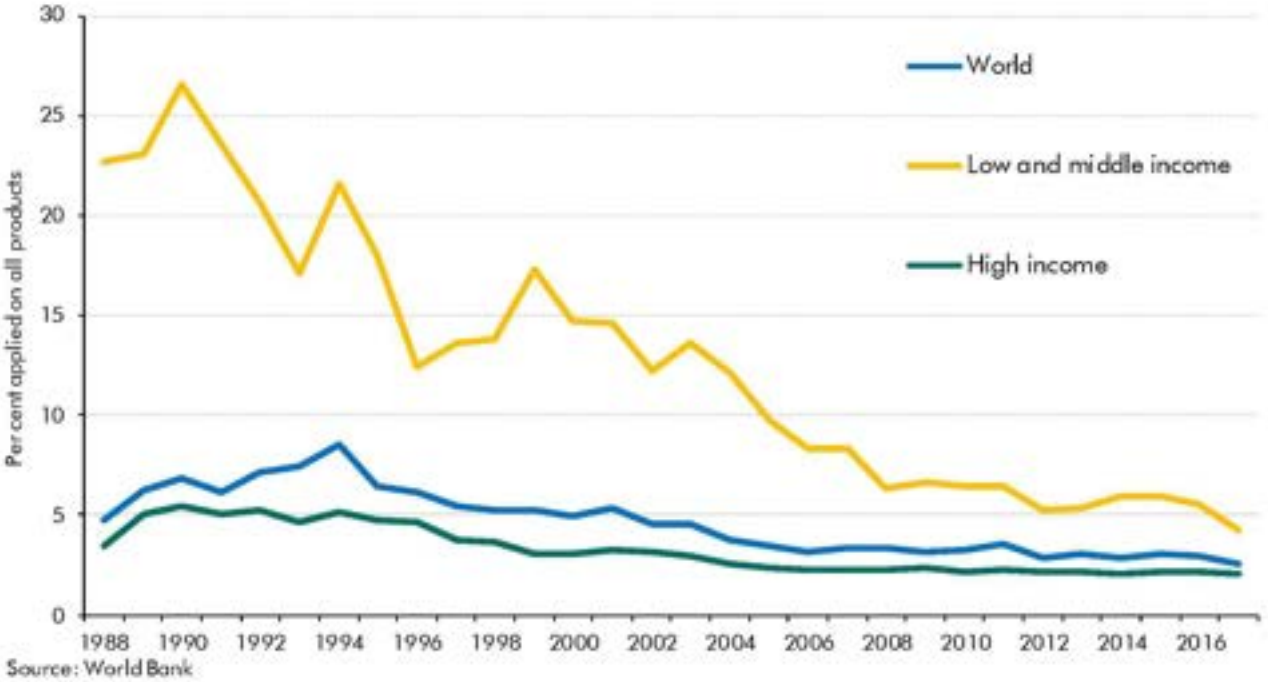
[a] Revenga, A., and A. Gonzalez, *Trade has been a global force for less poverty and higher incomes*, World Bank blogs, February 2017.
[b] See OBR, *Discussion paper No. 3: Brexit and the OBR's forecasts*, October 2018, for more information on the theoretical and empirical links between trade intensity and economic growth.
[c] Were, M., *Differential effects of trade on economic growth and investment: a cross-country empirical investigation*, Journal of African Trade, December 2015.
[d] Obstfeld, M., *Risk-taking, global diversification, and growth*, NBER Working Paper, June 1992.
[e] Almfraji, M. A., and M. K. Almsafir, *Foreign direct investment and economic growth literature review from 1994 to 2012*, Procedia-Social and Behavioral Sciences, May 2014.
[f] Warnock F. E., and V. C. Warnock, *International capital flows and U.S. interest rates*, Journal of International Money and Finance, October 2009.
[g] Carvalho D., and M. Fidora, *Capital inflows and euro area long-term interest rates*, European Central Bank working paper, June 2015.

2.52 The slowdown in the pace of integration in global trade and investment has been driven in part by the pursuit of more protectionist policies globally. The latest round of comprehensive multilateral trade liberalising negotiations at the WTO was initiated in Doha in 2001, but negotiations broke down in 2008 and progress since then has been minimal. Countries have increasingly moved to sign bilateral or plurilateral trade agreements with more like-minded countries, but the pace of their creation has also slowed in recent years. New agreements in force notified to the WTO numbered at or below 15 per year from 2016 to 2020, having previously numbered above 15 every year since 1999, except for 2001.[65]

2.53 The slowdown in the pace of trade liberalisation can be seen in global average tariff levels. The global trade-weighted average applied tariff rate fell rapidly from 22 per cent in low- and middle-income countries and 5 per cent in high-income countries in 1994 to 6 and 2 per cent respectively in 2008 (Chart 2.18). Since then, the pace of liberalisation has slowed, with tariffs falling an additional 2 percentage points in low- and middle-income countries in the decade since the financial crisis, and not at all in high-income countries. Similarly, the Global Trade Alert has tracked new measures related to trade globally since 2009 and has found that the number of new protectionist measures increased from 360 to 1,198 between 2009 and 2019 (Chart 2.19).

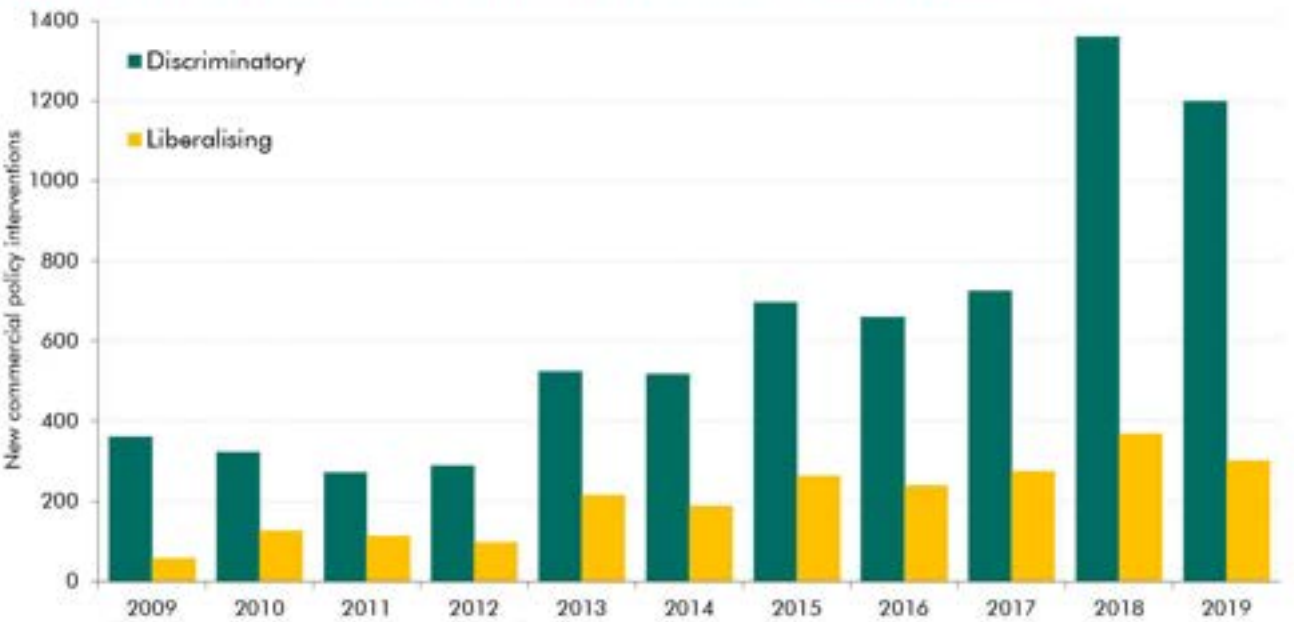
[65] World Trade Organization, *Regional trade agreements*, accessed 23 June 2022.

Chart 2.18: Global tariff rates



Source: World Bank

Chart 2.19: Increasing number of new protectionist measures globally



Note: Includes measures implemented and recorded within specified year.
Source: Global Trade Alert

2.54 After also becoming substantially more open in the 1990s, the pace of global capital market integration has also slowed in advanced economies and reversed in emerging markets in the subsequent two decades. The Chinn-Ito index of capital market openness suggests a reduction in openness among 'less developed' and 'emerging market' economies from the financial crisis in 2008, up to the most recent data in 2019. In contrast, 'industrial countries' saw a similar weakening in the index during the financial crisis but

returned to their former levels of openness in the most recent data.[66] The economic consensus around the desirability of unfettered capital flows has also weakened, with the IMF updating its advice to give countries more flexibility to use capital flow management measures to safeguard macroeconomic stability.[67]

2.55 A move away from the multilateral system by the US – the country most responsible for its creation and development – has accelerated some of these trends. The US began blocking reappointments to the WTO's appellate body in 2011, resulting in the breakdown of the organisation's dispute resolution system by 2019. The US substantially raised tariffs under President Trump, with most directed at China – US tariffs on Chinese imports rose from 3.1 per cent in 2018 to 19.3 per cent now, with Chinese tariffs on US imports rising from 8 to 21.2 per cent in response.[68] Alongside the tariffs imposed on China, traditional partners of the US such as the EU and UK were also hit. In 2018, the US announced tariffs of 25 per cent on all imports of steel and 10 per cent on imports of aluminium.[69] The tariffs targeted steel and aluminium imports from all countries with the exception of Mexico and Canada. The EU at the time was the second-largest exporter of steel and aluminium to the US after Canada.[70] The move to impose tariffs on EU steel and aluminium exports was followed by retaliation, with the EU imposing tariffs on targeted US products.[71] In March 2022, President Biden rolled back the tariffs and instead opted for a quota on UK steel imports, following similar deals with the EU and Japan.[72] While the new measures are less restrictive than under the Trump administration, the current trade arrangement is significantly more protectionist than under previous US administrations before Trump.

2.56 Beyond the generalised rise in protectionism, the world's major economies are increasingly using trade and investment restrictions to achieve wider policy aims – including for security reasons and as a lever to help on the path to net zero. The number of entities sanctioned by the US has risen ten-fold over the past two decades from 912 in 2000, to over 9,000 in 2021, with individuals and firms in Russia, North Korea, and Iran accounting for 35 per cent of the most recent total.[73] The Russian invasion of Ukraine has seen the West respond with a sweeping package of trade and investment restrictions.[74] In July 2021, the European Commission presented its proposal for establishing a carbon border adjustment mechanism that would, in effect, impose a tariff on the imports of those countries whose policies for fighting climate change are less ambitious than those in the EU to avoid 'carbon leakage'.[75] The merits of these wider security and environmental objectives aside, their effect is to reduce cross-border trade and investment and economic connectedness.

2.57 The forces underlying these trends toward greater global economic fragmentation show few signs of abating in the coming years. The WTO is focused on internal reform, leaving little

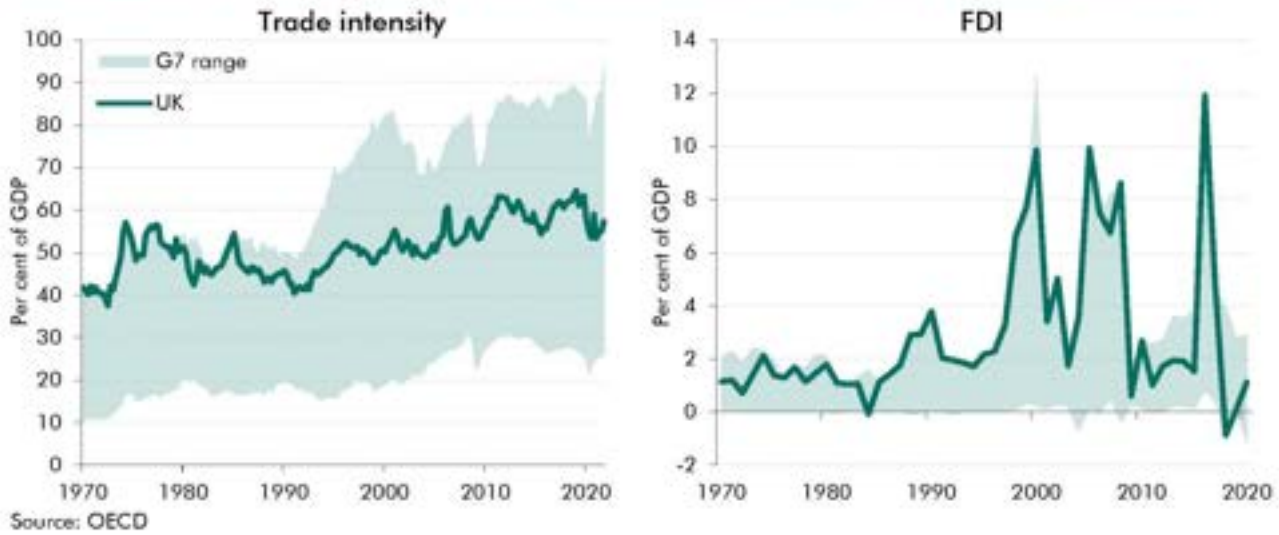
[66] Chinn, M., and H. Ito, *The Chinn-Ito Index: a de jure measure of financial openness*, August 2021.
[67] IMF Blog, *Why the IMF is updating its view on capital flows*, March 2022.
[68] Peterson Institute for International Economics, *US-China trade war tariffs: an up-to-date chart*, April 2022.
[69] The White House, *What you need to know: Section 232 investigations and tariffs*, March 2018.
[70] Peterson Institute for International Economics, *Europe is pushing back against Trump's steel and aluminium tariffs*, March 2018.
[71] CNBC, *Tariffs will cost Harley-Davidson more than $40 million in 2018*, October 2018.
[72] BBC News, *US rolls back Trump-era tariffs on UK steel*, March 2022.
[73] The US Department of the Treasury, *The Treasury 2021 sanctions review*, October 2021.
[74] The White House, *Joined by allies and partners, the United States imposes devastating costs on Russia*, February 2022.
[75] European Council, *Council agrees on the Carbon Border Adjustment Mechanism (CBAM)*, March 2022.

prospect of success for any renewed round of multilateral trade liberalisation negotiations. The growing use of economic policy for wider security or environmental policy aims can become self-sustaining, as target countries seek to reduce their exposure or retaliate with restrictive measures of their own. The disruption to global trade brought about by the pandemic has also prompted growing calls for firms to shorten supply chains to boost resilience. In a 2021 survey by McKinsey, almost 90 per cent of respondents said they expected to pursue some form of regionalisation of supply chains in the next three years, to address weaknesses exposed by the pandemic.[76] Popular support for trade and globalisation has also weakened, with the proportion of people globally saying that globalisation is good for their country falling by 10 percentage points between 2019 and 2021, to less than half.[77]

UK economic openness in comparative perspective

2.58 Having been at the forefront of past waves of global economic integration, the UK is increasingly lagging behind other major economies on several measures of economic openness. Brexit was the first example of a country choosing to leave a regional trade agreement, and the terms of the Trade and Cooperation Agreement (TCA) between the UK and EU has significantly increased non-tariff barriers relative to being a member of the EU and we expect that will lower UK exports and imports by 15 per cent in the long run.[78] Having been the second-most open economy to trade in the G7 in the late 1990s, the trade intensity of UK GDP was the third-lowest level in the G7, above the US and Japan, in 2021 (Chart 2.20). Inward FDI flows have also slowed since a spike in 2016 with the acquisition of Arm Limited by Softbank. While the UK regularly saw inflows as a share of GDP at or near the fastest rates in the G7 before 2016, FDI flows have also dropped to at or near the bottom of that group.

Chart 2.20: G7 trade intensity of GDP and flows of FDI as a percentage of GDP

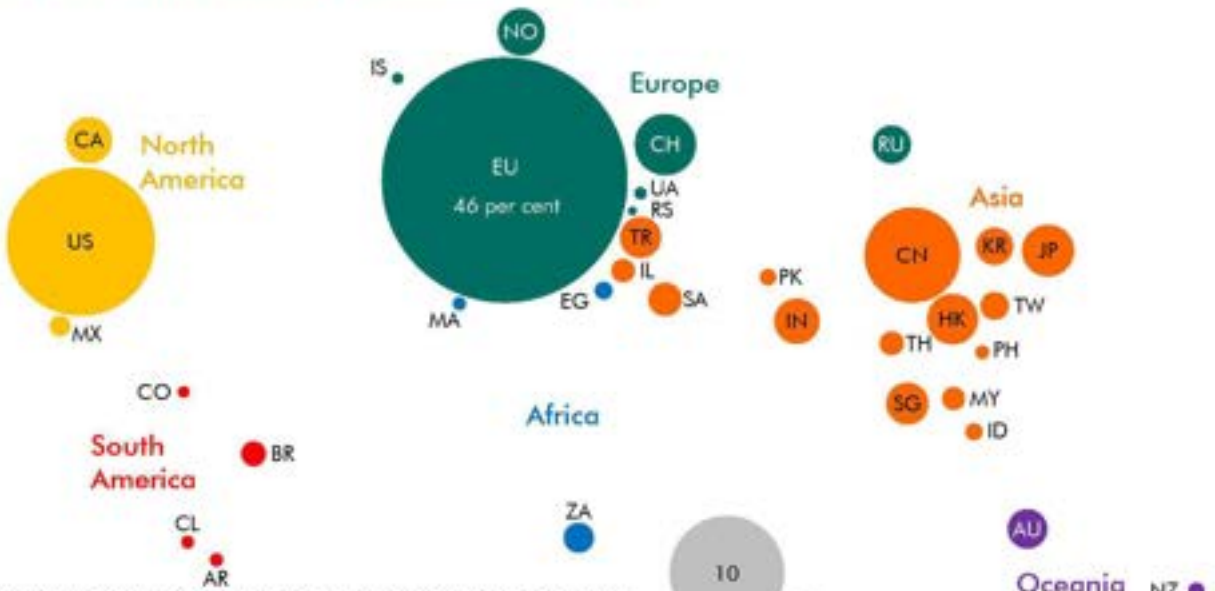


Source: OECD

[76] McKinsey, *How COVID-19 is reshaping supply chains*, November 2021.
[77] Ipsos, *Sentiment about globalization cooler than before the pandemic across the world*, August 2021.
[78] See our October 2021 *Economic and fiscal outlook*.

2.59 While the UK's departure from the EU has opened up the prospect of pursuing an independent trade policy, the new trade agreements reached so far with non-EU countries are unlikely to make up for lower trade with the EU in the foreseeable future. EU countries currently make up seven of the UK's top 10 trading partners (Chart 2.21) and 46 per cent of the UK's trade, despite accounting for only 17 per cent of global GDP. The new trade deals signed since leaving the EU, with Australia and New Zealand (setting aside the rolling over of pre-existing trade agreements), are with countries that make up 1.4 per cent of UK trade. The Government's assessment suggests these deals will add 0.11 per cent to the level of real GDP by 2035, while our latest forecast assumes a loss of 4 per cent of GDP resulting from Brexit.

Chart 2.21: The UK's largest trading partners



Note: Map includes UK trading partners representing more than 0.5 per cent of UK trade. Morocco includes Western Sahara.
Source: ONS

Impact of global fragmentation on the UK economy and public finances

2.60 An acceleration of recent trends toward greater fragmentation of global markets for goods, services, and investment could have serious economic and fiscal repercussions for the UK. A range of external estimates for the impact on the global economy of various scenarios of rising global protectionism have been produced, shown in the Appendix. The scenarios, mechanisms and channels vary widely. To illustrate the scale of the potential risk to the UK economy and public finances from global economic fragmentation, we start with a scenario of rising global protectionism based on a 2019 WTO working paper.[79] It incorporates direct and intermediate trade linkages and endogenous capital accumulation. In a scenario of uncooperative, but individually rational, tariff rate increases on goods trade across the world, shown in Table 2.2, the impact is an increase in average tariffs from 3 to 26 per cent, a decline in global trade (excluding intra-EU trade) of 17 per cent, and a reduction in

[79] Bekkers, E. and R. Teh, *Potential economic effects of a global trade conflict: projecting the medium-run effects with the WTO Global Trade Model*, WTO staff working paper, April 2019.

global real GDP of 2 per cent, after four years. This reflects a scenario in which countries set trade barriers rationally with respect to their market power, unconstrained by multilateral trade rules. We use it to illustrate the potential impact of an extreme but plausible rise in trade barriers, rather than to forecast the shape and type of global disintegration which may occur in the coming years.

Table 2.2: WTO working paper scenario and impact

Country/region	Average initial applied tariff	Additional applied tariff in trade conflict	Impact on value of goods exports	Impact on real GDP
Indonesia	2.3	4.7	-14.1	0.4
Latin America	4.1	6.1	-16.7	0.0
Middle East and Northern Africa	5.7	6.0	-10.7	-0.2
Brazil	8.2	13.1	-22.9	-0.4
Russia	7.6	5.4	-10.7	-0.4
Australia	3.1	11.9	-15.6	-0.5
India	6.4	7.3	-17.8	-0.5
Sub-Saharan Africa	9.9	10.3	-13.8	-0.9
Turkey	1.4	5.7	-20.0	-0.9
EU 27	0.7	14.7	2.8	-1.0
South Africa	4.8	9.2	-17.6	-1.0
Mexico	1.1	5.1	-17.9	-1.2
EFTA	0.7	9.6	-21.8	-2.0
United Kingdom[1]	**2.3**	**27.7**	**-21.8**	**-2.0**
Japan	1.9	29.1	-29.2	-2.0
United States	1.2	58.8	-55.8	-2.2
China	3.7	28.1	-35.7	-3.1
Canada	0.9	21.1	-25.0	-3.3
Korea	5.5	13.3	-23.4	-3.3
ASEAN	2.3	11.6	-13.8	-4.1
Global average	**3.1**	**25.6**	**-17.0**	**-2.0**

[1] UK tariff rate taken as average of intra-EU and non-EU tariff. UK economic and trade impact assumed to equal the EFTA average.

2.61 The impact of lower volumes of global trade in goods on the UK is assumed to be similar to other advanced European economies outside the EU. In a global trade war scenario, the UK would not be protected by membership of the EU or another trading bloc. The costs to the UK of this scenario would likely be similar to those of EFTA countries, which are similarly geographically and economically interconnected with the EU as post-Brexit UK and are estimated to experience a 2 per cent hit to GDP, in line with the global average.

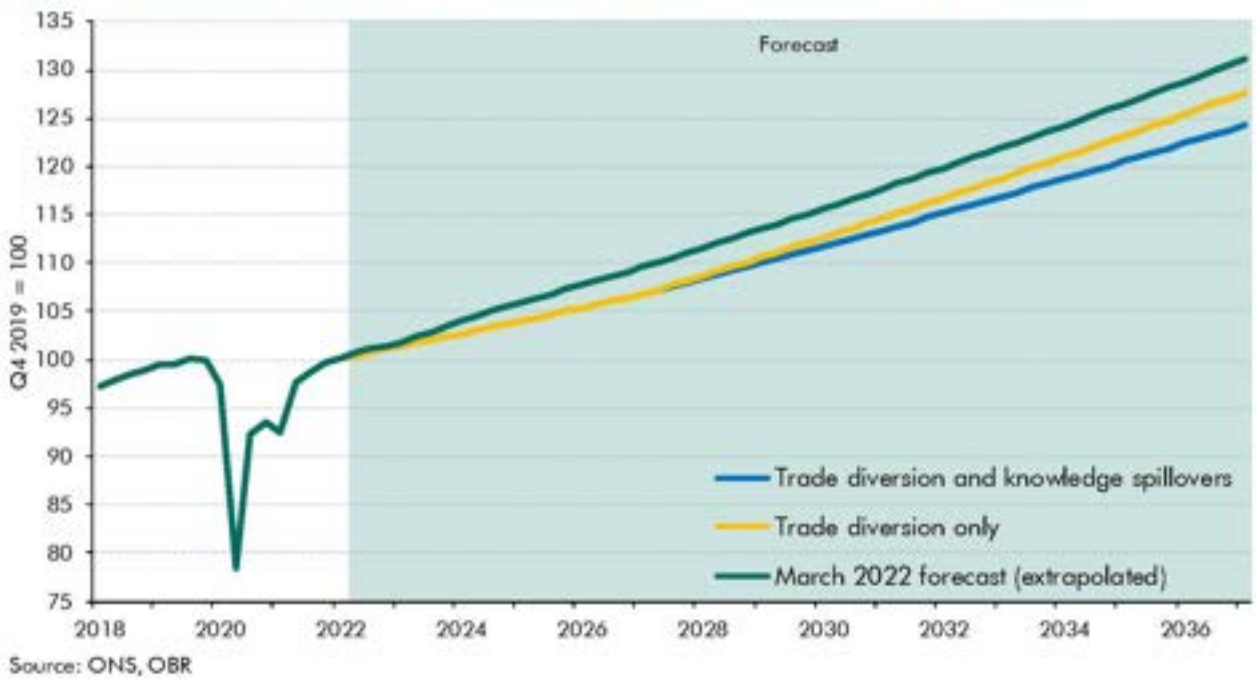
2.62 In addition to the impacts derived from the model used in the WTO paper, we include two additional factors in our scenario that would increase the costs of global economic fragmentation:

- **Lower services trade from higher non-tariff barriers**. Global services trade was 14 per cent of world GDP in 2019, while goods trade was 44 per cent (though services inputs

are increasingly embedded in the design, engineering and transportation of goods).[80] Assuming a global trade war would increase non-tariff barriers and reduce services trade by the same proportion as goods trade, and scaling the hit to global GDP by the value of global trade in services, could add another 0.6 percentage points to the hit to global GDP. The UK is relatively services-dependent, with trade in services amounting to 38 per cent of trade volumes and 24 per cent of GDP in 2019, which could make this global figure too low for the UK. But barriers to trade in services are generally higher already, leaving less scope for newly introduced measures to reduce trade, so we scale the impact proportionally. Therefore, accounting for trade diversion in both goods and services could reduce UK GDP by 2.6 per cent at the scenario horizon.

- **Dynamic effects and timeframe**. Many economic models assume that trade also supports productivity growth dynamically, with managerial and technological expertise passing across borders along with traded goods and services. Those papers that seek to model this channel explicitly generally find a large impact, albeit with substantial uncertainty, for example an IMF study finding that lower knowledge diffusion increases the size of the shock of decoupling by two to three times.[81] Also, the full effects of this decoupling are likely to take longer than the four-year horizon of the WTO scenario – for example, we assume that the full effect of Brexit on productivity will take 15 years to be realised. To account for these dynamic effects and timeframe differences, we double the impact implied by the WTO working paper, such that the level of real GDP declines by an additional 2.6 per cent to a total of 5.2 per cent over 15 years (Chart 2.22).

Chart 2.22: Illustrative GDP paths under global economic fragmentation



Source: ONS, OBR

[80] Antimiani, A. and L. Cernat, *Liberalizing global trade in mode 5 services: How much is it worth?*, Journal of World Trade, February 2018. These intermediate services are estimated to account for a third of the total value of manufacturing exports, having grown rapidly in the past two decades.

[81] IMF, *Sizing up the effects of technological decoupling*, March 2021.

2.63 Other economic factors that we do not include could further increase the impact of global fragmentation on global GDP beyond the path we set out above. These include:

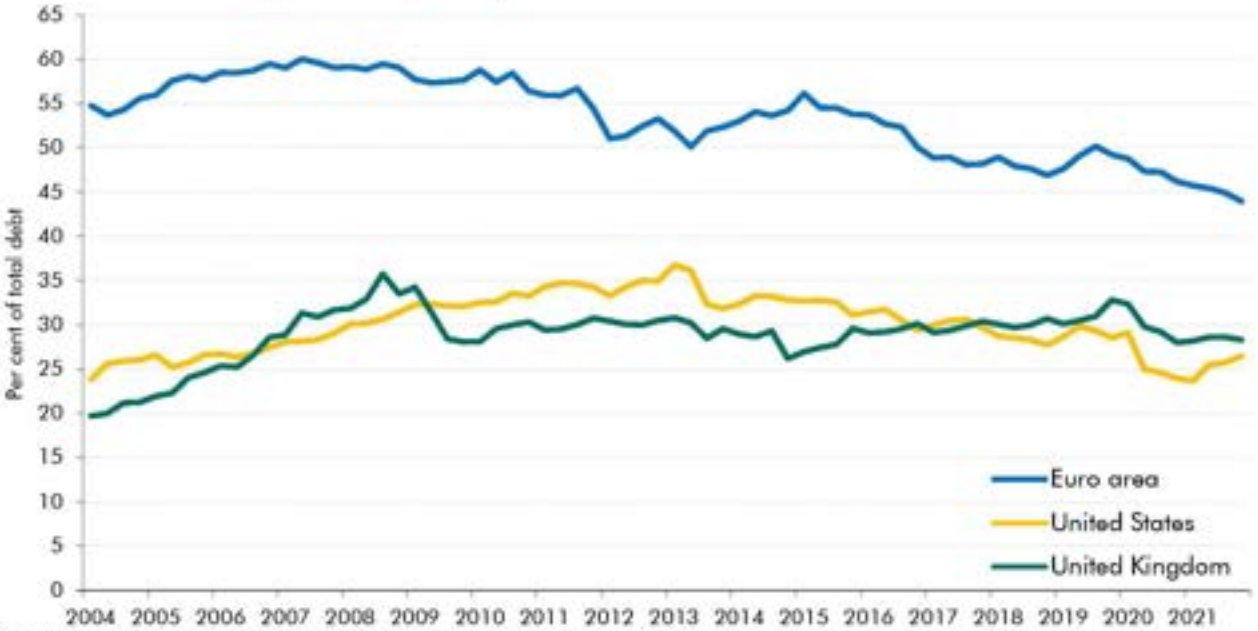
- **Greater uncertainty about trade policy**. In the short term, greater trade policy uncertainty would tighten financial conditions, weigh on confidence, and inhibit investment. The IMF estimates that trade policy uncertainty alone reduced global GDP by 1 per cent in 2019,[82] while its modelling found that the impact on global GDP of the confidence and market reaction effects of US-China trade tensions would be around three times their direct effects in the short run. However, these impacts are not thought to cause a lasting reduction in the level of GDP.

- **Lower inward FDI** could further reduce productivity beyond the effects captured by lower trade flows, although the estimated impacts are often small. For example, the Department for International Trade found in 2018 that a 1 per cent increase in the stock of inward FDI has resulted in an increase in labour productivity of 0.031 per cent.[83] If global economic fragmentation caused substantial repatriation of existing investments in the UK, the impact could therefore be significant; but if it merely slowed the flow of inward FDI (which in 2019 was 2.4 per cent of the stock of inward FDI in the UK), the impact on productivity would be minimal. However, the channels of FDI's impact on productivity are likely to be captured through lower technology and knowledge spillovers, which we include in our scenario separately.

2.64 In addition to the indirect effect via lower GDP, global economic fragmentation could also impact the public finances directly through higher interest rates. A more fragmented world would make it harder for capital to cross borders, which would reduce the number of potential buyers of government bonds. Studies in the US and euro area have found that large international capital inflows reduced long-term interest rates between 2000 and 2006, with every 1 percentage point increase in foreign holdings of euro area debt reducing long term interest rates by 0.13 percentage points.[84] While the increase in foreign holdings of sovereign debt has reversed in the US and euro area, foreign holdings of UK debt remain around 28 per cent, compared to 21 per cent in 2004 (Chart 2.23). If this share were to fall back to 20 per cent, using the elasticity found for the euro area would increase long-term interest rates by around 1 percentage point. We incorporate this interest rate rise, over a four-year period, in our scenario.

[82] IMF Blog, *Why we must resist geoeconomics fragmentation – and how*, May 2022.
[83] Department for International Trade, *Understanding FDI and its impact in the United Kingdom for DIT's investment promotion activities and services*, March 2021.
[84] Carvalho D. and M. Fidora, *Capital inflows and euro area long-term interest rates*, European Central Bank working paper, June 2015.

Chart 2.23: Foreign holdings of government debt



Note: Euro area is a simple average of France, Germany, Italy and Spain.
Source: IMF

2.65 In our scenario we assume countries fight the trade war through non-tariff measures (NTMs), rather than by raising tariffs. This is increasingly the way protectionism occurs, with the WTO finding in 2012 that *"averaging across countries…NTMs are almost twice as trade restrictive as tariffs."*[85] Were the UK and others to implement trade restrictions through tariffs instead, they would raise revenue. The UK collected an average of £3.3 billion a year in tariff revenue between 2015-16 and 2019-20, on an average value of goods imports of £466 billion a year, implying an effective tariff rate of 0.7 per cent. Increasing tariffs by 27.7 percentage points, as in the uncooperative tariff setting in the paper above, would therefore increase customs revenue substantially. But it would be misleading to assume that the amounts raised would be tens of times higher than is raised currently because the behavioural response to such a large tax rise would also be large. Those goods subject to the biggest increases in tariff rates would see the greatest falls in volumes of imports, lowering revenues. And the incentive to smuggle goods across borders would be greatly increased, lowering revenues further. Furthermore, to the extent that imports continued to arrive and tariffs were paid, the higher costs would feed through to consumer prices: evidence from the US tariff increases on Chinese imports in 2018 suggests the pass through to US consumers was significant.[86] This would reduce GDP and government revenue, while raising debt service costs on index-linked gilts.

2.66 In fiscal terms, the combination of a 5.2 per cent level hit to real GDP by 2036-37 and 1 percentage point higher interest rates means that borrowing rises significantly above the baseline in our global economic fragmentation scenario. This borrowing impact gradually increases, adding an extra 1.1 per cent of GDP in 2026-27, rising to 2.3 per cent of GDP

[85] World Trade Organization, *World trade report 2012*, May 2012.
[86] NBER, *US consumers have borne the brunt of the current trade war*, May 2019.

by 2036-37 (an extra £57 billion in today's terms), with higher gilt rates feeding into higher debt interest payments.

A geopolitical risk scenario

2.67 This section brings together the three sources of fiscal risk described above into a combined geopolitical stress test – a low-probability, high-impact scenario. Reflecting the tendency for global security and economic tensions to rise in tandem, it includes:

- **Higher defence spending over the medium term**. We include the costs of a future Government raising defence spending to 3 per cent by 2036-37, choosing to over-achieve the NATO minimum for defence spending and maintaining the UK's position as the second-largest contributor to NATO spending in absolute terms, after taking account of the latest German commitment to increase their spending to 2 per cent of GDP. Spending increases by 0.9 per cent of GDP above a baseline consistent with current spending plans (equivalent to £24 billion in today's terms). This is assumed to add directly to borrowing and place debt on a higher path, with no further indirect effects modelled.

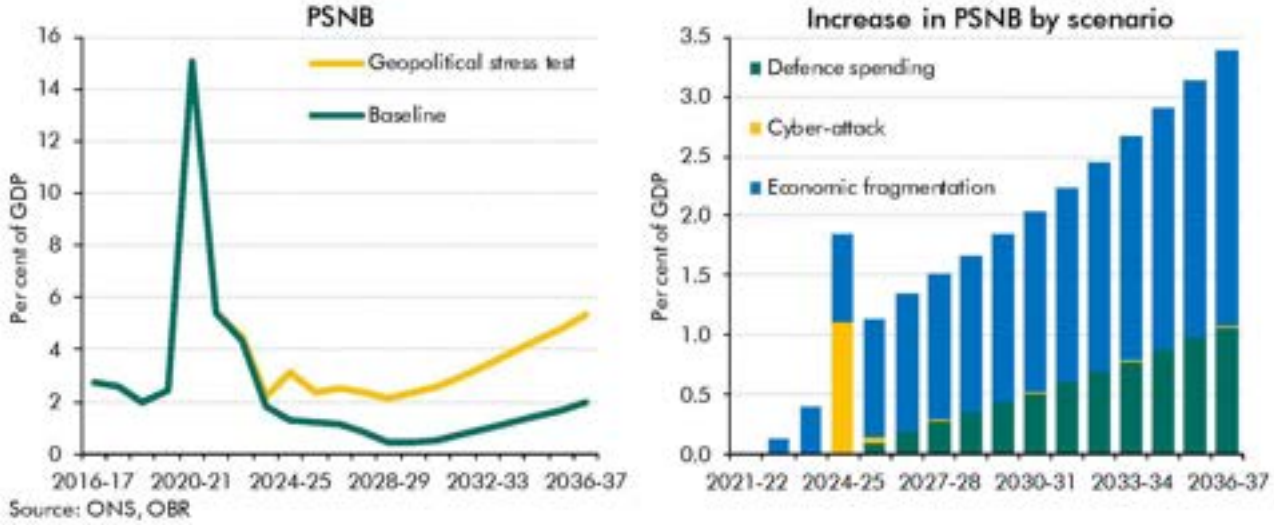
- **The fiscal cost of a major cyber-attack**. This element of the scenario quantifies the fiscal effects of a major cyber-attack on the UK electricity grid set out above. This involves a 1.6 per cent short-term hit to GDP in 2024-25 when we assume the attack takes place, and spending of just under £16 billion in government support, also in that year.

- **Global economic fragmentation**. This element of the scenario is modelled on a lasting global trade war, which results in a GDP impact of 5.2 per cent over the next 15 years. As well as hitting revenues due to weaker GDP, this scenario also includes a 1 percentage point increase in gilt rates relative to the baseline by the scenario horizon.

2.68 Taking these together, we combine both a short-term shock of a major cyber-attack with longer-term economic and fiscal factors that reduce government revenue and raise government spending. Using a simple ready-reckoner approach, the left side of Chart 2.24 illustrates the resulting path of government borrowing.[87] Combining the three aspects of our scenario, borrowing reaches a medium-term peak in 2024-25 at 3.1 per cent of GDP, £47.5 billion above baseline, and rises further to reach 3.4 per cent of GDP above baseline at 5.3 per cent of GDP at the scenario horizon of 2036-37. The right side of Chart 2.24 shows the contributions of each aspect of our scenario. In the case of defence spending, borrowing is in line with the baseline over the Spending Review period to 2024-25, then rises gradually to 1.1 per cent of GDP above baseline by 2036-37. There is a short, sharp addition to borrowing from the cyber-attack of 1.1 per cent of GDP (£28.7 billion) in 2024-25. The fiscal costs of global economic fragmentation rise steadily to reach 2.3 per cent of GDP in 2036-37 (equivalent to £57 billion in today's terms).

[87] The 'baseline' we compare our scenario against is an updated version of our March 2022 forecast, as set out in Box 3.3 in Chapter 3.

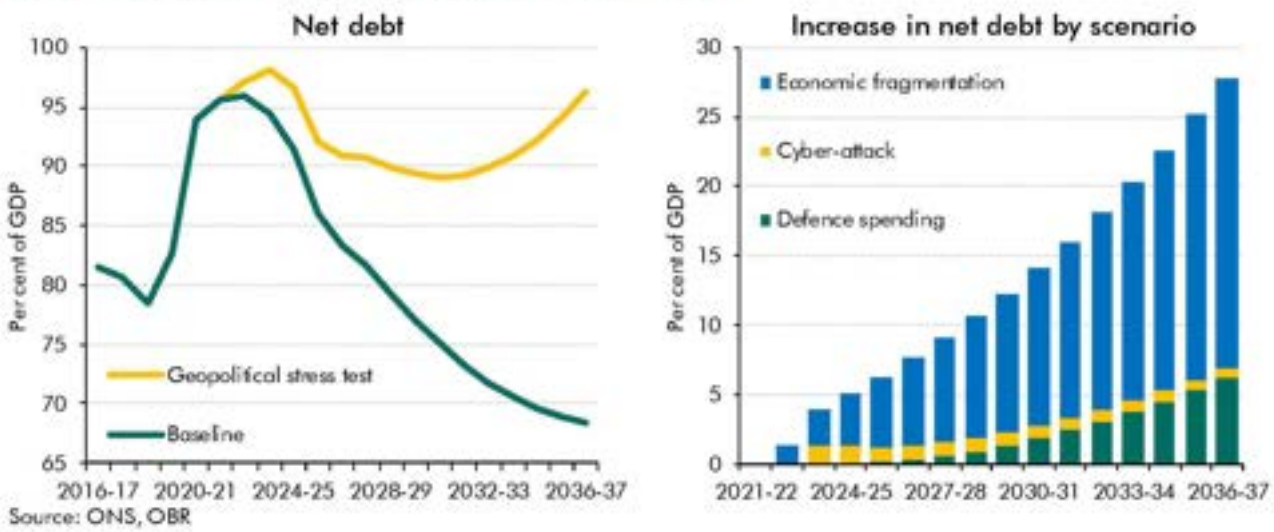
Chart 2.24: Net borrowing: baseline versus stress test



Source: ONS, OBR

2.69 These increases in borrowing push public sector net debt (PSND) up materially in the stress test. The left side of Chart 2.25 shows that debt starts at 97.2 per cent of GDP in 2022-23, from where it falls much more slowly than the baseline to reach 89.1 per cent of GDP in 2030-31 (14.1 per cent of GDP above the baseline), before rising back to 96.2 per cent of GDP by 2036-37, 27.8 per cent of GDP above the baseline. The right side of the chart shows that the cyber-attack has a relatively modest impact (around 1 per cent of GDP from 2024-25 onwards) since it is confined to two years. Higher defence spending pushes debt progressively higher, reaching 5.8 per cent of GDP above the baseline by 2036-37. But it is global economic fragmentation that adds more significantly to debt, raising it by over 20 per cent of GDP by 2036-37 – thanks to the damage done to nominal tax bases by the large hit to the productive potential of the economy and higher interest rate on government debt.

Chart 2.25: Net debt: baseline versus stress test

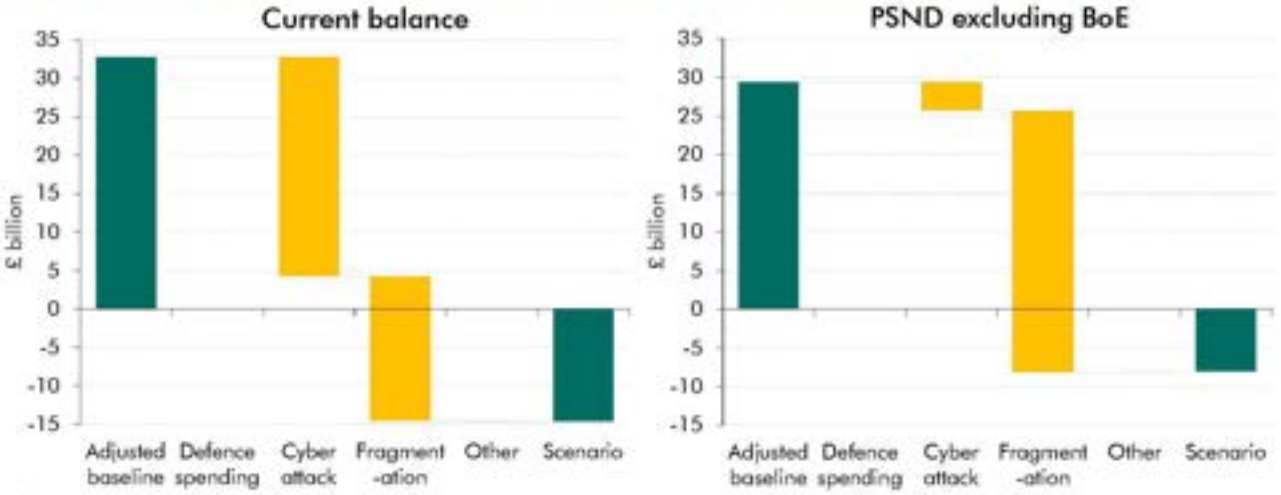


Source: ONS, OBR

2.70 The majority of the fiscal impact of the stress test falls beyond the Chancellor's legislated fiscal rules (to reach current balance and to have debt excluding the Bank of England falling

as a percentage of GDP in three years' time – which was 2024-25 in our March forecast). However, the near-term effects relating to the cyber-attack scenario and fragmentation scenario would affect performance against the fiscal targets, with both being missed in the stress test. The left panel of Chart 2.26 illustrates the effect on the current balance, which stands at a nearly £15 billion deficit in 2024-25, a £47.5 billion deterioration on baseline. This is split between a nearly £29 billion hit from the cyber-attack and nearly £19 billion from the fragmentation scenario. The right side of Chart 2.26 shows the effects on PSND excluding the Bank of England, which, instead of falling, rises by 0.3 per cent of GDP, missing the target by over £8 billion. This amounts to a £37.6 billion decrease on the baseline headroom, which comprises a nearly £34 billion deterioration resulting from the fragmentation scenario, and a nearly £4 billion deterioration from the cyber scenario.

Chart 2.26: Headroom against the Chancellor's legislated fiscal rules



Source: OBR

Appendix – papers estimating impacts of trade wars

Table A.1: Heightened geopolitical tensions

Source	Scenario	Channels	Macro impact
WTO (2019)	Global trade war – general tariff increases, median increase of 32 per cent	Direct goods trade, intermediate linkages, capital accumulation (WTO DCGE model)	Lower global GDP of 2 per cent at 4-year horizon, and 17 per cent reduction in global exports
Banque de France (2019)	10 per cent generalised increase in global tariffs	Goods trade, investment, uncertainty, productivity (GIMF model with additions)	Global GDP 2 per cent lower on impact and 3 per cent lower after 2 years
IMF (2021)	Cessation of trade in high-tech goods and technology between two or three global hubs	Goods and services trade flows, productivity, dynamic knowledge spillovers (GIMF with additions)	Real GDP in US and China is 3 to 4 per cent lower after 10 years, in US-China decoupling scenario
WTO WP (2022)	Western/Eastern blocs. Either complete decoupling or retaliatory tariffs (32 per cent increase)	Trade and technology (WTO DCGE augmented with productivity diffusion)	Western bloc range between -1 and -8 per cent (median: -4 per cent), in the Eastern bloc they are in the -8 per cent to -11 per cent range (median: -10.5 per cent) with a global projected real income loss of about 5 per cent
IMF WEO (October 2019)	Tariffs on all US-China goods trade increase by 25 percentage points	Trade, confidence, financial markets, productivity (GIMF model)	Global GDP −0.3 per cent smaller in longer term
IMF (2019)	Impact of trade war scenarios on US economy	3 scenarios – auto tariffs on everyone, transactional deal, escalation with China (General equilibrium model)	US economy smaller in all scenarios
ECB (2019)	United States increases tariff and non-tariff barriers on imports from all trading partners by 10 per cent, and the other countries retaliate symmetrically	Trade (goods and services) (GIMF), confidence (ECB global model)	In the first year, global trade and global activity could fall by more than 2.5 per cent and 1 per cent respectively
Econpol (2019)	Various US-China escalation scenarios, including 25 per cent tariff on all bilateral trade imposed by both countries	Goods trade, tariffs (Input-output model)	US and China value added falls 0.14 per cent and 0.25 per cent in the extreme scenario
Ossa (2014)	Global trade war, median tariff increase 56 per cent	Direct trade	2.9 per cent fall in welfare, 58 per cent fall in trade

3 Higher energy prices

Introduction

3.1 Energy prices had already begun to rise as economies reopened in the wake of the pandemic in the second half of 2021. They have since surged still higher in response to Russia's invasion of Ukraine in February of 2022. Measured in pounds rather than dollars, oil prices reached an all-time *nominal* high in May of this year, when prices were around 15 per cent higher than the peak seen in March 2012. Gas prices reached even more unprecedented all-time highs in *real* terms this year. These rises have been dramatic, but energy price shocks are not a new phenomenon – oil prices have risen sharply on five previous occasions over the past half century, with significant peaks in 1974, 1979, 1990, 2008, and 2012 (Chart 3.1). Recent history has also seen prolonged periods in which energy prices stayed high: from the mid-1970s to the mid-1980s and from the mid-2000s to the mid-2010s.

Chart 3.1: Real gas and oil prices

Note: Series deflated using CPI (ONS monthly rate for 1988-2022 and ONS historical estimates for 1970-1987). Natural gas prices were denominated in pence per therm and crude oil prices were denominated in dollars per barrel prior to indexing.
Source: Datastream, ONS

3.2 Fossil fuel prices have been highly volatile in the wake of the Russian invasion of Ukraine and several factors, both geopolitical and environmental, could mean that they remain elevated over the medium term. Sudden increases in energy prices can be highly disruptive economically and fiscally, as they were in the late 1970s and early 1980s. One focus of this chapter is therefore to explore the potential implications of higher and more volatile fossil fuel prices for the economy and public finances over the five-year horizon of our medium-

term forecasts. Over time, the composition of energy supply can adjust in response to price signals, regulatory changes, and other incentives, including those aimed at meeting the Government's target to reach net zero emissions by 2050. Building on the analysis in the climate change chapter of our 2021 *Fiscal risks report* (*FRR*), the second part of this chapter considers the longer-run changes in the UK's energy mix required to reduce the UK's dependence of fossil fuels and the potential fiscal risks associated with getting to net zero by the middle of this century in the context of greater focus on security of energy supply.

3.3 With these objectives in mind, this chapter:

- describes **how energy is produced and used in the UK**, and **how its price has changed in recent months**;
- explores **the channels through which energy affects the economy and public finances**;
- assesses the medium-term economic and fiscal implications of **two scenarios in which fossil fuel prices are higher than in our March 2022 forecast**;
- discusses **how our energy mix could change over the long run** in response to higher fossil fuel prices and to meet the Government's net zero target; and
- illustrates some of **the potential fiscal risks associated with the transition to net zero in the context of a greater policy focus on security of energy supply**.

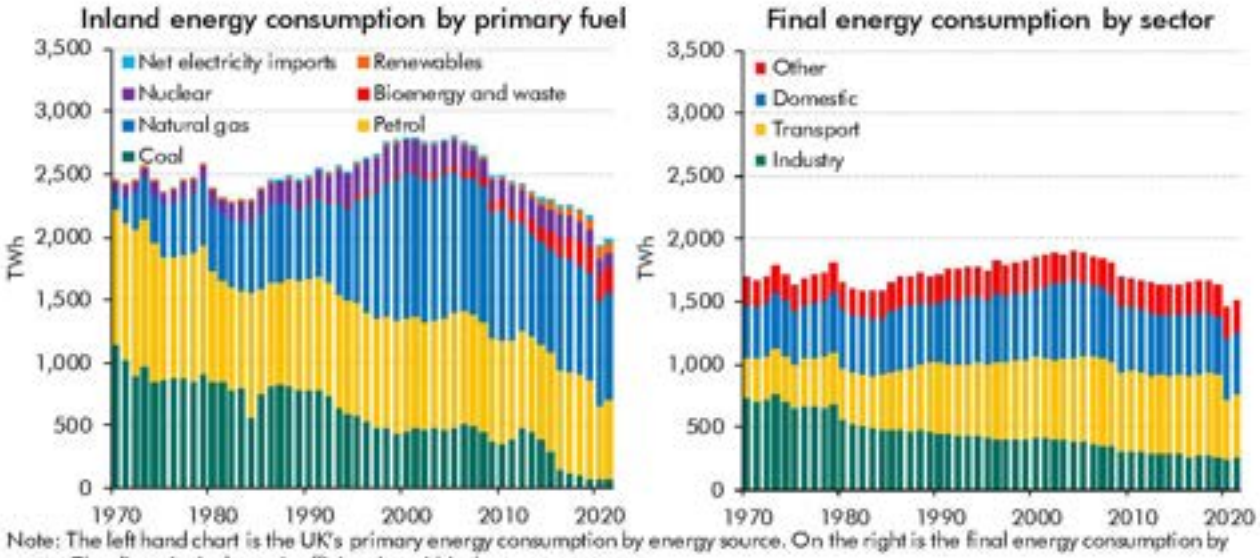
Energy use and prices

Energy use in the UK

3.4 Energy is an important output of one part of the economy, an important input in the production of most goods and services, and a major item in the consumption basket of most households. Over the past 50 years, the UK's overall energy use has remained broadly stable, driven by increasing energy efficiency and a reduction in the relative size of the manufacturing sector. In 1970, industry accounted for over 40 per cent of energy consumption. By 2019, this had fallen to 16 per cent, with the transport sector (including both freight and passenger use of road, rail, water and air transport) becoming the largest consumer of energy followed by households' domestic energy use. Broadly stable energy consumption alongside a growing economy has meant that the UK economy is now far less energy intensive than in the past – indeed, energy use per unit of GDP is the lowest it has been in at least three centuries.[1]

[1] See Fouquet, R., *Lessons from energy history for climate policy: technological change, demand and economic development*, 2016.

Chart 3.2: Sources and uses of energy in the UK since 1970



Note: The left hand chart is the UK's primary energy consumption by energy source. On the right is the final energy consumption by sector. The disparity is due to inefficiencies within the power system.
Source: BEIS

3.5 Renewable sources make up a growing share of UK energy, but the vast majority of our energy (78 per cent) ultimately still comes from – now largely imported – fossil fuels. The economy has steadily weaned itself off coal over the past 50 years (which made up only 3 per cent of energy used in 2019), but we have become somewhat more dependent on gas (40 per cent). Over this period, clean sources of energy have risen only gradually, albeit with rapid growth in renewable sources since 2010 (4 per cent in 2019), largely offsetting a slower fall in nuclear power since the turn of the century (6 per cent). A long-term decline in North Sea production as reserves have declined means the UK has been a net energy importer since 2004 (net imports made up 35 per cent of energy supply in 2019, as Chart A in Box 3.1 shows). The UK has become somewhat less dependent on energy imports since 2014, partly due to a rise in the renewables share of production as coal supplies are phased out. Oil is traded on global markets, but difficulties transporting and storing natural gas means much of our gas supply comes from Norway, so UK market prices are more affected by what happens in Europe. As Box 3.1 sets out, these and other factors mean that the UK is still exposed to fossil fuel price shocks, but that their impact is likely to be less than during the 1970s and 1980s.

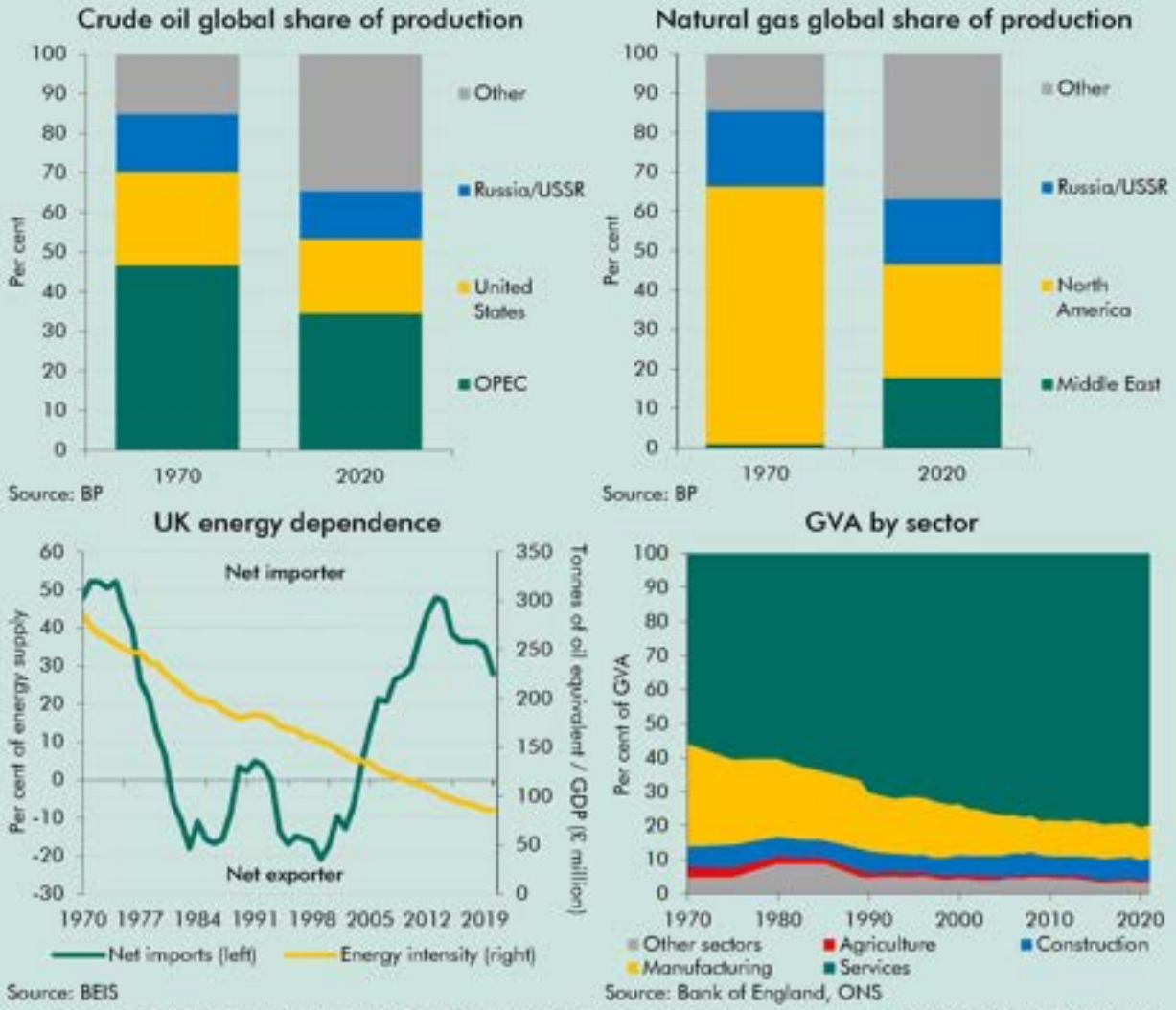
Box 3.1: The changing impact of fossil fuel shocks on the UK economy

The 1970s saw the last major global energy crises – driven first by the members of the Organization of the Petroleum Exporting Countries (OPEC) introducing an oil embargo on a number of industrialised countries in 1973 and second by the Iranian revolution in 1978.[o] Crude oil prices increased four-fold in 1974, then fell back somewhat before almost tripling again in 1979, triggering the early 1980s recession. Over the decade, CPI inflation and the unemployment rate peaked at 25 per cent and 5.7 per cent, respectively, and the economy fell into recession (with the combination of high inflation and recession leading to the term 'stagflation' being coined).

While the oil crises of the 1970s saw global energy prices rise by a similar magnitude as we have seen in the wake of the pandemic and Russian invasion of Ukraine, there are reasons to believe that the overall impact on inflation, output, and unemployment will be less severe and less persistent this time around. There are some similarities between the situation in the late 1970s and now, with the UK a net importer of energy, coming into the crisis with low unemployment and a tight labour market, and already facing rising inflationary pressures from other sources. But there are also important differences:

- **Market power of OPEC versus Russia**. As seen in the top left and right panels of Chart A, in the 1970s, OPEC accounted for about half of global oil production whereas today Russia accounts for only 12 per cent of global oil and 17 per cent of global gas production. While logistical constraints mean that gas markets are more regional than oil markets, in the long run energy importers are likely to have more scope to substitute away from Russian energy exports now than they had to replace OPEC oil exports then.
- **Energy intensity of the UK economy.** As seen in the bottom left and right panels of Chart A, the energy intensity of UK GDP has fallen by 70 per cent since the mid-1970s, driven by energy-intensive manufacturing making up far less of the UK's economy and improvements in economy-wide energy efficiency. The price elasticity of demand for gas and oil may have also risen due to the greater availability of technologies such as electric cars and renewable energy alternatives. Against that, the UK has also increasingly become reliant on global supply chains since the 1970s, leading to increasing reliance on fossil-fuel-dependent industries such as the global shipping industry.
- **The structure of the UK labour market.** Industrial relations have fundamentally changed since the 1970s with union bargaining power significantly reduced in part due to legislative changes and declining union membership.[b] Union membership has fallen from an average of 48 per cent during the 1970s to 23 per cent in 2021, and wage-price spirals driven by negotiated, across-the-board cost of living adjustments for entire workforces are perhaps less likely as a result – even if pressure from unions in the face of high inflation is nonetheless intense.
- **Monetary policy.** Since 1997, the Monetary Policy Committee of the Bank of England has been given independence in its setting of monetary policy to hit a Government-set inflation target. This has helped to reduce long-run inflation expectations and keep them generally anchored around the Bank's 2 per cent target.[c]

Chart A: The economic impact of the 1970s oil shocks compared to today



Note: In the top left and right panels, Russian figures exclude former Soviet Republics, although these are included in USSR figures. GVA by sector uses Bank of England data from 1970-1989 and ONS data from 1990-2021.

[a] Kesicki, F., *The third oil price surge – What's different this time?*, Energy Policy, March 2010.
[b] Waddington, J., *The Politics of Bargaining: Merger Process and British Trade Union Structural Development, 1892-1987*, 1995.
[c] Blanchard, O., and Gali, J., *NBER Working paper: The Macroeconomic Effects of Oil Shocks: Why are the 2000s So Different from the 1970s?*, November 2007.

Fossil fuel prices in our forecasts

3.6 Given the continued importance of gas and oil in the UK economy and our position as a net importer of both, changes in global fossil fuel prices are a significant source of economic and fiscal risk. Our medium-term economy forecasts are usually conditioned on market expectations for gas and oil prices. We typically use the path implied by the futures curve[2] for the first two years of our forecast then hold gas and oil prices flat in real terms as futures curves are not the best predictor of prices at extended horizons.[3] These gas and oil prices

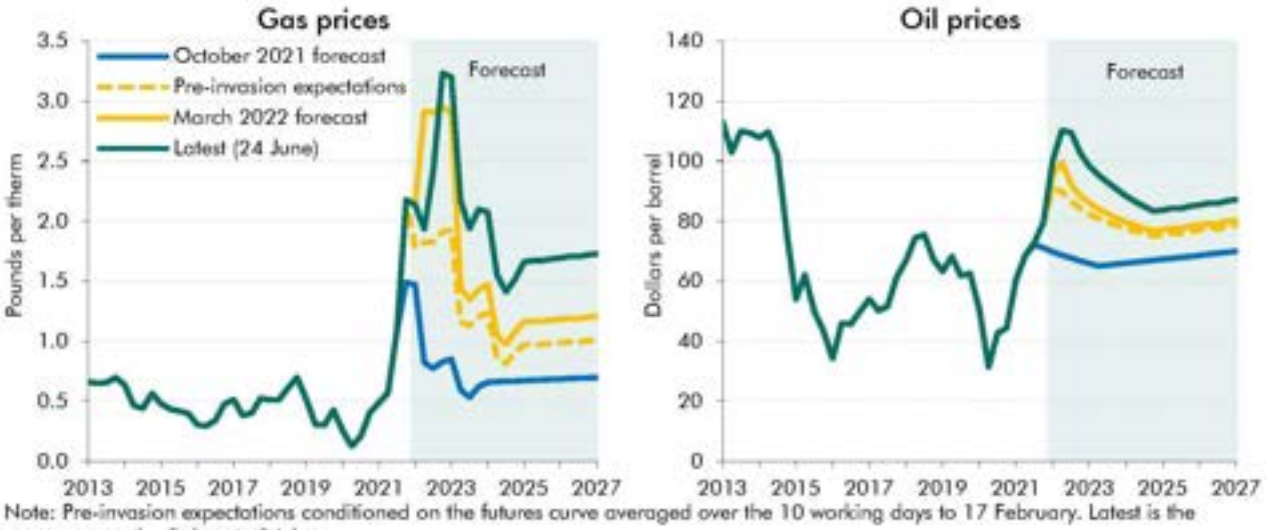
[2] Because futures curves are relatively volatile, we typically average futures curves over the 10 working days to our collection date.
[3] Reichsfeld, D. A., and S. K. Roache, *IMF Working Paper: Do Commodity Futures Help Forecast Spot Prices?*, November 2011.

feed into our economy forecast (for example via inflation), and directly and indirectly into our fiscal forecast through the channels discussed in the next section.

3.7 Gas and oil prices increased sharply following Russia's invasion of Ukraine and remained highly volatile thereafter, with the gas price reaching a (close of day) peak of £5.40 per therm and oil a peak of $129 per barrel. To capture the initial effects of the invasion on energy prices, our March 2022 *Economic and fiscal outlook* (*EFO*) forecast used the futures curve averaged over the five days following the invasion (24 February to 2 March) – the latest period possible given the forecast date. We also used three, rather than two, years of the futures curve, because the movements in gas price futures three years ahead were unusually significant, before holding prices flat in real terms. Chart 3.3 shows that the gas and oil prices in our March forecast peaked at 100 per cent and 40 per cent above their respective peaks in our October 2021 forecast, before falling back somewhat but remaining above our October forecast. In March, we expected these higher prices to have a transitory impact on inflation and GDP growth, but assumed no medium-term hit to potential output as prices were assumed to largely fall back.

3.8 Since we closed our forecast in early March, gas price outturns have been lower than we had anticipated. By 24 June, the latest data shown in Chart 3.3 suggested prices in the second quarter of 2022 would average around £1.90 per therm, compared to the £2.90 we had forecast in March. But despite this, expected *future* prices are now largely *higher* than assumed in our March *EFO*, peaking at £3.20 per therm in the fourth quarter of 2022 (compared with our March forecast of £3.00 per therm), before falling to £1.50 per therm by the fourth quarter of 2024. These higher futures prices for gas may reflect expected difficulties associated with storing natural gas in the face of higher demand in coming winters. In contrast, oil price outturns have been above our March expectation. The latest data suggests prices will peak at $110 per barrel in the second and third quarters of 2022 (compared to the $100 peak assumed in our March *EFO* forecast), before falling to $83 per barrel by the end of 2024. Both gas and oil futures have continued to be highly volatile.

Chart 3.3: Gas and oil prices in our recent forecasts



Note: Pre-invasion expectations conditioned on the futures curve averaged over the 10 working days to 17 February. Latest is the average over the 5 days to 24 June.
Source: Datastream, OBR

The economic and fiscal impact of higher fossil fuel prices

3.9 In the medium term, supply-driven higher fossil fuel prices pose fiscal risks due to their impacts on the economy, the public finances, and the pressures they put on fiscal policy.[4] Persistently more volatile fossil fuel prices could have some similar effects to sustained high prices if they added a risk premium to the futures prices at which many firms and energy suppliers purchase energy. This section therefore discusses:

- How higher fossil fuel prices raise economy-wide **inflation**, eroding **real incomes**, and weighing on **consumption**.
- How they may also weigh on the **potential output** of the economy, based on a simple model of the elasticity of output to changes in the prices of these fuels that we also use to inform the scenarios shown later in this chapter.
- How they could affect the economy via other channels, such as by lowering **investment** or raising **unemployment**.
- How higher fossil fuel prices could impact the **public finances**, including through their direct and indirect effects on tax receipts and spending, and through the pressures they create for fiscal policy to offset their impacts on people and businesses.

3.10 Importantly, over the medium-term horizon considered here, higher prices will mean consumers of fossil fuels (directly or via electricity) either pay more, because there is little ability to substitute away from fossil fuels to alternative energy sources, or reduce their demand. Later in the chapter we will discuss the long-term implications of higher prices in the context of the Government's 2050 net zero target and its recent energy security strategy. At this horizon, more substantial changes to the energy intensity of output are possible and the economy can substitute away from fossil fuels to alternative energy sources.

Inflation, incomes, consumption, and monetary policy

3.11 The initial economic impact of higher fossil fuel prices is likely to be to raise **inflation**. Although the precise shape of this impact would depend on the change in fossil fuel prices, this would nonetheless be felt in in four, partly overlapping, steps:

- First, higher oil prices will directly raise the 'pump' price of **petrol and diesel**.
- Second, higher gas prices raise domestic retail energy prices with a lag due to the **Ofgem energy price cap**, which is adjusted every six months to reflect changes in market expectations for future wholesale gas prices and other producer costs.[5]

[4] As is always the case, the economic and fiscal consequences of a shock depend on its underlying cause. In the case of energy prices, it matters whether they are being driven higher by surging demand (which would be associated with other beneficial economic and fiscal consequences) or by constrained supply (which would not). See Boxes 2.1 and 3.2 in our March 2015 *Economic and fiscal outlook*.
[5] In May 2022, Ofgem launched a consultation on whether the energy price cap should be updated quarterly rather than every six months. This would change the profile of inflation, as utility prices would respond more frequently to wholesale gas price changes.

- Third, higher fuel and energy prices will raise the cost of producing **other goods and services** – for example, food production is energy and fossil fuel intensive (including via the use of fertilisers). If firms pass on these higher input costs to consumers, inflation will rise beyond the direct impact of higher fuel and utility prices.

- Finally, the changes in inflation are likely to affect **other macroeconomic variables**, and these impacts will feed back to affect inflation. Most importantly, the drag on demand from lower real wages caused by high inflation could partially offset the upward cost pressures from higher fossil fuel prices (discussed in further detail below).

3.12 All else equal, as a net importer of fossil fuels, an increase in the price of those fuels amounts to a 'terms of trade' shock for the UK which would be expected to erode households' **real incomes**. How this shock works its way through the economy will depend on the degree of real wage resistance, including monetary policy's ability to keep inflation expectations anchored. But it is not possible for the UK as a whole to avoid the costs of such a shock – the only choice is about where they are borne. So long as energy prices rise relative to the price of UK-produced goods – and in the absence of an option to costlessly substitute away from imported fossil fuels – incomes will fall relative to the position with lower energy prices. Governments may insulate current consumers from some of this hit to living standards by moving it to the future but they cannot make that cost go away. The extent to which fiscal policy protects households today would determine the extent to which the costs are borne by future households paying to service a higher public debt.

3.13 If nominal wages rise in response to the shock, firms will either have to raise prices further or absorb some of the hit via lower profits and potentially lower investment. If nominal wages do not respond to the shock, lower real incomes would in turn lower private consumption. The extent of this effect would partly depend on households' abilities to substitute away from non-energy goods to energy. If the shock to energy prices is perceived to be temporary, households might be able to dip into their savings to maintain consumption, although this is less likely if the energy price shock is perceived to be permanent. But regardless of whether real wages and consumption, or real profits and investment, were hit hardest by the shock, real GDP would be lower.

3.14 Our forecasts typically assume that the Bank of England reacts to ensure inflation falls back to target over the medium term (consistent with the remit set for it by the Government), so higher fossil fuel prices would typically only have a transitory impact on inflation (though a permanent impact on the price level).

Potential output

3.15 In addition to the transitory effects discussed above, persistently higher fossil fuel prices would also be likely to have a permanent impact on the real economy by reducing the level of **potential output** (the supply capacity of the economy). Fossil fuels are a largely imported input into production in the UK, so permanently higher prices will reduce the quantity of output that firms find it profitable to produce and so reduce the economy's supply potential. The size of this effect depends on the importance of fossil fuels in the economy and how

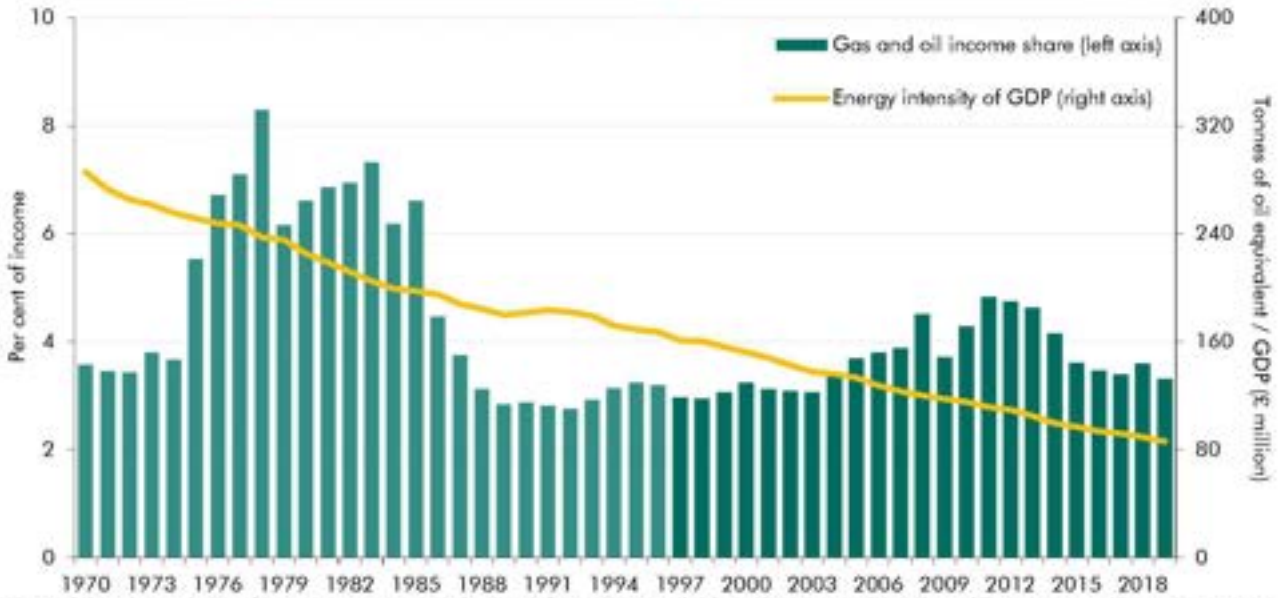
easy it is to substitute away from them to alternative forms of energy, such as nuclear, wind or solar. Over the five-year period we consider in our medium-term scenarios, relative to existing plans, it is hard to speed up the building of additional new infrastructure for generating renewable energy or nuclear power and to replace end-use infrastructure that relies on fossil fuels (such as gas boilers and petrol vehicles) at a large enough scale to replace a significant share of the UK's gas and oil consumption.[6] In reality, there is likely to be some substitution over the medium term to alternative energy sources, or investments to improve energy efficiency, which could dampen the economic impact. But the major changes in the UK's energy mix are likely to happen over a longer period, which we discuss later in the chapter.

3.16 One relatively simple way to model the medium-term impact of higher fossil fuel prices on potential output is to use a three-factor (labour, capital and fossil fuels) production function approach (Box 3.2).[7] This function relates these inputs (the 'factors') to the output of final goods and services. A rise in the price of gas and oil has a direct effect on the economy's supply potential by, all else equal, lowering the level of output firms are willing to produce for a given price. The size of this impact depends on the relative importance of gas and oil in the economy. As firms reduce their output, there is a 'second-round effect' on potential output by reducing overall demand for labour, capital and fossil fuel inputs into production. The effect of lower demand on each factor depends on how supply responds. We assume that the quantity of labour supplied is fixed, so lower demand is entirely reflected in real wages, and the supply of capital is fixed in the first year but can vary in future years.

3.17 The importance of gas and oil to the UK economy has declined since the 1970s. One way to measure this is using the energy intensity of output. Chart 3.4 shows the UK's energy intensity has declined by around two-thirds since the early 1970s. An alternative measure is the share of national income accruing to gas and oil inputs, both imported and domestically produced (the factor income share). This accounts for varying gas and oil prices by considering how much is spent on gas and oil inputs into production. We use this measure in our production function and the higher the gas and oil share, the greater the impact of a given percentage increase in their prices on potential output. In 2019, the latest available data, this share was 3.3 per cent (see Box 3.2 for more detail). Chart 3.4 shows that the gas and oil share is higher at times of high gas and/or oil prices, most notably the late 1970s to early 1980s and the early 2010s.

[6] For example, the Government's April 2022 *British energy security strategy* said the development and deployment of wind farms takes up to 13 years and the National Infrastructure Commission's September 2021 *Advice of nuclear power plant deployment* used an assumption of 22 years for a nuclear plant to come online, based on the experience of Hinkley Point C.
[7] This is an updated version of the model used in OBR, *Assessment of the Effect of Oil Price Fluctuations on the Public Finances*, 2010.

Chart 3.4: Energy intensity of output and the gas and oil share of income



Note: Oil and gas share of income approximated using information available in Groningen Growth and Development Centre long-run input-output tables pre-1997 and calculated using ONS tables post-1997.
Source: Groningen Growth and Development Centre, ONS, BEIS

3.18 Using our production function, we estimate the elasticity of potential output to gas and oil prices to be -0.013 in the short run (one year) and -0.018 in the medium run (five years). This means that a 10 per cent increase in prices reduces potential output by 0.13 per cent in the first year and by 0.18 per cent after five years. The medium-term impact is larger because we assume that the capital stock can adjust over this period. So, after five years, there is a lower quantity of capital because investment falls due to lower demand for capital in a smaller economy and as some existing capital is scrapped. In terms of factor income shares, higher gas and oil prices initially increase the fossil fuel share of the economy, while reducing both the capital and labour share. Then over the medium term, the higher fossil fuel share will be offset by a lower labour share via an erosion of real wages, while the capital share of income is unchanged (although the capital stock is lower).

Box 3.2: Energy prices and potential output: a production function approach

To estimate the impact of higher gas and oil prices we use a three-factor production function. Technology is characterised by a constant elasticity of substitution function, which combines labour, capital and fossil fuels (which combines gas and oil) to produce aggregate output:

$$Y = A(\alpha_L L^\rho + \alpha_K K^\rho + \alpha_F F^\rho)^{1/\rho}$$

Where Y, L, K and F are aggregate output, labour, capital and fossil fuels, respectively, and $\rho = (\sigma - 1)/\sigma$, where σ is the elasticity of substitution. We use a value of 0.4 for the elasticity of substitution in the UK.[o]

For the supply of the three factors of production, we assume:

- The UK's demand for gas and oil does not affect the price of either commodity as prices are set regionally (in the case of gas where UK prices move closely with Europe-wide prices) or globally (in the case of oil).
- In the short run, the price of capital can change but the quantity does not because it takes time to scrap or rebuild capital (the *short-run* capital supply is perfectly inelastic). In the long run, the quantity of capital used in the economy changes as capital is scrapped and new capital is employed but the price does not change because capital is supplied in an internationally competitive environment (the *long-run* capital supply is perfectly elastic). We assume this adjustment happens over our medium-term forecast period of five years.
- The quantity of labour, l^*, supplied in the economy does not change (it is perfectly inelastic in the short and long run). This means that a reduction in demand for labour causes a fall in real wages but no reduction in the quantity of labour.

The demand for each factor of production can be derived and the model expressed in terms of the equations for output and factor demands:

1 Output: $y = lnA + \frac{1}{\rho} ln(\alpha_L L^\rho + \alpha_K K^\rho + \alpha_F F^\rho)$

2 Labour: $l = y + \frac{1}{1-\rho}(ln\alpha_L + \rho lnA - w) = l^*$

3 Capital: $k = y + \frac{1}{1-\rho}(ln\alpha_K + \rho lnA - r)$

4 Gas and oil: $f = y + \frac{1}{1-\rho}(ln\alpha_F + \rho lnA - p_F)$

Where lower case letters reflect the logarithm of the variables and w, r and p_F are the prices of labour, capital, and fossil fuels, respectively.

While the economy is assumed to move instantaneously to the new equilibrium following the price change, we can nonetheless use these equations to understand the channels through which an increase in fossil fuel prices feeds through. A rise in p_F reduces the demand for fossil fuels (4), which then reduces aggregate output (1). This reduction in aggregate output then reduces the demand for capital and labour (2 and 3), and further reduces the demand for fossil fuels (4). This again reduces aggregate output and the process is repeated until the values for output and the three factors converge to equilibrium.

An important variable to assess the impact of gas and oil prices increases on the economy is the 'gas and oil share' (the income accruing to gas and oil inputs, both domestic and imported, as a share of total income). The higher the gas and oil share, the greater the impact of a given percentage increase in prices on aggregate output. To get the value of gas and oil as an input into production, we calculate the value of the intermediate consumption of gas and oil by other industries using the ONS's input-output tables.[b] This is equal to £58 billion in 2019, the latest available value. We also calculate non-oil, non-gas domestic income, which is equal to £1,715 billion in 2019.[c] The gas and oil share is then equal to: $a/(y + a)$, where a is the intermediate consumption of gas and oil by other industries and y is non-oil, non-gas domestic income. Using this approach, the gas and oil share in 2019 was 3.3 per cent. The 'capital share' is calculated

as non-oil, non-gas capital income and equals 25.2 per cent.[d] The 'labour share' is 71.5 per cent by residual.

Using these values, we find that the elasticity of output to fossil fuel prices is -0.013 in the short run and -0.018 in the long run.

[a] See, for example, Barnes, S., S. Price, and M. Sebastia Barrel, *The elasticity of substitution: evidence from a UK firm-level data set*, Bank of England Working Paper 348, April 2008.
[b] Specifically, we use the intermediate consumption of: (1) crude petroleum and natural gas and metal ores; (2) coke and refined petroleum products; and (3) gas; distribution of gaseous fuels through mains; steam and air conditioning supply.
[c] This is calculated as compensation of employees excluding the gas and oil sectors plus gross operating surplus and mixed income excluding the gas and oil sectors, less general government's, households' and non-profit institutions serving households' gross operating surpluses.
[d] This is non-oil private non-financial corporations' trading profits adjusted for gas profits using a multiple of 1.7 (proxied via assumptions in our North Sea tax forecast), plus financial companies' gross trading surplus and public corporations' operating surplus.

3.19 There are significant uncertainties around these estimated impacts of higher fossil fuel prices on potential output. For example:

- First, our approach captures the direct impact of higher gas and oil prices on potential output, but does not capture any indirect impacts from these higher prices raising **the costs of other intermediate inputs** into production. All else equal, adding in these indirect effects would increase the impact of higher fossil fuel prices on output.

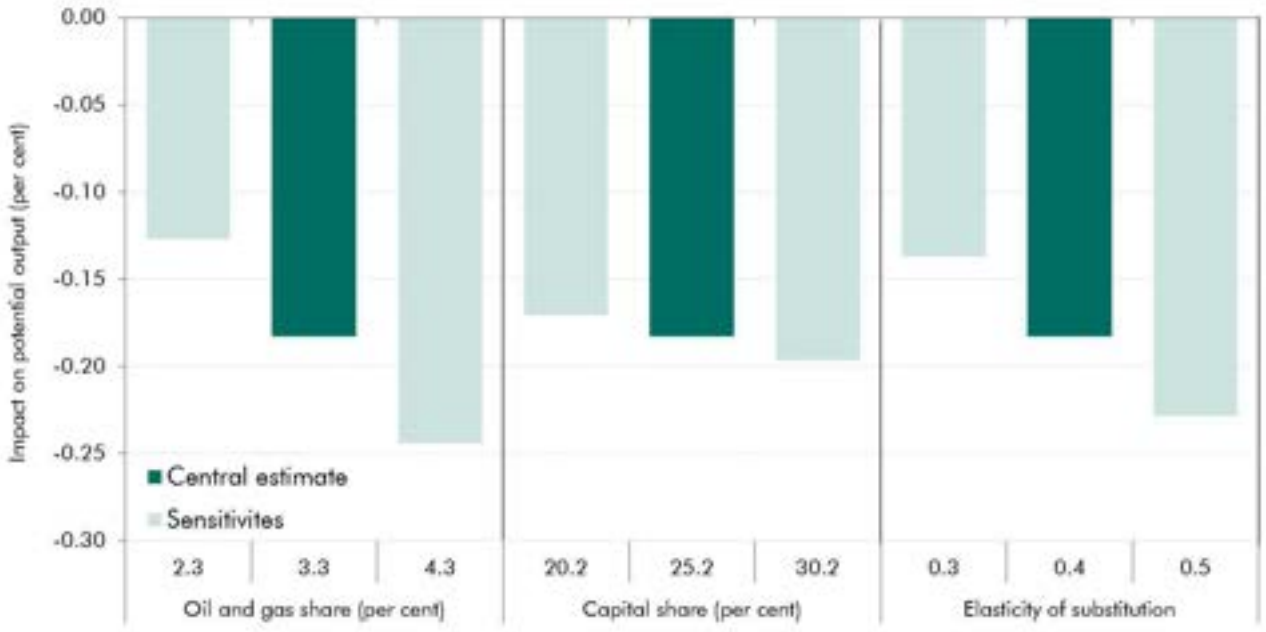
- Second, it assumes that the quantity of labour supplied remains constant, with lower demand for labour reflected entirely in lower real wages and the income and substitution effects of wage changes balancing off against each other. If **the supply of labour** was not fixed, lower demand would reduce the amount of labour employed in the economy and so raise the overall hit to potential output via a higher structural unemployment rate or a lower participation rate.

- Third, it assumes the capital stock adjusts to higher fossil fuel prices by the end of our medium-term forecast horizon of five years. A quicker **speed of capital stock adjustment** would imply a larger fall in potential output in the near term, whereas a slower adjustment would push some of the impact beyond the five-year horizon.

- Finally, the **gas and oil share changes** only because of higher prices. For instance, over the next five years, as the UK transitions towards net zero, downward pressure will be put on the fossil fuel share, and this could cause the impact on potential to decline over time. Higher fossil fuel prices are also likely to affect the speed of the transition by changing the incentives to invest in alternative energy sources.

3.20 Given these uncertainties, Chart 3.5 shows the sensitivity of our medium-term elasticity estimates to relatively small changes in key parameters. Variations in the gas and oil share of income (plus and minus 1 percentage point), capital share of output (plus and minus 5 percentage points), or elasticity of substitution between the three factors of production (plus and minus 0.1) would all vary the size of the impact of higher fossil fuel prices on potential output without altering the broad conclusions.

Chart 3.5: Medium-term impact of a ten per cent rise in fossil fuel prices: sensitivities



Source: OBR

3.21 Table 3.1 shows how our estimate of the impact of fossil fuel prices on potential output compared to a range of external estimates (with all presented as the impact of a 10 per cent rise in prices on output so that they can be compared like-for-like). As a further cross-check, it also includes two estimates provided to us by the Treasury based on assumptions provided by us and using two macroeconomic models: the National Institute Global Economic Model (NiGEM) and a computable general equilibrium (CGE) model. The median of all these estimates is slightly higher than ours for both the short and medium term. In part, this is likely to be because most of the estimates are older or based on past oil shocks (particularly the vector autoregressions), and therefore reflect a UK economy that was more fossil fuel intensive than the 2019 figures underpinning our estimate.

Table 3.1: External estimates of the elasticity of potential output to energy prices

Source	Type of oil shock	Model	Impact of a 10 per cent oil price increase on UK output (per cent)	Years
OBR (2022)	**Permanent[1]**	**Production function**	**-0.13**	**1**
			-0.18	**5**
Jiménez-Rodríguez & Sánchez (2006)	Permanent	Vector autoregression	0.0	1
			-0.2	3
Barrell & Kirby (2008)	Permanent	NiGEM	-0.4	2
Baumeister, Peersman & Robays (2009)[2]	Permanent	Structural vector autoregression	-0.3	1
			0.0	5
Cournède (2010)	Permanent	Production function	-0.3	3
OBR (2010)	Temporary	Production function	-0.17	1
	Permanent		-0.2	5
NIESR (2011)	Temporary	NiGEM	-0.2	2
	Permanent		-0.4	2
Bank of England (2013)	Temporary	Structural vector autoregression	-0.12	1
Van de Ven & Fouquet (2014)	Temporary	Structural vector autoregression	-0.15	1
Mohaddesay & Pesaran (2016)	Permanent	Structural vector autoregression	-0.11	1
			-0.2	5
Bergman (2017)	Permanent	Vector autoregression	-0.17	1
			-0.4	3
OBR (2022)[3]	Permanent[1]	Range of models including NiGEM and CGE	-0.19	1
			-0.24	5
Short-term external average[4]			**-0.16**	
Medium-term external average[4]			**-0.20**	

[1] Includes a shock to gas and oil prices.

[2] Zero impact after five years is explained by the UK's status as a net oil-exporting country.

[3] Estimates provided by the HM Treasury based on methodological approach and assumptions commissioned by the OBR.

[4] Short-term average is the median of the one-year estimates, medium-term average is for the three-to-five year estimates.

Note: The magnitude of the effect of an increase in price to UK output has been scaled linearly to a 10 per cent increase in price.

Other economic channels

3.22 In addition to their effects on real incomes and potential output, higher fossil fuel prices can affect the economy through several other channels:

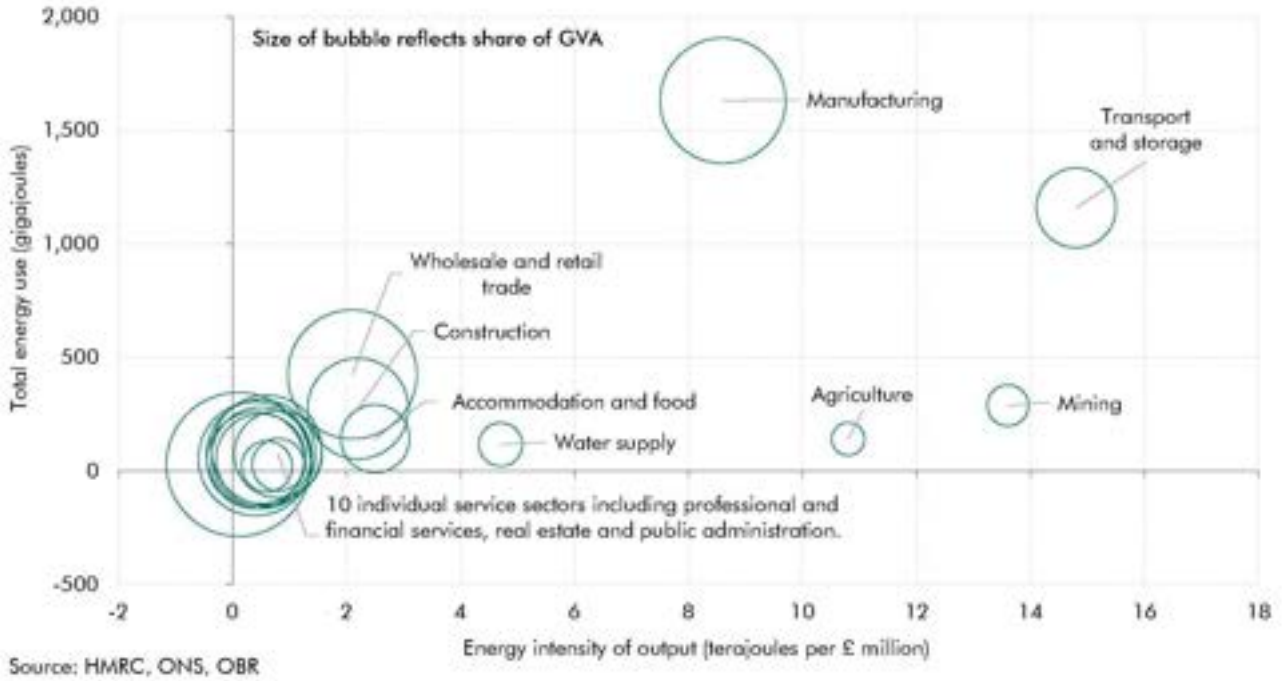
- **Business investment** could be temporarily lower as the higher cost of energy inputs erodes firms' profit margins. If the Bank of England temporarily raised interest rates in response to inflation, higher borrowing costs could also dampen investment growth. If energy prices were also more volatile, uncertainty would further weigh on investment.

- The impact on **net trade** would depend on several factors. On the import side, the UK is a net importer of energy, so the volume (though not the value) of imports is likely to fall in response to higher prices. On the export side, much of our trade is also with net energy importers, so a reduction from global demand might also reduce the volume (and probably also the value) of exports.

- The reduction in overall activity could affect **unemployment**. As the UK economy has become less energy intensive, employment in sectors that rely heavily on fossil fuels is likely to be lower than in the past, so significant levels of unemployment as labour is reallocated between sectors is somewhat less likely than following past energy shocks.

- The **sectoral impacts** of persistently higher prices will vary as the importance of fossil fuels differs by sector. Chart 3.6 shows the energy intensity of each sector, their relative sizes in the economy, and thus which sectors are the largest users of energy in the UK.[8] The manufacturing and transport and storage sectors are the largest users, so are likely to face the largest absolute loss of output if gas and oil prices remained high. The energy-intensive agriculture sector would also face a significant loss of output but is only a small part of the UK economy. The mining sector, which these days is almost entirely the extraction of North Sea gas and oil, is energy intensive but would benefit from rising prices for its outputs. The service sectors concentrated in the bottom left of the chart comprise most of the UK economy but would be less directly affected given their low energy intensity. However, the indirect effects of persistently higher energy prices, for example a reduction in consumer demand as spending is diverted to household energy, would affect these sectors.

Chart 3.6: Energy consumption and energy intensity of output by sector



Source: HMRC, ONS, OBR

- The channels discussed above assume that an energy shock hits the economy via prices. There have also been examples of direct shocks to **the supply of energy** leading to the rationing of supply, such as the three-day week in 1974. Supply constraints could be even more disruptive to output as even those willing to pay higher prices for

[8] Energy consumption here is defined as total consumption of all sources of energy, rather than the consumption of fossil fuels specifically.

fossil fuels would not be able to access supply. The sectoral impact would also be different and depend on which sectors were given priority access to energy.

Fiscal impacts of higher fossil fuel prices

3.23 Higher fossil fuel prices would have a direct impact on receipts by affecting the sizes of certain nominal tax bases:

- **North Sea oil and gas revenues** – a change in oil or gas prices raises profits in this sector, and so raises corporation tax receipts. The main North Sea receipts are 'ring fence corporation tax' and the supplementary charge, which respectively account for 83 and 17 per cent of total revenue from the sector.[9] Petroleum revenue tax (PRT) was previously also a source of North Sea revenue, but the rate was set to zero in 2016 (when older fields are decommissioned, losses can therefore still be carried back against past PRT payments). In our March 2022 forecast, higher oil and gas prices had already led these receipts to jump from £0.4 billion in 2020-21 to £7.8 billion in 2022-23. The new 'energy profits levy' the Government announced in May will provide an additional source of revenues, that it has stated will raise around £5 billion over its first 12 months of operation. The new tax has a sunset clause of December 2025. With full policy costings still pending, illustrative estimates of what the tax might yield are provided in Box 3.3.

- Higher oil prices are likely to reduce **fuel duty** receipts. In our March 2022 forecast, fuel duty is expected to raise £26.2 billion in 2022-23. Higher prices reduce demand for fuel, so reduce receipts as fuel duty is charged on a pence per litre basis. The fuel duty policy costings that are incorporated into our forecasts are based on an estimated elasticity of fuel purchases to prices of -0.03 over six months and -0.07 beyond that (i.e. a 10 per cent rise in petrol prices at the pump results in an initial 0.3 per cent fall in volumes purchased, rising to 0.7 per cent over time as driving behaviours respond more fully). Persistently higher prices might have even more of an effect by incentivising a faster move to electric vehicles.

- Domestic spending on energy bills also attracts a lower **VAT** rate than the average for other goods and services, so to the extent that households substitute away from standard-rated products, towards energy, VAT receipts will be reduced. In our March forecast, this effect reduces VAT receipts by around £1.6 billion in 2022-23. Petrol and diesel are subject to the standard 20 per cent rate of VAT, so higher pump prices boost receipts. There are a number of offsets – there will be modestly lower volumes of fuel purchases (because demand for road fuels is relatively price inelastic), businesses, including road hauliers, will reclaim the VAT they spend on fuel, and some of the additional spending on fuel will be at the expense of other standard-rated spending.

[9] For more detail, see House of Commons Library, *Taxation of North Sea oil and gas*, June 2022.

3.24 Higher fossil fuel prices would also have indirect impacts on the public finances via their effects on other economic aggregates. These include:

- **The effect of higher inflation on the uprating of certain taxes and benefits** – inflation is used to uprate many tax thresholds and benefits – for instance, RPI is used to uprate most excise duties (so higher inflation raises revenue), CPI is used to uprate income tax thresholds (so higher inflation reduces revenue, although not at the moment with thresholds frozen until April 2026). CPI is also used in much of the benefits system (so higher inflation raises public spending in cash terms).

- **The effect of nominal GDP on tax receipts** – all else equal, a smaller cash size of the economy will lower tax receipts. This effect is likely to be reasonably broadly based across all the main tax bases. In the case of an energy price shock, the effect of lower real GDP on nominal GDP will be partly offset by the impact of higher prices for domestically produced energy on whole economy inflation (the GDP deflator).

- **The effects of changes in inflation and interest rates on debt interest spending** – around a quarter of public sector net debt is linked to RPI inflation, so responds sharply to price changes. In addition to the direct impact of higher inflation on index-linked gilts, should the Bank of England raise interest rates in response, this would also feed through rapidly to higher debt interest spending due to the large stock of debt that has, in effect, been refinanced at Bank Rate via quantitative easing and the gilts held in the Bank of England's Asset Purchase Facility.

3.25 Finally, sharp increases in energy prices could put pressure on the Government to respond. These pressures might include calls to:

- **Support household incomes**. So far this year the Government has announced three substantial support packages, £9 billion worth of rebates for energy bills and council tax in February, £9 billion of cuts to fuel duty and NICs in the Spring Statement in March, and a further £15 billion cost of living support in May.

- **Bail out energy-intensive firms** that are struggling to pass on cost increases. So far the Government has provided £2 billion to temporarily nationalise Bulb energy (a sum that was reflected in our March 2022 forecast). Pressure to support energy-intensive industries such as the steel sector has also been apparent.

- **Reopen departmental budget settlements** that were fixed in nominal terms for three years in the October 2021 Spending Review. While real growth in these budgets was forecast to be 9.3 per cent over three years based on inflation expectations at the time they were set, our March 2022 inflation forecast suggested that this had been reduced to 7.3 per cent over the same period to 2024-25, with real departmental resource spending shrinking in 2023-24. For example, the IFS has noted that for the Ministry of

Defence *"rising prices will wipe out the modest real budget increase planned between this year and next"*.[10]

The medium-term impact of higher fossil fuel prices

3.26 In this section, we examine the medium-term economic and fiscal implications of two illustrative scenarios for higher fossil fuel prices. The first is a temporary but very sharp, one-year spike in gas and oil prices of the sort that might result from the sudden disruption to the export of these commodities from Russia. The second is a persistently higher price for gas and oil – though at a lower level than in the temporary spike scenario – that continues over the remainder of the five-year forecast period.

Baseline and methodology

3.27 The baseline for these two scenarios is the five-year economic and fiscal forecast set out in our March 2022 *EFO*, which we have adjusted to include the package of measures announced in May to support households with the cost of living this year, while also cancelling the energy rebate clawback and raising the tax on profits made by oil and gas producers (see Box 3.3). This is consistent with the requirements placed on us by primary legislation to reflect current Government policies in our forecasts. In this report, we have adjusted our baseline based on Treasury estimates of fiscal costs and have not made changes to our economy forecast to account for the impact of the policies. In our next *EFO*, we will analyse the costing of each policy and consider the indirect effects on the economy.

Box 3.3: May 2022 cost of living support package

On 26 May, the Chancellor announced a further package of measures to support households with the cost of living this year. It comprised three elements, as set out in Table A. First, payments to households in 2022-23 via several different schemes that the Treasury estimates will cost £15.3 billion. These include:

- an additional £200 **energy bills discount** for all households at a cost of £6.0 billion;
- **one-off cost-of-living payments** of varying sizes for those on: means-tested benefits (£650 per recipient, costing £5.4 billion), pensioners (£300 per recipient, costing £2.5 billion); and those on disability benefits (£150 per recipient, costing £0.9 billion); and
- a £500 million increase and extension of **the Household Support Fund**.

This additional spending is partially funded by revenue raised from a new '**energy profits levy**' (EPL) within the North Sea fiscal regime. The levy represents an additional 25 per cent surcharge on the profits of the oil and gas sector that will be abolished by the end of December 2025, or sooner if the Government removes it on the basis of energy prices returning to historically more normal levels.[o] The Treasury estimated that the EPL would raise around £5 billion in its first 12 months of operation (i.e., from 27 May 2022 to 26 May 2023). We will scrutinise this estimate at

[10] IFS, *Heightened uncertainty and the spectre of inflation hang over the Spring Statement*, March 2022.

our next *EFO*. But in the meantime, following consultation with the Treasury, to produce estimates of the measure's yield over its full lifetime, we have: (i) estimated its yield in 2022-23 by scaling down the £5 billion figure to adjust for the scheme starting partway through the current fiscal year; then (ii) scaled that £4.5 billion figure down further for 2023-24 and 2024-25 reflecting declining oil and gas prices in our March 2022 *EFO*; and finally (iii) scaled down 2024-25 revenues by a quarter to reflect the removal of the EPL at the end of December 2025.

The final component of the package was to **cancel the planned clawback of the initial £200 energy bills rebate** announced in the Spring Statement in March. This payment was due to raise £1.2 billion a year from 2023-24 to 2027-28 and will now raise nil.

We have not made explicit changes to our March economy forecast to account for the impact of the policies, except to reflect the measures' direct impact in calculations of the outlook for household disposable income growth. In our next *EFO*, we will scrutinise the costing of each policy and consider any additional indirect effects on the economy.

Table A: The direct fiscal costs of the Government's 26 May policy package

	£ billion				
	2022-23	2023-24	2024-25	2025-26	2026-27
Cost of living support	15.3	0.0	0.0	0.0	0.0
Energy profits levy	-4.5	-4.0	-2.5	-2.1	0.0
Cancelling clawback	0.0	1.2	1.2	1.2	1.2
Total PSNB impact	**10.8**	**-2.8**	**-1.3**	**-0.9**	**1.2**

Note: this table follows the convention that a negative number reduces PSNB, i.e., increases receipts or reduces spending.

[9] HM Treasury, *Energy Profits Levy Factsheet*, 26 May 2022.

3.28 For the economy variables in our scenario, we model the impact of higher prices as follows:

- **CPI inflation** rises by the direct impact of higher gas and oil prices on fuel prices and on utility prices via the Ofgem price cap. On top of this direct impact, and as in the March *EFO*, we scale up this effect by a quarter to account for the knock-on effect of higher energy prices on the prices of other goods.[11] We assume RPI inflation differs from baseline by the same amount as CPI inflation. For the GDP deflator, we scale down the impact given the differences between CPI and this broader measure of whole economy inflation and adjust for changes in fossil fuel import and export prices.[12] We assume the Bank of England does not respond to higher gas and oil prices as the second-round effects, for example on wages, are limited.

- The path for **actual GDP** falls in line with potential output and there is an additional short-term impact as higher inflation erodes real wages, hits consumer confidence and opens up a degree of spare capacity. In the temporary spike scenario, we add an

[11] See Box 2.2 of our March 2022 *Economic and fiscal outlook*.
[12] To calculate the change in the consumption deflator in the scenarios, we assume the proportion of the deflator reflecting imputed rents does not change and the remainder moves in line with CPI. For the import and export deflators, we assume the prices of fuel and crude materials increase in line with gas and oil prices in each scenario but there are no changes in the price of other products.

additional hit to GDP due the disruption caused by very high energy prices and weaker demand for UK exports. For potential output, we use the production function described earlier (Box 3.2).

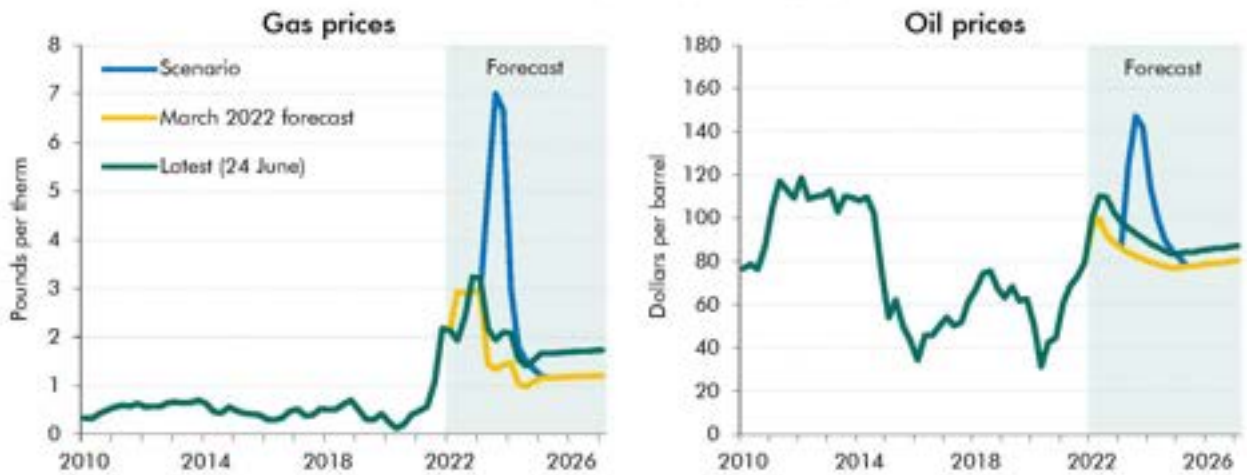
- We calculate the transitory increase in **unemployment** using an Okun coefficient (the relationship between changes in output and changes in unemployment) of 0.5.[13] But there is no permanent increase in unemployment despite the smaller economy because we assume real wages and productivity, rather than the quantity of labour, adjusts.

3.29 For the fiscal variables, we use our standard ready reckoners to estimate the impact of changes in the economy variables. For North Sea oil and gas revenues, we have used HMRC's model and adjusted for the extra revenues from the new energy profits levy by scaling up the revenue in proportion to the oil and gas price increase. We have assumed there is no change in departmental spending settlements from our March 2022 forecast, with high inflation therefore eroding the real value of these spending plans. Other assumptions are covered in the descriptions of the scenarios below.

Temporary energy price spike scenario

3.30 In our first scenario, we consider a sharp, temporary increase in gas and oil prices starting in the second quarter of 2023, with prices peaking a quarter later. Prices could increase rapidly in the short term due to geopolitical tensions, for example if Russia temporarily stopped exporting both commodities either voluntarily or as a result of stricter Western sanctions. Chart 3.7 shows an illustrative path for such a scenario, where gas prices peak at £7 per therm (a little over twice the peak in the latest gas price future curve and somewhat below the intraday high of £8 per therm reached in the weeks following Russia's invasion of Ukraine) and oil prices at $147 per barrel (close to their 21st century intraday peak), before quickly falling back to the same levels as in our March forecast by mid-2025.

Chart 3.7: Gas and oil prices in our temporary energy price spike scenario



Note: Latest is the average over the 5 days to 24 June.
Source: Datastream, OBR

[13] We apply the coefficient to the difference between actual GDP and potential GDP.

Economic impact

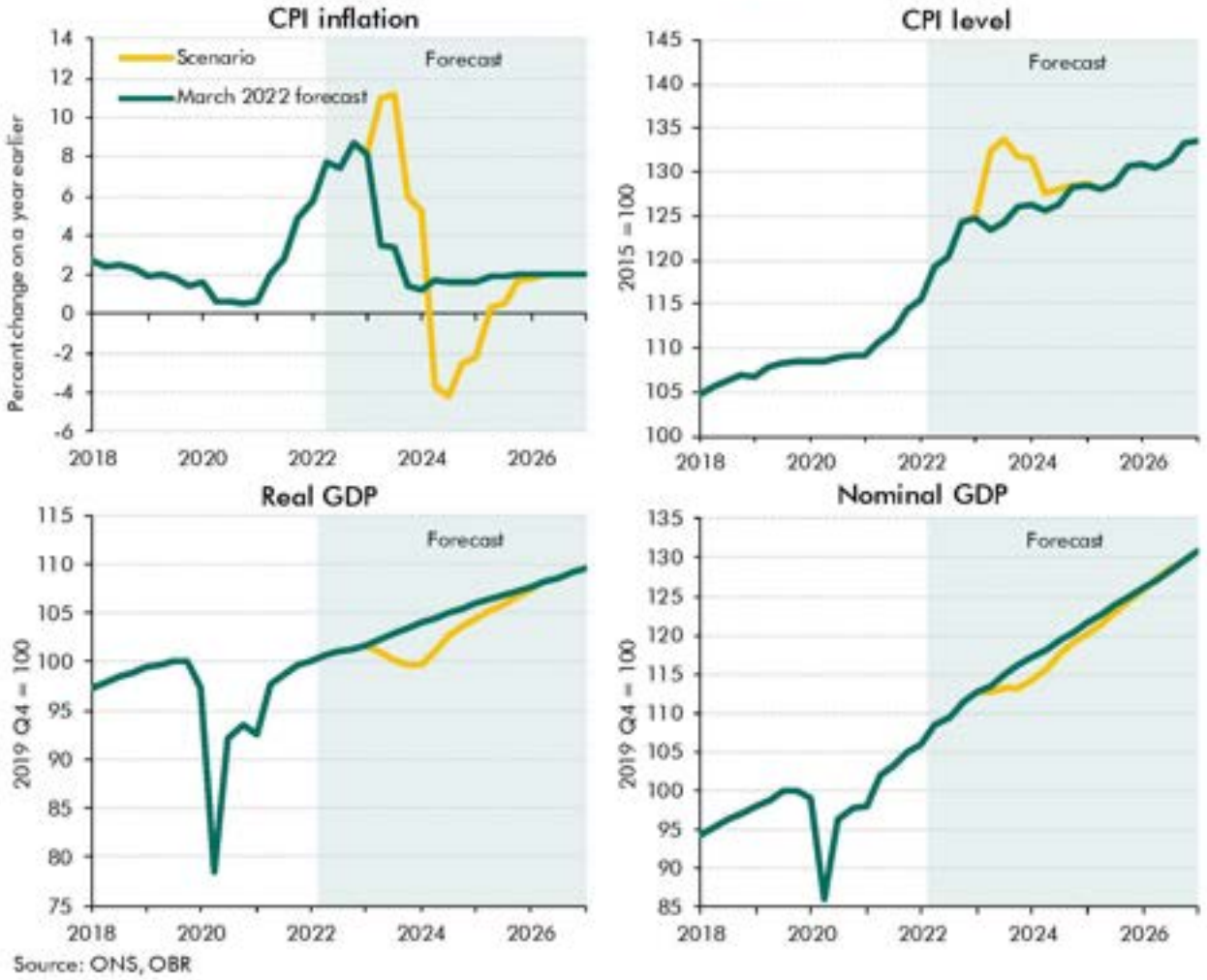
3.31 The key economic impacts of this scenario (shown in Chart 3.8) include:

- **CPI inflation** stays above 5 per cent for nine quarters, compared to five in our baseline. It peaks at 11.1 per cent in the third quarter of 2023, 7.8 percentage points above our March 2022 forecast, as the sharp increases in gas and oil prices feed into utility bills and fuel prices. Inflation was last this high in 1981 following the 1979 oil shock. Inflation then falls rapidly and drops well below zero as energy prices return to baseline, with CPI falling by 1.4 per cent in 2024 and rising just 0.1 per cent in 2025. Annual CPI inflation has fallen below zero in only three months over the past 30 years, with the largest fall being just 0.2 per cent in April 2015. The price level rises to 7.5 per cent above our baseline, before falling back to the same level by the second quarter of 2025 as inflation drops below zero. We assume that the indirect effects are limited to the one quarter described above and that the Bank of England looks through the temporary spike in inflation. However, a clear risk to this scenario is of greater second round effects, for example via wage increases, fuelling further inflation and requiring a more forceful monetary policy response.

- **Real GDP** falls to just over 4 per cent below baseline at the start of 2024 as the economy falls into a recession with GDP shrinking by 1.1 per cent in 2023-24. This reflects disruption to production as the price of energy soars, consumer spending shrinks sharply as real incomes fall and confidence is hit by disruption in financial and retail energy markets, and a fall in exports as the UK's trading partners are also hit by energy price increases. The 2 per cent peak-to-trough fall in GDP is around half the fall during the recession following the 1979 oil shock and around a third of the fall during the financial crisis. However, the impact on GDP is very uncertain given the limited recent historical examples of persistently very high inflation. The short-term impact would also be worse if the Bank had to raise interest rates to bring inflation back to target. As there is no permanent increase in energy prices, real GDP quickly returns to our baseline and there is no medium-term scarring to potential output.

- **Nominal GDP** falls 2.5 per cent below our baseline at the start of 2024 as real GDP shrinks. By the scenario horizon, nominal GDP returns to the same level as our March 2022 forecast as there is no scarring to real GDP and no change in the price level.

Chart 3.8: Economic impact of the temporary energy price spike scenario



Source: ONS, OBR

Fiscal impact

3.32 The key fiscal impacts of this scenario (shown in Chart 3.9) include:

- **Spending**. Spending increases sharply in 2023-24 due almost entirely to a £34 billion rise in debt interest spending as a result of the much higher RPI inflation. Spending then is largely unchanged in 2024-25 because debt interest spending falls £26 billion below baseline as RPI inflation drops below zero, but this is mostly offset by the £20 billion rise in welfare spending due to uprating in line with the very high September 2023 rate of CPI inflation.[14] High inflation leads to an annual increase in welfare spending of £32 billion in 2024-25, which would be the largest ever annual increase in nominal welfare spending. Despite CPI inflation falling to -4.2 per cent in September 2024, welfare spending is not 'downrated' in 2025-26 (because the triple lock means pensions still rise by 2.5 per cent while under current legislation other welfare payments would remain fixed in cash terms). Higher welfare spending therefore carries through the rest of the forecast horizon, up £16 billion in 2025-26 and £14 billion in 2026-27 compared to our March forecast. This permanently higher

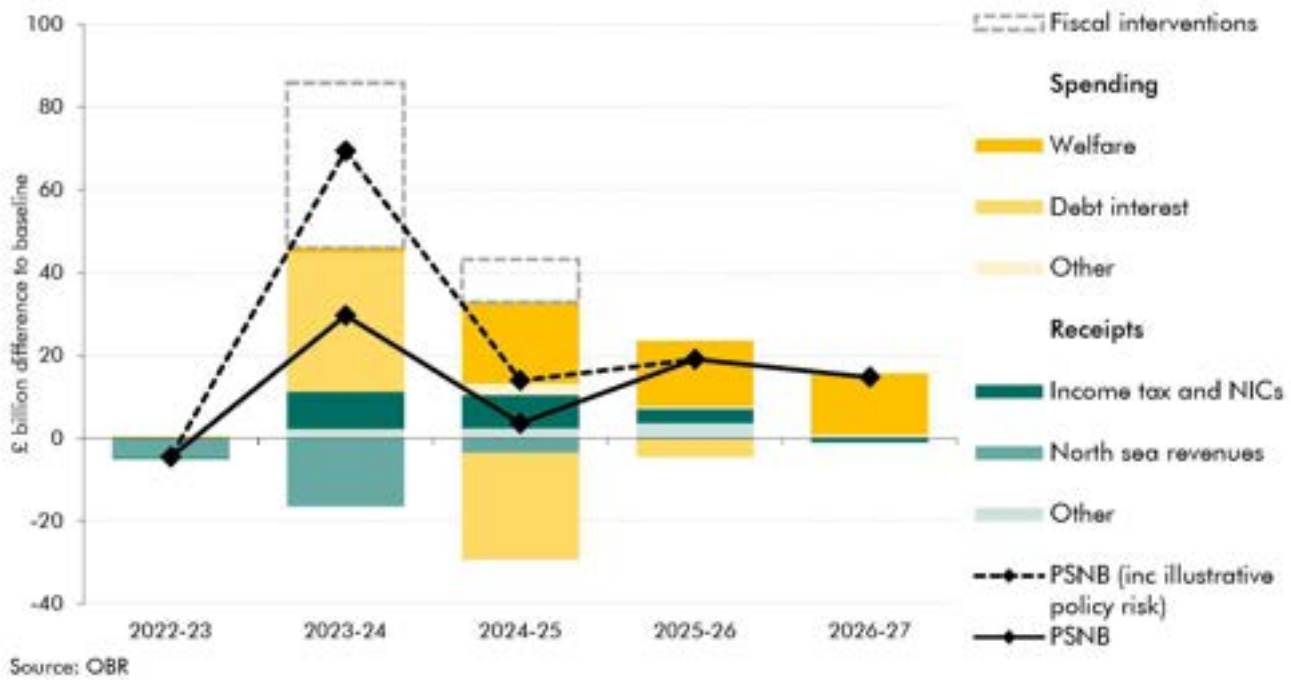
[14] The scenarios are produced on a quarterly basis, so we use third quarter figures to proxy for each year's September-based uprating.

level of welfare spending means overall spending as a share of GDP reaches 41.6 per cent in 2026-27, 0.5 per cent of GDP higher than our March forecast.

- **Receipts**. Receipts increase by £5 billion in 2023-24, which is more than explained by the rise in North Sea revenues and the energy profits levy as gas and oil prices increase sharply. Receipts then fall £7 billion below baseline in 2024-25 as falling gas and oil prices mean North Sea revenues are only marginally higher than in our baseline while lower employment and average earnings reduce receipts from income tax and NICs by £8 billion. There is little lasting impact of the price spike on receipts as nominal GDP is in line with our March forecast by 2026-27.

3.33 As noted earlier, in this scenario there would likely be pressure for the Government to respond to this further rise in energy prices – as it has done in the case of previous rises this year. To exclude this policy risk would not give a complete picture of the fiscal risks in this scenario. We therefore show the effects of one illustrative policy response informed by the interventions so far this year to provide an indication of the scale of the potential policy risk. There are many ways that this could be calculated, but for simplicity we have scaled up support for domestic energy bills by the additional increase in those bills in the scenario, and the cost of this year's fuel duty cut by the additional rise in oil prices. This illustrates how the fiscal implications of the shock would be greater if this policy risk were to crystallise. In this example, it could add £40 billion to borrowing in 2023-24 and £10 billion in 2024-25, raising the overall cost over five years by over three-quarters. As this is for illustration, we do not incorporate the (largely second order) wider macroeconomic effects that this higher government spending would have on the economy, nor its effects on debt interest spending. Providing more support, however, merely pushes the cost of higher energy on to future households as the Government cannot make the costs of more expensive energy go away, merely adjust who pays it and when.

Chart 3.9: PSNB breakdown in the temporary energy price spike scenario



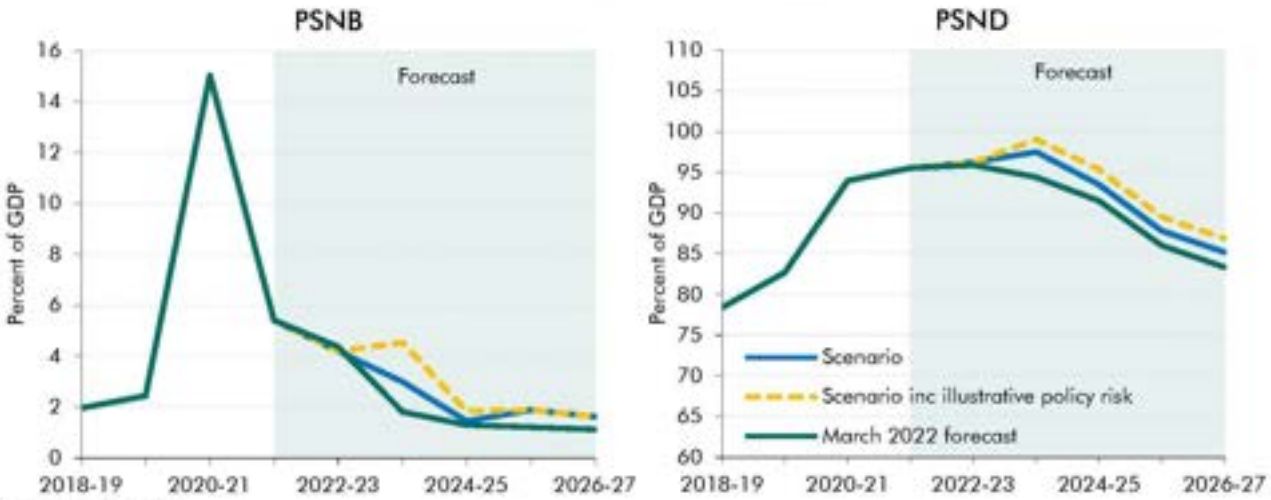
Source: OBR

3.34 Chart 3.10 shows PSNB and PSND as a share of GDP in the scenario, both with and without the illustrative policy risk:

- **PSNB.** In 2023-24, borrowing rises to 3.0 per cent of GDP (£77 billion), up from 1.8 per cent in the baseline (£47 billion). Borrowing falls as prices return to baseline levels, reaching 1.6 per cent of GDP (£47 billion) by 2026-27, but that is still 0.5 per cent of GDP higher than our March forecast due to the permanent rise in welfare spending. Including the illustrative policy risk, borrowing could rise to 4.5 per cent (£117 billion).

- **PSND.** Higher borrowing and lower nominal GDP push the debt-to-GDP ratio to 97.5 per cent in 2023-24, 3.1 percentage points above our baseline. The ratio then falls rapidly as borrowing falls back towards our baseline and the economy recovers. By the end of the scenario, the debt-to-GDP ratio is 85.2 per cent compared to 83.4 per cent in our baseline. Including the illustrative policy risk, debt could rise to 99.0 per cent in 2023-24 and decline to 86.9 per cent.

Chart 3.10: PSNB and PSND in the temporary energy price spike scenario



Source: ONS, OBR

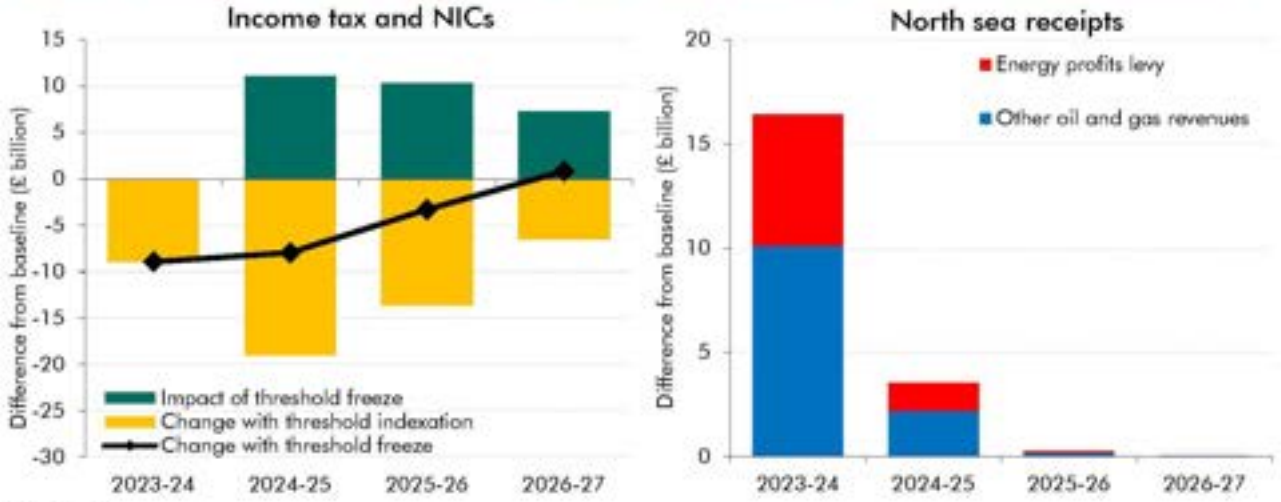
3.35 In our scenarios, two aspects of current government policy dampen the impact of a temporary spike in energy prices on the public finances:

- First, under current government policy, **income tax and NICs thresholds are frozen** rather than linked to inflation in the four years from 2022-23 to 2025-26. Receipts would be a further £11 billion lower in 2024-25 in the absence of this March 2021 Budget measure (which in effect raises much more than expected in the scenario). Despite the price level returning to the baseline, the effect on receipts in the absence of the threshold freeze would persist into 2025-26 because thresholds would not be downrated with the negative CPI inflation (a similar asymmetry to the one affecting non-pensioner welfare payments described in paragraph 3.32). This is illustrated in the left panel of Chart 3.11, which splits the impact of the scenario on income tax and NICs receipts into the component due to weaker real earnings that would in normal times generate reverse fiscal drag and the additional yield from the thresholds being

frozen in cash terms. The frozen thresholds therefore shift some of the direct cost of this shock from the public finances to income taxpayers. This contributes to the impact of the shock on real household disposable incomes described below.

- Second, the new **energy profits levy** increases the extent to which North Sea revenues offset some of rise in borrowing from other sources in 2023-24 in particular. The right panel of Chart 3.11 breaks down the additional North Sea revenues into that from the energy profits levy, which would be around £6 billion higher than in the baseline, and revenue from other North Sea taxes, which would be around £10 billion higher. These figures are particularly uncertain given the complexity of the North Sea fiscal regime, including as a result of the introduction of the new levy.

Chart 3.11: Income taxes and North Sea receipts in the temporary spike scenario



Source: OBR

Household incomes

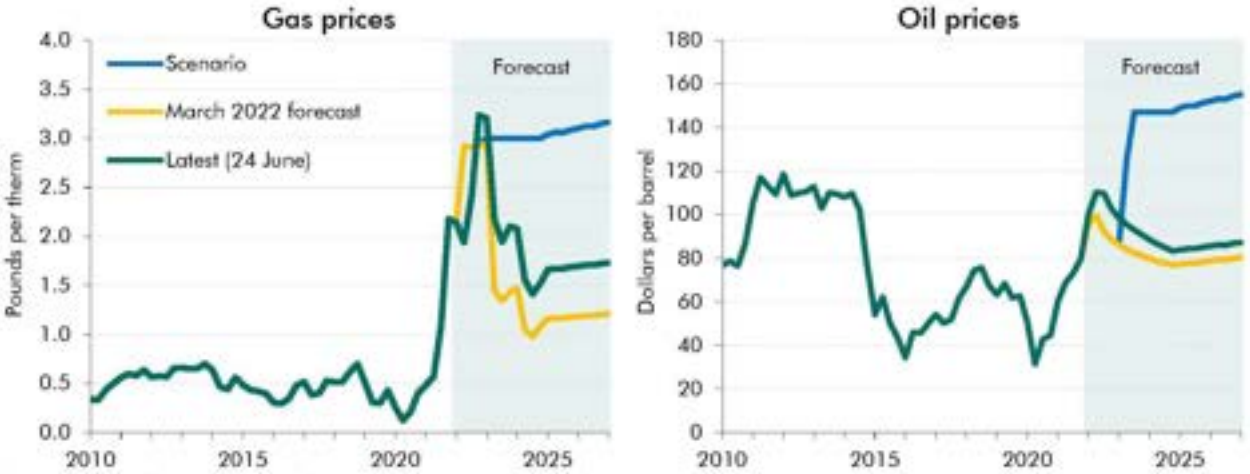
3.36 Excluding the impact of any further fiscal support, real household disposable incomes (RHDI) would fall by around 4 per cent in 2023-24, compared to a rise of 0.2 in our baseline (after adjusting for the direct impact of the Government's May policy package described in Box 3.3). The fall is almost entirely driven by higher inflation eroding the value of real wages. RHDI rises by just over 4½ per cent the following year when real wages begin to recover as inflation falls and benefits are uprated by CPI inflation with a lag. The illustrative policy response would offset around half of the fall in RHDI in 2023-24, though the extra government debt incurred means that this would essentially reflect households in aggregate borrowing from their future selves to smooth the effect of the shock on RHDI. By 2026-27, real household incomes are 0.7 per cent higher than baseline forecast due to higher state pensions and other welfare payments.

Persistent energy price shock scenario

3.37 Persistently higher gas and oil prices pose a different kind of risk to the economy and public finances than a temporary spike in prices. In our second scenario, we assume that prices of gas and oil rise to and remain at £3 per therm and $147 dollars per barrel respectively in

the first two years of our scenario and then remain constant in real terms thereafter. These levels equal the respective nominal monthly high for gas prices in our March 2022 forecast and the intraday high reached by oil prices in 2008.

Chart 3.12: Gas and oil prices in the persistent energy price shock scenario



Note: Latest is the average over the 5 days to 24 June.
Source: Datastream, OBR

Economic impact

3.38 For the impact on potential output, we combine these fossil fuel price assumptions with our estimates of the elasticity of output to fossil fuel prices. This leaves potential output just over 1 per cent below the baseline in the first year, rising to almost 2 per cent below after five years (as the elasticity of potential output to price rises is higher beyond the first year, while the price difference over the baseline also rises over time, as shown in Chart 3.12).

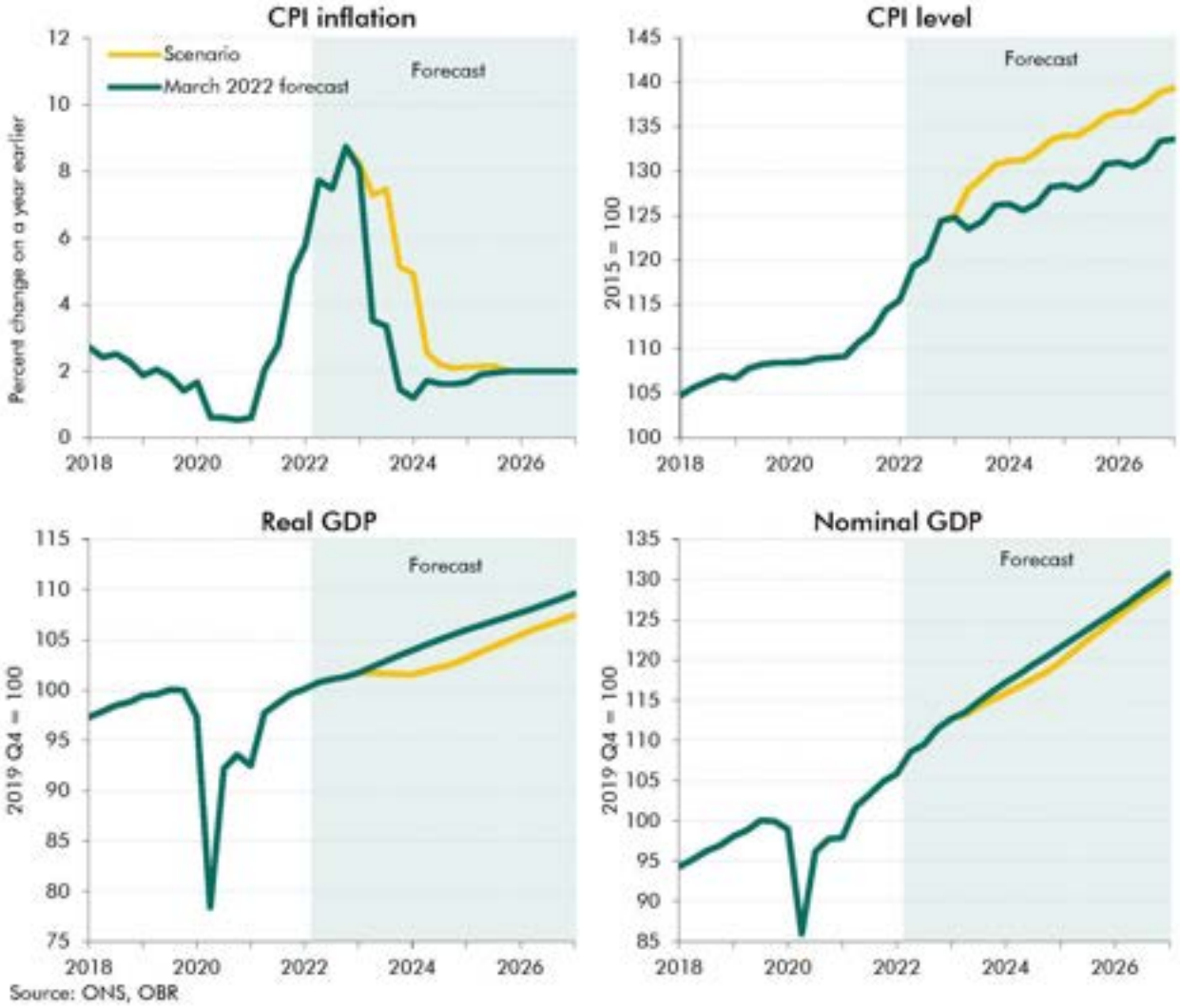
3.39 The key economic impacts of this scenario (shown in Chart 3.13) include:

- **CPI inflation** remains high next year and falls back sharply around a year later. As a result, it is 4.1 percentage points above our baseline (at 7.5 per cent) in the third quarter of 2023, before falling back to the 2 per cent target by the end of 2025. Inflation is pushed above our baseline by higher gas prices keeping utility costs high, while the rise in oil prices increases the cost of fuel. Given our assumption that the indirect effect of these higher prices is limited, we assume the Bank of England does not increase interest rates in response. In this scenario, the level of consumer prices rises above our baseline and remains 4.5 per cent higher at the scenario horizon.

- By the end of 2023, **real GDP** falls 1.8 per cent below our baseline as higher inflation weighs on the economy, via lower potential output and lower consumer demand. In the medium term, real GDP is 2 per cent lower, as a result of lower potential output. This is the same as the impact on potential output we expect the Covid pandemic to have in the medium term, but much smaller than the shortfall in output relative to the pre-crisis trend that followed the global financial crisis.

- **Nominal GDP** is 1.4 per cent below baseline in 2024. By the end of the scenario, it is 0.6 per cent below baseline as the higher price level offsets most of the impact of lower real GDP.

Chart 3.13: Economic impact of the persistent energy price shock scenario



Source: ONS, OBR

Fiscal impact

3.40 The key fiscal impacts of this scenario (shown in Chart 3.14) include:

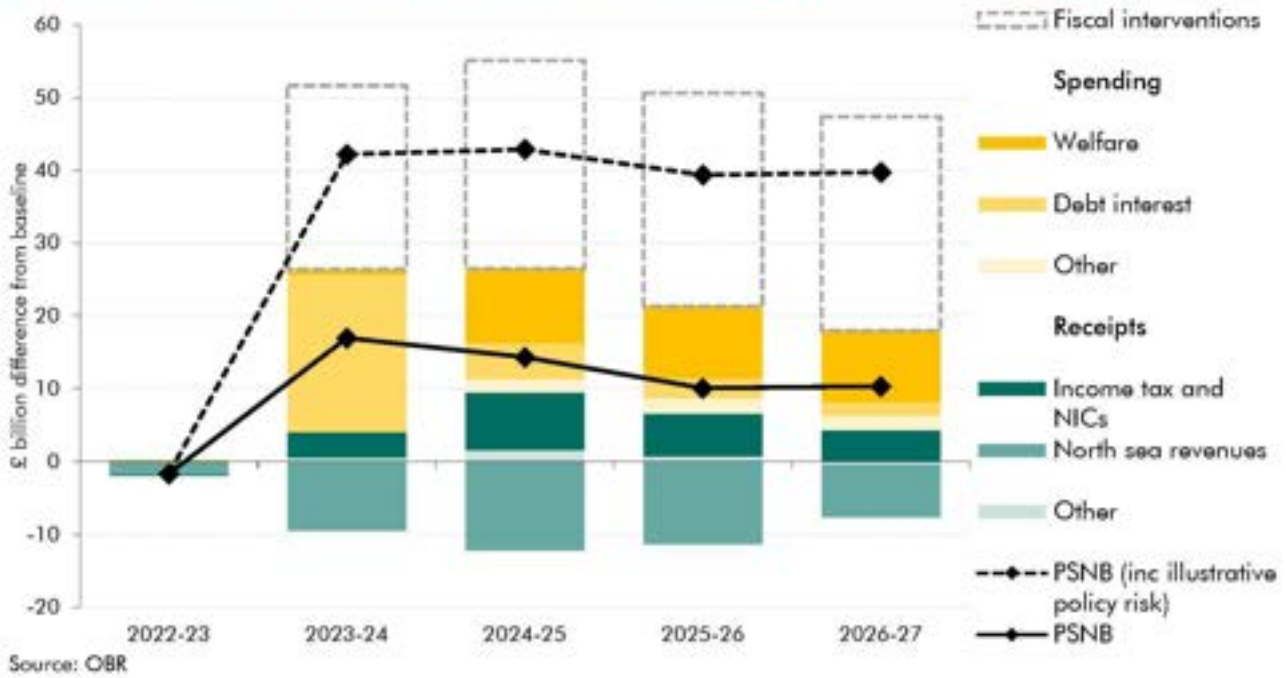
- **Spending.** The largest initial impact is on debt interest costs, which are £22 billion higher in 2023-24 due to higher RPI inflation. The lagged effect of higher inflation on welfare uprating is felt in 2024-25, causing annual welfare spending to increase by around £10 billion. It remains above our March forecast by this amount for rest of scenario as increases in welfare spending are locked in by the link between uprating and the permanently higher price level. Spending by 2026-27 is 41.9 per cent of GDP, 0.7 percentage points higher than the baseline.

- **Receipts.** Income tax and NICs receipts fall below baseline in the early years of the scenario reflecting the shortfall in nominal GDP. This effect peaks at an £8 billion shortfall relative to the baseline in 2024-25. Despite this, receipts are above the baseline in each year of the scenario due to the significant increase in North Sea revenues, including higher receipts from the new energy profits levy, though the latter only lasts until the levy is removed in December 2025 (under the sunset clause that will be legislated). North Sea revenues are just under £10 billion in 2026-27, more than four times the baseline revenues of £2.3 billion. Total receipts by 2026-27 are 40.4 per cent of GDP, 0.4 percentage points higher than the baseline.

3.41 To facilitate like-for-like comparisons with the temporary spike scenario, we also provide an illustration of the potential impact of the policy risk crystallising, using the method described in paragraph 3.33. This could have a very significant impact on the fiscal outlook in this scenario, increasing borrowing by between £25 and £30 billion a year (around 1 per cent of GDP). Again, we have not incorporated the indirect effect of this higher government spending on the economy or its effect on debt interest payments.

3.42 While it may be unlikely for temporary support to continue year after year if the Government knew that the energy price shock was a permanent one, history provides examples of policies originally intended to be temporary that became permanent (for example, the winter fuel payment). If energy prices remained high, as they do in this scenario, at whatever point fiscal support were to be withdrawn it would represent a significant hit to household disposable incomes in that year. But keeping such support in place over several years in the face of a permanently smaller economy, would obviously represent a much greater transfer from future households to current households than in the temporary spike scenario described above.

Chart 3.14: PSNB breakdown in the persistent energy price shock scenario



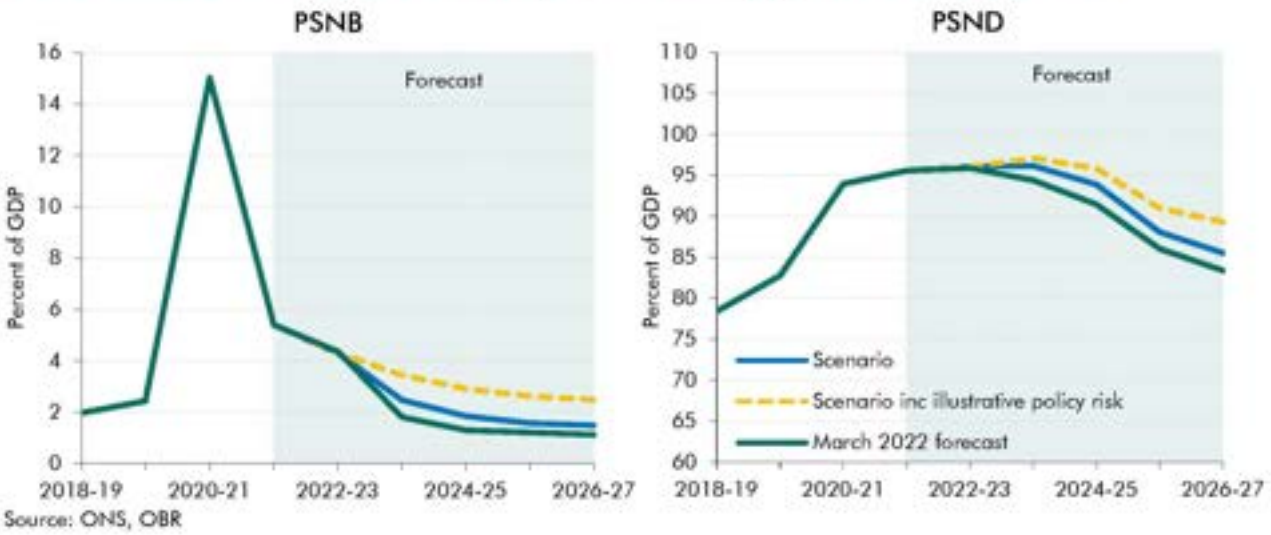
Source: OBR

3.43 Chart 3.15 shows PSNB and PSND as a share of GDP in the scenario, both with and without the illustrative policy risk:

- **PSNB.** Permanently higher gas and oil prices raise borrowing in each year of this scenario. The impact on borrowing peaks in 2023-24 at 0.7 per cent of GDP (£17 billion) as inflation pushes up debt interest spending on RPI-linked debt, before declining to 0.4 per cent of GDP (£10 billion) by 2026-27, with North Sea revenues offsetting a large portion of the increase in welfare and debt interest spending. Including the illustrative policy risk, PSNB reaches 2.5 per cent of GDP in 2026-27, more than double the baseline of 1.1 per cent.

- **PSND.** Higher borrowing means debt is also higher throughout the scenario. It reaches 96.2 per cent of GDP in 2023-24, compared to 94.4 per cent in our baseline. The debt-to-GDP ratio then falls back to 85.5 per cent by 2026-27, 2.2 percentage points above baseline. By contrast, if the policy risk were to crystallise and support were retained across the medium term, PSND relative to GDP rises more significantly above the baseline, reaching 89.3 per cent of GDP in 2026-27, up 5.9 percentage points. This illustrates the scale of the potential fiscal risk posed by initially temporary policy support becoming permanent in the face of an economic shock that has left the economy permanently poorer as opposed to experiencing a temporary hit.

Chart 3.15: PSNB and PSND in the persistent energy price shock scenario

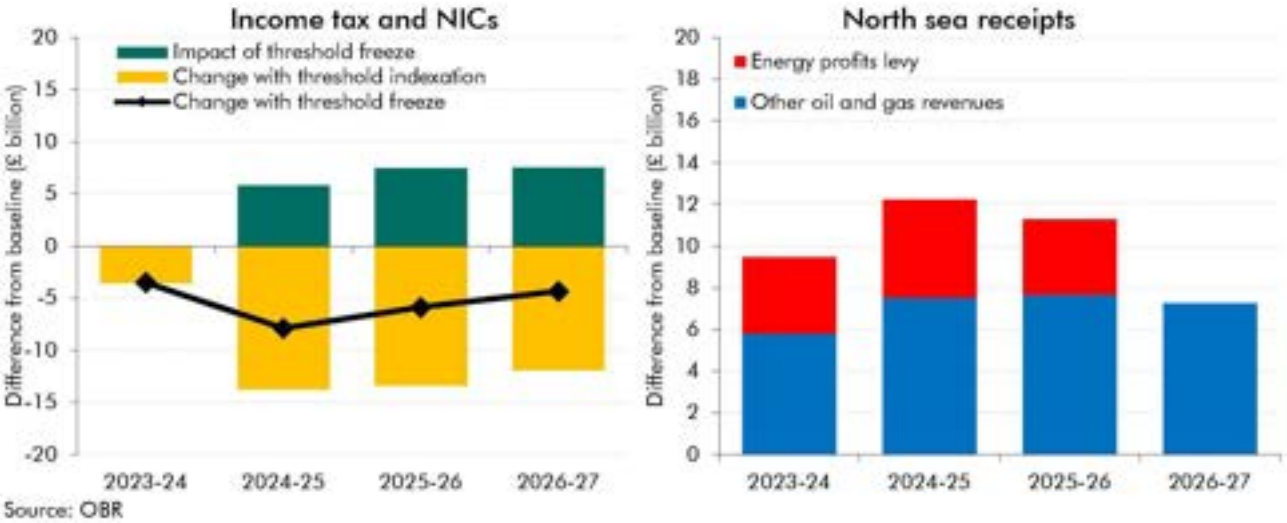


Source: ONS, OBR

3.44 As with the temporary spike scenario, frozen income tax thresholds and the energy profits levy dampen the fiscal consequences of persistently high energy prices. In this scenario, the permanently higher price level and lower real earnings mean frozen income tax thresholds raise more in the medium term: £8 billion in 2026-27, just above the £7 billion more in the temporary spike scenario (left panel of Chart 3.16). As above, frozen tax thresholds mean more of the direct impact of the shock is felt by income taxpayers rather than the public finances. With gas and oil prices higher throughout, North Sea receipts are dramatically higher (right panel). The £12 billion increase in receipts in 2024-25 represents a more than threefold increase on the baseline – thanks in roughly equal part to the existing taxes and

the new energy profits levy. The removal of the levy at the end of December 2025 reduces this surplus a little in 2025-26 and more significantly in 2026-27.

Chart 3.16: Income taxes and North Sea receipts in the persistent shock scenario



Source: OBR

Household incomes

3.45 Real household disposable income (RHDI) would fall by around 2½ per cent in 2023-24, as real wages are eroded by higher inflation, benefits are uprated by CPI with a lag, and the boost to incomes in 2022-23 from already announced support falls away. The freeze in income tax and NICs thresholds means the benefit to households from lower tax payments is less than if thresholds moved with CPI. This fall compares to a rise of 0.2 per cent in the baseline (adjusted for the May support measures), and would be a second consecutive year of falling real incomes following a 1 per cent fall in 2022-23.

3.46 Including the illustrative policy risk in the alternative scenario would offset approaching half of the almost 2½ per cent fall in RHDI in 2023-24. If that support were withdrawn after the first year of the scenario, RHDI would rise by a modest 0.3 per cent in 2024-25 compared to a more substantial rise of almost 2 per cent if the support continued.

3.47 By 2026-27 a smaller real economy and a lower labour share (which flows from the production function approach described in Box 3.2), mean that real household incomes are around 3½ per cent lower than our baseline forecast compared to a shortfall in real GDP of 2 per cent. If the illustrative policy continued until 2026-27, it would offset approaching half the fall in real household incomes – but only at the expense of much higher fiscal deficits and public debt that would need to be serviced by future households.

Uncertainties around the scenario results

3.48 Our scenarios are stylised illustrations of the impact of higher fossil fuel prices on the economy. But there are important risks and uncertainties around our results:

- The impact of higher gas and oil prices on **potential output** in both scenarios is very uncertain (discussed in paragraph 3.19).

- **The cause of the underlying shock** to gas and oil prices is likely to be important in determining its economic and fiscal impact. If higher prices primarily reflect higher global demand, rather than lower supply, an increase in UK exports could be expected to partially offset any fall in real incomes.[15]

- In our scenarios, there is either a high and constant price or a one-time increase in prices. We could get some combination of both our scenarios, where prices rise sharply in the near term then do not fully fall back to our baseline. An alternative is that **prices could be more volatile due to repeated shocks**, which would have different economic and fiscal implications. Higher uncertainty due to volatile prices could cause businesses to reduce investment, direct their resources towards technologies to reduce the impact of volatility (such as storage), or instead spend more on insuring themselves against volatile energy prices. If resources were diverted from more productive uses, this would reduce productivity over the long run. More volatile prices would also put pressure on fiscal policy makers, for example by ratcheting up the cost of the triple lock on state pensions or via repeated calls for support for households unable to smooth their consumption when hit by repeated energy price shocks.

- The price changes in our scenarios are also likely to have impacts on the UK economy from their **global effects**, which we have not explicitly modelled in these scenarios.

- We have assumed nominal **departmental spending** settlements remain in line with our March forecast, so that the higher inflation in our scenarios would erode the real value of that spending. This may be difficult to maintain in some areas, with any increases in cash spending to maintain real spending a potential source of fiscal risk.

- If higher prices were caused by more severely **disrupted supply**, it could result in different economic and fiscal outcomes (including potentially as the result of Government policy responses to such a scenario). For example, we have not considered the possible implications of energy rationing, but in the event of supply disruption, this could involve prioritising the supply of energy to some sectors over others and this could be material to how the economy responds to the shock.

- An important risk around our scenarios is that they assume limited **second-round effects** from higher prices. Clearly a risk to this outlook would be more persistent inflation or, in the extreme, a wage-price spiral, such as that which occurred in the aftermath of the 1970s energy shocks. However, there are important differences between the situation today and the situation almost five decades ago (see Box 3.1 above).

[15] For example, see Millard, S., and T. Shakir, *Oil shocks and the UK economy: the changing nature of shocks and impact over time*, Bank of England Working Paper No. 476, August 2013.

Longer-term fiscal risks of net zero and energy security

3.49 Last year's *FRR* presented several scenarios for the potential fiscal costs and opportunities that might be associated with the transition from a largely fossil-fuel-based economy today to an almost fully decarbonised one in 2050 – in line with the legislated commitment to achieve net zero greenhouse gas emissions by then.[16] We concluded that the net fiscal costs of getting to net zero were *"significant but not exceptional"*, with the call on public investment potentially averaging around 0.4 per cent of GDP a year (£10 billion a year in today's terms), an amount that we noted might be found from within the existing investment envelope rather than posing a fiscal risk. The largest fiscal cost came from the loss of existing emissions-related tax revenues worth 1.6 per cent of GDP a year (£39 billion), with fuel and vehicle excise duties accounting for more than 90 per cent of that loss. Modestly weaker GDP growth due to higher carbon prices also hit the public finances, but to a much smaller extent. Taxing carbon more heavily held out the prospect of additional revenues to offset some of these costs, so that our smooth transition, early action scenario added 21 per cent of GDP to debt by 2050-51. That was almost entirely due to the loss of motoring tax revenues, which might ultimately be addressed via other levies on motoring in the future – as the Government has mooted.[17]

3.50 Developments over the past year mean that we have now factored some of the net zero transition costs presented in last year's *FRR* into our baseline long-term fiscal projections presented in Chapter 4, while the balance of risks around those fiscal costs is likely to have changed. In particular:

- The publication of **the Government's Net Zero Strategy** (NZS) in October 2021,[18] and the decisions to allocate new net zero investment from within an unchanged overall public investment envelope at the 2021 Spending Review later that month, frames how we have factored net zero into our projections. Of the four main moving parts in last year's risk analysis, the loss of net-zero-affected taxes (primarily fuel duty) and the modest reduction in productivity growth during the transition have been reflected in the projections – with the former contributing materially to the fiscal sustainability challenge presented in Chapter 4. Net zero investment is now assumed to come from within existing public investment totals, so does not affect our long-term projections. And while taxing carbon more heavily is a Government ambition, as signalled in its latest consultation on the Emissions Trading Scheme,[19] no firm policy statements have yet been made. As such, our long-term fiscal projections do

[16] In June 2019, the Government amended the 2008 Climate Change Act to require net greenhouse gas emissions to be eliminated rather than targeting a reduction of 80 per cent from 1990 levels. See *The Climate Change Act 2008 (2050 Target Amendment) Order 2019*.
[17] The Prime Minister's November 2020 *Ten Point Plan for a Green Industrial Revolution* stated that *"As we move forward with this transition [to zero emission vehicles], we will need to ensure that the tax system encourages the uptake of [electric vehicles] and that revenue from motoring taxes keeps pace with this change"*. The Treasury's October 2021 *Net Zero Review* reiterated this message, noting that *"delivering net zero sustainably and consistently with the government's fiscal strategy requires expanding carbon pricing and ensuring motoring taxes keep pace with these changes during the transition."* The Government has not yet set out how motoring taxes might be reformed to keep pace with the transition to electric vehicles, so this possibility is not factored into our long-term fiscal projections.
[18] HM Government, *Net Zero Strategy: Build Back Greener*, October 2021.
[19] HM Government, the Scottish Government, the Welsh Government, and Department of Agriculture, Environment and Rural Affairs, Northern Ireland, *Developing the Emissions Trading Scheme (UK ETS)*, March 2022. See Chapter 6 on expanding the ETS within sectors that are currently covered and Chapter 7 on expanding it to sectors that are not currently covered. The latter seeks evidence on the possibility of expanding the ETS to cover domestic maritime transport, and waste incineration and energy from waste.

not include the potentially large revenue gains to be had from taxing all currently untraded emissions more heavily.

- **The dramatic rise in fossil fuel prices** in recent months and the expectation that they could remain higher for longer alters the balance of economic and fiscal risks associated with the transition to net zero and different future energy mixes. At the whole-economy level, it raises the cost of maintaining a fossil-fuel based economy (as the 'persistent shock' scenario set out above illustrates). Since it does not alter the long-term cost of operating a decarbonised economy, it reduces the *additional* economic cost of getting to net zero. Even so, it could make the transition more costly from a fiscal perspective. Some potential carbon tax revenue will instead be paid to the producers of imported fossil fuels. And more generally it could be harder to raise carbon taxes in an environment of already high fuel prices adding to the cost of living, resulting in greater use of public subsidies instead to generate the necessary incentives for decarbonisation. The first part of this section explores these potential fiscal risks.

- Russia's invasion of Ukraine has brought **the security and reliability of energy supply** to the forefront of policy makers' minds across Europe. The UK Government published its British Energy Security Strategy (BESS) in April 2022.[20] It reminds us that governments face a 'trilemma' in the transition to net zero, seeking energy sources that are cheap and secure, as well as clean. A greater focus on security alongside decarbonisation could bring with it new fiscal risks if the Government finds it necessary to invest more to achieve greater security and reliability of energy supply than the private sector alone would provide. That could take the form of: greater investment in carbon capture and storage infrastructure to maximise future use of domestic supplies of natural gas; greater contributions to the cost of constructing (and ultimately decommissioning) new nuclear facilities; and/or greater investment in whole-economy storage capacity to overcome the intermittency challenges posed by renewable energy sources like wind and solar. The second part of this section explores these potential fiscal risks.

Higher fossil fuel prices and the transition to net zero

3.51 This section discusses **why fossil fuel prices might remain high over the long term**, before considering two potential consequences of higher prices persisting:

- how higher prices affect the **whole-economy marginal cost of getting to net zero**; and

- how they might change the **fiscal implications of that transition**, in particular via the prospects of taxing carbon more heavily in future.

Why might gas and oil prices remain high into the longer term?

3.52 What factors might lead gas and oil prices to remain elevated over the long term? One might be global efforts to meet the Paris targets for reducing carbon emissions. In particular, if reduced investment in fossil fuel extraction means supply falls faster than

[20] BEIS, *British energy security strategy – Secure, clean and affordable British energy for the long term*, April 2022.

global demand for fossil fuels. There is some evidence that some major oil and gas companies are already scaling back their fossil fuel investment plans both in response to changes in their ability to raise the necessary financing and out of a desire to avoid their assets becoming stranded and unusable in a net zero world.[21,22] With 44 per cent of global oil and gas still coming from the Middle East, Russia, and Central Asia, average fossil fuel prices could also remain elevated if geopolitical tensions continue to rise (as explored in Chapter 2).[23] Finally, a climate change-driven increase in the frequency and severity of extreme weather could lead to periodic supply shocks in fossil-fuel-producing regions with a high degree of exposure to such events such as in the hurricane-vulnerable Gulf of Mexico.

3.53 It is, of course, also possible that fossil fuel prices could be significantly lower in the long term than implied by current futures curves. Demand for fossil fuels might fall faster than supply through, for example, a faster-than-expected switchover to nuclear or renewable energy generation or rollout of electric vehicles and heating.[24] However, as fossil fuels are internationally traded commodities and the UK accounts for just 1.2 per cent of global energy consumption,[25] the UK's ability to influence fossil fuel prices via its own actions is very limited. And there are significant upward pressures on fossil fuel demand coming from other parts of the world, most notably the rapidly growing economies of China and India but also countries like Nigeria with still rapidly growing populations. And it is in the nature of risks reporting to focus on more adverse, rather than benign, scenarios as a means of testing the sustainability and resilience of existing policy settings.

3.54 Finally, it is important to note the difference between fossil fuel prices paid at different stages of the supply chain – those charged by producers after the extraction stage, those charged by wholesalers distributing refined fuels around the economy, and those charged by retailers such as petrol forecourts and domestic energy suppliers. The latter could remain high due to the effects of additional policy instruments such as regulations or carbon taxes used to deliver net zero, even while prices commanded earlier in the supply chain fall due to the transition away from fossil fuels. (We return to the issue of carbon taxes later.) And these factors will interact to influence prices. For example, expectations of future carbon regulations or disruptions to global trade will affect firms' fossil fuel extraction investment decisions today.

Higher fossil fuel prices and the whole-economy cost of getting to net zero

3.55 The potential medium-term economic and fiscal consequences of fossil fuel prices remaining higher for longer could be significant – as the loss of productivity in the 'persistent shock' scenario illustrates. But even if gas and oil prices were to stabilise at the levels assumed at the end of our most recent *EFO* forecast, the balance of economic and

[21] BP, *From International Oil Company to Integrated Energy Company: bp sets out strategy for decade of delivery towards net zero ambition*, 4 August 2020; and Murray, S., 'Divestment: are there better ways to clean up 'dirty' companies?', *Financial Times*, 7 June 2022.
[22] See Semieniuk, G. et al., *Stranded fossil-fuel assets translate to major losses for investors in advanced economies*, Nat. Clim. Chang., May 2022; and Mercure, J.-F. et al., *Reframing incentives for climate policy action*, Nat. Energy, November 2021 for discussion on the risk of stranded assets.
[23] Compiled from BP, *Statistical Review of World Energy 2022*, June 2022.
[24] Helm, D., *Burn out: The Endgame for Fossil Fuels*, 2017.
[25] BP, *Statistical Review of World Energy 2022*, June 2022.

fiscal risks associated with the transition to net zero would be quite different to those assessed in last year's *FRR* and assumed in the Government's NZS. In particular, while oil prices settled close to those assumed in the Government's figures by the end of the forecast horizon, gas prices were 47 pence a therm higher (in 2019 prices) – nearly twice the levels assumed, which would materially raise the expected cost of whole-economy gas usage.[26]

3.56 Higher gas prices incentivise the shift to other sources of energy like renewables (as well as to compatible end-use technologies that improve energy efficiency, like heat pumps and electric vehicles), but are doing so in a costly, abrupt manner rather than the smooth transition policy makers might hope to achieve with a gradually rising carbon price.[27] And for a net energy importer like the UK, they damage prospects for GDP growth, thereby reducing the extent to which higher carbon prices represent a drag on productivity relative to a fossil-fuel-based economy. We can illustrate the consequences of higher fossil-fuel prices for the whole-economy cost of getting to net zero by recalculating the baseline against which the pathway to net zero consistent with the Government's NZS is compared.

3.57 The whole-economy cost of getting to net zero reflects the investment required to shift the UK's energy mix from fossil fuels to nuclear and renewables and the operating costs of that net zero energy mix *relative* to the investment and operating costs of continuing to burn fossil fuels. At the whole-economy level, the main way higher fossil fuel prices change this calculation is by raising operating costs in the carbon-intensive baseline by more than in the pathway to net zero. Chart 3.17 presents two such scenarios for the future energy use and mix in the context of the changes we have seen over the past five decades. It shows that:

- **The volume and mix of energy used in the UK has changed over the past half century.** Coal use has largely been replaced with natural gas, and while oil and nuclear have maintained fairly stable shares over the past 50 years, during the past decade the UK has seen the expansion of renewables. Total energy consumption in the UK peaked during the first decade of this century at 2,796 TWh in 2005, a 14 per cent increase relative to 1970, before falling 29 per cent over the next 16 years to a 58-year low of 1,984 TWh in 2021 (excluding the pandemic-affected year of 2020, which saw a sharp lockdown-induced year-on-year drop of 10 per cent). This decline in energy consumption comes despite a 182 per cent increase in GDP over the past 51 years, reflecting the switch from heavy industry to services during that time and resulting in the energy-intensity of GDP falling to an over 300-year low.[28]

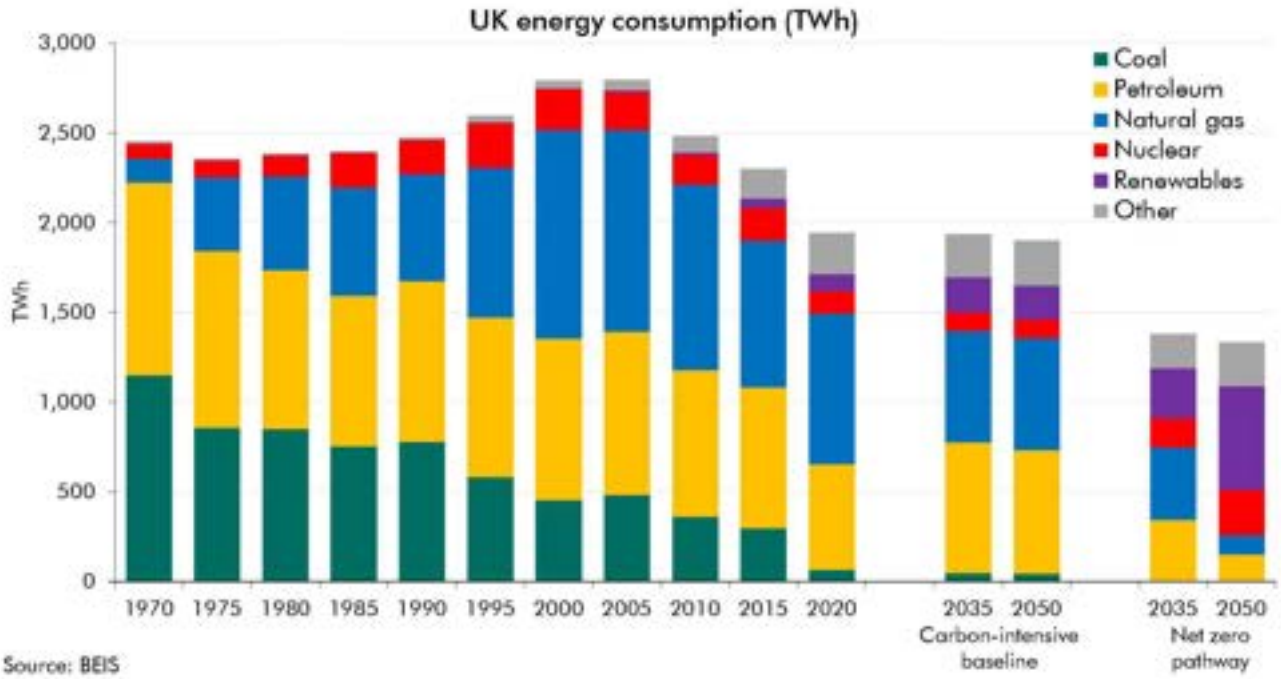
- **The carbon-intensive baseline** (derived from BEIS's NZS baseline 'do nothing' projections for primary energy demand out to 2040)[29] would see an 18 per cent decline in both petrol and gas use between 2022 and 2050, while coal levels would remain broadly where they are today. The main differences would be a 32 per cent decrease in nuclear capacity between 2022 to 2050, as old reactors come offline, and

[26] The latest market expectations are even higher at three times (91 pence per therm) above the NZS in 2026-27 (see Chart 3.3).
[27] Nesta, *Cheap loans and lower running costs triples demand for heat pumps, according to UK-wide experiment*, June 2022.
[28] Historic energy estimates are taken from the National Infrastructure Commission's collection of historical energy statistics (31 March 2021), which provides energy statistics for the UK dating back to 1700. Historic GDP estimates back to 1700 are from the Bank of England's Millennium of Macroeconomic data, published in April 2017.
[29] BEIS, *Energy & Emissions Projections Net Zero Baseline: Oct 2021, Annex E*, October 2021.

a more than two-fold increase in renewable capacity from 81 TWh in 2021 to 189 TWh in 2050, due to the increasing cost-competitiveness of renewable energy. Overall primary energy demand remains relatively similar between 2022 (2,155 TWh) and 2050 (1,899 TWh).[30] This provides the baseline against which the costs of getting to net zero can be compared.

- **The net-zero pathway** (based on the 'high electrification' pathway in the NZS, which sets out an indicative energy mix pathway to 2037, along with a projected 2050 energy mix, that is consistent with reaching net zero) would see total primary energy consumption fall by 22 per cent over the next three decades from 2022 to 2050.[31] The share of coal falls to less than 1 per cent, petrol use falls by 79 per cent to make up 10 per cent of the mix in 2050, while gas use falls by 86 per cent to make up just 7 per cent of the energy mix in 2050. Alongside these large falls in fossil fuels there is a 67 per cent increase in nuclear power generation, as well as a roughly seven-fold increase in renewable energy generation, nearly tripling by 2035, and more than doubling again to become the largest energy source in 2050, making up 38 per cent of the mix.

Chart 3.17: UK energy usage by source: historical trends and future pathways



Source: BEIS

3.58 Based on these two different paths for energy use and energy mix, we can calculate: (i) the additional whole-economy cost of gas usage in each scenario as a result of higher prices; and (ii) how that reduces the marginal cost of getting to net zero relative to the baseline. These differences can be compared in broad terms with the Climate Change Committee's (CCC) estimate of the whole-economy net cost of getting to net zero of £321 billion (in

[30] BEIS, *Energy and emissions projections: Net Zero Strategy baseline (partial interim update December 2021)*, December 2021.
[31] This fall in primary consumption reflects the efficiency gains of renewable energy sources over fossil fuels, rather than a reduced demand for energy.

2019 prices) – which reflects investment costs of £1,312 billion that are largely offset by operating savings of £991 billion, and give a net cost equivalent to 0.4 per cent of GDP a year on average. (Precise differences should not be over-interpreted since the energy mix scenarios are drawn from the NZS rather than the CCC, but unfortunately full NZS-consistent costs over the period to 2050 are not available.[32])

3.59 Specifically, gas prices are held in line with those assumed in our March 2022 *EFO* over the medium term and then constant at £1.01 per therm in 2019 prices (47p per therm above the NZS baseline from 2026 to 2050). As reported in Table 3.2, the effect of these higher gas prices on the whole-economy cost of getting to net zero would be as follows:

- In the **carbon-intensive baseline**, natural gas usage is relatively stable across the period at around 654 TWh a year on average, giving total usage between 2022 and 2050 of 19,000 TWh.[33] At the prices assumed in the NZS, that would cost £346 billion in real terms over 28 years (equivalent to 0.4 per cent of GDP a year). But at prices over the long term consistent with our March 2022 *EFO* forecast, the cost would be £360 billion higher at £707 billion (0.9 per cent of GDP a year).

- In the **net zero pathway**, natural gas usage declines steadily over the next three decades from 766 TWh in 2022 to 107 TWh in 2050, giving total usage of 11,700 TWh (38 per cent less than in the baseline scenario). At NZS-assumed prices, that would cost £214 billion in real terms (on a declining path from 0.6 per cent of GDP in 2022 to 0.1 per cent in 2050). At March 2022 *EFO* prices it would cost £244 billion more at £458 billion in total (0.6 per cent of GDP a year on average, but on a declining path from 2.9 per cent of GDP in 2022 to 0.1 per cent in 2050).

- The **marginal cost of getting to net zero relative to the baseline** would therefore fall by £116 billion in real terms over the period from 2022 to 2050 (equivalent to 0.1 per cent of GDP a year) as a result of higher gas prices. In very broad terms, that would bring the net cost of decarbonising the economy down by slightly over a third thanks to operating savings being roughly 12 per cent larger than in the CCC's 2019 estimates as a result of higher gas prices. It is worth stressing that this is not because getting to net zero has become cheaper in absolute terms – it is because *not* getting to net zero has become more expensive as a result of higher fossil fuel prices.

[32] The NZS only gives an estimate of total costs between 2020 and 2037 rather than extending all the way to 2050. Over that shorter period, it estimated the costs of the transition to be between £463 billion and £564 billion (in 2019 prices). That is 10 to 34 per cent higher than the CCC's total estimated cost of £420 billion over the same 17-year period in its balanced pathway (the net cost to 2037 is higher than the net cost to 2050 (£321 billion), as from 2041 onwards operating savings outweigh investment costs).
[33] The Government has not published a full yearly projection for energy use and mix in this baseline or its other scenarios. Instead, it has presented yearly paths to 2040 in its baseline scenario, and to 2037 in its net zero scenarios (the end of the period covered by the Sixth Carbon Budget) and single-year estimates for 2050. The calculations presented here assume trends in energy use and mix follow straight lines between 2037 and 2050 for the net zero pathway (and remain constant from 2040 to 2050 for the carbon-intensive baseline scenario).

Table 3.2: Whole-economy gas consumption costs: baseline versus net zero pathway

	Total cost from 2022 to 2050 (£ billion, 2019 prices)		
	NZS prices	Mar 2022 *EFO* prices	Difference
Carbon-intensive baseline	346	707	360
Net zero pathway	214	458	244
Net zero versus baseline	-133	-249	-116

Higher fossil fuel prices and the fiscal risk of getting to net zero

3.60 The baseline long-term fiscal projections presented in Chapter 4 capture the loss of net-zero-affected revenues associated with decarbonising the economy – thereby bringing our long-term projections into line with achieving the Government's net zero objectives and in effect crystallising the largest net zero fiscal risk identified in our 2021 *FRR* analysis. Revenues fall away somewhat faster than assumed last year reflecting the faster-than-expected rise in the share of electric vehicles in new car sales over the past year.[34] They also reflect the modest reduction in productivity growth during the transition associated with a rising carbon price – though the effect of this has been offset by other factors. And the projections now assume that net zero investment spending consistent with the NZS will be met from within existing totals – as happened at the 2021 Spending Review – so the fiscal risk associated with that spending in our 2021 *FRR* analysis has not crystallised.

3.61 The fourth main component of net-zero-related risks considered last year was the potential for higher revenue from taxing carbon more heavily. In this section we consider two ways in which higher gas prices might affect future carbon tax revenues: first, by raising the implicit carbon price in the economy and thereby reducing the need for policy measures (like a tax) to push it higher still; and second, by raising the cost of living and thereby making it harder to raise prices further, as would occur when taxing carbon more heavily.

Higher gas prices could displace potential carbon tax revenue

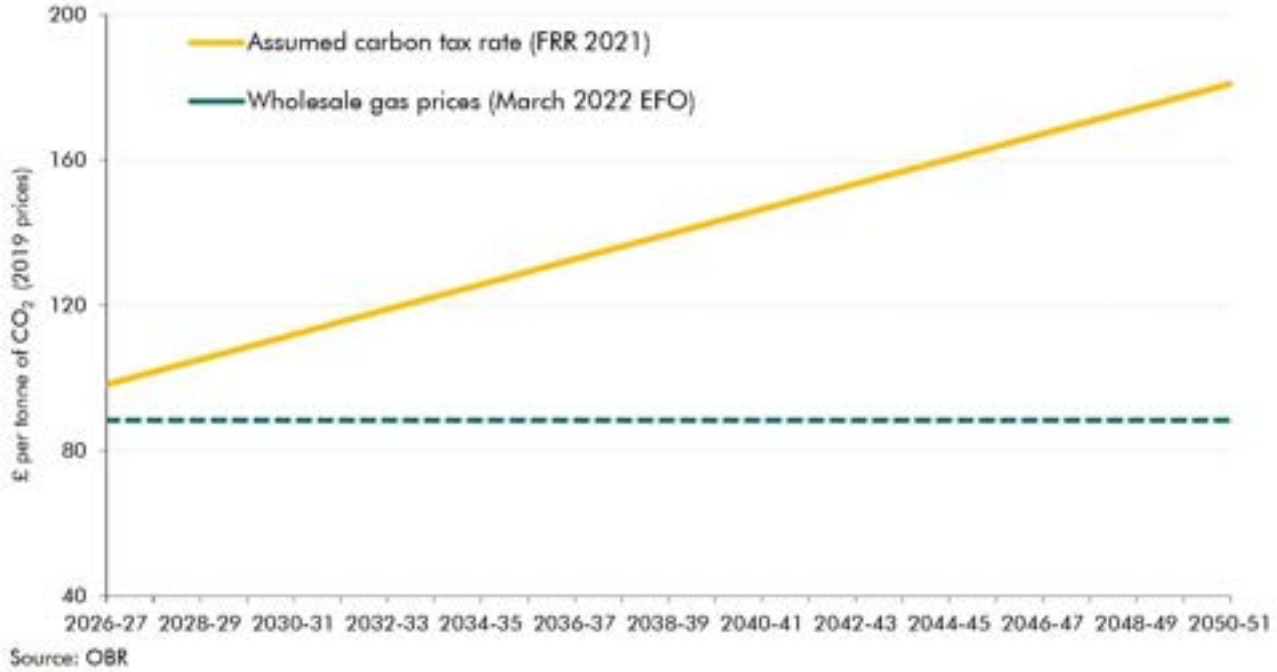
3.62 Higher natural gas prices should work in very similar way to levying a higher carbon tax by providing an incentive for end-consumers to reduce gas consumption, either by investing in energy efficiency or by switching to alternative fuels. In effect, market prices may have done some of the work that our *FRR* analysis assumed would be delivered via taxing carbon more heavily (although they have done it much faster, more akin to the Bank's abrupt and disorderly 'late action' scenario rather than the smooth 'early action' scenario that underpinned our baseline scenario). The key difference is that it would be fossil fuel producers that benefit from a higher carbon price delivered via gas prices, rather than the UK Exchequer benefiting from higher carbon tax revenue. In the case of imported natural gas, the loss of revenue would be complete. But even in the case of North Sea gas, profits

[34] As described in Box 3.3 of our March 2022 *Economic and fiscal outlook*.

from which are taxed relatively heavily, the Exchequer's share of the higher price would be much lower than in the case of taxing carbon.[35]

3.63 To illustrate the extent to which higher gas prices might eat into the potential carbon tax revenue shown in our *FRR* net zero scenario, we take the same 47 pence per therm increase in medium-term gas prices between our March 2022 *EFO* and the assumptions underpinning the NZS baseline, and convert it into pounds per tonne of carbon from burning gas (equivalent to £88 a tonne).[36] As Chart 3.18 shows, this brings the implicit carbon tax rate on natural gas up to roughly the increase assumed for the economy as a whole at the start of our *FRR* scenario. To estimate the impact of this on potential carbon tax revenues, we then need to calculate the share of whole-economy emissions affected.

Chart 3.18: Increased carbon prices: *FRR* 2021 carbon tax rate versus March 2022 *EFO* wholesale gas prices



Source: OBR

3.64 Chart 3.19 shows, perhaps surprisingly, that the reduction in potential carbon tax revenue as a direct result of higher gas prices is relatively small and decreases over time. Using our previous *FRR* prices, but adjusting our analysis to reflect developments since then,[37] cumulative additional carbon tax revenues would reduce debt by 17.2 per cent of GDP by 2050-51. All else equal, that falls by around a sixth (or 2.7 per cent of GDP) to 14.5 per cent. This modest impact reflects the fact that the emitting sectors that use natural gas are

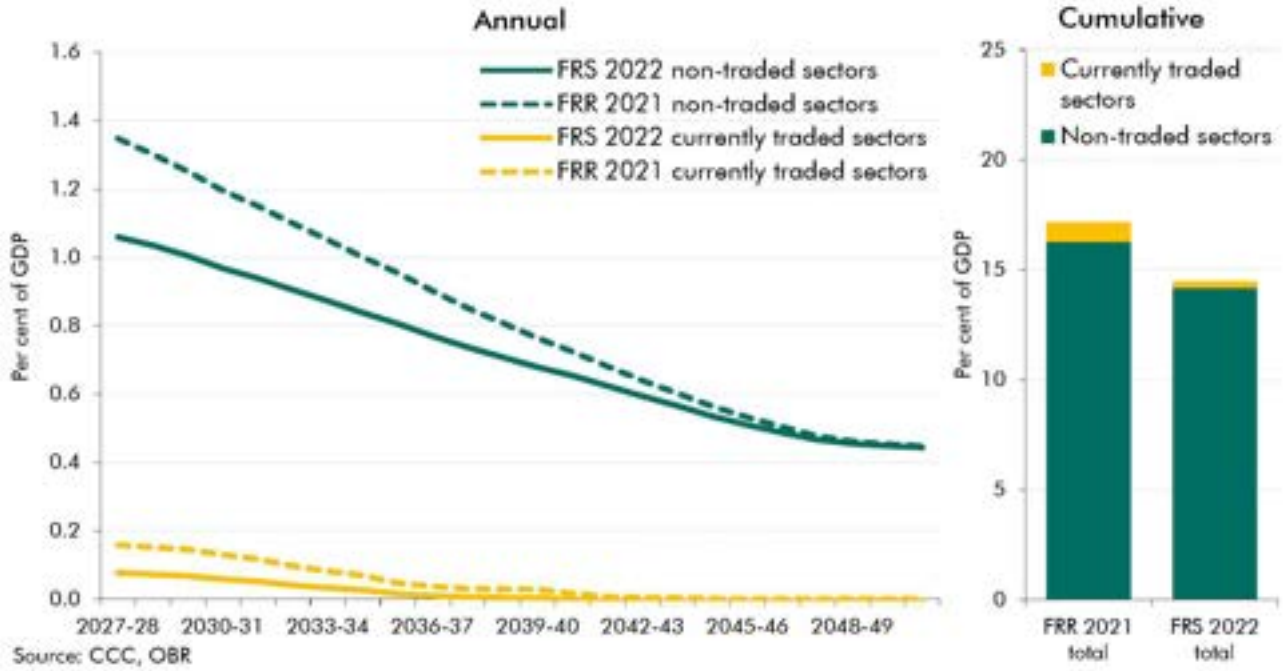
[35] The headline tax rate (excluding the new temporary energy profits levy) is 40 per cent (30 per cent ring-fence corporation tax and 10 per cent supplementary charge), but the effect of past losses and use of investment allowances means the effective tax rate (ETR) will be considerably lower than the headline rate. In our latest forecast, tax revenues divided by total sales (proxied by production multiplied by prices) wound indicate an ETR of 11.4 per cent over the period from 2021-22 to 2026-27.

[36] We assume 5.3 kg of carbon is emitted from the burning of one therm of gas, in line with standard conversion factors.

[37] This calculation is based on the same emissions path as in last year's *FRR* analysis (based on the CCC's balanced pathway) because the Government's NZS pathways do not split emissions between traded and non-traded sectors. This also means that the difference between the *FRR* figure and this updated figure is due to the direct effect of higher gas prices on gas-related emissions. We then adjust for the current share of gas use within each sector in the CCC's emissions breakdown. The baseline against which additional carbon tax revenues are calculated has been adjusted to reflect the latest, much higher, ETS carbon prices, moved back one year to align with the end of our medium-term forecast, and an updated GDP denominator in line with our latest long-run economic determinants.

either assumed to decarbonise completely by 2050 (notably the buildings sector, thanks to the electrification of heating) or they are already subject to relatively high carbon tax rates as they are covered by the ETS (electricity supply). The tax base towards the end of the transition is therefore largely composed of hard-to-decarbonise sectors such as aviation (which uses oil) or agriculture (which generates non-energy emissions such as methane).

Chart 3.19: Carbon tax revenue before and after higher gas prices



Source: CCC, OBR

What if it were more difficult to tax all carbon emissions more heavily?

3.65 Higher fossil fuel prices also create a risk that future governments might find it harder to tax carbon more heavily. The Government is currently consulting on a modest expansion of the sectors covered by the ETS, but our *FRR* scenario was based on all currently untraded emissions being taxed and all emissions being taxed more heavily than was then projected under the ETS. That would raise consumer prices, which may be more difficult if fossil fuel prices had already raised the cost of living and damaged growth prospects (in ways that the scenarios at the start of this chapter illustrate). The fiscal risk in this scenario would be the risk of not capturing potential additional revenues – an opportunity that cannot be grasped – rather than a downside risk relative to our baseline projections in the next chapter.

3.66 One way to illustrate the potential scale of this risk is to reduce the proportion of the 'shadow carbon price' that underpinned our *FRR* scenarios that is delivered via tax and raise the proportion delivered by public spending and regulation.[38] For example, we can consider a scenario in which the taxation of emissions is not expanded further and that half of this missing contribution to the shadow carbon price is be met by public spending and half via

[38] The 'shadow price' is a measure of the incentive to decarbonise, which rises over time as remaining emissions become more costly to abate. It can be delivered by raising the actual price of carbon via a tax or ETS, or by achieving changes equivalent to raising the actual price via regulations (such as banning the purchase of new petrol vehicles or imposing net zero standards on new build properties) or subsidies (which reduce the price of low-emissions activities and technologies relative to carbon-intensive ones).

more stringent regulation. The foregone carbon tax revenue would add 14.5 per cent of GDP to debt in 2050-51 relative to our *FRR* scenario, while the additional spending on subsidies required to meet the shadow carbon price (by reducing the price of low-emissions activities relative to carbon-intensive ones) would add 7.2 per cent. In effect this illustrates the cost that would be associated with a potential beneficial fiscal risk (from taxing more emissions) becoming an adverse one (from higher public spending).

Fiscal risks from a renewed focus on energy security

3.67 In response to the sharp rise in energy prices at the start of this year, in April the UK Government published a *British energy security strategy* (BESS).[39] Its subtitle *"secure, clean and affordable British energy for the long term"* reminds us that governments face a 'trilemma' in seeking to make the transition to net zero while increasing energy security. Historically UK energy sources have been either cheap, secure, or low carbon, but they were rarely all three. Higher fossil fuel prices and geopolitical tensions have the potential to partly alleviate the trilemma, for example, because clean energy has become cheaper relative to carbon-intensive sources and because they incentivise faster switching to more energy-efficient technologies that improve security by reducing demand. But even so, addressing the principal security shortcoming of each major energy source could nonetheless prompt significant government investment. To illustrate the potential fiscal risk that might come from attempting to increase energy security, we consider three main sources of power generation:

- **Fossil fuels**, where the greatest fiscal risk might come from the need to invest more publicly in unproven carbon capture and storage infrastructure to maximise future use of domestic supplies of North Sea natural gas – to secure the *"new lease of life for the North Sea"* set out in the BESS.

- **Nuclear**, where medium-to-long-term fiscal risks might come from subsidising the cost of constructing new nuclear facilities, while very-long-term risks come from decommissioning those facilities at the end of their multi-decade lives.

- **Renewables**, where the greatest risk might come from the need to invest more in economy-wide storage capacity and grids to overcome the intermittency challenges posed by wind and solar power generation – particularly if coordination failures meant that the private sector would under-provide such capacity without public intervention.

3.68 We present illustrative figures for the potential whole-economy costs of addressing the risks associated with the energy mix consistent with the BESS. The fiscal risk that such costs might pose would depend on the share of any that fell to the public sector, which we have not attempted to quantify at this stage. In some cases, such costs may already be reflected in baseline assumptions that reflect previous CCC analysis, so it is also not straightforward to determine the extent to which any costs would be additional to that baseline (and hence a

[39] BEIS, *British energy security strategy – Secure, clean and affordable British energy for the long term*, April 2022.

risk to our fiscal projections). We will therefore revisit this in a more quantitative manner once further assessments from the Government and/or the CCC are available.

The energy policy trilemma

3.69 In considering how to alter their long-run energy supply mix away from fossil fuels and towards either nuclear or renewable energy, countries like the UK face a trilemma between three potentially competing objectives. In particular, countries would like their energy supply to be:

- **Affordable ('Cheap')**. In assessing the overall cost of energy generation policy makers need to take account of: (i) the upfront capital costs of building the infrastructure (**construction**); (ii) the operating costs of production including fuel, employee wages, and maintenance (**operation**); and (iii) the costs of shutting down the infrastructure at the end of its life – and, in the case of nuclear, making it safe (**decommissioning**).

- **Reliable ('Secure')**. In assessing the overall reliability of energy supply policy makers need to take account of: either (i) geopolitical factors that may lead to sudden interruptions in supply or increases in price (as in the cases of the 1973, 1979, and 2022 fossil fuel crises); or (ii) geographic or meteorological factors than lead to intermittency or seasonality in supply (as in the case of UK wind and solar power).

- **Low carbon ('Clean')**. In assessing how clean a source of energy is, policy makers need to consider both the volume of carbon emissions created as a direct result of energy generation (which are relatively high in the case of fossil fuels) and the potential for mitigating those emissions (for example through nascent carbon capture and storage technologies).[40]

3.70 In the remainder of this section, we consider each energy source in the context of the policy trilemma, and how the varying costs involved in the construction, operation, and decommissioning of capacity might become the source of additional fiscal risks in an environment of continued focus on the security of supply.

Fossil fuels

3.71 Fossil fuels currently make up almost four-fifths of the UK's energy mix, with 43 per cent coming from natural gas, 32 per cent from oil, and 3 per cent from coal.[41] Assessing fossil fuels as a source of power generation against the policy trilemma:

- **Cheap**. The cheapness or otherwise of fossil fuel power generation largely relates to operating costs, mainly in respect of the cost of the fuel itself, which, as shown above, fluctuates significantly over time and is currently very high. Setting aside net zero ambitions, construction and decommissioning costs in respect of a such a well-

[40] There are other potential environmental benefits such as reduced air and water pollution that largely correlate with carbon emissions, but which are beyond the scope of this chapter.
[41] Figures refer to the preliminary 2021 data in BEIS, *Inland energy consumption, primary fuel input basis*, 26 May 2022.

established technology pose limited fiscal risks as they are likely to be met by the market. The potential fiscal risks associated with *traditional (unabated)* fossil fuel generation therefore come from two sources. First, protecting consumers and supporting households in periods when prices rise dramatically – as evidenced by the £17 billion of support towards energy bills announced so far this year. And second, incentivising reductions in households' demand for fossil fuels, in particular by improving insulation or installing heat pumps, a risk we discussed in our 2021 *FRR*.[42]

- **Secure.** In terms of security, the main challenge is the international supply of fossil fuels. Despite having its own domestic sources of gas and oil from the North Sea, declining production since the turn of the century has turned the UK into a net fossil fuel importer,[43] exposing it to geopolitical factors such as the disruptions to Russian supply in recent months. The BESS therefore argues that *"the North Sea will still be a foundation of our energy security"* in the future, and that *"we must fully utilise our great North Sea reserve [and] use the empty caverns for CO_2 storage"*.

- **Clean.** Burning fossil fuels represents the largest source of the UK's greenhouse gas emissions. But gas power generation can be compatible with net zero via carbon capture and storage (CCS) technologies, albeit at a higher cost: construction of a gas-fired power station with CCS is estimated to cost between £1,580 and £2,200 per kW,[44] more than double the construction cost of an unabated plant (£640 to £960 per kW[45]). The operating costs of plants with CCS are also double that for unabated plants (at £28,750 per MW per year and £14,570 per MW per year, respectively).[46] Natural gas can also be combined with capture technologies to produce hydrogen, which features more or less heavily in different potential pathways to net zero.

3.72 Achieving net zero alongside increasing security via more domestic fossil fuel production points to the additional costs of CCS – in comparison to unabated power generation – as the main area of potential fiscal risk. It is unfeasible to add CCS capacity to most of the current 30.7 GW fleet of gas-fired power stations in the UK due to their age (many of these will be coming to the end of their operational life in the next decade). However, meeting the gas capacity assumed in the NZS 'high electrification' scenario in 2050 could require at least 18 GW of new capacity.[47] Based on the over-twice-as-expensive construction costs

[42] See Box 3.3 in our July 2021 *Fiscal risks report*.
[43] See Box 2.2 in our March 2022 *Economic and fiscal outlook*.
[44] See Uniper Technologies, *BEIS: CCUS Technical Advisory – Report on Assumptions*, September 2018, which gives a cost of £1,508 per kW in 2014 (£1,795 per kW in 2022 prices); Energy Technologies Institute, *Reducing the cost of CCS: developments in the capture plant technology*, 2016, which gives a cost of £1,240 per kW (£1,581 in 2022 prices); and U.S. Energy Information Administration, *Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies*, February 2020, which gives a cost of £2,203 per kW (in 2022 prices).
[45] See Uniper Technologies, *BEIS: CCUS Technical Advisory – Report on Assumptions*, September 2018, which gives a cost of £540 per kW in 2014 (£643 per kW in 2022 prices); Energy Technologies Institute, *Reducing the cost of CCS: developments in the capture plant technology*, 2016, which gives a cost of £550 per kW (£701 in 2022 prices); and U.S. Energy Information Administration, *Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies*, February 2020, which gives a cost of £962 per kW (in 2022 prices).
[46] Uniper Technologies, *BEIS: CCUS Technical Advisory – Report on Assumptions*, September 2018 (costs are expressed here in 2022 prices).
[47] This figure comes from the 'electrification' scenario in National Infrastructure Commission's, *Net Zero: Opportunities for the power sector*, March 2020 report, in which at least 18 GW of gas-plus-CCS capacity is required in the UK by 2050, to generate 23 TWh of electricity. While the more-recent NZS 'high electrification' scenario also set out gas requirements (59 TWh by 2050) it did not specify how much of this would be met via domestic rather than imported generation; we have therefore used the NIC estimate.

described above, this might cost between £15.8 and £22.3 billion more to build than that same capacity delivered via unabated gas plants, with further additional costs associated with ongoing operation. These are costs that might fall to some extent to the state.

Nuclear power

3.73 Nuclear power accounted for around 9 per cent of total energy production and 15 per cent of the UK's electricity in 2021.[48] But five of the UK's existing six-strong nuclear fleet are due to cease generating power by 2028 and only one new power station is currently in the construction stage (Hinkley Point C, due to come online in 2027). Against this backdrop, the BESS outlines the Government's ambition to increase nuclear power generation to up to 24 GW by 2050, at which point it could account for up to a quarter of electricity demand. The BESS suggests that *"depending on the pipeline of projects, these ambitions could see our nuclear sector progressing up to eight more reactors across the next series of projects"*.

3.74 Assessing nuclear power against the policy trilemma:

- **Cheap**. The cost of nuclear power varies across its lifecycle. High upfront costs of construction are followed by relatively cheap electricity generation but then by potentially large, lengthy and uncertain costs associated with hazardous waste and decommissioning.

- **Secure**. The security risk of nuclear power generation once it is underway is low as it provides a reliable, constant source of electricity. Potential sources of security risk relate to the supply of uranium to fuel the reactors (with Kazakhstan accounting for almost half of global output in 2021[49]), as well as the occasional need for unplanned maintenance that could cause a temporary loss of output. Nuclear energy supply is also largely inflexible to daily or seasonal demand (unlike fossil fuels).

- **Clean**. Nuclear power is a clean energy source as electricity is generated with very low carbon emissions. The mining of uranium and construction of new plants are both carbon-intensive activities, but the fact that nuclear power plants can generate large amounts of electricity for many decades means lifetime emissions of nuclear power are similar to renewable sources such as wind.[50] Nuclear power does, however, produce hazardous radioactive waste. Although this does not affect how clean the source of energy is when focusing on carbon emissions, it is a wider public policy issue and contributes to high and uncertain decommissioning costs.

3.75 The main fiscal risks in relation to the Government's ambition to improve energy security by increasing nuclear power generation relate to the beginning and end of the lifecycle of the nuclear fleet. Decommissioning costs for new plants are meant to be fully covered through

[48] BEIS, *Energy Trends*, March 2022.
[49] World Nuclear Association, *World Uranium Mining Production*, June 2022.
[50] United Nations Economic Commission for Europe, *Life Cycle Assessment of Electricity Generation Options*, October 2021.

bills, although shortfalls have been experienced in the past, requiring government top-ups,[51] and there is no long-term solution for nuclear waste.[52] But the largest and most immediate fiscal risk relates to the additional capacity targeted in the BESS, given potentially prohibitive upfront construction costs if relying on the market alone. The BESS ambitions are consistent with up to 18 GW of additional capacity beyond Hinkley Point C and Sizewell C. Based on the estimated cost of Hinkley, that would imply potential construction costs approaching £170 billion in today's prices over the coming decades.[53] Even a modest fraction of this falling to the public sector would be fiscally material.

Renewables

3.76 Renewable technologies have risen in importance in the UK's energy mix over the past decade and produced over a quarter of UK electricity in 2021. Wind power is the largest source of renewable electricity generation (with onshore and offshore accounting for 9 and 11 per cent respectively), while solar power contributes a more modest 4 per cent (with the remaining renewable electricity generation coming from hydro, at 2 per cent).[54]

3.77 Viewed through the lens of the energy policy trilemma:

- **Cheap**. Renewables are an increasingly affordable source of power generation with lifetime costs (including capital and operation) now approaching those of unabated fossil fuels (£65 per MWh for renewables versus £50 per MWh for unabated gas plants in 2020, prior to the latest gas price spike), and expected to become cheaper than fossil fuels within the next decade.[55] The construction costs for offshore wind – the UK's main source of renewable power – are higher than those for new unabated gas plants, at £1,710 per kW, although large-scale solar is cheaper to construct (at £420 per kW).[56] Affordability is further supported by policy: successive governments have intervened to support renewable generation through environmental levies on energy bills. The most notable are the renewable obligation and the contracts-for-difference schemes, which provide certainty over prices received for generators. This support is expected to be worth £14.1 billion a year by 2026-27.[57]

[51] The first generation of nuclear plants were fully publicly owned, with the decommissioning costs estimated at £132 billion over 120 years falling to the Nuclear Decommissioning Authority (NDA – a non-departmental public body). Second generation decommissioning costs will be met by a Nuclear Liabilities Fund, although this has recently required a £10.7 billion cash injection from the Government. See Nuclear Decommissioning Authority, *Annual Report and Accounts 2020-21*, July 2021; Nuclear Liabilities Fund, *Annual report and accounts 2021*, March 2021; National Audit Office, *The decommissioning of AR6 nuclear power stations*, January 2022.
[52] A Geological Disposal Facility (GDF) is the favoured solution, which could cost between £20 billion and £53 billion. See Nuclear Waste Services, *GDF Annual Report 2020-2021*, February 2022.
[53] This is based on the construction of Hinkley Point C, which is expected to cost £26 billion (in 2015 prices) in total and have a 3.2 GW capacity, implying construction costs of £9.6 billion per GW when converted to 2022 prices. See EDF, *Hinkley Point C Update*, 19 May 2022.
[54] BEIS, *Renewable electricity capacity and generation*, March 2022.
[55] See Table A3.4.b of the Climate Change Committee's *The Sixth Carbon Budget: Electricity generation*, December 2020 report.
[56] National Infrastructure Commission, *Net Zero: Opportunities for the power sector*, March 2020, supporting evidence.
[57] Contracts-for-difference (CfDs) are in effect a consumer-funded, Government-mandated hedge for producers. They provide a subsidy equivalent to the difference between a guaranteed 'strike price' stipulated in the contract and the market price. The cost of that subsidy is paid via household and business electricity bills. The funds therefore pass from consumers to producers via energy suppliers, although in the public finance statistics they are treated as a tax on consumers and subsidy to producers (because the scheme is Government mandated). Up until this year, CfDs have always represented a subsidy to producers, but the very high price of electricity this year means that funds will flow in the opposite direction, with the contribution of CfDs to electricity bills turning negative for the first time.

- **Secure**. Renewables are not as exposed to the same geopolitical security threats that are relevant to fossil fuels (although there is an increasing reliance on scarce metals used in renewable technologies, which have been subject to recent supply issues[58]). Instead, they are subject to reliability challenges, where demand for energy over the course of the day and the year does not match with supply due to the intermittency that comes from the unpredictability and seasonality of weather conditions. Addressing this challenge is likely to involve a mixture of storage solutions (including pumped-hydro storage, batteries, compressed air, and electrolysis to produce hydrogen); laying more interconnectors to import supply from Europe (and export UK surplus); and more actively managing fluctuations in demand. In this vein, the BESS commits to *"sufficient large-scale, long-duration electricity storage to balance the overall system by developing appropriate policy to enable investment"* and *"smartening up the system with more flexible pricing, through Time of Use tariffs and battery storage through electric vehicles"*.

- **Clean**. Renewables are low carbon technologies. Lifetime carbon footprints are estimated at between 8 g and 83 g of CO_2 per kWh for solar and 8 g to 23 g for wind, compared to 403 to 513 g for natural gas.[59]

3.78 With fossil fuel prices high, renewables therefore look attractive from both an affordability and net zero perspective. But the intermittency problem is significant, especially as the share of energy generation that comes from these sources grows. The NZS therefore raises the prospect of an entirely new fuel system (hydrogen) produced from renewables to help manage the challenge. Beyond any costs to the public sector associated with the move to hydrogen (which it has not been possible to quantify), a source of future fiscal risk relates to greater renewables storage capacity or connectivity – particularly if coordination failures mean that the private sector under-provides this on the basis of price signals alone. Although highly uncertain, recent estimates suggest somewhere around an additional 28 GW of capacity is required, much of which will need to be long duration.[60] If that additional capacity were provided by any single technology, costs could total:

- £12 to £21 billion for sufficient lithium-ion battery storage (although batteries cannot currently provide for longer durations, so could only be a partial solution);[61]

[58] Rare earth metals, particularly those required for electric vehicles, and lithium have recently been exposed to supply chain issues, with most of the current mining of these resources isolated to China. See Reuters, *China frictions steer electric automakers away from rare earth magnets*, July 2021; and Forbes, *Lithium Shortage May Stall Electric Car Revolution And Embed China's Lead: Report*, November 2021.
[59] United Nations Economic Commission for Europe, *Life Cycle Assessment of Electricity Generation Options*, October 2021.
[60] Aurora Energy research, *Long duration electricity storage in GB*, February 2022. Calculations are based on the scenario buildout of 11 GW of pure storage, 6 GW peak control and 11 GW of CCS or hydrogen power.
[61] Estimates of the cost of lithium-ion battery storage fall from £475 per kW in 2020 to £198 per kW by 2050 (in 2012 prices; £584 per kW falling to £243 per kW in 2022 prices). See: Mott Macdonald, *Storage costs and technical assumptions for BEIS*, August 2018; BEIS, *Battery storage boost to power greener electricity grid*, July 2020. In Aurora Energy's research (cited above) the estimated costs for a four-hour Li-ion battery were significantly higher, at £920 per kW in 2020, falling to £579 per kW by 2050 (in 2016 prices; £1,064 per kW falling to £669 per kW in 2022 prices).

- over £19 billion if met via pumped hydro-storage (although this is unlikely to be achievable in full with the UK's geology);[62] or

- around £20 billion for interconnectors to access other countries' renewable energy advantages (although this figure does not account for the upstream capital costs).[63]

3.79 No single source of additional renewables storage is likely to be sufficient or appropriate. Whatever the chosen mix, these estimates suggest that the costs of storage or connectivity could fall somewhere around £20 billion, with implications for the public purse if governments chose to bear some of the cost of overcoming the intermittency challenge.

Energy security summary

3.80 In effect, the Russian invasion of Ukraine has put greater focus on energy security alongside getting to net zero ambitions and keeping energy costs low in the trade-offs that determine the UK's long-term energy mix, and the Government's role in delivering it. The fiscal risks posed by greater security depend on the share of any associated costs that falls to the public sector, which it has not been possible to quantify, but the illustrative whole-economy costs presented here give a sense of their potential scale. More broadly, the analysis across our *FRR* last summer and this chapter demonstrates that higher energy costs – whether driven by higher global fossil fuel prices, net zero ambitions, or new energy security objectives – raise numerous fiscal risks such as inflation-driven increases in welfare spending, and the impact of carbon taxes, regulation, and government subsidies to incentivise the transition to net zero or improve the security of supply. The scale of these fiscal risks rests on decisions about the balance of higher costs between consumers and the Exchequer (and therefore, implicitly, current and future generations of taxpayers). Governments cannot make the costs of more expensive energy go away, they can only adjust who pays them, and when.

[62] A proposed new 1.5 GW storage station at Coire Glas in Scotland is estimated to cost "over £1 billion". See Coire Glas website, www.coireglas.com, accessed 24 June 2022.
[63] The latest 1 GW interconnector cost £700 million (£721 million in 2022 prices), and significantly more interconnector capacity is being planned. See: National Grid, *Press release: National Grid's new undersea power cable between Britain and France energises race to net zero*, October 2020.

4 Long-term fiscal pressures

Introduction

4.1 To complement the analysis of potential shocks and pressures on the public finances over the medium term in Chapters 2 and 3, this final chapter provides an updated assessment of long-term fiscal sustainability. We start from where the public finances stand today and then assess the impact of demographic, economic, technological, and other trends on future government revenue, spending, and financial transactions. We then project forward their implications for the potential path of public sector net borrowing and debt over the coming half-century. In doing so we explore alternative assumptions for several of these underlying trends to illustrate the sensitivity of the long-term fiscal position to those assumptions.

4.2 Alongside analysis of fiscal risks in previous reports, long-term projections of this kind facilitate a relatively comprehensive assessment of fiscal sustainability. They take into account future commitments already specified, such as the future cost of public service pensions, as well as government's many non-contractual – but nonetheless implicit – ongoing spending commitments in the areas of education, health care, and defence. The projections also recognise that future governments will continue to impose taxes and raise revenues but that some existing revenue sources are likely to be eroded over time, as in the case of fuel and vehicle excise duties that are linked to carbon-intensive activities.

4.3 The first five years of these projections are consistent with the medium-term forecast published in our March 2022 *Economic and fiscal outlook* (*EFO*), adjusted to include the net cost of the package of support for household energy costs and surtax on energy company profits announced in May 2022.[1] From 2027-28, we construct long-term projections of spending and revenue streams through an unconstrained 'bottom-up' analysis.

4.4 Key spending and revenue items are sensitive to both the size and age structure of the population, and our approach to projecting the public finances allows us to isolate the changes in both spending and revenue that would be caused by demographic changes as well as non-demographic cost pressures (by otherwise holding spending and tax revenues per person fixed relative to average earnings, so that in the absence of these pressures borrowing would remain flat as a share of GDP). We make use of individual spending and revenue profiles for males and females, each capturing the age distribution of spending or revenue over a representative individual's lifetime. By applying age profiles and population projections to spending and revenue it is possible to calculate the total spending and revenue per person of a given sex and age. It is this calculation that forms the basis of our projections of the public finances. For all but health spending, these per capita allocations

[1] The details of this adjustment are explained in Box 3.3 in Chapter 3.

are raised in line with earnings over the projection horizon and combined with population projections to generate future spending and revenue streams. For health spending, per capita allocations are also increased each year to reflect our assumption that non-demographic pressures (like the rising prevalence of chronic diseases or the cost-raising nature of technological advances in the health care sector) will be accommodated.

4.5 These projections are also based on our long-term economic determinants. These have been updated relative to those published on 24 May to incorporate a weaker long-term outlook for net inward migration than assumed by the Office for National Statistics (ONS) in its 2020-based interim projection.[2] We also present a scenario consistent with the higher path of net migration that is assumed in the ONS projections.

4.6 We have not produced a full update to our long-term projections since our 2018 *Fiscal sustainability report* (*FSR*), since our 2020 *FSR* was recast to address the near-term fiscal impact of the pandemic, which was then in its initial stages. These new projections therefore capture a lot of news that has accrued over the past four years. This includes not just the pandemic, which is still with us and whose long-term consequences for health in particular are uncertain, but also post-Brexit changes to the trade and migration regimes, as well as material increases in the size (and composition) of the state and the tax burden to finance it. The ONS interim population projections on which our fiscal projections are based have also been revised substantially. We therefore attempt to quantify the contributions of these many factors to the change in the long-term fiscal outlook since 2018.

4.7 To explore the implications for fiscal sustainability arising from demographics and shocks, this chapter:

- details the **key assumptions** underpinning our long-term projections, including demographic assumptions, employment rates, other long-term economic determinants, the medium-term fiscal position, and long-term policy assumptions;
- presents **long-term fiscal projections** on the basis of those assumptions and tests the sensitivity of the results to interest rates, the primary deficit and economic shocks;
- discusses **indicators of fiscal sustainability**, including the decade-by-decade fiscal tightening that would be necessary to stabilise the debt-to-GDP ratio in the long term; and
- tests the **sensitivity of the projections to shocks**, including the stress test and scenarios presented in Chapters 2 and 3.

[2] ONS, *National population projections: 2020 based interim*, January 2022.

Key assumptions

Demographics

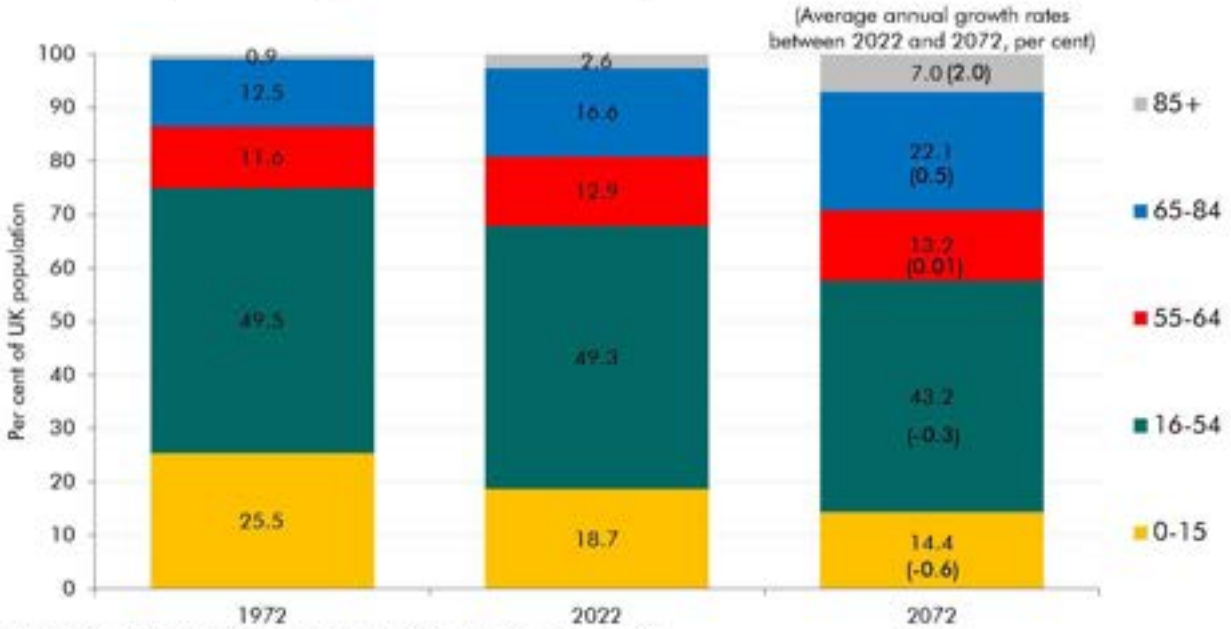
4.8 One of the most important drivers of fiscal sustainability is the outlook for the size and age structure of the population, which influences both the future size of the economy and the health of the public finances. The projected size and age structure of the population are determined by assumptions regarding birth rates,[3] mortality and migration. These are highly uncertain at any time, with Brexit and the pandemic having added to this uncertainty.

4.9 There is also uncertainty at present over the size of the UK population today. The first results of the 2021 census – covering only England and Wales – were released on 28 June 2022. They point to the population in England and Wales standing at 59.6 million in 2021 – 0.6 per cent smaller than assumed in the ONS interim population projections. The census results for Northern Ireland were released earlier this year, with the population broadly in line with the ONS interim projections. Initial estimates of the size of the Scottish population will not be released until next year. We will return to the implications of the full census results for the public finances in future reports.

4.10 Despite these sources of uncertainty, we can still be reasonably certain about some developments in population structure. For example, we can be confident that the larger cohorts that resulted from the post-WWII and early-1960s baby booms will continue to pass through the projections as these people age. In addition, past trends of declining birth rates and increasing longevity have together created an ageing population, meaning that a higher proportion of the population will be in older age brackets (Chart 4.1). This is a common feature across all advanced economies, with the UK having a similar share of the population in old age as other advanced economies today but seeing a smaller further increase in that share over the next 50 years (as described in Box 4.1).

[3] We use the term 'birth rates' in this report to describe what the ONS calls the 'fertility rate'. It is a measure of births per woman aged 15 to 46, therefore the projected number of births is determined by the birth rate and the number of women at these ages.

Chart 4.1: Population age structure in 1972, 2022 and 2072



Note: 2022 and 2072 readings are from the OBR low migration baseline.
Source: ONS, OBR

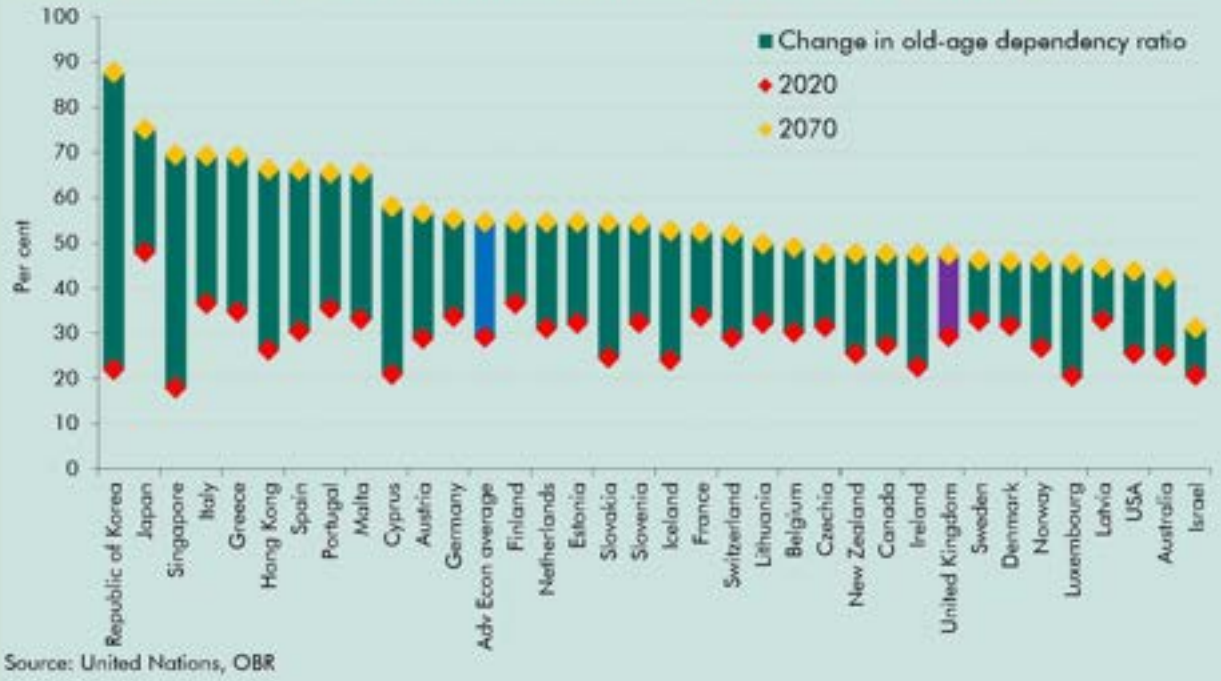
Box 4.1: International demographic trends

The UK is far from alone in having an ageing population. Indeed, the United Nations (UN) projects that the populations of all advanced economies will age over the next 50 years (Chart A).

According to the latest UN population projections compiled in 2019, the UK old-age dependency ratio – which the UN defines as people aged 65 and over as a proportion of the people aged 15 to 64 – is close to the average across advanced economies.° However, the UK ratio is projected to rise by 18 percentage points between 2020 and 2070 – a smaller increase compared to most other advanced economies which, on average, see a 26 percentage point rise. This would leave the UK with one of the least aged populations among the advanced economies in 2070 – in common with the Scandinavian countries, as well as the United States, Australia and Ireland. The most rapid ageing and the highest future old-age dependency ratios are projected across advanced economies in Asia and in Southern Europe.

The UK population ages more slowly than the average across other advanced economies due to higher birth rates and higher net migration rates. Between 2020 and 2070, the UN assumes that the birth rate in the UK will be just above the advanced economy average (at 1.8 births per woman compared to 1.7), and a net migration rate of 2.2 net inward migrants per 1,000 population compared to an advanced economy average of 1.9. Our projections incorporate both lower birth rates (at 1.6) and a lower net migration rate (at 2 on the UN metric) than assumed in the UN projections, which results in the UK old-age dependency ratio in our projections increasing to around 50 per cent in 2070, compared to 47 per cent in these UN projections.

Chart A: Projected old-age dependency ratios in advanced economies



Source: United Nations, OBR

[a] United Nations Department of Economic and Social Affairs, World Population Prospects 2019.

4.11 The outlook for the size and age-structure of the population has changed materially since our 2018 long-term fiscal projections. They reflected ONS population projections that were based on 2016 population data and demographic assumptions that were selected in mid-2017. Our new projections use the latest 'interim' ONS population projections from January 2022, which are based on 2020 population data and reflect updated assumptions about birth rates, mortality improvements and net migration. Unlike in previous releases, the ONS presented only one projection this year rather than several variants. To ensure consistency between our medium-term forecast (to 2026-27) and our long-term fiscal projections, we have used the ONS's projections for birth and death rates, but a lower net migration assumption. This reflects a forecast judgement made in our March 2020 *EFO* to capture the effect of the post-Brexit migration regime (see paragraph 4.13). Since then, our medium-term forecasts have assumed that net migration will settle at 129,000 a year, rather than the 205,000 currently assumed by the ONS. We have extended this assumption over the long term and called this the '**OBR** low-migration baseline'. Overall, this reduces the population by almost 6 million by 2072 relative to a scenario consistent with net migration at 205,000 – the 'ONS interim projection' (see Chart 4.2 below).

4.12 The latest ONS population projections are subject to an unusual degree of uncertainty. First, they are based on population data from mid-2020 that can be expected to be revised when the full 2021 census data become available next year. Second, the pandemic is likely to have further slowed the pre-pandemic trend towards declining mortality but to an uncertain degree. Third, birth rates have fallen significantly, again with uncertainty over the extent and persistence of those falls. Fourth, the pandemic saw measurement of migration temporarily suspended, while changes to migration policy are in train, both of which make looking at

history (which is the main method used by the ONS) a less reliable guide to future migration patterns. We will return to the issue of uncertainty around demographic projections in a future *FRS* once the ONS has published a full suite of variant population projections consistent with the latest census data.

4.13 With those uncertainties borne in mind, the main differences between our latest population assumptions and those used in our 2018 and 2020 *FSR*s (Table 4.1) are:

- **Lower birth rates.**[4] At 1.59 births per woman, the assumed birth rate has fallen further below the 2.1 figure that would be required for the population to remain stable in the long term in the absence of migration or changes in mortality. The latest assumption is 11 per cent lower than the 1.79 in our 2020 *FSR* and 14 per cent lower than the 1.84 in our 2018 *FSR*. It represents the lowest birth rate assumed in any set of official population projections published over the past seven decades.[5] It is clear that forces that have driven down birth rates over the past decades have not been reversed. In light of that, the ONS projections assume that recent low birth rates persist.

- **Slower improvements in life expectancy.** Mortality rates have been revised up relative to previous projections, albeit still on a slowly declining path over time. This partly reflects the pandemic, whose effect is assumed to persist for four years; but is more the result of slower increases in life expectancy in recent years, which has lowered assumptions about the long term. 'Cohort life expectancy' at birth – the metric that factors in future improvements in life expectancy – for females has been revised down by 0.2 per cent from 92.8 to 92.6 years since our 2020 *FSR* but by a more material 3.1 per cent from 95.6 to 92.6 years since our 2018 *FSR*. For males, life expectancy has been revised down by 0.6 per cent since our 2020 *FSR*, from 90.6 to 90.1 years, and by 3.4 per cent since our 2018 *FSR*, from 93.3 to 90.1 years. This reflects the weaker pre-pandemic trends in mortality improvements.

- **Lower net migration.** This reflects our assumptions about the impact of the post-Brexit migration regime, as discussed above. The ONS projections for net migration have been revised up from 165,000 a year in its previous projections, which underpinned our 2018 *FSR*, to 205,000 a year in the latest ones, reflecting the higher 25-year average value that the projections are based on. Our latest assumption is unchanged from our 2020 *FSR* at 129,000 a year and is 22 per cent lower than in our ONS-based 2018 *FSR* assumption of 165,000 a year. This is a particularly uncertain assumption at present, but reflects a view that the new post-Brexit migration regime is, on average, tighter than the pre-Brexit regime it replaced,[6] and tighter than the regimes that were in place in the 25-year historical period that informs the ONS assumption, so that current levels of net migration are unlikely to be sustained.

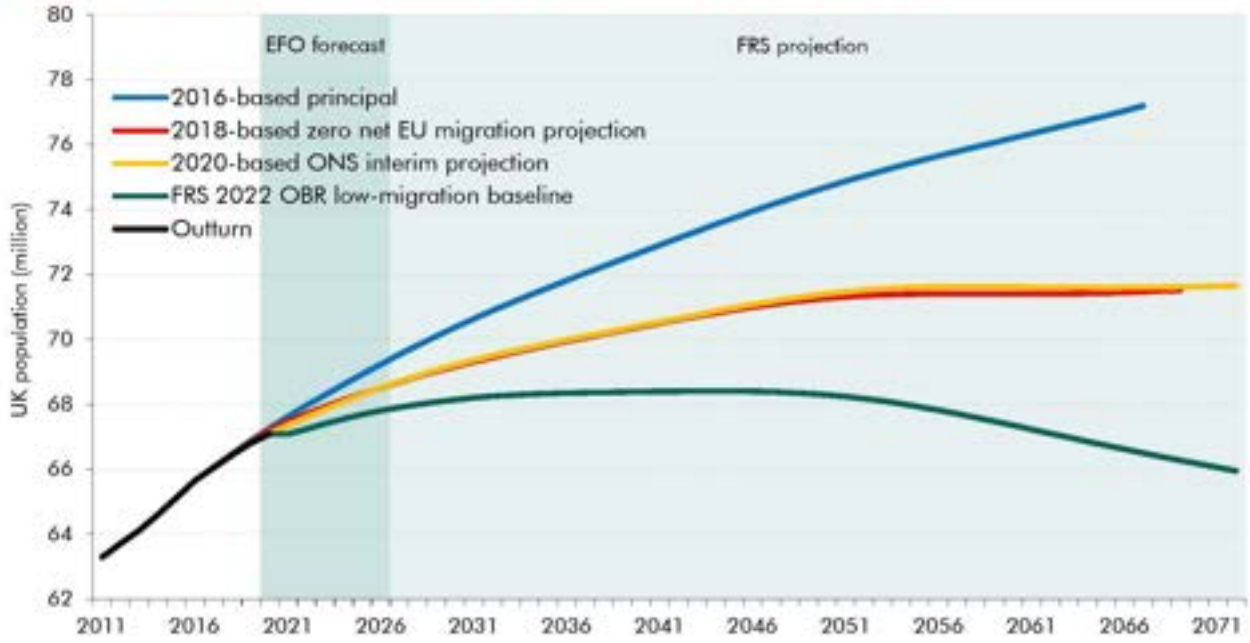
[4] These are long-term birth rates, 25 years into the projections. The birth rate is modestly lower in the initial years of the projections.
[5] See Box 3.3 in our 2014 *FSR* for a summary of the evolution of official population projections since 1955.
[6] See Box 2.4 of our March 2020 *EFO* for the analysis underpinning this view. The regime is tighter than what was in place previously for EU migrants but looser for non-EU migrants, and is judged to be tighter on average across the two.

Table 4.1: Demographic assumptions

	Birth rate	Life expectancy at birth in 2045 (years)				Long-term average annual net inward migration	Size of population in 2072 (millions)	
		Period		Cohort				
		Males	Females	Males	Females	(thousands)	16-64	Total
Levels								
FRS 2022	1.59	82.2	85.3	90.1	92.6	129	38.1	65.9
FSR 2020	1.79	82.8	85.7	90.6	92.8	129	41.2	71.6
FSR 2018	1.84	83.9	86.7	93.3	95.6	165	45.4	78.0
Memo: Latest ONS projection	*1.59*	*82.2*	*85.3*	*90.1*	*92.6*	*205*	*41.2*	*71.7*
Changes since 2018 FSR								
FRS 2022	-0.25	-1.7	-1.4	-3.2	-3.0	-36	-6.9	-12.1
FSR 2020	-0.05	-1.1	-1.0	-2.7	-2.8	-36	-3.8	-6.4
Memo: Latest ONS projection	*-0.25*	*-1.7*	*-1.4*	*-3.2*	*-3.0*	*40*	*-3.3*	*-7.1*

4.14 Taking all these changes together, the population in our latest projection is broadly flat over the next three decades before declining gently but steadily. Overall, it falls by 1.3 million between 2022 and 2072 from 67.2 million to 65.9 million, reflecting the fact that net inward migration is insufficient to offset the effect of a low birth rate on the natural change in the size of the population. If net migration were zero instead of 129,000 a year, the population would shrink by 10.0 million over the next 50 years due to the low birth rate.

Chart 4.2: UK population outturns and successive projections



Source: ONS, OBR

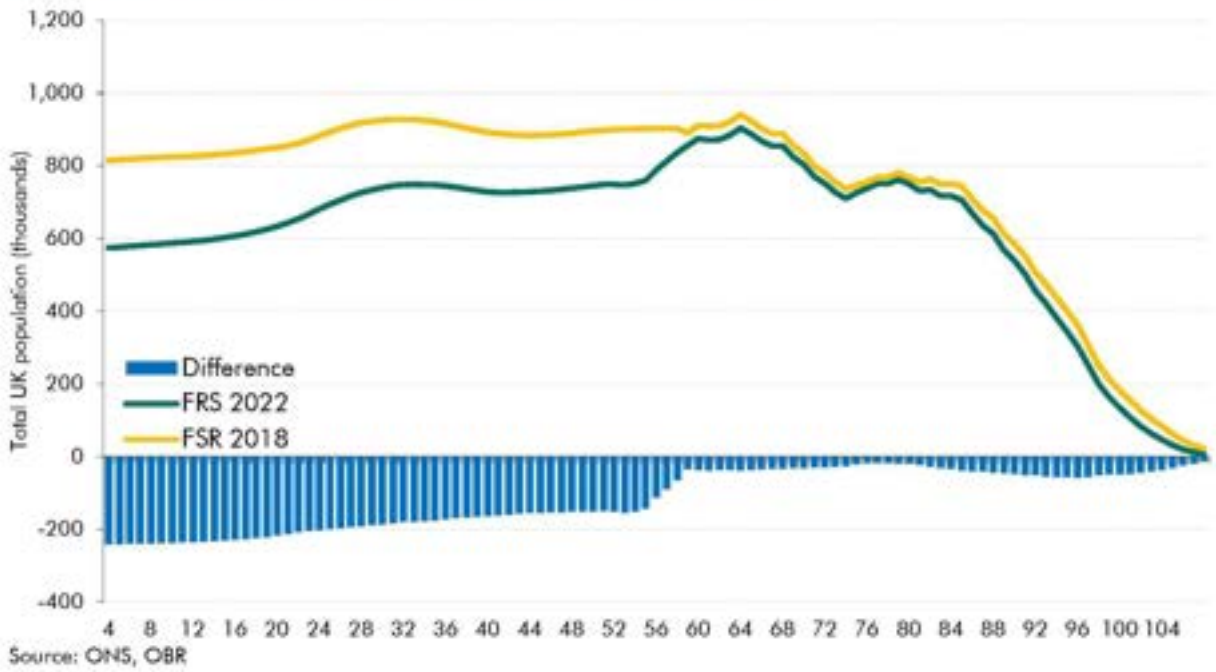
4.15 The size of the population is relevant to fiscal sustainability – for example, in a shrinking population, a given amount of previously incurred debt will represent a greater burden per person. But a declining population might also make some policy objectives easier to meet – for example, by placing less pressure on housing and other infrastructure, or by reducing

demands on finite natural resources, making net zero and other environmental objectives more achievable. But the key driver of fiscal sustainability is not the size but the age structure of the population, given the very different amounts of public spending and revenue associated with people of different ages (as shown in Chart 4.11 later in the chapter).

4.16 The projected age profile of the population has also changed materially over the past four years, as shown in Chart 4.3:

- Lower birth rates result in far **fewer children** – the population aged 0 to 18 is 28 per cent smaller at the end of our latest projection than it was in our 2018 projection.
- As those smaller cohorts age, there are in due course **fewer younger working-age adults** – the population aged 19 to 50 is 19 per cent smaller in 2072 than previously projected.
- There is little change in the number of **older working-age adults** where lower birth rates in the 2020s will not affect the population at these ages by 2072 – the population aged 51 to 68 (the State Pension age (SPA) at that point) is only 6 per cent smaller than in our 2018 *FSR*.
- Slower improvements in life expectancy result in fewer **pension-age adults** – the population aged 69 and over is 8 per cent smaller in 2072 than it was in our 2018 projections.

Chart 4.3: Age profile of the UK population in 2072



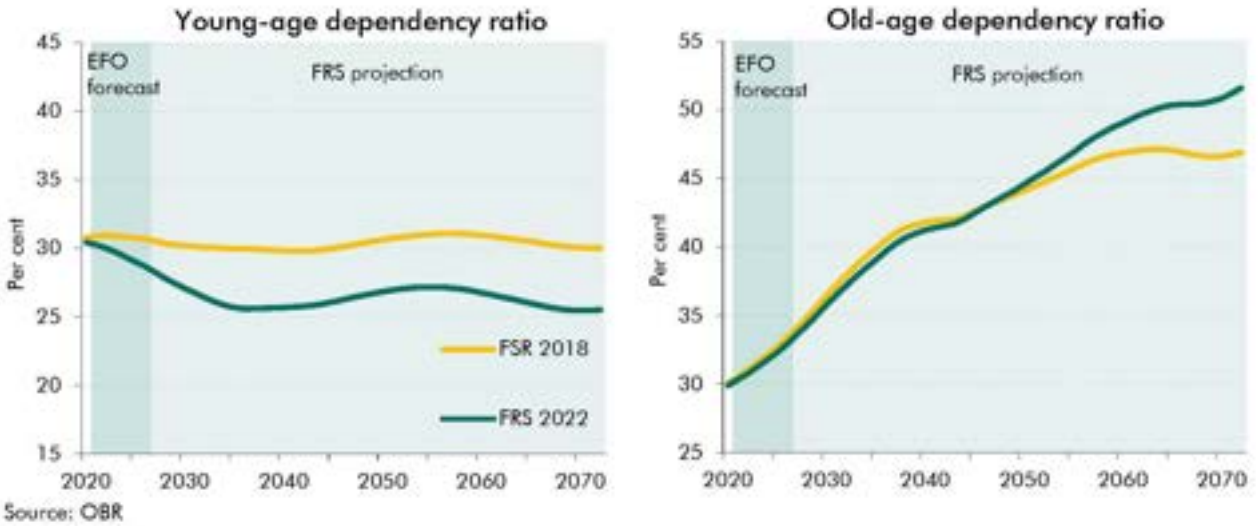
Source: ONS, OBR

4.17 The fiscal implications of these changes in the age-structure of the population are best captured via the changes they imply for the young- and old-age dependency ratios (Chart 4.4). The young-age dependency ratio has been revised down by 4.3 percentage points by the mid-2030s and by 4.5 percentage points by 2072 – which reduces spending on health,

education and child-related welfare payments relative to GDP. The old-age dependency ratio has been revised down by 0.5 percentage points on average in the period up to the mid-2040s, but revised up 4.7 percentage points by 2072 – reflecting the interplay between revisions to birth rates, mortality rates and net migration flows. All else equal, that reduces spending on health, social care and pensions as a share of GDP in the first half of the projection but raises it by the end of the period.

4.18 Taking these two revisions together, the overall dependency ratio (the sum of the young- and old-age ratios) is lower for much of the *FRS* 2022 projection than in our 2018 *FSR* but rises faster towards the end of the period. Specifically, it starts at 60 per cent in 2020 (broadly in line with the 2018 projections), then falls progressively further below the 2018 projections (by up to 5 percentage points in the mid-2030s), before returning to a level that is broadly in line with the *FSR* projections again (at 77 per cent) at end of the 50-year projection period in 2071. This means demographic pressures on the public finances are less severe for most of the projection period than was assumed in 2018, but those pressures are building more rapidly at the projection horizon than previously assumed.

Chart 4.4: Young- and old-age dependency ratios: latest versus previous projections



Source: OBR

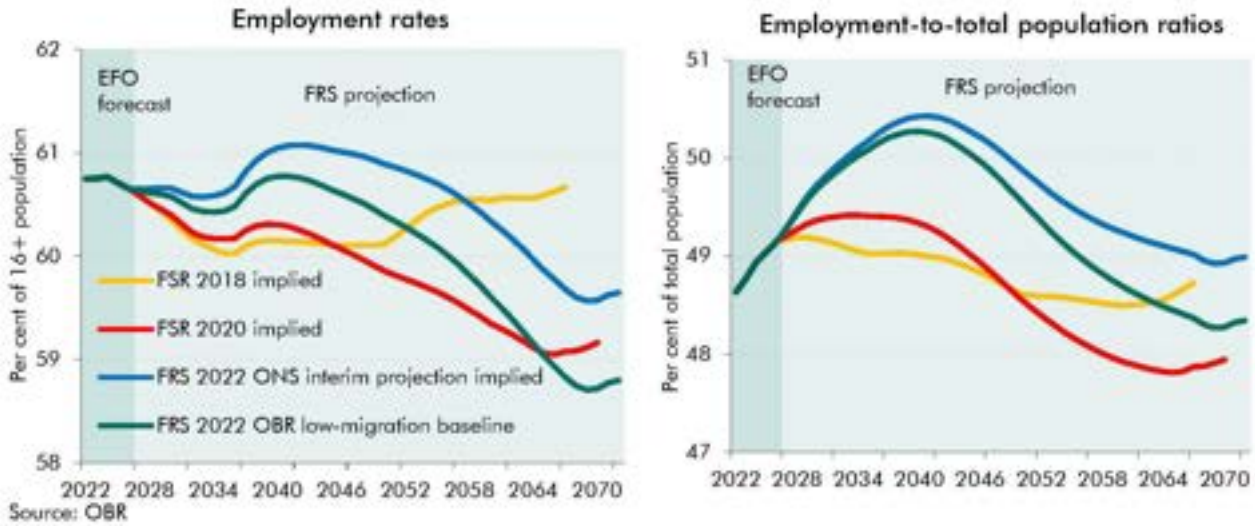
Employment

4.19 Our long-run employment projection combines our population projection with participation and employment rate projections. We calculate an employment rate consistent with unemployment being stable at around 4 per cent of the labour force (which in turn is consistent with our medium-term forecast). We adjust participation rates for changes in the State Pension age (SPA) set out in Table 4.6. Even though we assume that most people will carry on opting to exit the labour market either before or after they reach the SPA, exit rates do spike around that point. We capture the effect on participation rates of raising the SPA by assuming in effect that exit rates move one-for-one with changes in the SPA, so that a 66-year old when the SPA is 67 has the equivalent exit rate to a 65-year old when the SPA is 66. As in our previous *FSR*s, we smooth this transition over earlier periods, as individuals would be expected to adapt their labour market participation choices over a longer period.

4.20 From our employment rate projections (left panel of Chart 4.5),[7] we can project future employment levels as the population ages and cohort sizes vary. The biggest factor driving these projections is the size of the population, although the changing age profile also results in variations in the whole economy participation rate. The ratio of employed people to the total population including children (right panel of Chart 4.5) is a key determinant of the tax-to-GDP ratio.

4.21 As noted above, the largest proportionate changes between our 2018 and 2022 population assumptions relate to the number of children due to lower birth rates. As a result, the proportion of the population in our baseline projection that are of working age has been revised up and thus a greater share of the population is in employment than in our previous projections.[8] All else equal, this raises the tax-to-GDP ratio – though, as described later in the chapter, this effect is small relative to the revisions to age-related spending as a share of GDP that flow from the revised age-composition of the population.

Chart 4.5: Employment rates and employment-to-total population ratios



Source: OBR

Other economic assumptions in the long-term projections

4.22 Our projections for GDP are informed by our view of the labour supply (based on the population projections and age-specific labour market participation trends discussed above) and average trend growth in productivity or output per hour (informed by its historical path). Over longer horizons, the difference between output growth and the real interest rate paid on government debt is also important in determining the dynamics of debt sustainability.

4.23 Table 4.2 lists the underlying long-term assumptions used in our projections. Our latest economic forecast shows the gap between actual and potential output closing over the next few years, and we assume the output gap remains closed thereafter. In reality, actual output

[7] We have used employment growth to project the employment rate forward from our March 2022 forecast horizon to abstract from differences in the starting levels that are largely unrelated to demographics.
[8] The employment rates and ratios fall in our low-migration baseline, ultimately to levels below *FSR* 2018, as the lower birth rates translate into fewer working-age adults, which offsets the effects of a falling adult and total population on these measures.

will fluctuate around its potential as the economy is hit by unexpected shocks, but we do not attempt to predict the scale and timing of such shocks – instead we present a stylised projection that incorporates the fiscal impact of shocks of a scale witnessed historically alongside our baseline projection (see Chart 4.21 towards the end of the chapter).

4.24 Key changes to our long-term economic assumptions since our 2018 and 2020 *FSRs* are:

- **Lower population and employment growth**. These changes are discussed above.
- **Lower productivity growth**. We revised down our long-term productivity growth assumption in our March 2020 *EFO*, to 1.5 per cent a year, reflecting the data outturns and evidence at the time.[9] This was reflected in our 2020 *FSR*, but is 0.5 percentage points below our 2018 assumption.
- **Incorporating the transition to net zero**. Our 2021 *Fiscal risks report* (*FRR*) discussed the implications of the Government's net zero ambitions for fiscal sustainability. One aspect was a modest reduction in productivity growth of around 0.1 percentage points a year during the transition due to the rising carbon price, which was consistent with scenarios published by the Bank of England.[10] The Government has since published its *Net zero strategy*, which sets out more of the policies required to achieve net zero. We have therefore conditioned our baseline projections on measures announced to achieve net zero by 2050 – the largest implications of which relate to revenues rather than this modest productivity impact.
- **Higher government capital investment**. In the March 2020 Budget, the Chancellor increased the planned level of public sector net investment (PSNI) by more than a quarter over the medium term as a share of GDP. At the time we judged that this would be consistent with raising general government fixed investment – the component of PSNI that adds to the public sector's capital stock – by 0.7 per cent of GDP in the medium term. We estimated in March 2020 that sustaining public investment at that higher level could increase the public sector's capital stock by around a quarter over the long term. That in turn would be consistent with raising the level of productivity in the long term by around 2.5 percentage points and thereby raising productivity growth by a little under 0.1 percentage points a year. We have assumed that this fully offsets the effects of the higher carbon price to reach net zero, leaving long-run productivity growth at 1.5 per cent a year.
- **Lower RPI inflation**. The ONS has announced that the RPI measure of inflation will in effect be discontinued in 2030 when the methodology will be aligned precisely with the CPIH measure of inflation.[11] While we develop our CPIH forecast methodology, our updated long-term fiscal projections are based on an interim assumption that RPI and RPIX inflation will both match CPI inflation at 2 per cent a year from 2030-31

[9] For more information, see Annex B of our March 2020 *EFO*.
[10] Specifically, we used the real GDP path consistent with the Bank's 'early action' scenario. See Bank of England, *Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change*, June 2020.
[11] HM Treasury and UK Statistics Authority, *A response to the consultation to the reform on retail prices*, November 2020.

onwards. For simplicity, the change is assumed to occur at the start of the fiscal year rather than at the February 2030 price index revision point.

- **Higher 'triple lock' uprating.** We model the long-term cost of the triple lock via an average premium relative to uprating the state pension in line with earnings growth. Based on the latest outturn data and our latest forecast, we have increased the premium above average earnings growth from 0.36 to 0.47 percentage points (Chart 4.6). This reflects the high inflation expected over the coming year, as well as the effects of greater volatility in earnings growth in recent years.[12]

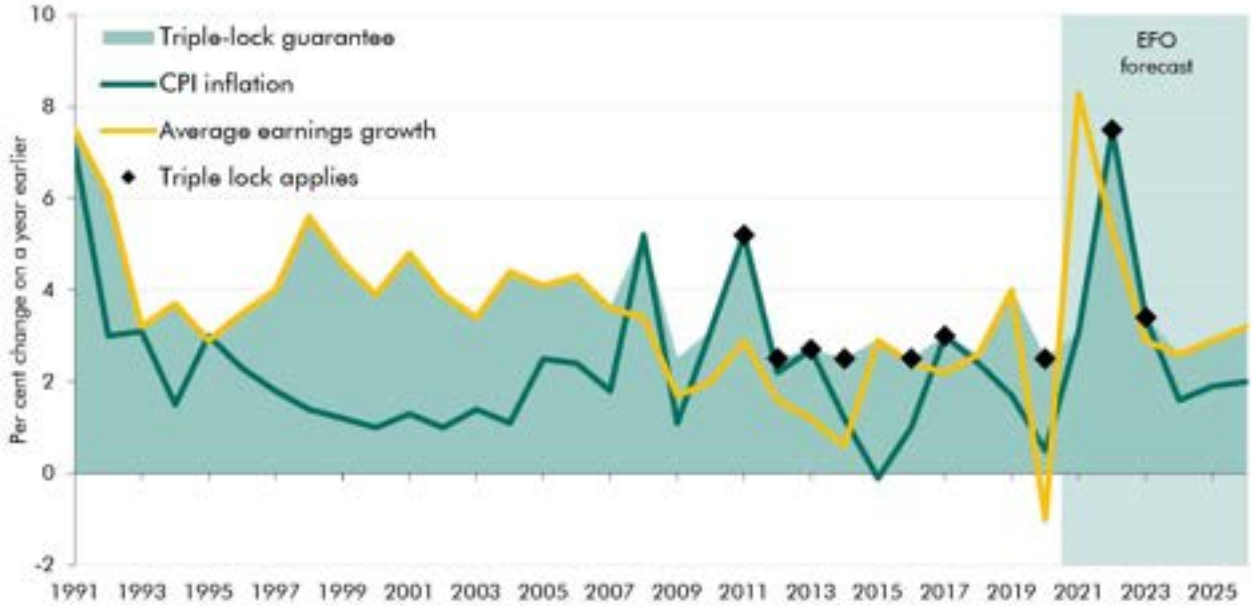
Table 4.2: Long-term economic determinants

	Annual growth rate, unless otherwise stated		
	FSR 2018	*FRS* 2022	Notes on *FRS* 2022 determinant
Employment			
Population growth	0.3	-0.1	From OBR's low migration baseline.
Workforce growth	0.2	-0.1	OBR assumption, consistent with cohort modelling and population projections.
Labour productivity growth	2.0	1.5	OBR assumption.
Earnings and prices			
Average earnings growth	4.2	3.8	Sum of labour productivity growth and GDP deflator growth.
Public sector earnings growth	4.2	3.8	Assumed to grow in line with private sector.
GDP deflator growth	2.2	2.3	Constant from end of forecast.
CPI inflation	2.0	2.0	Constant from end of forecast at inflation target.
RPI inflation	3.0	2.0	In line with CPI.
RPIX inflation	2.8	2.0	In line with CPI.
'Triple lock'	4.6	4.3	Average earnings growth plus 0.47 percentage points.
Interest rates (per cent)			
Gilt rate	4.7	3.9	Nominal GDP growth plus 0.2 percentage points.
Bank Rate	4.7	3.9	Nominal GDP growth plus 0.2 percentage points.
Memo: average real GDP growth	*2.2*	*1.4*	*Sum of labour productivity and employment growth.*
Memo: average real GDP per capita growth	*1.9*	*1.5*	*Real GDP growth less population growth.*
Memo: average nominal GDP growth	*4.5*	*3.7*	*Sum of real GDP and GDP deflator growth.*

Note: If we were to use the ONS interim projection, population growth and employment growth would be 0.1 per cent a year on average. This would give long term GDP growth of 1.6 per cent, GDP per capita growth of 1.5 per cent and nominal GDP growth of 3.9 per cent.

[12] For the purposes of the calculation of the triple lock premium over earnings growth we assume that the triple lock operated during the year in which it is suspended, 2022-23, so that there is no premium relative to earnings growth in that year instead of a negative one.

Chart 4.6: Triple lock premium



Note: These figures are used to uprate state pensions in the following financial year.
Source: ONS, OBR

4.25 Our latest medium-term forecast runs to 2026-27, so the long-term assumptions set out above are applied from 2027-28 onwards, with the following exceptions:

- **Productivity growth** is assumed to rise from 1.3 per cent in the final year of our latest medium-term forecast to its steady state of 1.5 per cent a year by 2036-37. We assume that leaving the EU would reduce the level of productivity by around 4 per cent in the long run, but that it will take 15 years from the date of the UK's departure from the EU for the impact to come through in full. This reduction in the level of productivity thereby reduces productivity growth over the period of adjustment, but it has no longer-lasting effect on productivity growth beyond that point.

- **RPI inflation**, which matches CPI inflation from 2030-31 onwards as discussed above. Prior to that, it is affected by the rising path of interest rates as the housing costs component of the RPI basket is affected by changes in mortgage rates.

- **Interest rates** are assumed to rise steadily from their current very low levels in real terms and relative to nominal GDP growth to stabilise at 0.2 percentage points above nominal GDP growth from 2041-42 onwards. That implies nominal interest rates on government bonds rising from 1.6 per cent in 2026-27 (the final year of our latest forecast) to 3.9 per cent in our long-term projections. A key determinant for fiscal sustainability and debt dynamics is the growth-corrected interest rate (or 'R-G'). When this is positive and high, the debt-to-GDP ratio can increase very quickly. When it is negative, it is possible to sustain primary deficits without placing the debt-to-GDP ratio on a rising path. The assumption that the long-term nominal interest rate rises to just above nominal output growth (by 0.2 percentage points) is in line with longer-term historical experience, although that positive gap is substantially higher than recent

history, when it has generally been negative.[13] We test the sensitivity of our projections to different interest rate assumptions later in this chapter (from paragraph 4.55).

Medium-term fiscal position

4.26 Our long-term fiscal projections begin in 2027-28 from a starting point determined by the fiscal position at the end of our latest medium-term forecast – that is, the 2026-27 forecasts from our March 2022 *EFO* – adjusted for the cost of the package of measures announced by the Chancellor in May. So another key source of differences from our last long-term projections is those stemming from this fiscal 'jumping off' point. Table 4.3 decomposes the changes in borrowing at the end of our medium-term forecast since our 2018 *FSR*, with Chart 4.7 breaking down changes due to Government policy by forecast since then.

4.27 The most dramatic event since the 2018 *FSR* was of course the Covid pandemic, which saw the deficit and debt balloon in 2020-21 and 2021-22, largely as a result of the £310 billion spent on discretionary fiscal support for households, businesses and public services. But by 2026-27, the borrowing effect has largely disappeared; although, the starting point of net debt has been raised slightly from 80.2 per cent of GDP at the medium-term horizon for our 2018 *FSR* to 83.6 per cent of GDP in 2026-27 in the latest projections. Given the scale of the economic shock and fiscal support provided in the wake of the pandemic, its relatively marginal impact on the medium-term fiscal position is striking.[14]

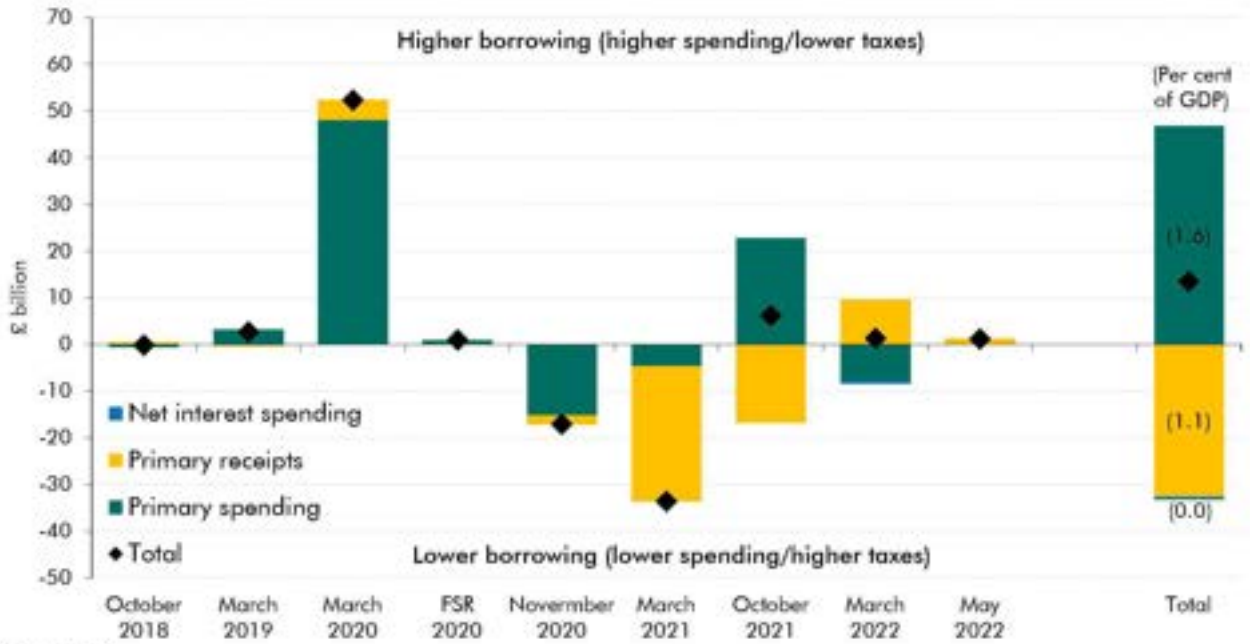
Table 4.3: Changes in public sector net borrowing since *FSR* 2018

	Per cent of GDP at the end of the medium-term forecast				
	Primary receipts	Primary spending	Primary deficit	Net interest spending	Net borrowing
	(a)	(b)	(c) = (b) - (a)	(d)	(e) = (c) + (d)
Restated *FSR* 2018	36.4	36.9	0.5	1.6	2.1
FRS 2022	38.9	38.7	-0.2	1.3	1.1
Changes since *FSR* 2018	2.5	1.9	-0.7	-0.4	-1.0
of which:					
Direct effect of Government decisions	1.1	1.6	0.5	0.0	0.5
Forecasting changes	1.4	0.3	-1.1	-0.3	-1.5

[13] We discussed the growth-corrected interest rate and risks around our assumptions in depth in Chapter 7 of our 2019 *FRR*. One key conclusion of that analysis was that no plausible assumption about sustained negative (i.e., very favourable) growth-corrected interest rates would be large enough to offset the upward pressures on primary spending in our long-term fiscal projections.

[14] Some of the effect of borrowing in 2020-21 and 2021-22 relative to our 2018 *FSR* medium-term horizon will have been dampened by upward revisions to nominal GDP, which is the denominator in the debt ratio, coming from new Blue Book data. See, for example, Box 2.3 in our October 2021 *EFO* for a discussion of the upward revisions in Blue Book 2021.

Chart 4.7: Total effects of Government decisions in 2026-27 since *FSR* 2018



Source: OBR

4.28 Focusing on differences in overall borrowing at the medium-term jumping off point for our 2018 *FSR* and for the projections presented in this chapter, there are three main changes to this starting fiscal position:

- **Increases in tax revenues**, due to both policy decisions and forecast changes. These have increased primary receipts as a share of GDP from 36.4 per cent at the end of the medium-term of our 2018 *FSR* projections to 38.9 per cent in 2026-27, a 2.5 percentage point increase. Discretionary net tax increases since our 2018 *FSR* account for just under half of this and amount to 1.1 per cent of GDP in 2026-27. As Chart 4.7 shows, these rises came largely in the two Budgets in 2021 and include raising the headline rate of corporation tax to 25 per cent; introducing the health and social care levy; and freezing the thresholds of personal income taxes, thereby increasing fiscal drag (very substantially so as a result of subsequent upside inflation surprises).[15] These tax rises have been only partially offset by raising National Insurance contributions thresholds and the future reduction in the basic rate of income tax announced in March 2022. Receipts have increased by an additional 1.4 per cent of GDP due to forecasting changes, mostly as a result of higher outturn data indicating a more tax-rich economy than previously assumed.

- **Increases in primary spending**, mostly reflecting larger departmental settlements than were implied by the 2018 *FSR* projections as a result of the three Spending Reviews since then. These have contributed to primary spending increasing as a share of GDP by 1.9 percentage points from 36.9 to 38.7 per cent. Health spending by the end of the medium-term forecast is 0.7 per cent of GDP higher, and in line with the rise in spending we had projected in our 2018 *FSR* for 2026-27 on the basis of demographic

[15] Cancelling the energy rebate clawback as part of the May 2022 announcements costs £1.2 billion a year in 2026-27, hence this largely temporary package of measures having a modest impact on the medium-term fiscal position.

and other pressures being accommodated beyond the medium term. Departmental capital spending plans have been raised significantly too. They are a third (0.7 per cent of GDP) larger in 2026-27 than at the medium-term horizon in our 2018 *FSR*.

- **A reduction in net interest spending**, despite the somewhat larger debt stock we now forecast for 2026-27 (83.6 per cent of GDP) than we did for the medium-term horizon in the 2018 *FSR* (80.2 per cent of GDP). This reflects the fall in the weighted average interest rate on conventional gilts from 2.1 to 1.6 per cent, and the expansion of quantitative easing since then. Although in March 2022 we forecast debt interest to be substantially higher in 2022-23 due to higher inflation, we assume that inflation falls quickly back to target (2 per cent), so the only influence on the jumping-off point for our long-term projections is the 0.6 percentage point fall in real interest rates in the medium term. That said, there are clearly risks to this assumption – interest rates have risen from their trough during the worst of the pandemic and have risen further since our March forecast (for example, the rate on 10-year gilts rose from 1.6 per cent on 23 March to 2.4 per cent on 27 June).

4.29 The changes set out above mean that at the end of the medium-term forecast, public sector net borrowing is 1.0 per cent of GDP lower than the level in our 2018 *FSR*, while net debt is 3.4 per cent of GDP higher. When compared with our 2020 *FSR* central scenario, net debt is much lower (by 18 per cent of GDP), thanks to lower borrowing in outturn and less medium-term scarring from the pandemic reducing cumulative borrowing. Higher inflation has also raised the nominal GDP denominator relative to our 2020 *FSR* assumptions.

Table 4.4: Selected fiscal aggregates at the medium-term horizon

	Per cent of GDP (unless otherwise stated)		
	Restated *FSR* 2018 principal projection	*FSR* 2020 baseline scenario	*FRS* 2022 baseline projection
Primary receipts (a)	**36.4**	**36.6**	**38.9**
Primary spending (b)	**36.9**	**40.3**	**38.7**
of which:			
Health	7.6	8.2	8.3
Adult social care	1.3	1.4	1.4
Education	4.1	4.1	4.2
State pensions	5.0	4.9	5.1
Other departmental capital spending	2.1	2.8	2.8
Other primary spending	16.7	18.9	16.9
Primary deficit (c = b - a)	**0.5**	**3.7**	**-0.2**
Net interest spending (d)	**1.6**	**0.9**	**1.3**
Public sector net borrowing (e = c + d)	**2.1**	**4.6**	**1.1**
Public sector net debt	**80.2**	**102.1**	**83.6**
Public sector net financial liabilities	**63.9**	**87.9**	**74.4**
R-G (percentage points)	-1.3	-3.2	-2.2

Assumptions about policy in the long term

4.30 The projections in this report assume that, other than the May cost of living measures and tax increase, Government policy is unchanged from that which underpinned our March

2022 *EFO*. But that is not straightforward over a 50-year horizon, with several policies only stipulated over the medium term. Table 4.5 summarises our major long-term policy assumptions for this report. As well as filling in gaps, these include indexing various parameters in the tax and welfare system to earnings rather than inflation (as they are in the medium term). This assumption – common to all our previous reports – ensures that fiscal drag does not generate implausibly high effective tax rates or implausibly low benefit replacement rates (i.e. the value of benefit awards relative to earnings) over the long term.[16]

Table 4.5: Policy assumptions in the long-term projections

Policy	Long-term assumptions in the baseline projections
Taxes	Direct tax allowances and thresholds and indirect tax duty rates uprated in line with earnings from 2027-28. All tax escalators to end by 2026-27.
Health spending	Functional health spending consistent with the 2021 Spending Review, which set the budget for the Deparment of Health and Social Care up until 2024-25, and based on historical proportions of DHSC's share of total UK health spending, which is then projected forward within the SR period. We have reclassified social-care-related Better Care Fund expenditure away from health to adult social care spending. For 2025-26 and 2026-27, we assume that health spending grows in line with the annual average growth rate between 2019-20 and 2024-25. From 2027-28 onwards, health spending is grown by demographic and other cost pressures.
Other departmental spending	Spending by function is projected forward based on historical splits, as splits consistent with the 2021 Spending Review are not yet published. Functional education current spending is consistent with the 2021 Spending Review, which set the budget for the Department for Education up until 2024-25, and based on historical proportions of DfE's share of total UK education spending. From 2024-25 onwards, spending by function is grown in line with nominal GDP, apart from items subject to demographic influences.
Pensioner benefits	State Pension age (SPA) reaches 67 between 2026 and 2028 (legislated) and 68 between 2037 and 2039 - which the previous SPA review recommended and the Government stated it would accept. Subsequent SPA changes are based on changes in life expectancy. Qualifying ages for other state pensions spending, such as pension credit, and pensioner-related benefits, such as the attendance allowance, rise in line with SPA. Basic state pension and new State Pension uprated using the 'triple lock' mechanism. Additional pension uprated in line with CPI.
Other benefits	All working age benefits uprated with earnings from 2027-28.
Student loans	The cap on tuition fees and the repayment threshold is uprated in line with earnings from 2027-28. Projections are in line with the reforms to student loans from February 2022, which included reducing interest rates, lowering repayment thresholds and extending repayment terms for new borrowers to 40 years - see Box A.1 of our March 2022 EFO for more detail.
Public service pensions	Incorporates previous policy reforms: to increase employee contributions; uprate payments with CPI; and amend scheme benefits in line with the Public Service Pensions Act 2013, including linking pension age to the SPA.

[16] See Box 3.2 in our 2014 *FSR* for more on this issue.

State Pension age

4.31 The Government has legislated for a review of the State Pension age (SPA) to take place at least once every six years. The second SPA review is currently in progress and must be published by 7 May 2023 in accordance with the Pensions Act 2014.[17] The SPA has already risen to 66 for both women and men. It is legislated to rise gradually to 67 between 2026 and 2028. There is a further legislated SPA increase to 68 between 2044 and 2046, but the previous review, published in 2017, recommended that the Government consider bringing it forward to happen between 2037 and 2039, which the Government announced that it intended to follow. It also committed to 'up to 32 per cent' as the proportion of adult life people should expect to spend in receipt of the state pension, although it said it did not intend to formalise policy beyond 2037 to 2039 at that stage.

4.32 Table 4.6 shows how our baseline projection for the SPA – based on the Government's 2017 policy statement – compares with the legislated path. The differences are the earlier rise to 68 by 2039, as well as a further rise to 69 in 2073 implied by the 32 per cent principle and the population projections. Both paths would see the SPA rise faster than it would if the principle of 32 per cent of adult life spent in retirement were applied to the latest ONS projections. The slower projected improvements in life expectancy would see the 32 per cent threshold met precisely if the SPA increased to 67 in 2042 and to 68 in 2056. This helps to illustrate how the 32 per cent principle and the existing legislation and policy commitments combine to allocate the fiscal risk from changes in life expectancy between pensioners and the Exchequer, with both the current legislated timetable – and in particular the Government's 2017 policy statement – placing somewhat more of the cost of future ageing on pensioners relative to the 32 per cent principle alone. This will be one among many factors that the ongoing review of the SPA will consider over the coming months, and one that we will return to in more detail in the next *FRS*.

Table 4.6: Projected changes to the State Pension age over the next 50 years

State Pension age	Year within which the rise is fully implemented		
	67	68	69
Baseline[1]	2028	2039	2073
Legislated	2028	2046	
Memo: 32 per cent principle	*2039*	*2055*	*2073*

[1] The Government has announced its intention to bring forward the increase to 68 to 2039 (currently legislated to take place by 2046).

Other long-term assumptions

4.33 We need to make several additional assumptions to complete our projections for the public finances. These include cost and other non-demographic pressures on public services, as well as tax bases that are particularly susceptible to net zero and decarbonisation.

Non-demographic pressures on health spending

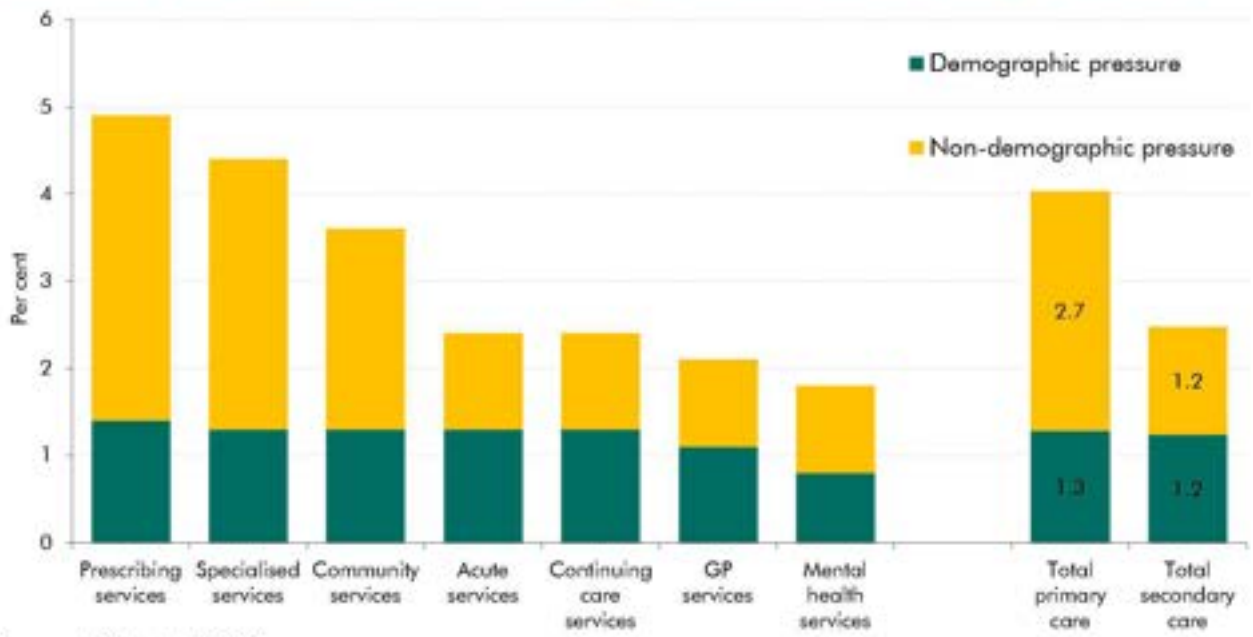
4.34 In our September 2016 *Working paper No. 9: Fiscal sustainability and public spending on health*, we reviewed the assumptions that underpin our health spending projections against

[17] Department for Work and Pensions, *Second State Pension Age Review launches*, January 2022.

historical evidence on the drivers of health spending and against the assumptions used by international organisations and the US Congressional Budget Office. We concluded that, alongside income and demographic effects, non-demographic cost pressures – for example, the cost-raising nature of technological advances in health care and the rising prevalence of chronic conditions like diabetes and obesity – have been an important driver of past growth in health spending (and the most important driver of its growth as a share of GDP). We therefore decided to assume that ongoing non-demographic cost pressures would continue to be accommodated in our baseline health spending projection in *FSR* 2017 and have continued to do so in all subsequent projections.

4.35 To include these other cost pressures in health in our projections, we estimate the effect of such pressures in the medium term and make assumptions about whether they will remain constant or vary over the longer term. We have used an NHS England estimate for non-demographic cost pressures in 2015-16 – of 2.7 and 1.2 percentage points for growth in primary and secondary care respectively – as the starting point of our projections (Chart 4.8).[18] The NHS has not repeated this exercise since then, so this starting point is unchanged from our previous reports. We assume these pressures decline over time as health spending takes up an ever-larger share of national income. Specifically, we have assumed a linear convergence for both primary and secondary care to a 1.0 per cent a year increase from 2042-43 onwards. There is clearly huge uncertainty regarding these pressures, however, and we explored the sensitivity to this assumption in our 2018 *FSR*. It showed that a 0.5 percentage point a year higher or lower increase would leave spending 2.5 per cent of GDP higher and 2.1 per cent of GDP lower, respectively, after 50 years.

Chart 4.8: Demographic and non-demographic real health spending pressures



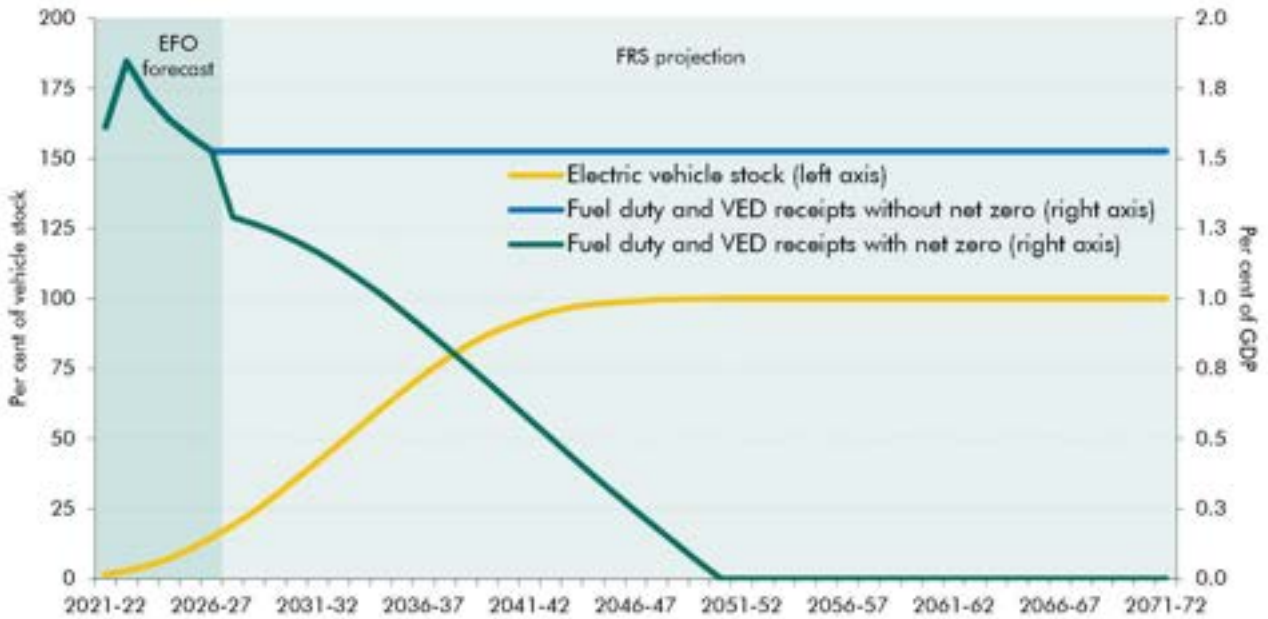
Source: NHS England, OBR

[18] NHS England, *NHS Five Year Forward View: Recap briefing for the Health Select Committee*, May 2016.

Receipts affected by net zero

4.36 As described above, in this *FRS* we are incorporating elements of the Government's commitment to reduce greenhouse gas emissions to net zero in our baseline projections for the first time. Aside from a modest impact on productivity growth, the key impact of this is to lower our projections for taxes affected by decarbonisation, notably fuel duty and vehicle excise duty (which will fall to zero on current policy as the sale of new petrol and diesel cars ends by 2030 and existing ones are eventually retired from use).[19] We illustrated the effect of net zero on receipts in our 2021 *FRR*, and have updated those estimates to reflect the higher path for electric vehicle take-up adopted in our March 2022 *EFO*. Under those assumptions, the vehicle stock will be 95 per cent electric by 2042, 99 per cent by 2046 and fully by 2050, with fuel duty and vehicle excise duty revenues falling to zero by then. Overall, the loss of net zero-affected revenues amounts to 0.5 per cent of GDP by 2031-32, 1.1 per cent of GDP by 2041-42 and almost 1.6 per cent of GDP from 2050-51 onwards.

Chart 4.9: Electric vehicle stock and fuel duty projections



Source: OBR

Non-demographic pressures on adult social care spending

4.37 In our baseline 50-year projection, we allow for increasing spending on adult social care, which largely reflects the rising costs of care associated with higher demand and steady increases in life expectancies of successive cohorts. Projections for adult social care spending in England are provided to us by the Department of Health and Social Care, and reflect the Department's 2021 Spending Review settlement. We have also incorporated the charging reform announced in September 2021, which brought in a cap on lifetime adult social care costs to be paid by anyone in England, as well as changes to the calculation of those costs and asset limits at which they apply (as detailed in Box A.1 of our October 2021 *EFO*). This adds around 0.2 per cent of GDP to social care spending by 2071-72, reflecting

[19] As was the case in our *FRR* analysis, we also include receipts from landfill tax and the plastic packaging tax in this definition.

the fact that more of the cost is borne by the state than by private individuals. This is similar in magnitude to previous versions of these charging reforms recommended by the 2011 Dilnot Commission on social care reform, which were initially accepted by the Government but later shelved before having been implemented.

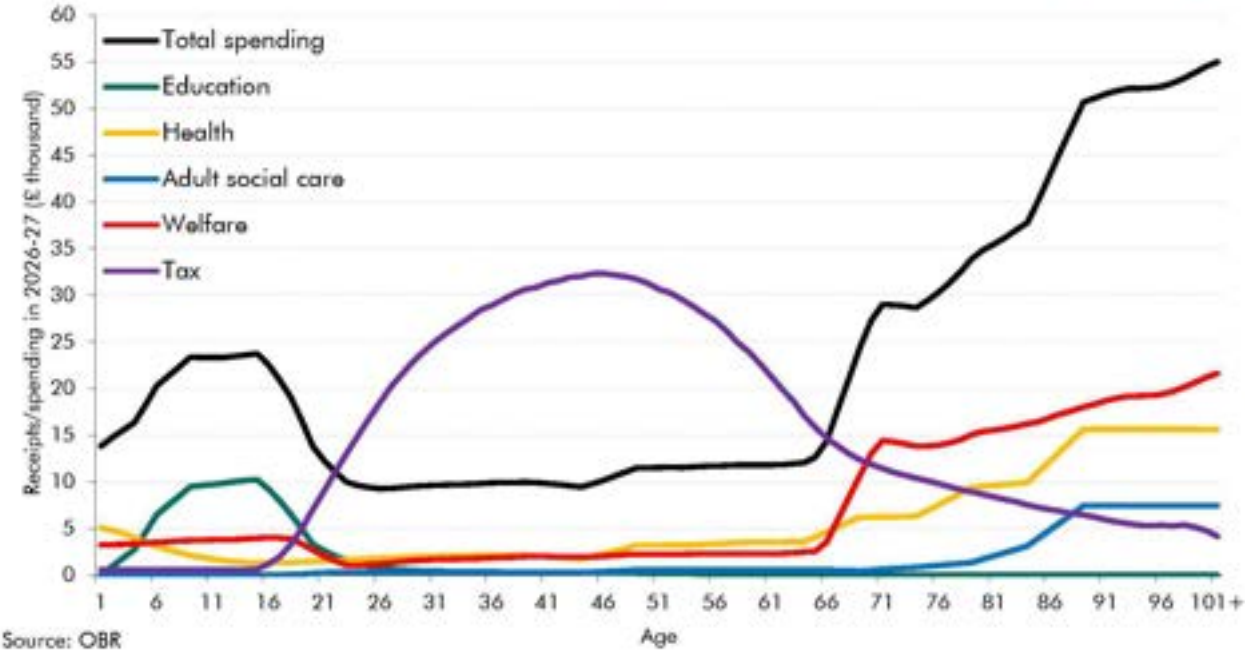
Chart 4.10: Long-term cost estimate of social care funding reforms, per cent of GDP

Source: DHSC, OBR

Long-term fiscal projections

4.38 From 2027-28, we construct long-term projections of spending and revenue through an unconstrained 'bottom-up' analysis that grows each from a starting point in 2026-27 that is consistent with our adjusted March 2022 *EFO* forecast. This involves initially holding spending and tax revenues per person fixed relative to average earnings, such that borrowing would remain flat as a share of GDP, then layering on the consequences of demographic changes and the accommodation of non-demographic pressures. Chart 4.11 shows the representative tax, public services and welfare spending profiles by age that form the basis of our projections. Its key features are the relatively high levels of spending on health for very young children and for older people, on education for children, and on pensions and social care for older people, while revenues per person rise steadily until people are in their mid-40s and then fall steadily thereafter.

Chart 4.11: Representative profiles for tax, public services and welfare spending



Source: OBR

Tax and spending projections to 2071-72

4.39 In this section, we present the results of our bottom-up revenue and spending projections, using the methodology and modelling assumptions outlined above. These projections are not intended to provide a forecast of the actual evolution of revenue or spending. Rather they show what would happen if policy were unchanged and if our other conditioning assumptions also held true – most importantly that spending pressures are accommodated. If the projections suggest that the public finances are on an unsustainable path, and that were indeed to prove to be the case in practice, then one might expect a future government to take corrective action at some point.

Classification changes

4.40 To allow us to compare our latest projections with our previous ones on a like-for-like basis we first restate our 2018 projections for subsequent methodological changes. This has had little effect on the primary deficit, but has reduced debt by 4 per cent of GDP. Specifically, we have restated the 2018 projections for the following ONS changes:

- **Student loans accounting treatment** now treats outlays that are not expected to be repaid as public spending at the time of disbursement and no longer accrues interest on that portion of the loan balance. This raises accrued spending and borrowing in the medium term but has no significant effect in the long run (as the previous treatment would have recorded large loan write-offs from the 2040s onwards), and has no effect on debt (which simply reflects the unchanged cash outlays).

- **Accrued corporation tax receipts** were restated following a correction to cash data prior to April 2019. This reduced accrued receipts and raises borrowing by around £4

billion a year in the medium term, which over the long run increases debt by 6 per cent of GDP.

- Several additional **public sector pension schemes** are now captured in the public finances data. This raises accrued spending and revenues, with little net effect on borrowing. Its compound effect over the long run is to reduce net debt by 10 per cent of GDP due to the relatively large holdings of gilts by these schemes, which increased the proportion of debt held within the broader public sector.

- Public sector capital stocks data were heavily revised, changing **depreciation spending** materially. This does not affect borrowing or debt, as depreciation is neutral, but it raises the level of both receipts and spending, affecting their shares of GDP.

Receipts

4.41 The revenue projections from 2026-27 are presented in Table 4.7 and reflect the latest population projections, as well as medium-term policy changes and revenue losses from decarbonisation. Non-interest revenues are relatively flat over the projection period apart from the revenue losses due to implementing net zero, meaning that by 2071-72 they are around 37 per cent of GDP. At that point, revenues are 1.0 percentage point higher than in our 2018 projections, but they decline by around 1.7 per cent of GDP (equivalent to £42 billion in today's terms) between 2026-27 and 2071-72, which is almost entirely explained by the disappearance of fuel and vehicle excise duty.

4.42 The upward revision relative to our 2018 projections mostly relates to changes to our medium-term forecast that affect the starting point from which long-term projections are made (2026-27 for our latest projections and 2022-23 for our 2018 *FSR*):

- **Income tax** is 1.0 per cent of GDP higher at the end of the medium term compared to our 2018 projections. This is largely driven by the four-year freeze of thresholds announced in the March 2021 Budget, as well as higher receipts from a more tax-rich economy, partly offset by the forthcoming cut in the basic rate of income tax announced in the 2022 Spring Statement. This higher starting point carries through to the long term.

- **Social contributions**,[20] the largest component of which is National Insurance contributions (NICs), are 0.4 per cent of GDP higher at the end of the medium term, largely as a result of the introduction of the health and social care levy from April 2023. This change also carries through to the long term, though receipts fall by 0.2 per cent of GDP between 2026-27 and 2071-72 as a result of the decline in the working population as a share of the total population (as NICs are only levied on those below the SPA).

- **Corporation tax receipts** are 1.0 per cent of GDP higher by the end of the medium term. Our 2018 projections were conditioned on the corporation tax rate dropping to 17 per cent, whereas our latest projections incorporate the cancellation of the cut to 17 per cent

[20] Social contributions projections also include other compulsory social security contributions, such as the (relatively small) immigration health surcharge and the (relatively large) health and social care levy that will take effect in April 2023.

(announced in Budget 2020) and the rise to 25 per cent (effective from April 2023 and announced in the March 2021 Budget). This carries through to the long term.

- **VAT receipts** are 0.2 per cent of GDP lower at the end of the medium term, largely reflecting our lower medium-term nominal consumption forecast. This too persists over the long term.

- **Capital tax receipts** are 0.3 per cent of GDP higher at the end of the medium term, largely reflecting upside surprises in outturn data, which persists in the long term. Capital tax receipts have risen strongly relative to GDP in recent years, which is reflected in our medium-term forecast but we do not assume continues over the long term.

- **Net-zero-affected taxes** (notably fuel duty and vehicle excise duty) are assumed to disappear as the economic decarbonises by 2050 as described above, which reduces receipts by around 1.6 per cent of GDP in the long run.

- **Other receipts** are projected to be broadly flat at 9.2 per cent of GDP.

Table 4.7: Non-interest receipts projections

	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Income tax	9.4	10.1	10.1	10.1	10.1	10.1	10.1
NICs	6.7	6.9	6.7	6.7	6.7	6.7	6.7
Corporation tax	2.7	3.3	3.2	3.2	3.2	3.3	3.3
VAT	6.6	6.0	6.0	6.0	6.0	6.0	6.0
Capital taxes	1.7	1.8	1.9	1.9	2.0	2.0	2.0
Net-zero-affected taxes	1.6	1.5	1.2	0.6	0.0	0.0	0.0
Other receipts	8.3	9.3	9.2	9.2	9.2	9.2	9.2
Receipts[2]	**37.0**	**38.9**	**38.3**	**37.7**	**37.1**	**37.2**	**37.2**

[1] Receipts consistent with the March 2022 *Economic and fiscal outlook*.
[2] Excludes interest and dividends.

Table 4.8: Changes in non-interest receipts projections since *FSR* 2018

	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Income tax	0.4	1.0	1.0	1.0	1.0	1.0	1.0
NICs	0.3	0.5	0.4	0.4	0.4	0.4	0.4
Corporation tax	0.4	1.1	1.0	1.1	1.1	1.1	1.2
VAT	0.5	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Capital taxes	0.1	0.2	0.3	0.3	0.3	0.3	0.3
Net-zero-affected taxes	0.0	-0.1	-0.4	-1.0	-1.6	-1.6	-1.6
Other receipts	-1.0	0.1	0.0	-0.1	-0.1	-0.1	-0.2
Receipts[2]	**0.7**	**2.6**	**2.1**	**1.5**	**0.9**	**0.9**	**1.0**

[1] Receipts consistent with the March 2022 *Economic and fiscal outlook*.
[2] Excludes interest and dividends.

4.43 Our long-term receipts projections are relatively simple. They are not adjusted for many other possible non-demographic factors that may affect receipts. These include, for example, downside risks from reduced prevalence of smoking hitting tobacco duties, or the potential two-side risks associated with digitalisation (which could make some activities more difficult to tax but could also enhance the efficiency of tax administration). We have discussed several of these issues in previous *FSR*s and *FRR*s.

Public spending

4.44 We project total non-interest public spending to rise from 38.7 per cent of GDP in 2026-27 to 48.4 per cent in 2071-72 (Table 4.9). The increase of 9.7 per cent of GDP is equivalent to £245 billion in today's terms. The main drivers of the increase in non-interest spending are ageing effects on state pensions and pensioner benefits, and the pressures on health spending from an ageing population and rising non-demographic costs.

4.45 Table 4.10 shows changes to our projections since we last updated them in 2018. Non-interest spending is 3.6 per cent of GDP higher as a share of GDP by 2071-72 than projected in our 2018 report on a like-for-like basis, while the increase between the medium-term horizon and the end of the long-term projection is 1.7 per cent of GDP larger. The main drivers of these changes include:

- **Health care** spending by the end of our medium-term forecast is similar to the level we projected for 2026-27 in our 2018 *FSR* (0.1 per cent of GDP higher), highlighting that the Government's plans for the health service are broadly consistent with our long-term assumption of the accommodation of demographic and other cost pressures. In the long term, there are two main factors that have affected our health spending projections. First, the fall in the young-age dependency ratio (left panel of Chart 4.4) reduces health costs associated with early years, and this effect dominates until the 2050s, with spending as a share of GDP down by around 0.2 per cent of GDP. But second, beyond the 2050s the higher old-age dependency ratio (right panel of Chart 4.4) dominates, as an older population is associated with higher health costs, such that by 2071-72 health spending is 1.0 per cent of GDP higher than in our 2018 *FSR*.

- Spending on **adult social care** is little changed in the medium term, but over the long term it is 0.5 per cent of GDP higher. This is in part due to the charging reforms in England, which increases the proportion of adult social care paid for by the state (raising spending by 0.2 per cent of GDP a year by 2071-72), with the remainder being driven by the higher old-age dependency ratio (see Chart 4.4 above).

- **Education** spending has increased over the medium term but is materially lower by 2071-72 (down by 0.4 per cent of GDP relative to our 2018 projections, and around a fifth lower as a share of GDP relative to 2026-27).[21] This large downward revision over the longer term reflects the downward revision to birth rates, which means there are

[21] For comparability with our previous projections, student loans spending is presented separately from other education spending.

over a quarter fewer children in 2071-72 than previously projected and the young-age dependency ratio is materially lower.

- Spending on **state pensions** is unchanged as a share of GDP in the medium term. From there it drops to 0.6 per cent of GDP below our 2018 projections in the 2040s before rising to 1.2 per cent of GDP above those projections by 2071-72. The profile of these changes reflects changes in the old-age dependency ratio, which is more favourable in the 2030s but less so later in the projection period (Chart 4.4 above). On top of demographic factors, the cost associated with the triple lock on state pension uprating has been revised up by 0.1 per cent of GDP in 2071-72.

- **Other pensioner benefits** (such as housing benefit and attendance allowance), which are uprated in line with average earnings rather than the triple lock, follow a similar profile to state pension, revised down slightly until the 2050s before being higher as a share of GDP by 0.1 per cent by 2071-72 relative to our 2018 projections.

- Spending on **public service pensions** is 0.2 per cent of GDP higher by the projection horizon relative to our 2018 *FSR*.

- **Non-pensioner benefit** spending is little changed in 2026-27, but it is 0.2 per cent of GDP lower by 2071-72 than in our 2018 projections. This reflects the lower birth rate reducing child benefit and child-related elements of working-age benefits.

- **Other departmental capital spending** (excluding capital spending associated with health, education and social care, which is captured in the individual spending lines above) is around 0.7 per cent of GDP higher than in our 2018 *FSR* projections, largely as a result of the increase in capital budgets announced in the March 2020 Budget. It remains essentially flat over the long term.

- **Other spending** is little changed, with a small increase (0.4 per cent of GDP) as a result of higher current budgets for departments in the medium term, which we project to remain broadly flat as a share of GDP over the long term.

Table 4.9: Non-interest spending projections

	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Health	9.1	8.3	8.7	10.1	11.7	13.3	15.0
Adult social care	1.2	1.4	1.5	1.8	2.0	2.3	2.5
Education	4.2	4.2	3.8	3.4	3.5	3.5	3.3
State pensions[2]	4.8	5.1	4.9	5.5	6.2	7.3	8.1
Pensioner benefits	0.7	0.7	0.8	1.0	1.2	1.4	1.5
Other welfare benefits	4.8	4.6	4.4	4.2	4.2	4.1	4.0
Public service pensions	2.0	2.0	1.9	1.8	1.7	1.8	1.7
Total age-related spending	**26.8**	**26.3**	**25.9**	**27.8**	**30.5**	**33.7**	**36.1**
Other departmental capital spending	2.3	2.8	2.8	2.8	2.8	2.8	2.8
Other spending	11.3	9.6	9.5	9.5	9.5	9.5	9.6
Spending[3]	**40.3**	**38.7**	**38.3**	**40.2**	**42.8**	**46.0**	**48.4**

[1] Spending consistent with the March 2022 *Economic and fiscal outlook*.
[2] Includes many items in addition to the basic state pension and single-tier pension, such as pension credit, winter fuel payments and the Christmas bonus.
[3] Excludes interest and dividends.

Table 4.10: Changes in non-interest spending projections since *FSR* 2018

	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Health	1.6	0.1	-0.2	-0.3	-0.2	0.2	1.0
Adult social care	0.0	0.0	0.1	0.1	0.2	0.4	0.5
Education	0.1	0.1	-0.2	-0.4	-0.3	-0.3	-0.4
State pensions[2]	-0.1	0.0	-0.5	-0.6	-0.3	0.5	1.2
Pensioner benefits	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	0.1
Other welfare benefits	0.2	0.1	0.0	0.0	0.0	-0.1	-0.2
Public service pensions	-0.2	-0.1	-0.1	0.0	0.1	0.3	0.2
Total age-related spending	**1.5**	**0.1**	**-1.1**	**-1.3**	**-0.6**	**0.9**	**2.6**
Other departmental capital spending	0.1	0.7	0.7	0.7	0.7	0.7	0.7
Other spending	1.9	0.4	0.3	0.3	0.3	0.3	0.3
Spending[3]	**3.5**	**1.2**	**-0.1**	**-0.3**	**0.4**	**1.9**	**3.6**

[1] Spending consistent with the March 2022 *Economic and fiscal outlook*.
[2] Includes many items in addition to the basic state pension and single-tier pension, such as pension credit, winter fuel payments and the Christmas bonus.
[3] Excludes interest and dividends.

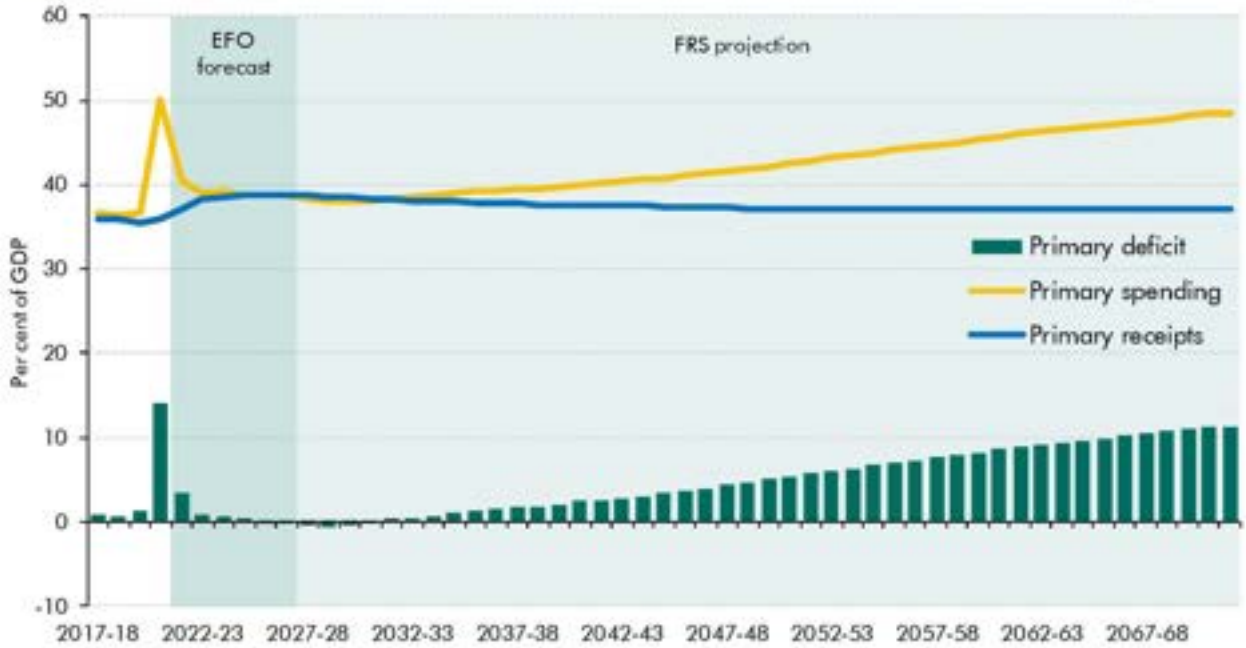
Net borrowing and net debt projections

Primary deficit

4.46 Our baseline projections show the primary balance worsening progressively over the long term, from a surplus of 0.2 per cent of GDP in 2026-27 to a deficit of 11.2 per cent of GDP in 2071-72. This rise of 11.4 per cent of GDP is equivalent to £287 billion in today's terms. The largest contributions to this rise are: 6.7 per cent of GDP from health spending (thanks to both demographic and non-demographic pressures); 3.0 per cent of GDP from state

pensions spending (thanks to demographic pressures and the cost of the triple lock); 1.5 per cent of GDP from the loss of tax revenues due to decarbonisation; and 1.1 per cent of GDP from adult social care spending (thanks to both demographic pressures and the costs of the charging reforms in England announced last year).

Chart 4.12: Non-interest receipts and spending and the primary deficit



Source: OBR

Student loans and financial transactions

4.47 We now consider future financial transactions to project how this long-term outlook for the primary balance will feed through to public sector net debt and the cost of servicing the debt. These affect net debt via their effect on the Government's cash requirement. For most financial transactions, we assume that, in the absence of Government policy, there is a zero net effect over the projection period. The main exception to this is student loans, but we also account for the winding down of past gilt premia and the Asset Purchase Facility (APF).

4.48 In February 2022 the Government announced reforms to the student loans system in England. This included freezing maximum tuition fees until 2024-25, reducing interest rates for new borrowers to equal RPI inflation, lowering repayment thresholds and extending repayment terms from 30 to 40 years (see Box A.1 in our 2022 March *EFO*). In the medium term, the reforms reduced both debt and accrued borrowing as a result of lower outlays (from lower fees) and higher repayments (from lower repayment thresholds). In the long term, they leave the primary deficit unchanged but reduce debt by 2071-72 by around 11 per cent of GDP thanks to higher interest receipts as borrowers repay more of their loans over a longer horizon.

4.49 In the long term, the discontinuation of the RPI measure of inflation will also affect interest rates for new borrowers because, from 2030 onwards, it will converge to CPIH inflation (see paragraph 4.24). This in turn reduces 'modified' interest on student loans beyond 2030.

Public sector net debt and net interest

4.50 The combination of the primary balance and financial transactions projections set out above would leave public sector net debt and net interest spending on an unsustainable upward path over the long term (Table 4.11 and Chart 4.13 below). Up to the 2040s, net debt declines slowly reflecting relatively small primary deficits and relatively favourable growth-corrected interest rates (that result in low net interest spending).

4.51 Relative to our 2018 *FSR*, our medium-term forecast for net interest spending has fallen, despite the somewhat higher debt stock in the aftermath of the Covid pandemic, reflecting the fall in real interest rates. Net interest spending is 2.1 per cent of GDP lower than in our previous report in 2041-42, and 3.3 per cent of GDP lower by 2071-72. The scale and profile of these revisions reflects the downward revision to the debt-to-GDP ratio (initially large, but diminishing over time), which in turn reflects the downward revision to the primary deficit and the consequences of these changes for debt interest spending itself.

Table 4.11: Baseline projections of fiscal aggregates

	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Primary spending	40.3	38.7	38.3	40.2	42.8	46.0	48.4
Primary receipts	37.0	38.9	38.3	37.7	37.1	37.2	37.2
Primary deficit	3.3	-0.2	0.1	2.5	5.7	8.8	11.2
Net interest	2.1	1.3	0.7	0.5	2.4	5.1	9.0
Total managed expenditure	43.4	41.1	40.7	43.3	47.7	53.6	60.0
Public sector current receipts	38.0	40.0	40.0	40.4	39.5	39.6	39.7
Public sector net borrowing	5.4	1.1	0.7	3.0	8.1	14.0	20.3
Public sector net debt	96	84	73	69	98	167	267
Public sector net financial liabilities	83	74	62	58	88	158	259
Public sector net worth (inverted)	79	66	63	64	90	153	245

[1] Estimates are consistent with the March 2022 *Economic and fiscal outlook*.

Table 4.12: Changes in the baseline projections of fiscal aggregates since *FSR* 2018

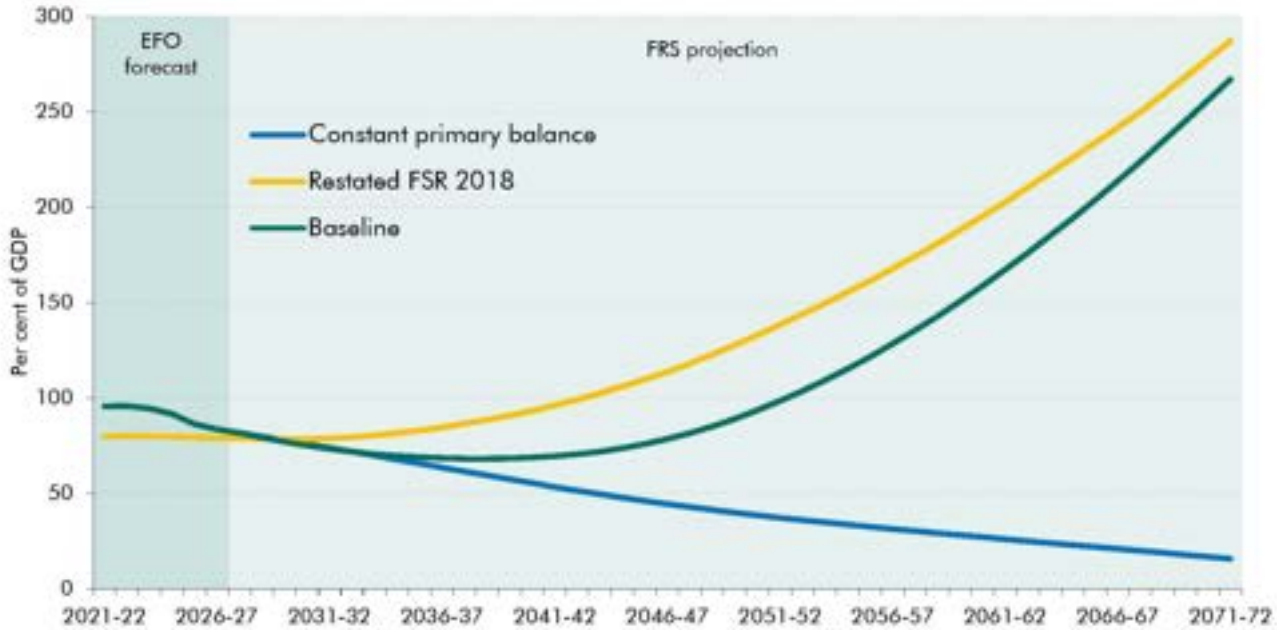
	Per cent of GDP						
	Estimate[1]		FRS projection				
	2021-22	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
Primary spending	3.5	1.2	-0.1	-0.3	0.4	1.9	3.6
Primary receipts	0.7	2.6	2.1	1.5	0.9	0.9	1.0
Primary deficit	2.8	-1.4	-2.2	-1.8	-0.5	1.0	2.6
Net interest	0.5	-0.1	-0.6	-2.1	-2.7	-3.1	-3.3
Total managed expenditure	3.6	0.5	-1.2	-2.6	-2.6	-1.5	0.1
Public sector current receipts	0.4	2.1	1.6	1.4	0.6	0.6	0.8
Public sector net borrowing	3.3	-1.5	-2.8	-3.9	-3.2	-2.1	-0.7
Public sector net debt	15.8	4.4	-5.6	-26.7	-40.0	-35.5	-20.1
Public sector net financial liabilities	18.0	11.7	1.9	-16.7	-28.6	-23.9	-11.3

[1] Estimates are consistent with the March 2022 *Economic and fiscal outlook*.

4.52 In the absence of offsetting policy changes, our baseline projection for net debt is still for it to rise substantially over the long run, reaching 267 per cent of GDP by 2071-72, and

rising both very quickly and at ever faster rates at the projection horizon. This is because primary spending rises over the projection period to accommodate cost and demographic pressures, whereas receipts from net-zero-affected taxes disappear by 2050-51 while those from other sources remain essentially flat as a share of GDP. Our baseline projections contrast with the downward path that debt would take if the primary balance were maintained at the modest surplus reached at the end of our medium-term forecast over the long term (Chart 4.13). Indeed, running a 0.2 per cent of GDP primary surplus alongside the moderately favourable interest rate-growth rate dynamics assumed on average over the next 50 years would take net debt close to zero by 2071-72.

Chart 4.13: Projections of public sector net debt



Source: OBR

Changes since our 2018 *FSR* projections

4.53 Despite our projections still showing an unsustainably large increase in the debt ratio over the next 50 years, relative to our 2018 *FSR* the baseline long-run fiscal outlook has improved somewhat. Debt is lower in every year of the projection though by a relatively modest 20 per cent of GDP lower at the 50-year horizon. That reflects an improved starting primary deficit and initial interest conditions, as well as demographics that are less fiscally challenging over much of the projection. These downward revisions are largely offset by the removal of net zero affected taxes (as shown in Table 4.13, which presents a detailed decomposition of changes in the primary deficit and debt by 2071-72).[22] The primary deficit is lower than previously projected until the mid-2050s but higher thereafter, and it is rising

[22] It is worth noting that when decomposing the effects of large changes that interact with each other in a multiplicative way, it is not possible to present simple additive diagnostics. We have ordered and allocated the decomposition in the charts and tables in this section in the way that most usefully describes our changes, but it should be stressed that applying the assumptions in a different order would yield different results. Any residual interaction terms have been grouped in the 'other forecasting changes' line of the table.

faster than in our 2018 *FSR* projections in the long term, such that by 2071-72 it is larger by 2.6 per cent of GDP.

4.54 The main sources of this 2.6 per cent of GDP worsening in the primary deficit in 2071-72 and the 20 per cent of GDP improvement in debt in that year relative to our 2018 *FSR* are detailed in earlier sections of this chapter, but in summary:

- **The primary deficit at the end of the medium term** has improved by 0.7 per cent of GDP. All else equal, this more favourable starting point results in a 30 per cent of GDP reduction in net debt by 2071-72. This reflects both policy, in the form of net tax increases, and forecasting changes from a more tax-rich economy.

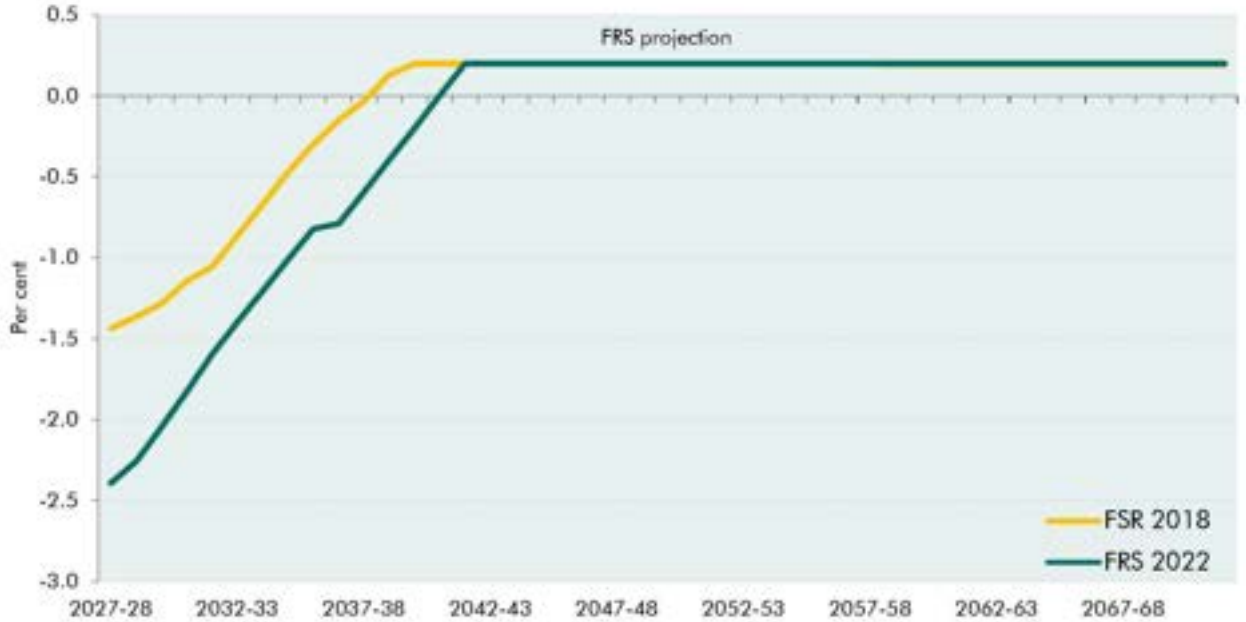
- **More favourable interest rates** at the end of the medium term, which are assumed to unwind over the following 15 years, as shown in Chart 4.14. These do not affect the primary balance but lower the debt-to-GDP ratio by 21 percentage points by 2071-72.

- **Demographic changes** reduce the primary deficit in the near future but increase it in the long term (Chart 4.15), the cumulative effect of which is to reduce debt in 2071-72. This reflects the profile of revisions to dependency ratios flowing from the updated demographic assumptions. Lower migration reduces the working population and so increases young- and old-age dependency ratios, while increased mortality reduces the old-age dependency ratio. The lower birth rate reduces the young-age dependency ratio throughout, but eventually results in fewer working-age adults and so increases the old-age dependency ratio in the long run.

- **The loss of net-zero-affected revenues** – most notably fuel duty and vehicle excise duty – reduces revenues by 1.6 per cent of GDP a year from 2050-51 onwards. This adds 58 per cent of GDP to debt by 2071-72 relative to our 2018 projections, which did not factor in the goal of getting to net zero emissions by 2050 (which was legislated for in 2019 and for which the associated delivery strategy was published in 2021).

- **Other long-term policy changes** have a modest effect on the primary balance and net debt, with adult social care reforms raising primary spending somewhat, while student loans reforms reduce debt by relatively small amounts.

Chart 4.14: Growth-corrected interest rate ('R-G'): *FRS* 2022 versus *FSR* 2018

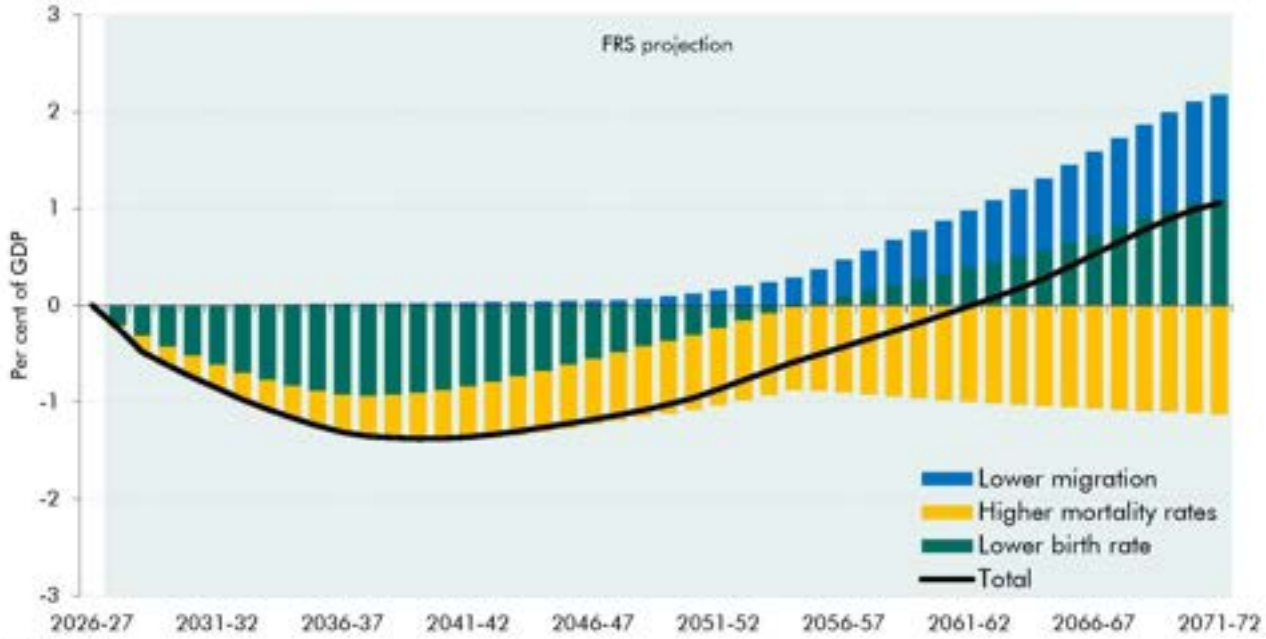


Source: OBR

Table 4.13: Changes in the primary balance and net debt since *FSR* 2018

	Per cent of GDP	
	2071-72	
	Primary deficit	Debt
***FSR* 2018**	**8.6**	**291**
Classification changes	0.0	-4
***FSR* 2018 restated**	**8.7**	**287**
Difference	**2.6**	**-20**
Forecasting changes	**-0.3**	**-49**
Starting primary deficit	-0.7	-30
R-G	0.0	-21
Other forecasting changes	0.4	2
Demographics	**1.1**	**-26**
Birth rate	1.1	-7
Mortality	-1.1	-33
Migration	1.1	14
Long-term policy changes	**1.8**	**55**
Net zero affected taxes	1.6	58
Adult social care charging reform	0.2	8
Student loans reforms	0.0	-11
***FRS* 2022**	**11.2**	**267**

Chart 4.15: The effect of revised demographic assumptions on the primary deficit since *FSR* 2018



Source: OBR

Sensitivity analysis

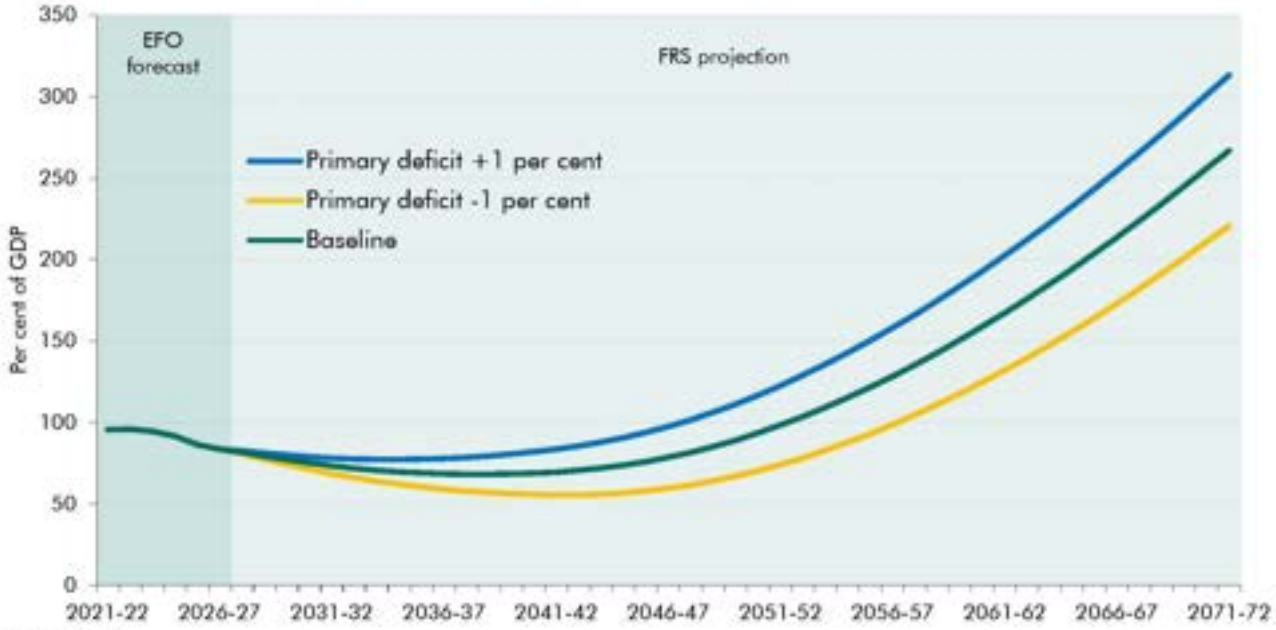
4.55 This section analyses the sensitivity of our baseline projections to the medium-term primary deficit, interest rates (and therefore the growth-corrected interest rate, or R-G), and a continuation of the historical pattern of fiscal shocks hitting around once a decade.

Sensitivity to the medium-term primary deficit

4.56 Our March 2022 *EFO* forecast for 2026-27, in combination with the May 2022 cost of living package, provides the starting point for our *FRS* projections. The gap between spending and receipts at that point is important for the long-term projections because we apply demographic and other pressures via growth rates from that starting point – so a more favourable starting point will, all else equal, mean a more favourable debt path.

4.57 Chart 4.16 illustrates the sensitivity of the path of the debt ratio to a 1 per cent of GDP improvement or deterioration in the primary balance reflecting underlying tax and spending conditions and not cyclical fluctuations in 2027-28. It shows that a 1 per cent deterioration would see net debt rising to 313 per cent of GDP by 2071-72 instead of the 267 per cent in our baseline projection; conversely, a 1 per cent larger surplus would see debt rising to 221 per cent of GDP by the long-term horizon.

Chart 4.16: Sensitivity of net debt projections to the primary deficit in 2027-28



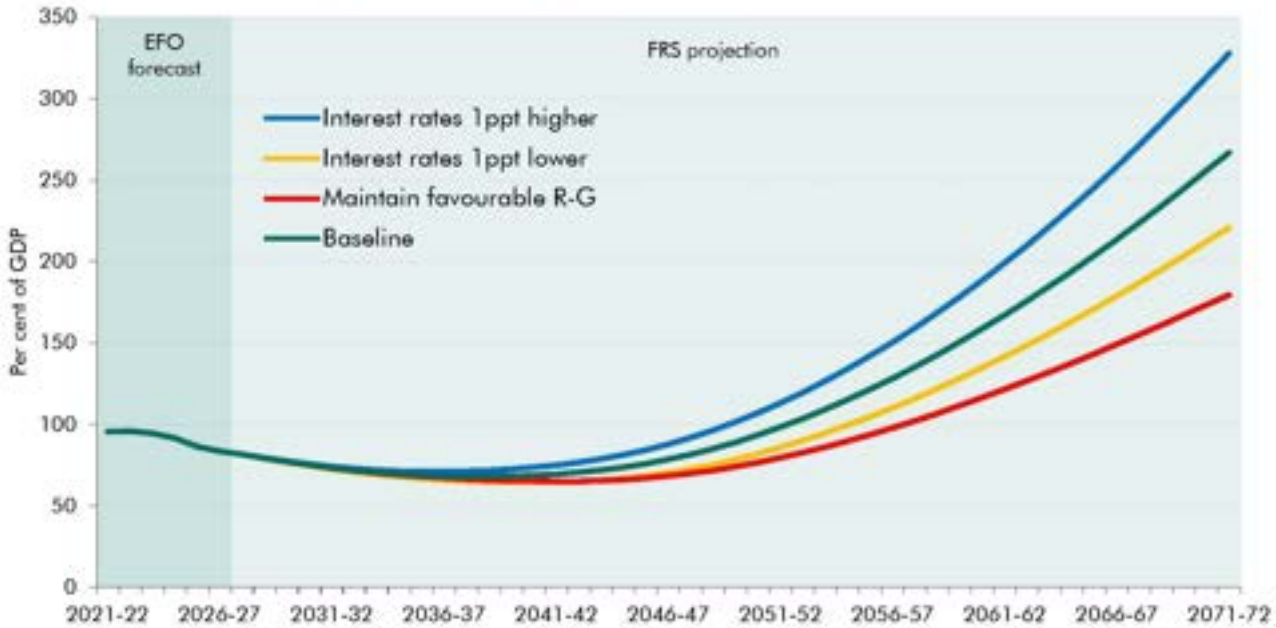
Source: OBR

Sensitivity to interest rates

4.58 Another key assumption in our projections is that the interest rate the government pays on its newly issued debt gradually rises to 3.9 per cent in the long term, 0.2 percentage points above the rate of nominal GDP growth. Rather than the level of either, it is the gap between the two – known as the 'growth-corrected interest rate' or 'R-G' – that is the key determinant of long-run debt dynamics. Our projected interest rates are higher than market expectations currently imply over the long term. But gilt rates could end up higher than assumed, for example if demand for safe assets were to fall if economic uncertainty receded. Indeed, they have risen markedly in recent months – and by around 1 percentage point since we closed our March forecast. There is also uncertainty surrounding our GDP growth projection.

4.59 Chart 4.17 illustrates the path of net debt if gilt rates were 1 percentage point higher or lower from 2027-28 onwards, but GDP growth remained the same. Over a short horizon, the impact is relatively small, as changes would only apply to new debt issued and the UK has a relatively long average debt maturity. But as the stock of debt matures, and the primary balance deteriorates, the effects would increase. Over a 50-year horizon, a 1 percentage point variation in interest rates would add or subtract around 50 to 60 per cent of GDP to net debt, with debt climbing more or less steeply thereafter. Even if R-G were to remain at its highly favourable 2026-27 level of -2.2 percentage points across the long term, debt would still be on a rising path, reaching 180 per cent of GDP in 2071-72.

Chart 4.17: Sensitivity of net debt projections to interest rates in 2027-28

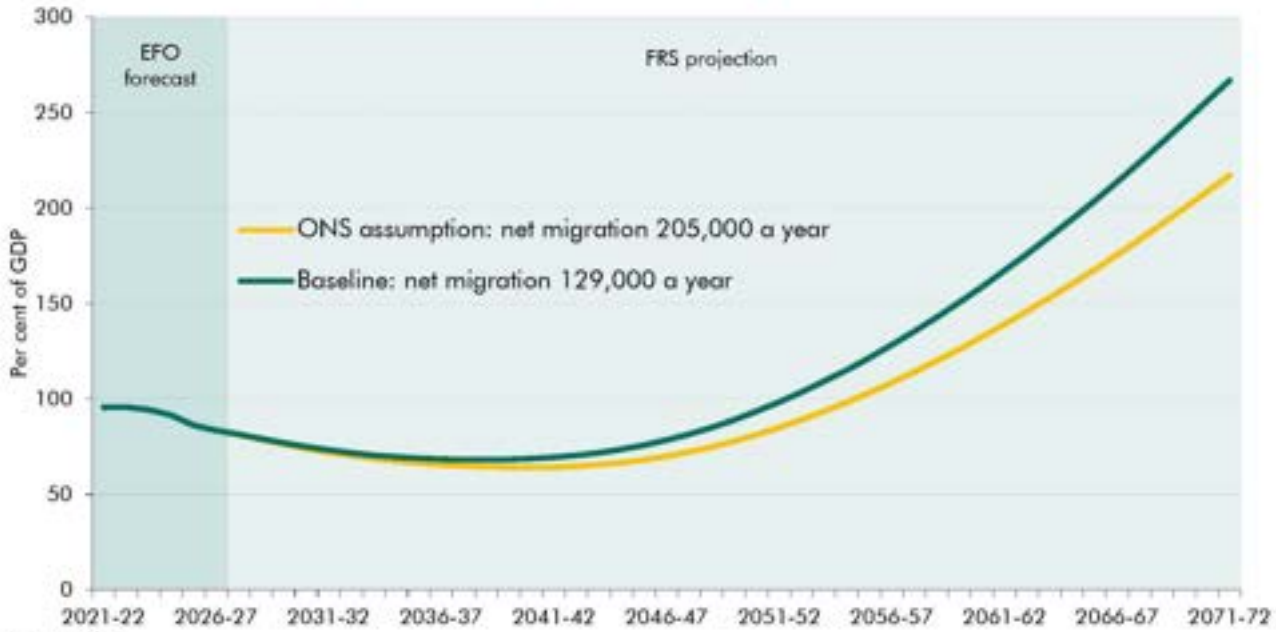


Source: OBR

Sensitivity to migration assumptions

4.60 As discussed above, in our baseline projection we deviate from the ONS's interim projections in that we assume lower net migration (129,000 a year) than the ONS does (205,000). Chart 4.18 illustrates how sensitive our projections for net debt are to these assumptions. Here we assume that the extra migrants (on the ONS projection) have exactly the same characteristics as those in our baseline. As Chart 4.15 above shows, lower net migration throughout comes to increase the primary deficit, all else equal, and the path of net debt shows a similar profile. Nevertheless, higher net migration at the level in the ONS's interim projections would not be enough to stop the increasing path of net debt, though it would be around 217 per cent of GDP in 2071-72 using those projections rather than the 267 per cent in our baseline projection.

Chart 4.18: Sensitivity of net debt projections to migration assumptions



Source: OBR

Indicators of fiscal sustainability

4.61 In this section, we analyse three different types of indicators of sustainability: fiscal gaps, the intertemporal budget constraint, and a suite of fiscal indicators compared with their pre-2007 (i.e. pre-global financial crisis) median.

Fiscal gaps

4.62 The fiscal gap is the immediate and permanent change in the primary balance needed to achieve a chosen debt-to-GDP ratio in a given year. This typically involves picking a policy target or historically pertinent level and a target date far enough ahead to capture the most significant (typically demographic) future influences on the public finances, but not so far ahead that the projections are subject to any greater uncertainty than necessary.

4.63 One of the main strengths of fiscal gaps is that they are intuitive and can be interpreted easily in the context of any policy rules on the level of government debt relative to GDP. But there is no consensus regarding the optimal debt ratio or how quickly one should aim to return to it if the public finances move off course. In fact, no UK government has targeted a particular level of debt-to-GDP ratio since 2008, and the current fiscal mandate is for debt to be falling as a share of GDP from one year to the next.[23] We therefore calculate fiscal gaps relative to a debt-to-GDP ratio of 75 per cent, the level at which debt stabilised in the March 2020 Budget that reflects the Government's pre-pandemic fiscal goals.

[23] The fiscal mandate is for underlying debt (excluding the Bank of England) rather than public sector net debt.

4.64 Table 4.14 shows the fiscal gap calculations for the baseline projection. The primary balance necessary to achieve a given level of debt as a share of GDP depends on the difference between the interest rate and the long-term economic growth rate. We therefore show the gaps not only for our central assumption that the long-run interest rate exceeds the long-term economic growth rate by 0.2 percentage points, but also under alternative assumptions where the difference is 1 percentage point higher or lower, in line with the sensitivities discussed in the previous section.

4.65 In all cases the fiscal gap is negative, consistent with the unsustainable fiscal position over the long run. To get the debt-to-GDP ratio to 75 per cent in 2071-72 would require a permanent increase in taxes and/or cut in spending of 4.2 per cent of GDP (£104 billion in today's terms) in 2027-28. Since it is very unlikely that a government would try to offset several decades' worth of future demographic and other cost pressures via a single upfront adjustment, a more realistic alternative adjustment is illustrated via the 'gradual progress' variant, which would require a series of tax increases or spending cuts worth an additional 1.5 per cent of GDP (£37 billion in today's terms) each decade. This tightening is additional to any other tightening already announced, such as the health and social care levy, and in addition to announcements that are expected to affect the public finances over a longer time horizon and that are included in our central projection, such as linking changes to the State Pension age to life expectancy.

Table 4.14: Fiscal gap estimates to hit 75 per cent of GDP debt ratio in 2071-72

	Adjustment in primary deficit, per cent of GDP
Baseline projection	-4.2
Baseline projection (gradual progress)[1]	-1.5
Interest rate 1 percentage point higher	-4.3
Interest rate 1 percentage point lower	-3.9

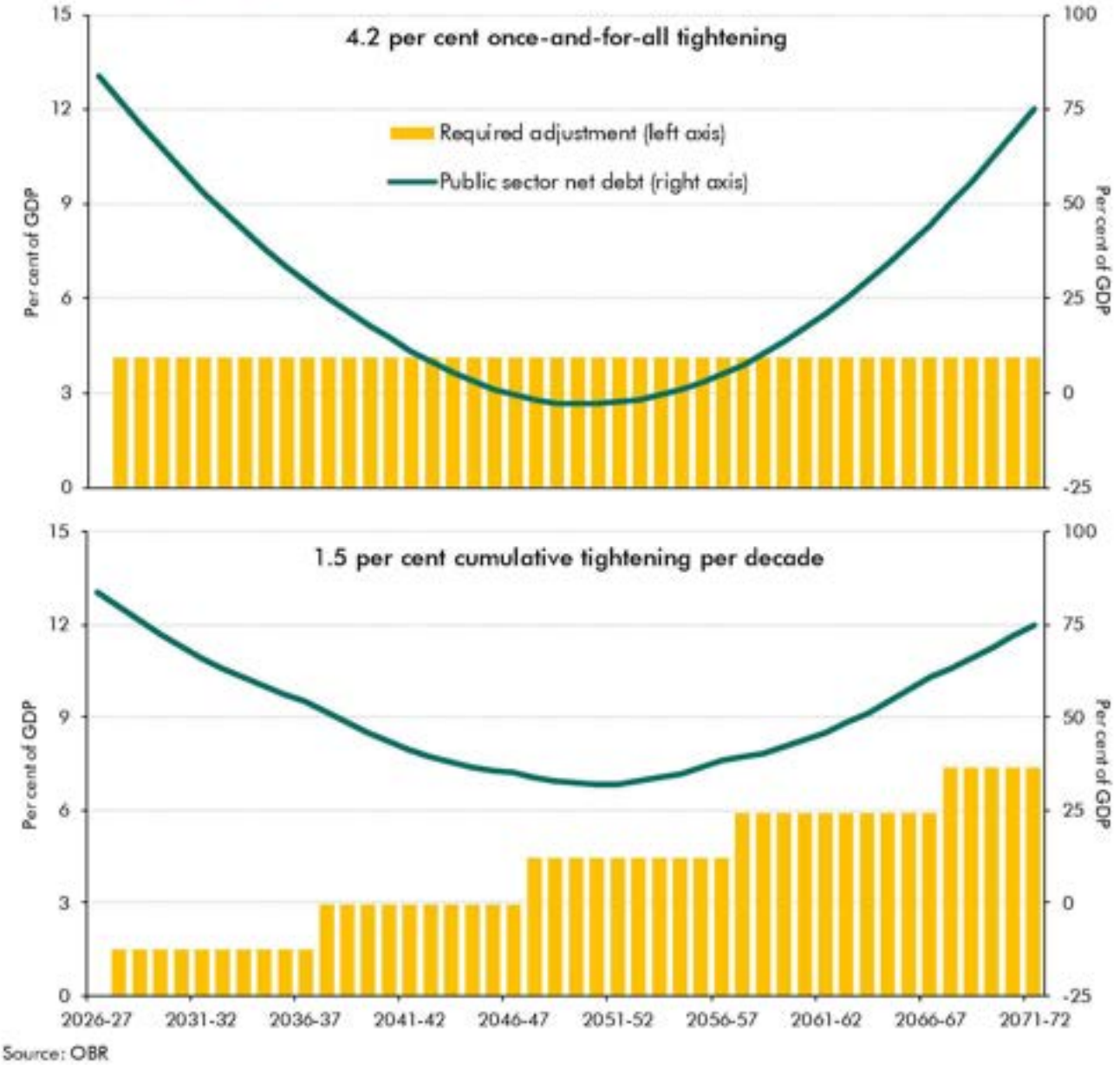
[1] Adjustment required each decade.

4.66 Chart 4.19 illustrates the difference that the choice between a one-off permanent adjustment and an initially smaller, but ultimately larger, cumulative decade-by-decade adjustment makes to the path of net debt on the way to the target date. It shows that:

- A **once-and-for-all policy tightening** of 4.2 per cent of GDP in 2027-28 would see the debt ratio fall well below 75 per cent of GDP at the end of the 2020s, reach a trough of minus 3 per cent of GDP around 2050 and then rise back to 75 per cent of GDP in 2071-72. But pressures would continue to exist, with debt rising exponentially from the 2050s onwards.

- A **cumulative policy tightening** of 1.5 per cent of GDP a decade would see the debt ratio fall more slowly to a trough of 32 per cent around 2050 and rising towards 75 per cent by the end of the projection period. By the target date the cumulative tightening since 2027-28 would have reached 7.4 per cent of GDP. But again, debt would still be on a rising path at that point, requiring further adjustment beyond the projection horizon to stabilise the debt-to-GDP ratio over the very long run.

Chart 4.19: Alternative adjustments to the primary balance and the implied path of net debt if targeting a debt-to-GDP ratio of 75 per cent in 50 years



Source: OBR

Intertemporal budget gap

4.67 While a fiscal gap might be a reasonable depiction of how policymakers might address the challenge posed by our fiscal projections, it is not a formal measure of sustainability. Other definitions of fiscal sustainability are built on the concept of solvency – the government's ability to meet its future obligations, which in formal terms is given by its intertemporal budget constraint. This is usually expressed in terms that the present value of future revenues should be equal or greater than the sum of its existing debt plus the present value of its future spending over an infinite horizon. As this intertemporal budget constraint seeks to eliminate rather than stabilise debt, meeting it will usually require greater fiscal tightening.

4.68 If a government is not on course to satisfy its intertemporal budget constraint, the intertemporal budget gap is a measure of the immediate and permanent increase in taxes and/or cut in public spending as a share of GDP that would put the government back on course. The size of the adjustment and the level of the primary balance required to satisfy the intertemporal budget constraint depends on the growth-corrected interest rate. The higher the interest rate, the quicker debt will accumulate; the higher the growth rate, the easier it is to service and pay it off.

4.69 In our central projections, we assume that the long-run interest rate is close to the long-term nominal growth rate of the economy (3.9 per cent versus 3.7 per cent), which implies that an adjustment close to the size of the primary deficit at the end of our projection would be sufficient to stabilise the debt-to-GDP ratio in the long term – and a somewhat larger one would be sufficient to close the intertemporal budget gap. We calculate that the UK's intertemporal budget gap is currently equal to 10.8 per cent of GDP. In other words, under our central projections the Government would need to increase taxes and/or cut spending by 10.8 per cent of GDP (£271 billion in today's terms) from 2027-28 onwards to satisfy the intertemporal budget constraint with an immediate and permanent adjustment. This is 2.4 per cent of GDP more than the 8.4 per cent of GDP reported in our 2018 *FSR*, and largely reflects the worsening position of the primary deficit in the final decade of the projections due to increased demographic pressures.

Dashboard of fiscal indicators

4.70 In our March 2022 *EFO* we published a dashboard of balance sheet and debt affordability indicators that give a sense of the fiscal position over the medium term and that have been specified by the Government in the latest edition of the *Charter for Budget Responsibility*. These are not fiscal targets but broader indicators of fiscal performance and we compare them generally against the median that prevailed from 1967-68 to 2006-07 (the four decades preceding the financial crisis before debt ratcheted higher consequently).

4.71 In this report we publish a similar table (Table 4.15) looking at the position over a 50-year horizon. The dashboard shows net debt, net financial liabilities, and net worth all in the two quintiles with the highest observations.[24] Over the projection period, net debt and net financial liabilities both fall significantly until the 2040s but rise exponentially from the 2050s onwards as demographic and cost pressures build. Net worth follows a similar path, although with a less pronounced improvement in the first two decades of projections.

4.72 Net interest costs remain low by historical standards until the 2050s, reflecting the favourable interest rates at the start of the projections (shown in Chart 4.14 above) and the declining path for net debt. But after that net interest costs rise rapidly as interest rates are assumed to reach their steady state and net debt starts to rise exponentially. As a share of GDP, net interest costs reach 5.1 per cent in 2061-62 and almost double over the final decade of the projection to reach 9.0 per cent in 2071-72. Net interest costs rise faster than net debt in that final decade because the effective interest rate on debt is still rising as

[24] Net worth is a measure of net assets rather than net liabilities, so has been inverted to aid comparability.

longer maturity debt is still being rolled over at the higher interest rates. When expressed as a share of non-interest revenues, the path is similar since the revenue-to-GDP ratio is stable from the 2050s onwards. As a result, net interest costs jump to 13.8 per cent of revenues in 2061-62 and almost double over the final decade of the projection to just under a quarter of revenues in 2071-72.

Table 4.15: Dashboard of balance sheet and debt affordability indicators

	Pre-2007 median	2026-27	2031-32	2041-42	2051-52	2061-62	2071-72
	Level (per cent of GDP, unless otherwise stated)						
Balance sheet metrics							
PSND	36.3	83.6	73.3	69.5	98.4	167.3	267.0
PSNFL	31.6	74.4	62.1	57.6	88.0	157.9	258.5
PSNW (inverted)	-12.4	66.4	63.2	63.7	90.3	152.7	244.7
Debt affordability metrics							
Net interest costs	2.8	1.3	0.7	0.5	2.4	5.1	9.0
Net interest costs (per cent of revenue)	7.9	3.3	1.8	1.3	6.5	13.8	24.3

Note: Pre-2007 median is from 1967-68 to 2006-07 in levels. PSNW has been inverted to facilitate comparisons with the other three metrics.

Sensitivity of the projections to shocks

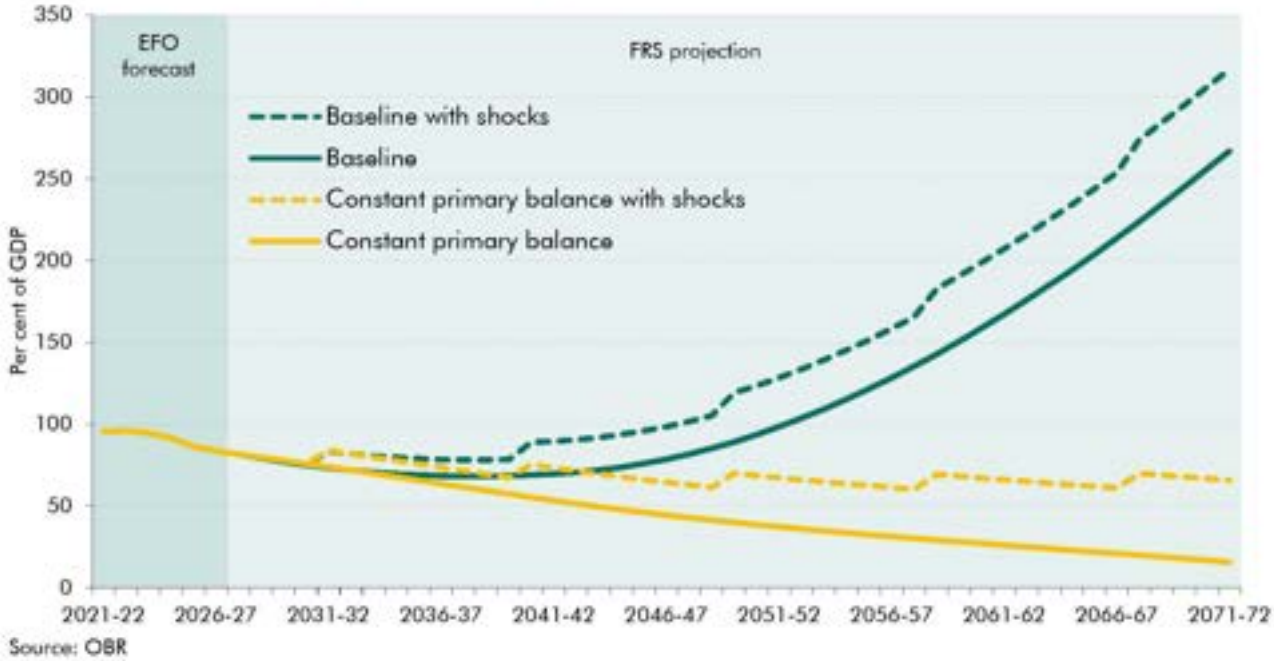
Sensitivity to economic and fiscal shocks

4.73 Over a long horizon the fiscal consequences of economic shocks are an important contributor to the path of debt. There were seven recessions in the 63 years from 1956 to 2018, or one every nine years on average.[25] International and historical evidence suggests that a typical recession could add around 10 percentage points to the debt-to-GDP ratio.[26] Most importantly, the impact of shocks on the public finances is skewed to the downside – debt gets pushed higher by adverse shocks but is more rarely pushed lower by favourable ones (in part because the associated fiscal upside is often spent, reflecting the tendency to misread cyclical upswings for structural improvements in economic and fiscal performance). We therefore analyse the sensitivity of our baseline net debt projection to a shock that adds 10 per cent of GDP to debt being realised every nine years (Chart 4.20).

4.74 The addition of the ratchet effect from economic shocks on a scale witnessed in the past would raise the baseline projection for net debt from 267 to 317 per cent of GDP in 2071-72. But even with an otherwise constant primary balance, debt would be much higher after accounting for the after-effects of periodic shocks. It also highlights that the declining path for debt in the 2030s and 2040s in our baseline projection would be undone by the public finances being hit by regular-sized economic shocks at historically regular intervals.

[25] See our 2019 *FRR*.
[26] See, for example, IMF, *Analyzing and Managing Fiscal Risks—Best Practices*, June 2016.

Chart 4.20: Sensitivity of net debt projections to stylised shocks



Source: OBR

Stress test and scenarios

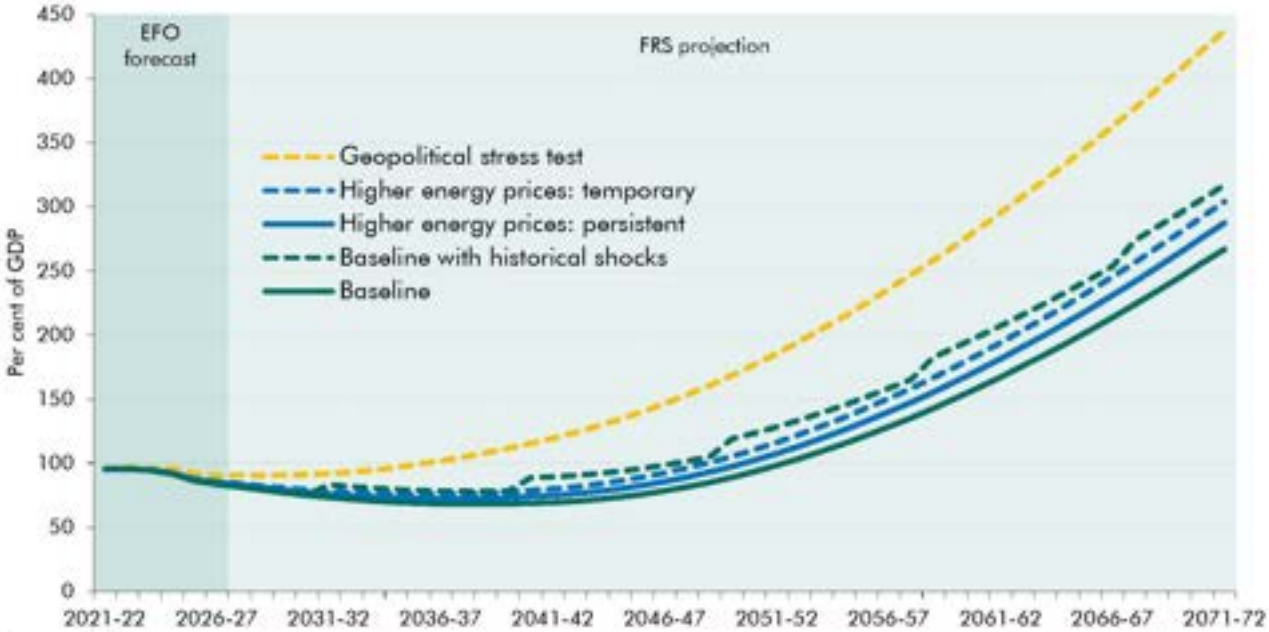
4.75 With the baseline projection and the effect of stylised economic shocks as comparison points, we also present the potential additional fiscal costs of specific risks explored in Chapters 2 and 3 (Chart 4.21). The long-term implications of these nearer-term shocks have been captured simply via their impact on the primary balance and debt at their medium-term horizons, with no further assumptions beyond that. In summary:

- **Geopolitical stress test (Chapter 2).** If geopolitical tensions continue to rise, with threats to both security and economic integration crystallising, the fiscal outlook could be materially weaker – as illustrated in this year's 'fiscal stress test'. It includes: a future Government increasing defence spending from just over 2 to 3 per cent of GDP, at a cost of £24 billion in today's terms; a major cyber-attack that delivers a short, sharp recession in 2024 that pushes public debt higher, but leaves no lasting scars; and a global trade war that escalates over time and eventually subtracts 5 per cent from UK productivity and adds 1 percentage point to interest rates on government debt. This simultaneous crystallisation of several risks adds about 30 per cent of GDP to public debt in 2036-37 and leaves debt at 437 per cent of GDP in 2071-72.

- **Near- and medium-term energy price shocks (Chapter 3).** If energy prices were to spike even higher or to persist at current high levels this would also adversely affect the long-run fiscal outlook. In our 'temporary spike scenario' gas prices double later this year and oil prices spike too, keeping inflation in double figures next year. The associated recession leaves public debt higher in the medium term, with it reaching 304 per cent of GDP in 2071-72. In our 'persistent shock scenario', high gas and oil prices weigh on the economy's productive potential. The fiscal impact of this also raises public debt in the medium term and leaves it at 288 per cent of GDP in 2071-

72. (Asymmetries in the welfare system explain the short shock being fiscally more costly than the persistent one.) Additional discretionary support for households of the type seen this year would dampen the short-term hit to household incomes, but only at the expense of passing a higher public debt burden onto future households.

Chart 4.21: Net debt projections: baseline with stress test and scenarios



Source: OBR

4.76 The slightly more benign baseline fiscal projection compared to our previous long-term projections should be viewed in light of these nearer-term risks. The experience of the past two decades makes it hard to escape the conclusion that the world is becoming a riskier place, with emergent geopolitical and energy challenges adding to, rather than replacing, the risks we studied in previous *FRRs*. The combined picture is a challenging one for this and future governments as they steer the public finances through a combination of slow-building pressures and inevitable future shocks.

Index of charts and tables

E02748612
ISBN 978-1-5286-3375-8