Office for
Budget Responsibility

Fiscal risks report

July 2021

CP 453

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Fiscal risks report

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Exchequer Secretary to the Treasury
by Command of Her Majesty

July 2021

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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 showing probabilistic ranges ('fan charts') for the key economic and fiscal aggregates based on historical forecast errors. Our biannual *EFOs* also feature alternative scenarios and sensitivity analysis to illustrate the implications of changing key forecast judgements. The long-term projections in our *Fiscal sustainability reports (FSRs)* include sensitivity analysis to changes in key demographic, macroeconomic, and other assumptions. And we have relied on scenario analysis more than ever over the past year to illustrate the huge uncertainties surrounding the path of the coronavirus pandemic and the public health and fiscal policy response.

In the October 2015 update to the *Charter for Budget Responsibility*, Parliament required us to produce a report on fiscal risks at least once every two years, and for the Government to respond formally to each report within a year. We produced our first *Fiscal risks report* (*FRR*) in July 2017 and the Government responded in *Managing fiscal risks* in July 2018. Our 2019 *FRR* reflected on the Government's response and extended the dialogue. We continue the series of exchanges in this report, taking account of the Government's understandably limited written response to our previous report, and develop the discussion in the light of the crystallisation of one of the largest risks in centuries, the coronavirus pandemic, and the unprecedented array of policy measures introduced to mitigate its economic and fiscal impact.

Our previous two *FRRs* took an encyclopaedic approach, aiming to provide a full account of the – mostly adverse – risks to the public finances. One of the main conclusions of both was that major shocks to the public finances are inevitable, if unpredictable, so governments need to recognise that they are very likely to have to confront them at some point. But while those two editions identified more than 90 different fiscal risks, neither considered in any detail the potential economic and fiscal consequences of a global pandemic. However, the fiscal stress test included in our first *FRR* did presage the roughly 30 per cent of GDP rise in government debt resulting from the pandemic, albeit as a result of a different combination of shocks. This underscores the value to fiscal forecasters and policymakers of exploring, and trying to communicate to the public, the nature and scale of potential shocks to the public finances, even if their precise nature, timing, and magnitude is uncertain. Exploring the consequences of a global pandemic – which sat atop the Government's 2015 *National Risk Register* – would of course have been more valuable still.

This *FRR* has been prepared in the wake of the largest fiscal risk to have crystallised in peacetime – the coronavirus pandemic – the economic and fiscal consequences of which continue to be felt. It therefore focusses on what we can learn from this experience to enhance our understanding, and inform the Government's management, of other potentially catastrophic or 'tail risks' facing the UK and other countries around the world. So, this *FRR* departs from the encyclopaedic approach of past

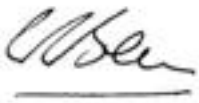
reports and shifts focus onto three sources of potentially very large fiscal risks: the coronavirus pandemic, climate change, and the cost of public debt. It also provides updates on significant developments regarding the specific risks highlighted in previous *FRRs*.

The analysis and conclusions presented in this document represent the collective view of the three independent members of the OBR's Budget Responsibility Committee. We take full responsibility for the judgements that underpin them. We have been hugely supported by the staff of the OBR, to whom we are as usual enormously grateful, particularly in the wake of a very demanding year.

We have also drawn on the help and expertise of officials across numerous government departments and agencies, including HM Treasury, the Bank of England, Climate Change Committee, Debt Management Office, Department for Business, Energy and Industrial Strategy, HM Revenue and Customs, Joint Biosecurity Centre, National Infrastructure Commission and the Scientific Pandemic Influenza Group on Modelling. We are very grateful for their insight.

In addition, we have benefitted from discussions with experts from outside government who have spoken to us about our three main topics. In particular, we would like to thank colleagues at the IMF, Jan Vlieghe of the Bank of England's Monetary Policy Committee, Dimitri Zenghelis at the Bennett Institute at Cambridge University, Kevin Daly at Goldman Sachs, Anita Charlesworth and colleagues at the Health Foundation's REAL centre, Paul Johnson and Carl Emmerson at the Institute for Fiscal Studies, Andrew Scott at the London Business School, Tony Travers and Lukasz Rachel from the London School of Economics, Bill Allen at the National Institute of Economic and Social Research, Torsten Bell and colleagues at the Resolution Foundation, and Ian Mulheirn and Tim Lord at the Tony Blair Institute for Global Change. Finally, we are particularly grateful to Sarah Breeden and her team at the Bank of England for sharing insight and analysis on their climate change scenarios, which we draw on in this report. We would also emphasise that despite the valuable assistance received, all judgments and interpretation underpinning the analysis and conclusions of the *FRR* are ours alone.

We provided the Chancellor of the Exchequer with a summary of our main conclusions on 25 June. Given the importance of the report to the Treasury in managing fiscal risks, we have engaged with officials there regularly throughout and requested their assistance in understanding developments since our previous report in order to enrich our analysis. We provided an advance pre-release copy on 2 July and a full and final copy 24 hours prior to publication, in line with pre-release access arrangements set out 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.


Richard Hughes Sir Charles Bean Andy King

The Budget Responsibility Committee

Executive summary

1 Just two decades into this century, the UK has already experienced two 'once in a century' economic shocks – the 2008 financial crisis and the 2020 coronavirus pandemic. These two shocks triggered the two largest post-war recessions, accounted for successive peacetime government borrowing records, and added over £1 trillion (50 per cent of GDP) to public debt – taking it above 100 per cent of GDP for the first time since 1960. While these shocks have very different origins, impacts, and likely legacies, both offer a stark reminder of the importance of understanding risk to effective fiscal forecasting and policymaking.

2 As we emerge from the largest peacetime economic and fiscal shock in three centuries, our third *Fiscal risks report* (*FRR*) departs from the encyclopaedic approach of our previous two and shifts focus onto three sources of potentially very large fiscal risks: the coronavirus pandemic, climate change, and the cost of government debt. These three risks are very different in nature, but nevertheless have some important features in common. There is a high degree of uncertainty concerning both their timing and associated costs. They are characterised by non-linearities or 'snowball effects' in which costs can escalate dramatically from the point of crystallisation. And they are global in nature, with the potential for rapid contagion across countries. Governments seeking to manage these threats must thus weigh the known costs of early action to mitigate these risks against the uncertain costs of dealing with the fallout when they crystallise. They must also weigh the limited but more deliverable benefits of acting unilaterally against the greater but more elusive gains from acting globally.

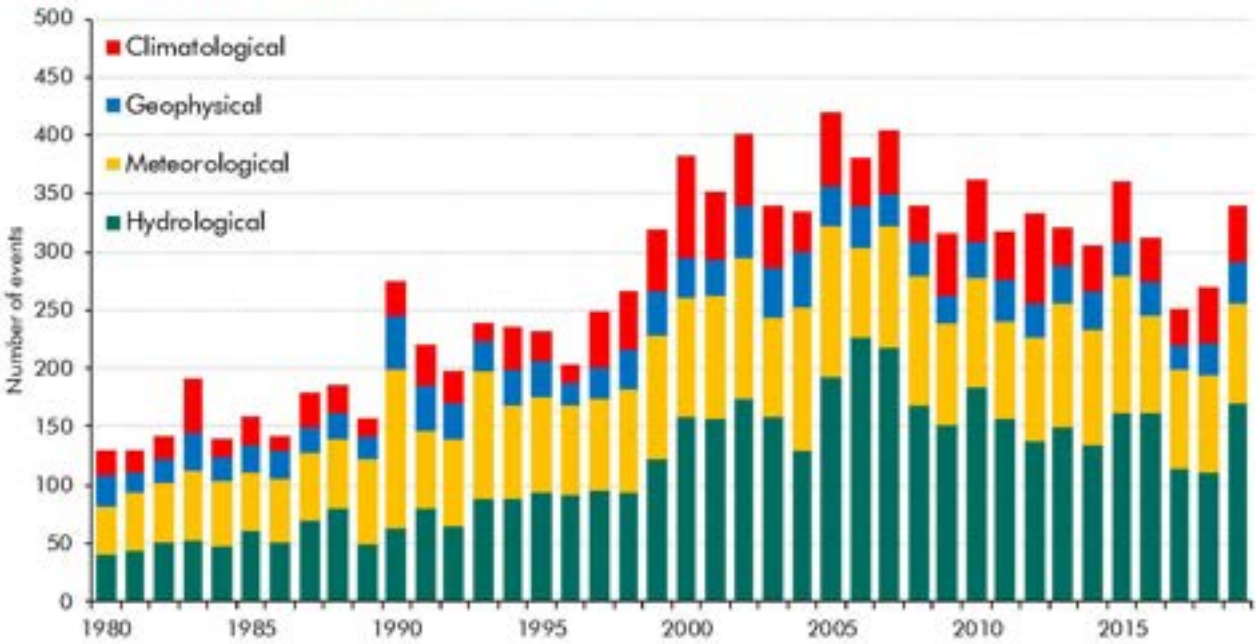
Increasing fiscal exposure to catastrophic risks

3 Chapter 1 defines what we mean by fiscal risks, outlines our approach to analysing them, and considers whether governments are becoming more exposed to potentially catastrophic risks. Fiscal risks are factors that lead fiscal outcomes to deviate from forecasts over the medium term or threaten fiscal sustainability over the long term. Our *FRR*s tend to focus on adverse or 'downside' risks. This asymmetric approach reflects the tendency for shocks to the public finances (especially large ones) to be bad rather than good, as well as governments' tendency to spend, rather than save, unexpected windfalls, but to absorb, rather than offset, unexpected costs. It is, of course, a central function of government to pool and manage risks that cannot be borne solely by individuals or firms. During normal times, governments provide varying degrees of 'social insurance' for the unemployed, the sick, and the old. During crises, in which multiple risks tend to crystallise at once, governments can and do take on a much broader range of costs by virtue of their role as 'insurer of last resort'.

4 The arrival of two major economic shocks in quick succession need not constitute a trend, but there are reasons to believe that advanced economies may be increasingly exposed to large, and potentially catastrophic, risks. While the threat of armed conflict between states

(especially nuclear powers) appears to have diminished in this century, the past twenty years have seen an increase in the frequency, severity, and cost of other major risk events, from extreme weather events to infectious disease outbreaks to cyberattacks (Chart 1). And estimates from major insurers and others of the amount of global GDP at risk from these and other potentially catastrophic risks have been rising steadily. This appears to reflect a combination of the increased frequency and severity of some anthropogenic risks (such as climate change and cyberattacks), growing numbers of people living and working in greater proximity to the sources of those risks (such as floodplains and isolated ecosystems), and deepening global interconnectedness (through travel, trade, finance, and the internet).

Chart 1: Incidence of major risk events



Source: The Emergency Events Database

5 As countries' exposure to large, and potentially catastrophic, risks increases, so do the associated risks to their public finances. This is because such risks are not only more disruptive to the economies that generate governments' revenues but also because they are more likely to overwhelm private risk management and insurance mechanisms, prompting governments to step in as insurer of last resort. This may be particularly true in an era when economic shocks are more severe, financial institutions and firms are more leveraged, and monetary policy is more constrained. So knowing where risks reside and how they spread across economies and onto government balance sheets is central to understanding the evolution of the public finances over the past two decades and the potential threats to fiscal sustainability over the rest of this century.

Coronavirus pandemic

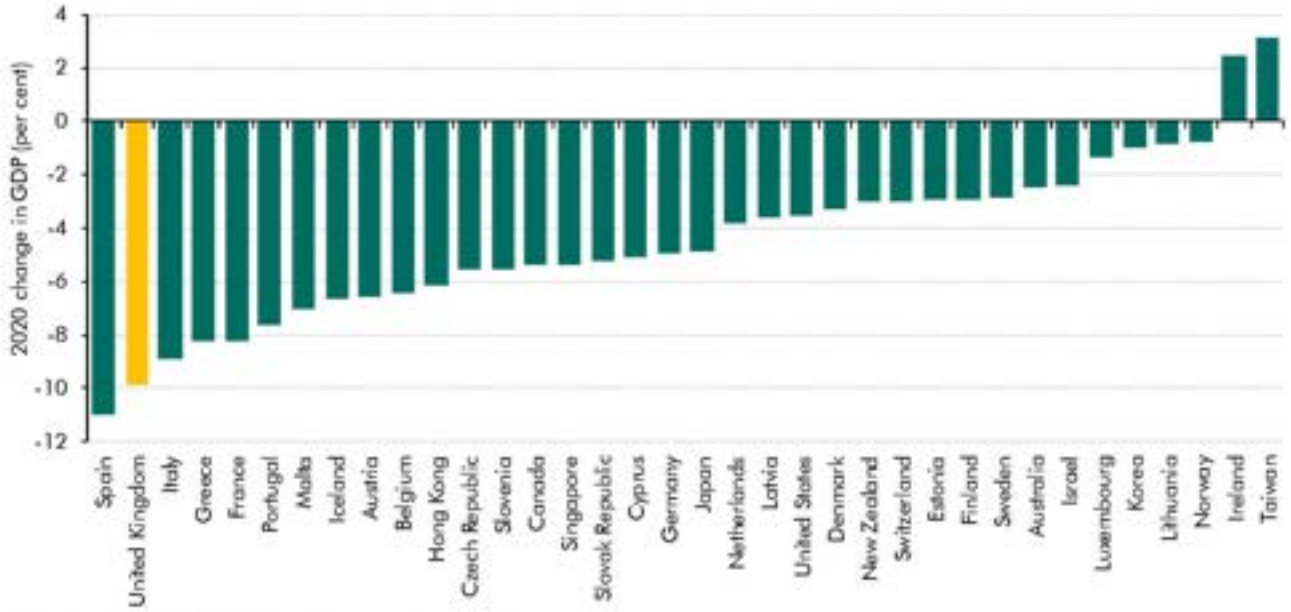
6 Chapter 2 therefore looks back at the fiscal impact of the coronavirus pandemic over the past year and ahead to its potential legacy for the public finances over the medium and long term. It would be premature to draw definitive conclusions about the economic and fiscal

consequences of the pandemic while the virus continues to circulate and mutate, economic activity remains subject to public health restrictions, and extensive fiscal support remains in place. But it is nonetheless instructive to look at the UK's experience to date, in both historical and international context, as a case study in potentially catastrophic fiscal risk.

Economic impact

7 The pandemic brought about the largest and most synchronised peacetime shocks the world economy has faced since the Great Depression of the 1930s. Global output fell by 3.3 per cent in 2020, far greater than the 0.1 per cent fall seen during the global financial crisis in 2009. Regardless of how successfully they insulated themselves from the virus itself, few countries escaped its economic consequences. Almost 90 per cent of economies suffered a decline in output last year, including every advanced economy except Taiwan and Ireland (Chart 2). While the pandemic is not yet over, countries that were able to contain the spread of the virus early have so far typically experienced shorter and shallower downturns and faster recoveries, on average returning to pre-pandemic levels of activity at the start of 2021.

Chart 2: Fall in real GDP in 2020 in advanced economies



Note: Based on IMF definition of advanced economies.
Source: IMF, ONS

8 The UK suffered one of the deepest recessions among advanced economies, with UK GDP falling by 10 per cent in 2020 as a whole, twice the advanced economy average. The relative severity of the downturn in the UK last year compared with other advanced economies, which is only partly reduced when looking at alternative measures that allow for cross-country methodological differences in measuring real output,[1] is likely to be a consequence of our being relatively hard hit by the virus itself (suffering among the highest

[1] Box 2.4 of our March *Economic and fiscal outlook* looked in detail at international comparisons of the economic impact of the pandemic up to the third quarter of 2020. On the current vintages of data, the UK experienced a larger fall in output in 2020 than most other major advanced economies, even after adjusting for differences in the measurement of government output.

rates of infections, hospitalisations, and deaths in 2020), spending more time under stricter public health restrictions (second only to Italy), and being more economically vulnerable to the pandemic due to our large share of social consumption in output (second only to Spain).

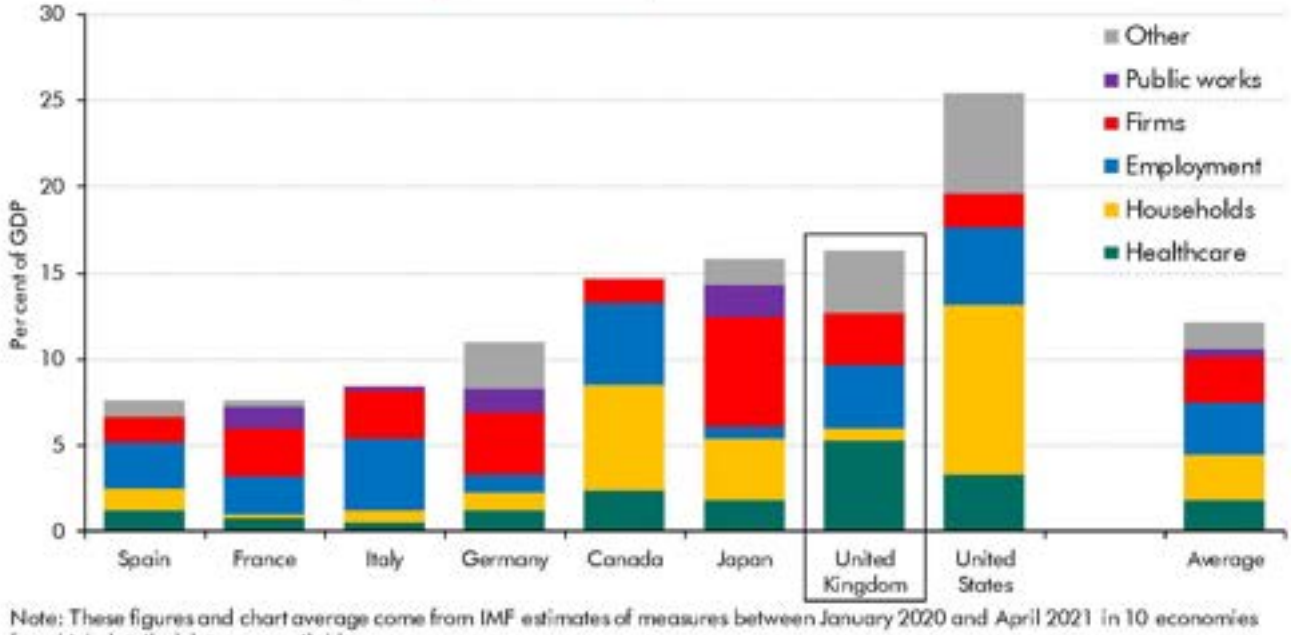
9 However, the economy has also proved surprisingly adaptable and resilient to the coronavirus shock. The relationship between the stringency of public health restrictions and levels of economic output weakened significantly over the course of the pandemic. And economic activity rebounded quickly once those restrictions were eased. So while output after the 2008 financial crisis did not return to its pre-crisis level for more than 4½ years, our latest forecast assumes it will regain its pre-pandemic level by the middle of next year, just over two years since coronavirus arrived in the UK. This economic resilience is likely to reflect the lack of any overheating of the economy going into the pandemic, coupled with the unprecedented amount of fiscal support provided to all parts of the economy which helped keep firms liquid and solvent and employees attached to their employers.

Fiscal impact

10 Reflecting its outsized impact on the UK economy, the pandemic also imparted an extraordinary shock to the UK public finances. At the time of our March forecast we expected it to push government borrowing to a peak of 16.9 per cent of GDP in 2020-21, the highest since 1944-45, and for public sector net debt to reach a peak of 108.6 per cent of GDP in 2023-24, its highest level since 1958-59. The UK saw the fourth largest increase in government borrowing among 35 advanced economies (after Canada, Norway and Singapore) in 2020. And in contrast to what happened during the financial crisis, the bulk of the increase in cash borrowing was the result of discretionary increases in government spending rather than the impact of the crisis on government receipts.

11 The UK's fiscal policy response to the pandemic was large by both historical and international standards (Chart 3). The UK's coronavirus rescue package cost 16.2 per cent of GDP over 2020-21 and 2021-22, almost ten times that provided during the financial crisis in 2008-09 and 2009-10. This was the third largest among 35 advanced economies after the United States and New Zealand, and was also more heavily skewed toward spending on healthcare, making up a third of total pandemic-related spending in the UK versus less than 15 per cent on average across the advanced economies. The relative size of the UK's fiscal policy response is likely to be a consequence of several factors including the pandemic's outsized impacts on the economy and health services, the fact that the UK entered the pandemic with relatively little spare capacity in the health service, and a pre-pandemic system of working-age welfare support that replaced less of the incomes of those losing hours or falling out of work. This extent of the overall rescue package not only protected household and firm incomes, but also tax revenues, which fell much less than one would expect given the dramatic fall in GDP.

Chart 3: Fiscal rescue packages across major economies



Note: These figures and chart average come from IMF estimates of measures between January 2020 and April 2021 in 10 economies for which detailed data are available.
Source: IMF, OBR

12 Pandemic rescue packages in the UK and across the advanced economies made unprecedented use of unconventional fiscal instruments, some of which carry risks for public finances well into the future. Advanced economy governments extended about as much in loans, guarantees, and other forms of quasi-fiscal support in 2020 as they did in conventional tax reliefs and subsidies. The UK made relatively active use of these instruments, guaranteeing 16 per cent of GDP in loans and about half of all lending to small and medium-sized businesses in 2020-21. While their ultimate cost is highly uncertain, our latest forecast assumes that around one-third of the total value of these loans will end up being covered by the taxpayer.

Medium-term fiscal legacy

13 A relatively rapid economic recovery (supported by the UK's early rollout and high take-up of vaccines) and the withdrawal of pandemic-related fiscal support should lead to a sharp fall in borrowing this year. But there are significant risks to the Government's medium-term fiscal plans from the legacy of direct funding pressures that the pandemic may leave behind for public services. Departmental spending plans make no provision for virus-related spending beyond this financial year. Instead, spending totals from 2022-23 onwards were cut by £14½ billion a year in Spending Review 2020 and the 2021 March Budget relative to the sustained rises in departmental spending planned pre-pandemic. At the same time, overall public spending is still forecast to be higher as a share of GDP in the medium term than it was pre-pandemic.

14 The extent to which any additional spending to meet pandemic-legacy pressures leads to higher departmental resource spending (RDEL) overall would depend on choices made at future Spending Reviews, starting with the next one this Autumn. The Government might, for example, keep total spending over the coming years unchanged and choose to allocate less than it otherwise would have done to its pre-pandemic priorities given the changed circumstances. Or it could choose to increase total spending, which would either require further tax rises or put at risk the Chancellor's aim of balancing the current budget and getting debt falling by the middle of the decade.

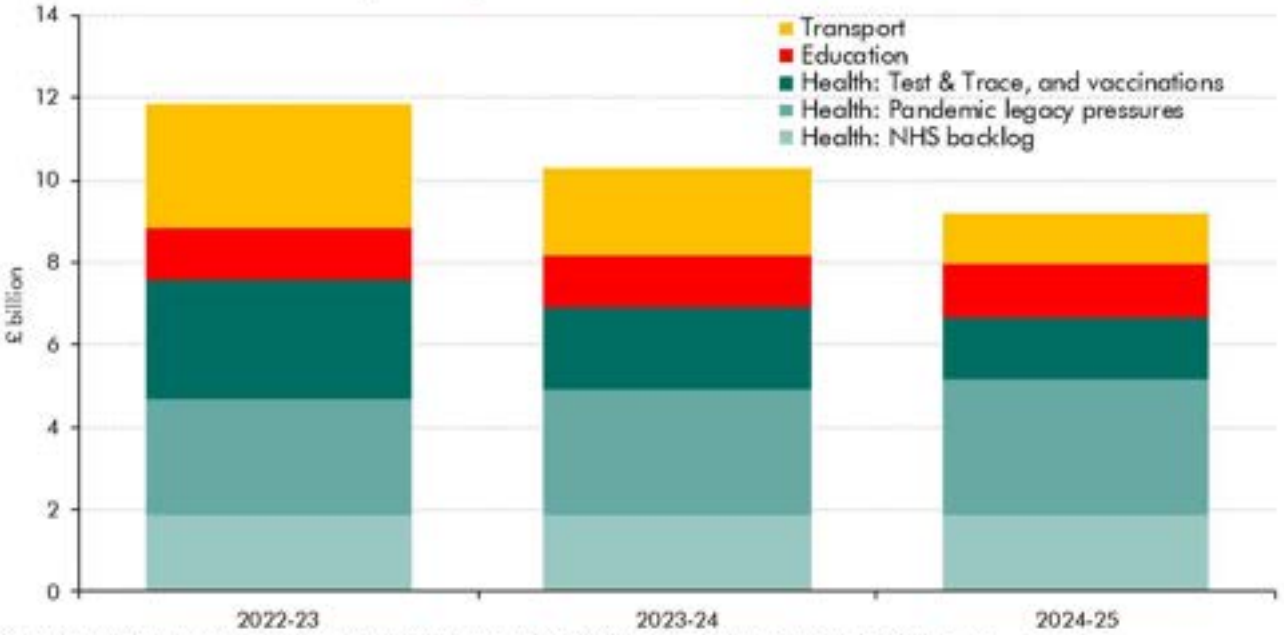
15 In any case, these potential unfunded legacy costs of the pandemic represent a material risk to the public spending outlook. Considering just selected pressures in three major spending areas, the Government could face spending pressures of around £10 billion a year on average in the next three years. These include:

- **Health.** Pressures on health budgets could be around £7 billion a year from the potential need to pay for: standing test and trace and revaccination programmes; the consequences of the pandemic for individuals' physical and mental health; additional spare capacity to cope with possible future outbreaks; and the pandemic-related backlog of treatments.

- **Education.** Schools may require around £1¼ billion a year to enable pupils to catch up on the estimated two to three months of education that they have lost on average during the pandemic, in addition to the £1.4 billion that has been committed since the Budget, with the intention of reviewing the case for further funding in the Spending Review.

- **Transport.** Around £2 billion a year may be needed to fill a 10 to 25 per cent hole in the fare revenues of the new Great British Railways and Transport for London (TfL) if passenger numbers do not return to pre-pandemic levels. The Government has already provided £12.8 billion of direct support to the railways and TfL in 2020-21. However, as of June 2021, passenger numbers on national rail and the London Underground were still down a half on pre-pandemic levels.

Chart 4: Illustrative estimates for selected pandemic-related pressures on departmental resource spending



Note: Assumptions and sources underpinning estimates of individual pressures can be found in Chapter 2.
Source: OBR

Long-term economic legacy

16 Beyond these direct medium-term pressures, the longer-term fiscal risks associated with the pandemic will depend on its lasting impact on potential GDP. As set out in our last two *Economic and fiscal outlooks*, we have so far assumed a 'scarring' effect (defined as the shortfall of potential output relative to the pre-pandemic trajectory at the five-year forecast horizon) of 3 per cent in our central forecast. This scarring results from lower investment, lower labour supply, and lower total factor productivity in roughly equal proportions.

17 Evidence to date on the potential degree of scarring has been mixed. There has been some upside news on the paths of both GDP and investment, but against that there has been downside news on net outward migration over the past year. And there remains considerable uncertainty regarding the future size of the workforce due to continuing lower net inward migration and the effect of the pandemic on participation and hours. Some forecasters, including the Bank of England and IMF, have lowered their estimates of scarring from the pandemic in the light of recent developments. We should learn more about the effects of the pandemic in the coming months as remaining public health restrictions are lifted, the furlough and other business support schemes wind down, and borders reopen. But it is the medium and longer-term outlook for GDP – which will reflect a combination of pandemic effects, Brexit effects, and assumptions about underlying potential output growth – that matters for the sustainability of the public finances.

Climate change

18 Chapter 3 looks ahead to the fiscal risks presented by climate change, and the economic and fiscal implications (both positive and negative) of alternative paths to meeting the Government's legislated goal to reduce net greenhouse gas emissions to zero by 2050. The fiscal risks from climate change can be split into those stemming from global warming itself ('physical risks') and those relating to the move to a low-carbon economy, including the policies to achieve that ('transition risks'). In unmitigated climate change scenarios, the physical risks dominate, whereas the more that is done to mitigate global warming by reducing emissions, the more important transition risks become.

19 Climate change results from several market failures – most importantly that the costs of emissions to current and future generations are not borne by those who produce them today. This can be addressed by applying an appropriate price on carbon (for example via a tax or an emissions trading scheme (ETS)). But there are many other policy challenges to overcome, so the path to net zero can be expected to involve many policy levers on top of carbon taxes and ETSs, including bans and other regulations, and public subsidies and investment. These will all have economic and fiscal implications of one sort or another – either directly (via taxes and spending) or indirectly (via wider economic outcomes).

The transition to net zero

20 By international standards, the UK has made good progress in reducing emissions over the past 30 years, but there are greater challenges ahead. As of 2019, UK greenhouse gas emissions were down 44 per cent relative to 1990. In particular, the source of power generation with the highest emissions – coal – has disappeared from the energy mix thanks to concerted policy efforts. Getting the rest of the way to net zero by 2050 will require us to find ways of overcoming both the technological obstacles to delivering cost-effective carbon removals at scale, and the delivery challenges associated with upgrading insulation and installing low-carbon heating systems in more than 28 million homes.

21 Between now and 2050 the fiscal costs of getting to net zero in the UK could be significant, but they are not exceptional. In net terms they will entail any direct public spending on the cost of transition, receipts *lost* from existing emissions-related taxes (especially fuel duty), receipts *gained* from taxing carbon more heavily, and the indirect effects of different paths for the economy on the public finances. To construct paths for each of these, we draw on scenarios produced by the Climate Change Committee (CCC) for whole economy costs and savings from decarbonisation, and by the Bank of England for the price of carbon necessary to achieve net zero and its economic implications. In the Bank's 'early action' scenario (which we use as our reference scenario), the imposition of a higher and steadily rising carbon price weighs on economic activity, with GDP settling 1.4 per cent below its (purely hypothetical) counterfactual path in which there are no additional climate-related headwinds.

An early action scenario

22 The fiscal impact of achieving net zero in the early action scenario adds 21 per cent of GDP to public sector net debt in 2050-51 (£469 billion in today's terms). That is somewhat smaller than the addition to net debt as a result of the pandemic. It reflects:

- **Net zero public spending.** The CCC puts the cumulative investment cost for the whole economy between now and 2050, plus the operating costs of emissions removals, at £1.4 trillion in 2019 prices. The Government has not said how much of that cost it expects to bear. Our scenario assumes that public spending meets around a quarter of it. When combined with savings from more energy-efficient buildings and vehicles, the net cost to the state is £344 billion in real terms. But spread across three decades, this represents an average of just 0.4 per cent of GDP a year.

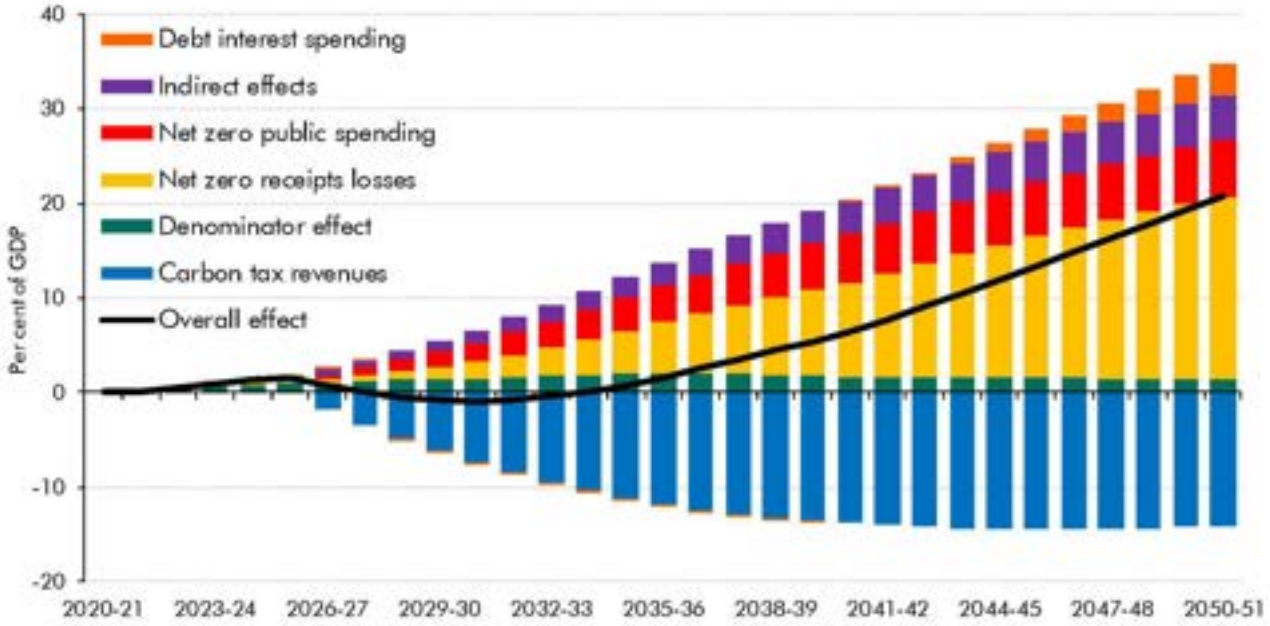
- **Net zero receipts losses.** Fully electric vehicles pay no fuel duty and are exempt from vehicle excise duty (VED), so receipts from both fall almost to zero by 2050-51. Some smaller tax bases (air passenger duty, landfill tax, the plastic packaging tax) are hit too. Overall, receipts worth 1.6 per cent of GDP are lost in 2050-51, with fuel duty accounting for 76 per cent and VED for 18 per cent.

- **Carbon tax revenues.** Our scenario assumes all emissions are taxed, and more heavily, from 2026-27 onwards (which could be achieved by extending the UK ETS or imposing a uniform carbon tax in its place). Based on elements of the Bank and CCC scenarios, the tax rate starts at £101 per tonne (in real terms) and rises steadily to reach £187 per tonne in 2050-51. On this basis, additional carbon tax revenues raise 1.8 per cent of GDP in 2026-27, after which revenues decline steadily to 0.5 per cent of GDP in 2050-51 as falling emissions more than outweigh the effect of the rising tax rate. Towards the end of this time frame revenues are very uncertain, with an increasingly narrow tax base and an increasingly high tax rate, meaning even small differences in the pace of emissions abatement would have large revenue impacts.

- **Indirect fiscal consequences.** We assume that public services and non-climate-related investment are maintained in real terms in the face of modestly lower GDP. That raises public spending as a share of GDP by 0.3 percentage points on average.

- **Debt interest costs.** The higher path for debt increases debt interest spending by increasing amounts, particularly towards the end of the period when fuel duty losses are greatest. Additional debt interest reaches 0.7 per cent of GDP in 2050-51.

Chart 5: Early action scenario: impact on public sector net debt



Source: OBR

Alternative scenarios and sensitivities

23 The economic and fiscal consequences of the transition to net zero are subject to many sources of uncertainty. We therefore also consider alternative scenarios and sensitivities (Chart 6). These capture the implications of:

- **Unmitigated climate change**. The fiscal risks from extreme, unmitigated climate scenarios cannot be quantified with any precision. But to give a sense of the potential orders of magnitude, we produce an illustrative path for debt if average UK temperatures were to rise by around 4°C by the end of this century, relative to the average over the 20 years to 2000. (We use this longer horizon because the UK is relatively insulated from climate change in the next few decades.) This entails greater economic and fiscal costs to adapt to higher temperatures, but more importantly it is assumed to result in progressively more frequent and more costly shocks to the public finances than have historically been the case, reflecting both extreme weather events at home and the spillovers from even greater damages in hotter countries. Relative to a baseline that incorporates only the historical frequency and cost of such shocks, debt ratchets up more sharply to reach 289 per cent of GDP by the end of the century.

- **Delayed action.** To test assumptions about the timing and smoothness of action to deliver the transition by 2050, we use the Bank's 'late action' scenario. Decisive steps to cut emissions globally and in the UK are delayed until 2030, then introduced abruptly to deliver the necessary reductions in the shorter period left to the target date, causing economic disruption and the premature scrapping of some capital. The main differences to the early action scenario are that GDP settles around 3 per cent lower

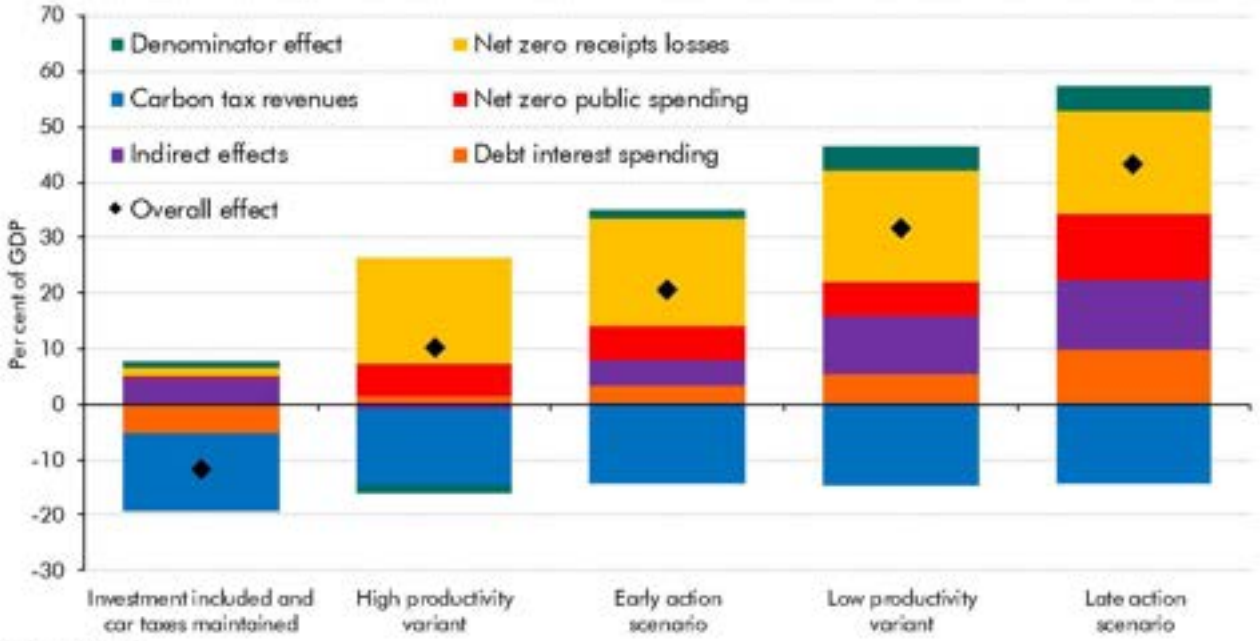
still, while direct public spending costs increase by around a half. Overall, debt in 2050-51 is 23 per cent of GDP higher than in the early action scenario.

- **Uncertain consequences for productivity.** The costs of low-carbon technologies could fall further and faster than assumed, so an optimistic variant assumes decarbonisation actually boosts productivity (by 0.1 percentage points a year). But equally, the costs associated with such a major structural change over a sustained period could easily be greater than assumed – for example, if a technology that has been heavily invested in proves unsuccessful – so a pessimistic variant assumes it weighs more heavily on productivity (by the same margin). In the high productivity variant, the larger economy, and the lower path for public spending as a share of GDP that results, lowers debt by 11 per cent of GDP relative to the early action scenario by 2050-51. The results are approximately symmetrical in the low productivity variant.

- **High versus low public sector share of net zero investment.** Our reference early action scenario assumes the state pays around a quarter of the total direct cost of the transition, but the public sector's share of investment in decarbonisation could vary greatly. At the minimum, it will need to meet the costs associated with public sector buildings and vehicles. At the higher end of the spectrum, it could deliver a much greater share of net zero infrastructure, for example to overcome inertia in areas like the domestic heating transition where progress to date has been slower. Our low spending variant, in which the state bears around an eighth of the whole economy costs, results in debt in 2050-51 being 5.2 per cent of GDP below the early action scenario. In the high spending variant, in which the state bears two-fifths of the cost, debt rises to 5.9 per cent of GDP above the early action scenario.

- **Potential for offsetting fiscal policy adjustments.** Rather than increase total expenditure to pay for the costs of decarbonisation, the Government could choose to allocate the additional public investment from within its existing spending envelope. And rather than allow existing taxes on motoring to fall to zero, the Government could maintain the tax burden on motoring by levying other taxes such as a road-user charge. If net zero investment were allocated from within the baseline, debt would be 8.4 per cent of GDP lower in 2050-51 than if it were all additional (as it is in the early action scenario). And if the tax burden on motoring were maintained (in contrast to the early action scenario) it would be 24 per cent of GDP lower. Doing both would leave debt 32 per cent of GDP lower in 2050-51, which would actually be 12 per cent of GDP lower than the hypothetical baseline, reflecting the gains from additional carbon tax revenues.

Chart 6: Climate scenarios: impact on public sector net debt in 2050-51



Source: OBR

Cost of public debt

24 Chapter 4 considers the fiscal risks associated with the Government's elevated stock of debt. This stock is both the product of past fiscal risks having crystallised and a source of future fiscal risks that could. The risks that this poses to the fiscal outlook depend on the future path of interest rates and the speed with which any changes in them are reflected in the Government's debt servicing costs. Over the past four decades, net interest payments by the Government have fallen fourfold from 3.8 per cent of GDP in 1980-81 to 0.9 per cent in 2020-21, despite the debt-to-GDP ratio more than doubling from 40 to 100 per cent in that time. This reflects the downward drift in global and UK short and long-term interest rates to historically low levels, both in absolute terms and relative to the growth in GDP.

25 But higher post-pandemic government debt, combined with a shorter effective debt maturity as a by-product of quantitative easing, leaves the UK's public finances more exposed, and more quickly, to increases in interest rates. The Government's current fiscal plans, which delivered a stable medium-term outlook for underlying public sector net debt as a per cent of GDP in our latest forecast, were conditioned on rates remaining low, in line with market expectations. But were they to return to historically more normal levels, it would become significantly more expensive to service a given stock of debt. The Government acknowledged this risk by making explicit reference to monitoring debt servicing costs in the fiscal targets that guided the current Chancellor's 2020 Budget.

26 As a starting point for our evaluation of the risk of future interest rate rises, we review the various explanations that have been put forward for the decline in the cost of government borrowing over the past thirty years. It is likely that demographic developments have played some role, as well as slower productivity growth and increased preference for safe assets. But

there is considerable uncertainty about their respective contributions to the fall and their permanence. While some of these factors are likely to remain in place in the future, justifying our central forecast that borrowing costs will remain relatively low, others may reverse. Given the uncertainty about the sources of the past decline, it is prudent to evaluate the risks to the public finances were rates to rise. We therefore present several scenarios that illustrate the consequences of assuming different future paths for borrowing costs, inflation, and GDP growth for the public finances.

Higher global real interest rates

27 Our first two scenarios examine the fiscal impact of a globally driven rise in real interest rates. In the first of these ('higher R and G'), a gradual rise in real interest rates ('R') of 2.5 percentage points is associated with a similar pick-up in productivity growth ('G'). In the second scenario ('higher R'), the higher interest rates occur not as a consequence of a pick-up in productivity growth but as a consequence of a shift in investor preferences towards riskier assets and away from government bonds.

28 In the first and more benign scenario, borrowing reaches 5.1 per cent of GDP in 2050-51 (versus 2.9 per cent in the baseline), pushed up by higher interest rates as net interest payments rise to 3.3 per cent of GDP – a level last seen in 1985-86. But that is offset by higher growth so that the debt-to-GDP ratio falls slightly below the baseline, although it remains above pre-pandemic levels at the end of the scenario in 2050-51. In the second and more challenging scenario, higher interest rates gradually feed through to the effective interest rate paid on government debt, pushing borrowing up to almost 7 per cent of GDP in 2050-51. Without the offsetting gain from faster growth, debt hits 139 per cent of GDP by 2050-51, its highest level since 1954-55.

Higher inflation

29 Borrowing costs could rise not only because real interest rates rise but also because inflation rises. The recent strong rebound in activity, expansionary macroeconomic policies (especially in the US), and inflation outturns have prompted speculation of a reappearance of inflation. We therefore consider two inflation scenarios. In the first, a burst of domestically generated inflation of 5 per cent necessitates a temporary rise in Bank Rate to bring inflation back to the 2 per cent target. In the second, consistent either with continued sanctioned inflation overshoots or an increase in the target (as some commentators have advocated), inflation runs persistently at 4 per cent, with a corresponding rise in short-term interest rates and somewhat larger rise in long-term bond rates reflecting a higher inflation risk premium.

30 The fiscal implications of these scenarios demonstrate that inflation is, in fact, no longer a very effective way to reduce the debt-to-GDP ratio, reflecting both the shortening of the effective maturity of public debt as a by-product of quantitative easing and the relatively high proportion of index-linked debt in the UK. The temporary burst of inflation has only a modest impact on the debt-to-GDP ratio, which initially falls more quickly than the baseline mainly due to primary spending being held constant in cash terms. By 2050-51, debt reaches 95 per cent of GDP, just 2 per cent of GDP below the baseline. With a persistent rise in inflation,

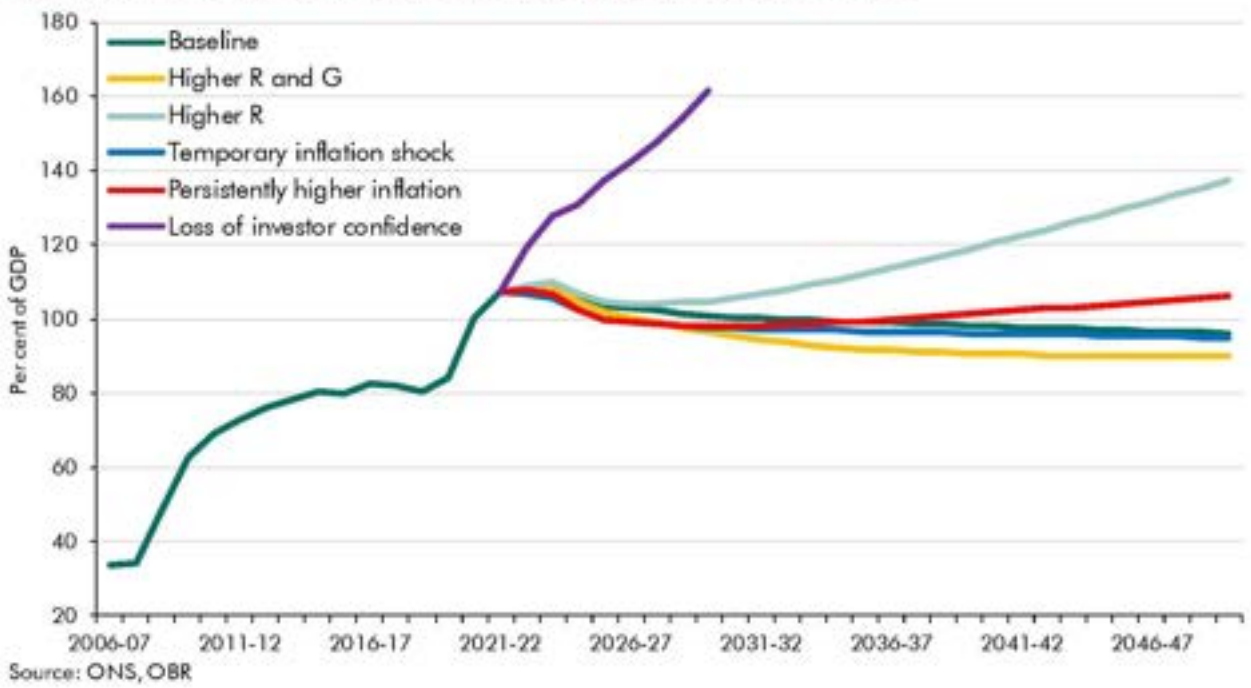
there is a marginal improvement in the debt-to-GDP ratio in the first 13 years as inflation erodes the real value of the nominal debt (though again moderated by the shortening of the effective maturity of debt). But in the long run, the debt-to-GDP ratio actually rises to 107 per cent of GDP by 2050-51 (10 per cent of GDP above the baseline) as a result of the extra inflation risk premium being paid on the government's borrowing.

A loss of investor confidence

31 Our final scenario explores the extreme case of a loss of investor confidence in the UK's creditworthiness that causes a flight from UK government bonds. This leads to a vicious circle where rising debt raises borrowing costs, which in turn increase the rate at which debt rises. In this scenario, an adverse shock, similar in magnitude to that experienced in the financial crisis, and a loss of investor confidence lead to a sterling depreciation and a rise in the risk premium on gilts. Higher inflation and the falling pound also force the Bank of England to raise Bank Rate to 4 per cent. The higher borrowing costs mean that growth remains weak. The escalating crisis also forces the Government to borrow at shorter maturities so that higher market rates feed through into debt interest costs even more quickly.

32 Borrowing increases throughout the scenario due to a worsening primary balance as the economy shrinks, as well as escalating interest costs. Borrowing reaches 15 per cent of GDP in 2029-30, close to its peak last year. The adverse feedback loop between higher debt and higher gilt rates leads to steadily rising interest costs, with the debt-to-GDP ratio increasing in every year. By 2029-30, the average gilt rate hits 10 per cent – a rate last seen in 1991. We end the scenario in 2029-30 when the government's interest costs reach 9.5 per cent of GDP, above any level seen in war or peacetime.

Chart 7: Cost of public debt scenarios: public sector net debt

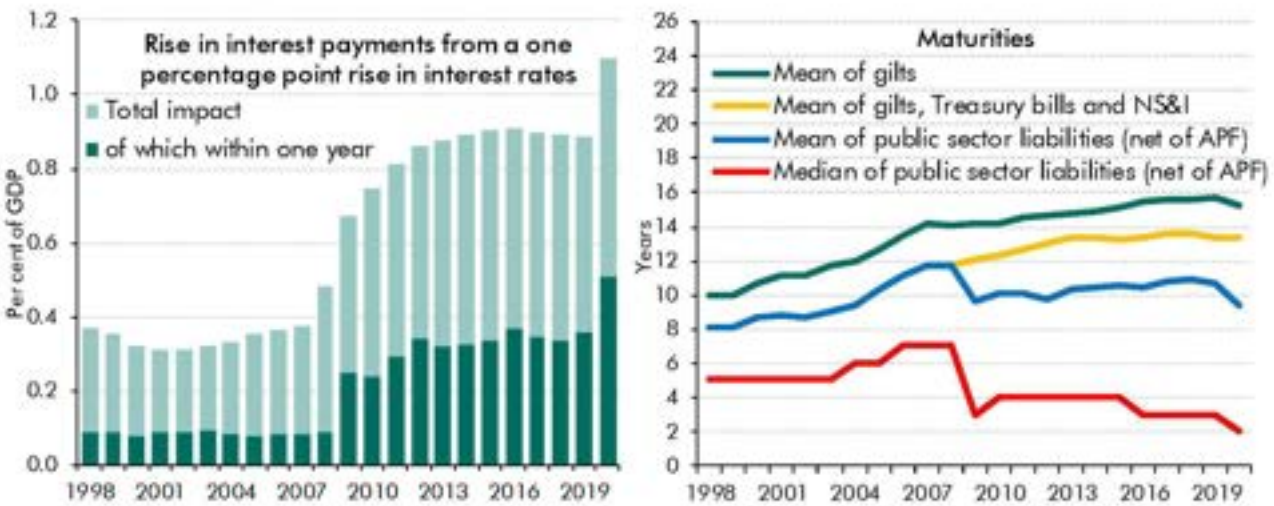


Source: ONS, OBR

Sensitivity to interest rate changes

33 These scenarios illustrate the greater sensitivity of public debt to future changes in its cost. This is partly due to the trebling in the debt-to-GDP ratio since just prior to the financial crisis. However, it is also the result of the shortening of the effective maturity of that debt as a by-product of quantitative easing, which has replaced relatively long-dated gilts with (less expensive) central bank reserves carrying an overnight rate of interest. The net result has been a shortening of the median maturity of the consolidated liabilities of the public sector from seven to two years since 2008 (the red line in the right panel of Chart 8). That contrasts with the *rise* in the mean maturity of the total stock of gilts (in both public and private hands) from 14 to 15 years over the same period. The proportion of debt on which interest rates respond within a year has more than doubled over that time, which combined with the debt-to-GDP ratio being almost three times higher, has made the first-year fiscal impact of a one percentage point rise in interest rates six times greater than it was just before the financial crisis, and almost twice what it was before the pandemic, just 18 months ago.

Chart 8: Sensitivity of interest payments to a rise in interest rates



Note: Consolidated public sector liabilities are proxied here by the stock of Bank reserves, Treasury bills, NS&I products and gilts net of those held in the APF. The total impact of a one percentage point rise in interest rates is on consolidated public sector liabilities. The impact within one year is on liabilities with a maturity of less than 1 year (gilts net of APF holdings with a remaining maturity of under one year, Bank reserves, Treasury bills and NS&I). The median shows the year in which half of the outstanding public sector liabilities would be impacted by a change in interest rates.
Source: Bank of England, Heriot-Watt/Faculty and Institute of Actuaries Gilt Database, ONS, OBR

Other fiscal risks

34 While this report focuses on three large and looming threats to the public finances, the array of other fiscal risks highlighted in previous *FRR*s has not evaporated. Indeed, as history warns can happen, the pandemic has triggered the crystallisation of several of these risks, aggravated many others, and even diminished a few. In Chapter 5 we set out how these other risks have evolved since our previous *FRR* in 2019 and how our full risk assessment has changed after factoring in both those changes, and the major risks discussed above.

35 We have recast and consolidated some of the risks that were identified on our 2019 risk register, so **for this report we start from a total of 97 risks**. Of these, we find that:

- **14 have crystallised** including weaker productivity growth, lower net migration, and the declining proportion of spending subject to firm DEL controls. Of these, **13 remain active** risks in future (including normal cyclical downturns, the deterioration in public sector net worth, and cost overruns for major projects) and **1 has been removed** (the balance sheet risk relating to the classification of housing associations).

- **19 have increased**, including those related to higher future health and social care spending as a result of the pandemic, the longer-term sustainability of the fuel duty tax base in light of the bringing forward of the ban on petrol-driven cars, and the pandemic-driven increase in the non-payment of taxes due.

- **11 have decreased**, including the tendency for fiscal policy to respond asymmetrically to movements in our underlying forecasts following the tax rises announced in the March Budget, the risks associated with persistent household financial deficits in light of the savings accumulated by some during the pandemic, and the loss of revenue from people moving to more lightly taxed forms of employment status.

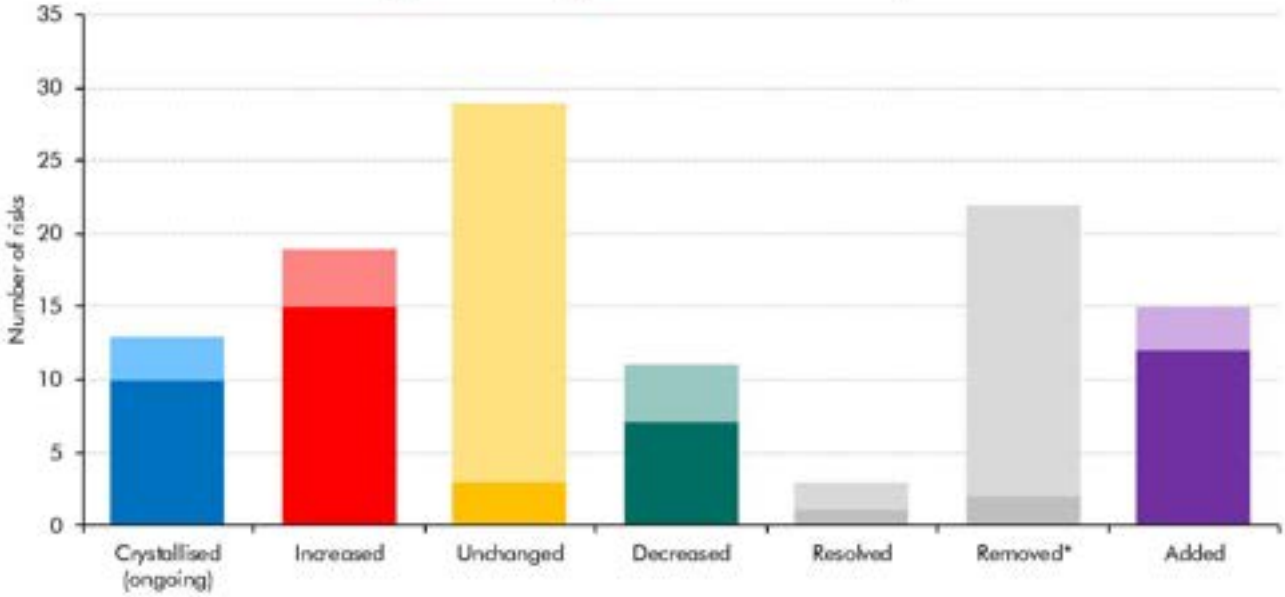
- **29 remain unchanged**, including our broad assessment around risks associated with the financial sector which has so far weathered the coronavirus storm, clean-up costs for nuclear plants, and those around stated policy aspirations.

- **3 have been resolved and removed** from the register, including those around the possibility of a 'no deal' Brexit and the rise in local authorities' prudential borrowing for commercial property purchases.

- **21 have been removed for other reasons** including their being unquantifiable, superseded by analysis presented in this report, or consolidated with other risks (taking the total number of risks removed from the register to 25).

36 Finally, **15 risks have been added** in this report, including nine arising from the coronavirus pandemic, three associated with climate change, two relating to the cost of public debt and a final one on the threat posed by a potential cyberattack. This takes the **total number of risks in our 2021 register to 87**. Chart 9 depicts these changes as well as the number of risks that have been affected to some extent by the pandemic.

Chart 9: OBR fiscal risk register: changes since our 2019 report



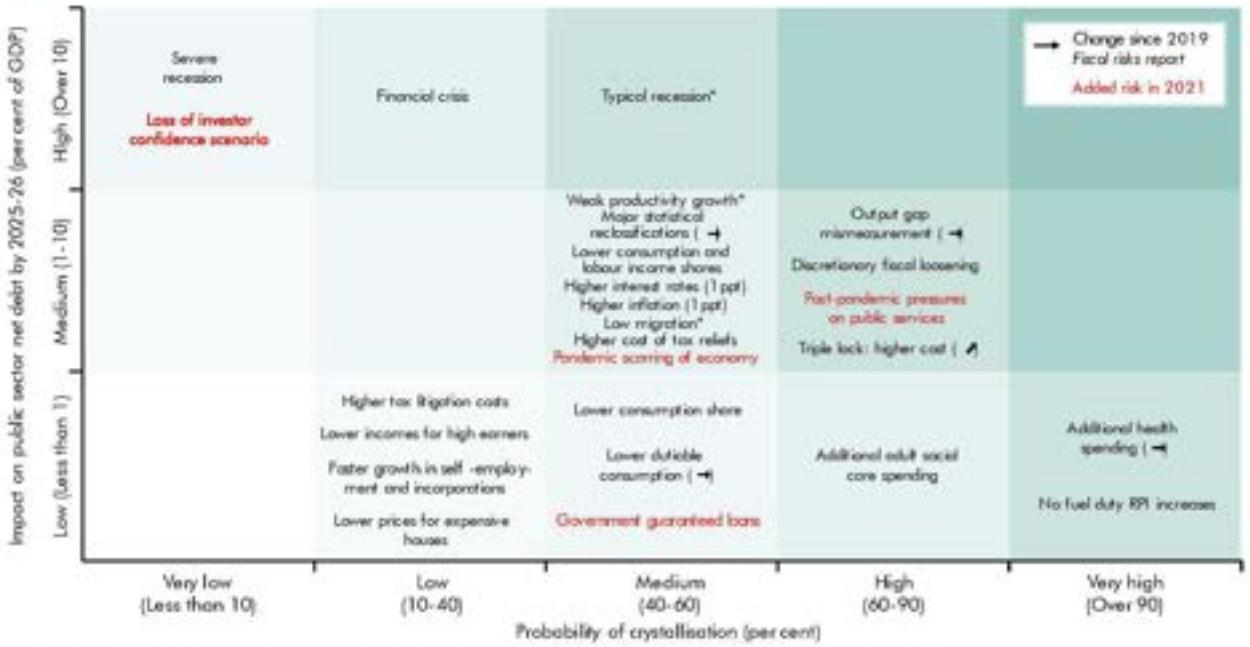
Note: Darker shaded portions show the number of risks within each category that have been affected to some extent by the pandemic.
* The one risk that has crystallised and is no longer on the register is included in 'Removed'.
Source: OBR

37 Reflecting the correlated nature of fiscal risks, of the 97 risks from 2019, 38 have been affected to some extent by the coronavirus pandemic. This includes around half of the economy risks, two-thirds of the public spending risks, half of the risks relating to the Government's balance sheet and one-third of revenue risks. These include the pandemic-related pressures on health spending and drop in net migration described above, as well as the interaction between pandemic-driven fluctuations in earnings growth and the state pensions triple lock that could cost £3 billion a year relative to our March forecast.

38 However, it is notable that one major and recurrent source of fiscal risks for the UK, that of a financial crisis, has not crystallised despite the strains of the pandemic. This reflects both the strengthening of capital requirements and other bank regulations since the financial crisis, as well as the extensive and pre-emptive action taken by the Government and Bank of England that protected household incomes, kept firms liquid, and maintained the supply of credit.

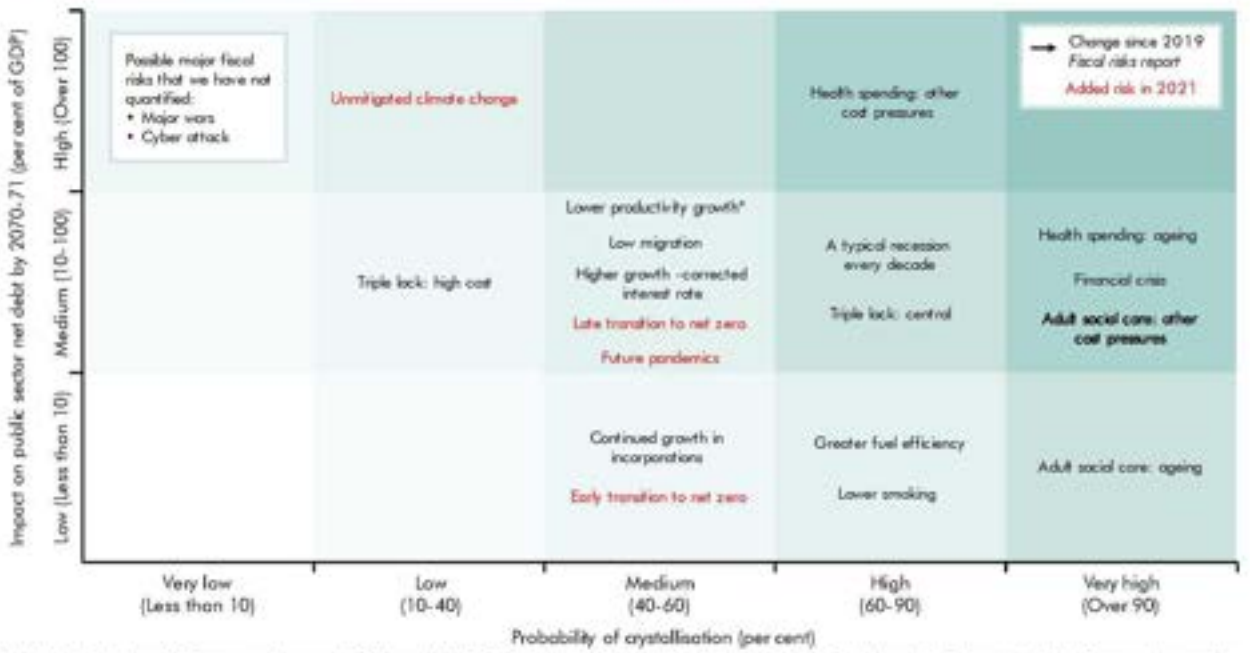
39 Alongside this report we have also published an updated and comprehensive risk register on our website, listing all the fiscal risks discussed in this report, our assessment of their size and likelihood, and, for those identified in our 2019 report, any changes since then. Figures 1 and 2 summarise the main risks to our medium-term fiscal forecasts and to long-run sustainability respectively, categorised by size and likelihood.

Figure 1: Sources of fiscal risk over the medium term



Note: '2019 stress test: no-deal Brexit' has been resolved and 'Low migration' has crystallised and therefore have been removed.
* denotes crystallised but remains active
Source: OBR

Figure 2: Sources of risk to fiscal sustainability



Note: We judge the 'Higher growthcorrected interest rate' risk to have increased but has moved from high to medium impact due to improved scenario estimations. * denotes crystallised but remains active
Source: OBR

Lessons for understanding fiscal risks

40 Our foregoing analysis of the experience of the pandemic, the threat posed by climate change, and the risks to the cost of public debt, points to 10 lessons for understanding and responding to potentially catastrophic fiscal risks:

1 **Catastrophic risks are real and may have become more frequent.** Just two decades into this century, advanced economies have now experienced two 'once in a century' economic shocks. And increasing economic and financial interconnectedness may make future shocks both more frequent and more severe. Putting greater emphasis on the analysis of risks and the uncertainty surrounding our central projections will help ensure that policymakers can incorporate these risks into their decision making and the public understand the trade-offs being made.

2 **Economic shocks affect both supply and demand.** While conventional cyclical shocks affect mainly demand, recent shocks – the financial crisis, Brexit and the pandemic – have each hit both supply and demand. The principal focus of the Government's coronavirus rescue package was the preservation of supply-side capacity while demand was deliberately suppressed. Tackling climate change requires action to address not only the (excessive) demand for carbon but also (inadequate) supply of net zero technologies. And understanding risks to the cost of government debt requires investigation of the drivers of supply *and* demand for gilts. We need to improve our understanding and modelling of the supply-side impacts of shocks and policies.

3 **Global interconnectedness can be both an asset and a liability.** The UK's openness exposes it to risks emanating from abroad, but it also attracts the international talent and investment that has made it a world leader in genomic sequencing and vaccine research and development. Digital connectivity enabled our economy to continue to operate through the pandemic, but also renders it vulnerable to cyberattacks. And rising overseas demand for UK government debt has helped to keep gilt yields low, but also exposes the public finances to sudden changes in international investor sentiment.

4 **While it is difficult to predict when catastrophic risks will materialise, it is possible to anticipate their effects**. While a global pandemic topped government risk registers for over a decade before coronavirus arrived, it attracted little attention from the economics community. But previous epidemics and pre-pandemic modelling by official bodies provided a clear indication of how economies might be affected. Similarly, the tail risks associated with extreme climate change or spiralling debt servicing costs scenarios can be quantified, even if we do not know precisely when they might occur.

5 **When investing in risk prevention, governments have a tendency to 'fight the last war'**. The regulatory response to the 2008 financial crisis helped prevent the pandemic from triggering another financial crisis. But post-crisis fiscal consolidation also cut advanced country expenditure on preventative health programmes. Dealing with post-pandemic economic and fiscal pressures may hamper governments' efforts to invest the relatively modest sums need to avoid the much greater cost of unmitigated climate change.

More regular and comprehensive horizon-scanning could help to identify where the next crises could emerge and how they can be prevented or mitigated.

6 **There are advantages in preventing or halting a process that involves rapidly escalating costs early**. While economic theory and practice emphasises the option value of delaying decisions, this can be suboptimal in the face of rapidly rising costs. Pandemics, climate change, and public debt dynamics are all subject to amplifying feedback mechanisms and tipping points that can result in spiralling and irreversible costs that put a premium on acting early. Countries that acted quickly to contain the virus have so far experienced fewer deaths, shallower recessions, and faster economic recoveries. In making the transition to net zero, delaying decisive action to tackle carbon emissions by ten years could double the overall cost.

7 **People appear willing to make sacrifices for a clearly defined public good**. Levels of compliance with public health restrictions and vaccine take-up in the UK have been surprisingly high. In total, the UK experienced a 10 per cent loss of output and committed 12 per cent of GDP in public funds in order to combat the pandemic in 2020. The annual economic and fiscal costs of tackling other potential catastrophic risks, like climate change, are likely to be just a fraction of this.

8 **Economies can sometimes adapt remarkably quickly to structural changes.** While the initial output loss from lockdowns was greater than many predicted, most were also surprised by the speed at which the economy adapted and rebounded as restrictions were lifted. Prior investments in digital infrastructure and services were critical to enabling this transition, as was fiscal support to households and firms. The path to net zero will also require more gradual adaptation to new technologies and changes in behaviour. But fiscal policy could also play a role in facilitating the transition.

9 **Fiscal policy can and needs to be more nimble than in the past.** Across advanced economies the fiscal policy response to the pandemic was unprecedented in its speed, scale, and novelty (partly reflecting constraints on monetary policy). This added over 20 per cent of GDP to debt, but also prevented the much greater economic costs associated with not intervening. Similar fiscal policy nimbleness and creativity may be required to support an economy-wide transition to net zero. And flexibility in both deploying, and withdrawing, fiscal support is likely to be critical if governments are to respond to future shocks without jeopardising debt sustainability in the long run.

10 **In the absence of perfect foresight, fiscal space may be the single most valuable risk management tool.** Throughout its history, the UK has relied on its ability to borrow large sums quickly in order to respond to major economic and political threats. It was able to do so courtesy of its relatively low levels of public indebtedness, deep and liquid domestic capital markets, and by maintaining the confidence of international investors in its long-run creditworthiness. In the face of an array of major economic and fiscal risks, policymakers must trade off making significant investments in the prevention of specific potential threats with preserving sufficient fiscal space to respond to those risks that it did not anticipate or could not prevent.

1 Introduction

Background

1.1 The UK has been a leader in the analysis of fiscal risks in recent years.[1] The legislation establishing the OBR has always required us to set out the main risks that we consider to be relevant in any report that we produce.[2] From our establishment in 2010, our biannual *Economic and fiscal outlooks* (*EFO*) have regularly featured fan charts, sensitivity analysis, and alternative scenarios to illustrate the risks around our central forecasts. The Treasury's September 2015 review of the OBR expanded our remit in this area by recommending that we *"produce a new report on fiscal risks, extending existing analysis and meeting the recommendations of the International Monetary Fund's Fiscal Transparency Code"*.[3] Parliament reflected this in the October 2015 edition of the *Charter for Budget Responsibility*. And the IMF's November 2016 Fiscal Transparency Evaluation of the UK subsequently recommended that the report should represent *"a comprehensive and quantified fiscal risk statement that includes all major risks to the fiscal position"*.[4]

1.2 The *Charter* tasks us with producing a biennial report on *"the main risks to the public finances, including macroeconomic risks and specific fiscal risks"*. We published our first *Fiscal risks report* (*FRR*) in July 2017. Several countries produce regular fiscal risk assessments, but most are undertaken by finance ministries or cabinet offices. The UK is unusual in outsourcing it to an independent fiscal institution, thereby boosting objectivity and transparency in the analysis of fiscal risks. And the UK is also unique in setting a legal requirement for the Treasury to respond formally to our *FRR* within a year of its publication, thereby encouraging accountability for the Government's management of those risks.

1.3 This chapter describes our approach to analysing and reporting on fiscal risks. It starts by defining fiscal risks and distinguishing between those risks that governments are exposed to in normal times and the large, and potentially catastrophic, shocks that governments face from time to time. It then considers whether the latter type of risk may be becoming more relevant for advanced economies in the twenty-first century, and how this motivates the content of our third *FRR*.

[1] This has been recognised by both the IMF and the OECD. See, for example, *"The UK Fiscal Risk Report raises the bar on the assessment and quantification of fiscal risks to a new level"* in *Stressing the public finances – the UK raises the bar*, IMF Public Financial Management blog, July 2017, and, *"It is commendable that the OBR has been at the forefront of this type of analysis"*, OECD, *Independent Fiscal Institutions Review of the OBR*, September 2020.
[2] Section 4, subsection 6(b) of the 2011 Budget Responsibility and National Audit Act.
[3] *HM Treasury review of the Office for Budget Responsibility, Led by Sir Dave Ramsden, Chief Economic Adviser to HM Treasury*, HM Treasury, September 2015.
[4] *United Kingdom: Fiscal Transparency Evaluation*, IMF, November 2016.

Our approach to analysing fiscal risks

What is a fiscal risk?

1.4 The International Monetary Fund (IMF) defines a fiscal risk as *"the possibility of deviations of fiscal outcomes from what was expected at the time of the Budget or other forecast"*.[5] On this basis, we would define a fiscal risk as any potential deviation from the 5-year-ahead central forecasts for public sector spending, receipts, borrowing and debt contained in our *EFOs*, and from the corresponding 50-year-ahead projections in our *Fiscal sustainability reports* (*FSR*). We are required by Parliament to base these forecasts and projections on currently stated Government policy, although in most cases current policy is much less clearly defined over the long term than over the medium term. Where appropriate, we consider policy risks – areas where government statements or past behaviour point to likely future policy changes (as we do throughout this report).

1.5 On this definition, however, what constitutes a fiscal risk depends crucially on which developments in the public finances are incorporated into our central projection and which are regarded as potential deviations. Given the sensitivity of long-term projections to these sorts of judgements, we focus on risks around our central forecast over the medium term, but on risks to fiscal sustainability (rather than around our latest central projection) over the longer term. This ensures that we do not end up ignoring some of the most important long-term risks – notably pressures on health spending – simply because we already assume they crystallise gradually over time.

1.6 Our focus on risks to sustainability also implies an asymmetry of approach – we are more interested in potential 'bad news' than 'good news'. Experience over time and across countries suggests that shocks to the public finances (especially big ones) are more likely to be adverse than beneficial – as the cost of the coronavirus pandemic has illustrated so dramatically – and that governments are usually quicker to spend unexpected windfalls from good news than they are to anticipate and provision for unexpected costs from bad news.

1.7 The definition of fiscal risk we use in this report focuses on surprises relative to forecasts and pressures on fiscal sustainability. But it is important to remember that the purpose of much of government activity is to pool risks that society has decided (via the political process) would be better carried by the state than borne by individuals (either directly or through private insurance markets). For example:

- **During normal times**, the state provides a degree of 'social insurance' to its citizens. For example, the NHS takes on the health costs people would otherwise face when they fall ill; state pensions put a floor under pensioners' incomes; and universal credit reduces the risks associated with periods of unemployment or on low pay.

- **During catastrophes and other crises**, states often take on a much broader range of costs as large risks crystallise. For example, during the current pandemic the

[5] IMF Fiscal Affairs Department, *Fiscal risks – sources, disclosure and management*, 2009.

Government has at some point paid the salaries of over 8.7 million furloughed staff; guaranteed loans to 1.6 million businesses; and provided grants to support the incomes of 2.6 million self-employed people.

Our first two *Fiscal risks reports*

1.8 Our first two *FRRs* considered both sorts of risk, devoting much of their analysis to the risks facing government in normal times while noting that periodic shocks were inevitable:

- ***FRR 2017*** attempted a comprehensive survey of the universe of risks to the public finances, ranging from whole economy risks emanating from macroeconomic shocks and financial crises down to the long tail of generally smaller risks to individual components of the public finances (from the potential costs of reforming adult social care to the potential loss of fuel duty receipts as cars become more fuel efficient). It also included a fiscal stress test based on a severe recession scenario used by the Bank of England to assess the financial resilience of the UK banking sector. We identified 57 issues for the Government's response ranging across this spectrum. In its July 2018 *Managing fiscal risks* publication, the Government detailed its approach to these issues and the steps it had taken in several areas to enhance its risk management.

- ***FRR 2019*** reviewed the risks we had previously identified and the Government's response, which allowed us to assess the degree to which risks had intensified or abated. We also looked more deeply into several key risks that had been covered in less depth, or not at all, in our first report, including: fiscal policy risks, the 'growth-corrected interest rate', and climate change. The report included another fiscal stress test, this time based on an IMF no-deal Brexit scenario. Our report again raised a set of issues for the Government to consider in its response, but this was overtaken by the exigencies of the pandemic. As such, the Government's formal response to our 2019 *FRR* in July 2020 understandably constituted a brief written statement to Parliament.[6]

This *Fiscal risks report*

1.9 Unlike previous editions, this third *FRR* focuses not on the risks that the government faces in normal times but the exceptional, systemic shocks that can potentially lead to economic and fiscal crises. The reasons for doing so are self-evident. The coronavirus pandemic has provided a stark reminder that such 'catastrophic' risks, while inherently more difficult to anticipate and analyse, are real. These include financial crises, severe recessions, extreme weather events, destructive cyberattacks, pandemics, and major armed conflicts. While most advanced economies have been largely spared such catastrophic risks in the latter half of the twentieth century (and certainly by comparison with the first half),[7] there are several

[6] Chancellor of the Exchequer, *OBR 2020 Fiscal Sustainability Report and response to the OBR 2019 Fiscal Risks Report*, 15 July 2020.
[7] This is not to say that advanced economies did not experience any shocks in the second half of the twentieth century. The Korean War in the late 1940s and early 50s; the Vietnam War in the 1960s and 70s; the oil shocks of the 1970s; the bursting of the Japanese bubble in the late 1980s; Black Wednesday in the UK, and the Scandinavian and Asian financial crises of the 1990s, all had significant adverse economic and fiscal impacts on the economies most directly affected. But none of these matched either the 2008 financial crisis or 2020 coronavirus pandemic in the depth of the fall in global output or number of countries adversely affected.

reasons to believe that they are increasingly susceptible to large and disruptive economic and fiscal shocks in the twenty-first. The next section explores why this might be so.

1.10 This edition of the *FRR* does not include a new scenario-based fiscal stress test, but the discussion of the fiscal impact of the pandemic in Chapter 2, and the more severe climate change and debt scenarios in Chapters 3 and 4, serve the purpose that stress tests have in our previous *FRRs*. And the update on other fiscal risks in Chapter 5 underscores one of the central insights that those stress tests provided – that fiscal risks are highly correlated and governments can face a cascade of crystallising risks when hit by large shocks.

Is the world becoming a riskier place?

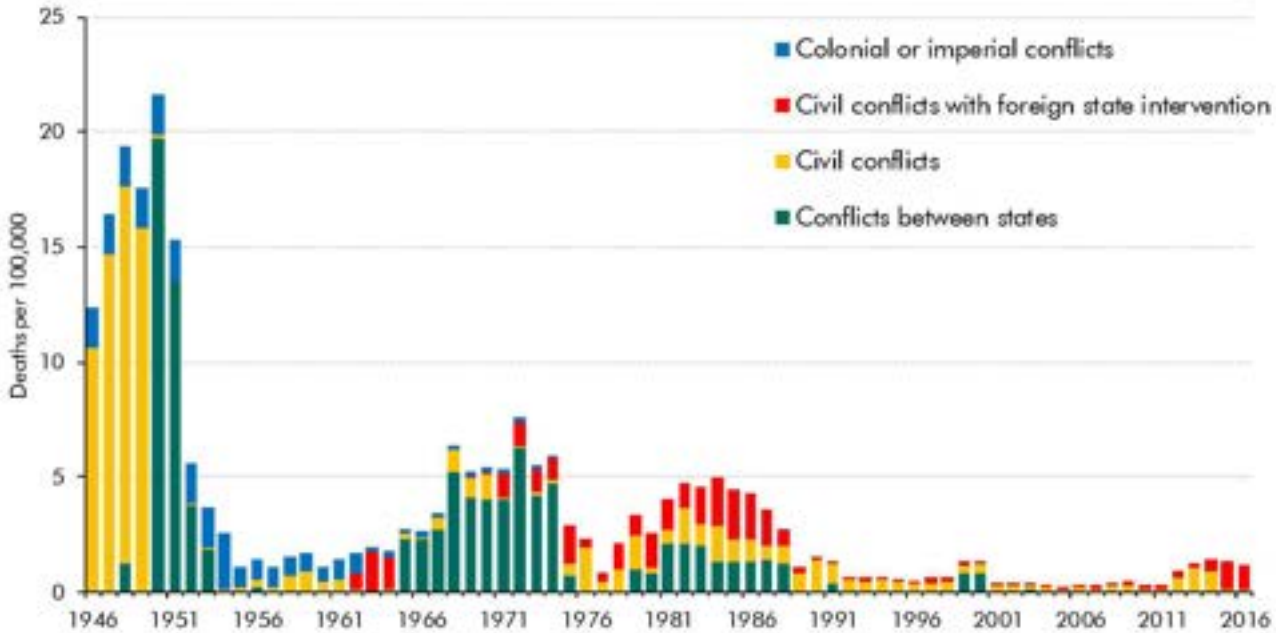
1.11 So far this century, the UK has been hit by two 'once in a century' economic shocks in the form of the 2008 financial crisis and 2020 coronavirus pandemic. While two observations do not constitute a trend, these events raise important questions for fiscal forecasters and policymakers about the nature of risk in the twenty-first century and how to respond to them – specifically: Are catastrophic risks becoming more likely? Are catastrophic risks becoming more severe? Are countries becoming more exposed to catastrophes happening elsewhere?

Incidence of catastrophic risks

1.12 The first two decades of this century have shown that major shocks to advanced economies can emanate from a variety of sources. The incidence of some of these shocks, like the earthquakes in Japan and New Zealand, depend on natural forces outside human control. The incidence of other major risks, such as cyberattacks, are entirely the product of human action. For many risks, such as pandemics and climate change, the incidence of shocks is a product of the interaction of people with their environment. Compared to the previous century, at least one important source of potentially catastrophic risk, that of armed conflict between states (especially nuclear powers and their close allies), appears to have diminished (Chart 1.1).[8] That said, deaths from civil conflicts within states (including with foreign state intervention) have remained significant throughout the first two decades of this century.[9] And such conflicts can put pressure on advanced economies by generating large refugee flows and providing havens for international terrorist groups.[10]

[8] Compared with the first half of the twentieth century, the decline in deaths due to inter-state conflicts is of course much greater. Indeed, more battle-related deaths were recorded during the two World Wars than were recorded in the entire period since 1946.
[9] Deaths have been largely concentrated in the Middle East in the past decade.
[10] HM Government, *National Risk Register, 2020 Edition*, 2020.

Chart 1.1: Battle-related deaths in state-based conflicts

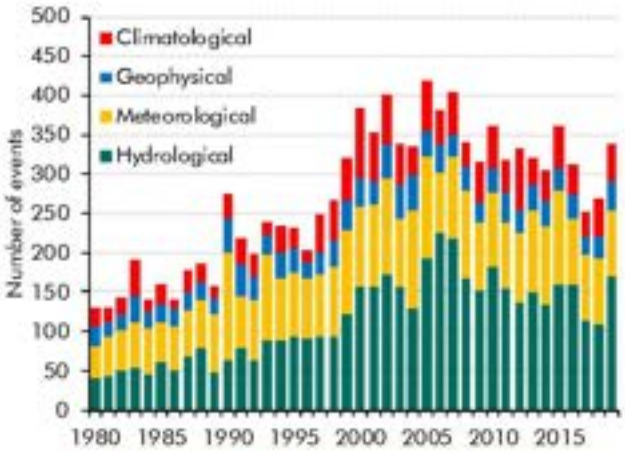


Source: International Peace and Research Institute, Oslo; Uppsala Conflict Data Programme

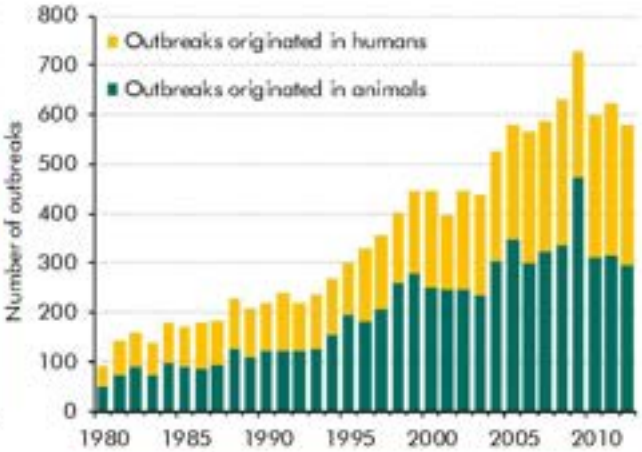
1.13 At the same time, recent surveys of systemic risks to the global economy point to growing threats from other sources. Even before the coronavirus pandemic, the 'global risks index' produced by Cambridge University's Centre for Risks Studies pointed to a steady increase in the amount of 'GDP at risk' from a range of sources, putting the total at $577 billion (1.6 per cent of world GDP) in 2019.[11] Their most recent report identified financial crises, interstate conflicts, climate change, human pandemics, and cyberattacks among the top threats (largely echoing the Government's own assessment as set out in the 2020 edition of its *National Risk Register*[12]). This partly reflects a rise in the frequency of risks materialising, especially in the case of severe weather events and human infectious disease outbreaks, where the numbers of reported incidents have doubled and trebled respectively since the 1990s (Chart 1.2). This may partly be a function of increased surveillance and reporting of incidents. However, it is also likely to be driven by the growing numbers of people living closer to the sources of risks such as flood plains and isolated ecosystems.[13]

[11] University of Cambridge Judge Business School, *Cambridge Global Risk Index 2019*, 2019. 'GDP-at-risk' sums estimates across 279 major cities around the world (covering 41 per cent of world GDP) that are based on their economic output, their exposure to particular threats related to their geography and type of economy, offset by their estimated resilience in recovering from shocks.
[12] HM Government, *National Risk Register, 2020 Edition*, 2020.
[13] Gavi, *How has our urban world made pandemics more likely?*, 2020.

Chart 1.2: Numbers of international disasters and infectious disease outbreaks



Source: The Emergency Events Database



Source: KF Smith et al. (2014)

Severity of catastrophic risks

1.14 The rise in the amount of global GDP at risk from catastrophes also reflects an increase in the severity of some of those incidents when they materialise. For example, hurricanes have not only become more frequent in the North Atlantic over the past fifty years, with 2020 seeing the highest ever number of named storms at 29, but also more destructive as global temperatures rise.[14] In the case of risks emanating from the economy, studies of business cycles among major economies suggest that, while periods of economic expansion among G7 economies have become smoother and longer, economic contractions have become larger and more severe than preceding expansions. This implies that risks arising from macroeconomic volatility have become increasingly skewed toward the downside with longer periods of steady economic expansion punctuated by deeper recessions.[15] This partly reflects greater financial integration both within and across countries, which allows for longer credit cycles but also gives rise to more disruptive credit 'shake-outs'.

Transmission of catastrophic risks

1.15 Related to the above, a final reason why the world may be becoming riskier is the increase in global interconnectedness. The past forty years has witnessed a seven-fold increase in air passenger numbers,[16] twenty-five-fold increase in international capital flows,[17] and a six-fold increase in the volume of international trade.[18] So even in areas where the incidence and severity of risks has stayed the same or declined, the potential for those risks to be transmitted between countries has risen, increasing the risk exposure for any given country.[19] This is especially relevant for countries like the UK which, according to one index of cross-border economic linkages compiled by DHL, is the ninth most globally connected country in the world (Chart 1.3).[20]

[14] Li, L., and Chakraborty, P., *Slower decay of landfalling hurricanes in a warming world*, Nature, Vol. 587, 2020.
[15] Jensen, H., et al, *Leverage and Deepening Business-Cycle Skewness*, American Economic Journal: Macroeconomics, Vol. 12, No.1, 2020.
[16] World Bank, *Air Transport, passengers carried*, 2021.
[17] IMF, *Balance of Payments and International Investment Position Statistics*, June 2021.
[18] World Bank, *Exports of goods and services (constant 2010 US$)*, 2021.
[19] Ferguson, N. *Doom: The Politics of catastrophe*, 2021.
[20] DHL, *Global Connectedness Index 2018: The State of Globalisation in a Fragile World*, 2018.

Chart 1.3: Global connectedness

Source: DHL

Are governments more exposed to catastrophic risks?

Government as 'insurer of last resort'

1.16 As advanced economies' exposure to potentially catastrophic risks increases, so do the associated risks to the public finances. This is not only because of the disruptive effects of the associated economic shocks on government revenues and non-discretionary spending. Governments are also more directly exposed because catastrophic risks are, by their nature, difficult or impossible to price or insure against. This means that the private sector cannot manage them without active government intervention. Government is therefore in effect obliged to step in to act as an 'insurer of last resort'. This was the topic of a timely Treasury report published in March 2020, which set out a series of proposals for improving the management of government guarantees and other contingent liabilities.[21]

1.17 However, the experience of the past two decades has highlighted that government's exercise of its insurer of last resort function goes beyond just the issuance of guarantees and other explicit forms of insurance. During the financial crisis, advanced economy governments stepped in to acquire or underwrite the assets of their largest banks in order to prevent an even greater credit crunch. During the coronavirus pandemic, governments stepped in to provide grants to businesses and help pay the wages of individuals hit hardest by the pandemic. These and other interventions in the economy dramatically increased government cash outlays at the same time as output and revenues were squeezed.

[21] HM Treasury, *Government as insurer of last resort: managing contingent liabilities in the public sector*, 2020.

Increased resort to the 'last resort'

1.18 The fiscal risk associated with governments' propensity to 'socialise' costs in the event of major shocks may be increasing over time. This partly reflects the more disruptive nature of recessions in an era of deeper financial integration and greater financial leverage, as discussed above. Significant government interventions in asset and credit markets are therefore required to prevent widespread bankruptcies or to avoid disorderly workouts of corporate and household debts. More recently, it reflects the limitations on the ability of monetary policy to support the economy imposed by the effective lower bound on interest rates. It is also due to the idiosyncratic nature of the coronavirus shock, which required the kind of targeted intervention in the most affected sectors that only fiscal policy can provide.

Challenges for fiscal policymakers

1.19 The fact that fiscal risks may be becoming more frequent, severe, and contagious, combined with increasing expectations that government will bear the immediate costs of shocks, poses important challenges for those managing the government finances. Both the financial crisis and the pandemic have required governments around the world to exercise their insurer of last resort function with dramatic and lasting consequences for government borrowing and debt. Policymakers face a difficult trade-off in deciding how much to spend today to reduce the odds of these potentially catastrophic risks from materialising versus how much 'fiscal space' to hold in reserve to mitigate their effects when they do. That judgement is further complicated by the challenge of assessing quite how much fiscal space is available to policymakers (Box 1.1).

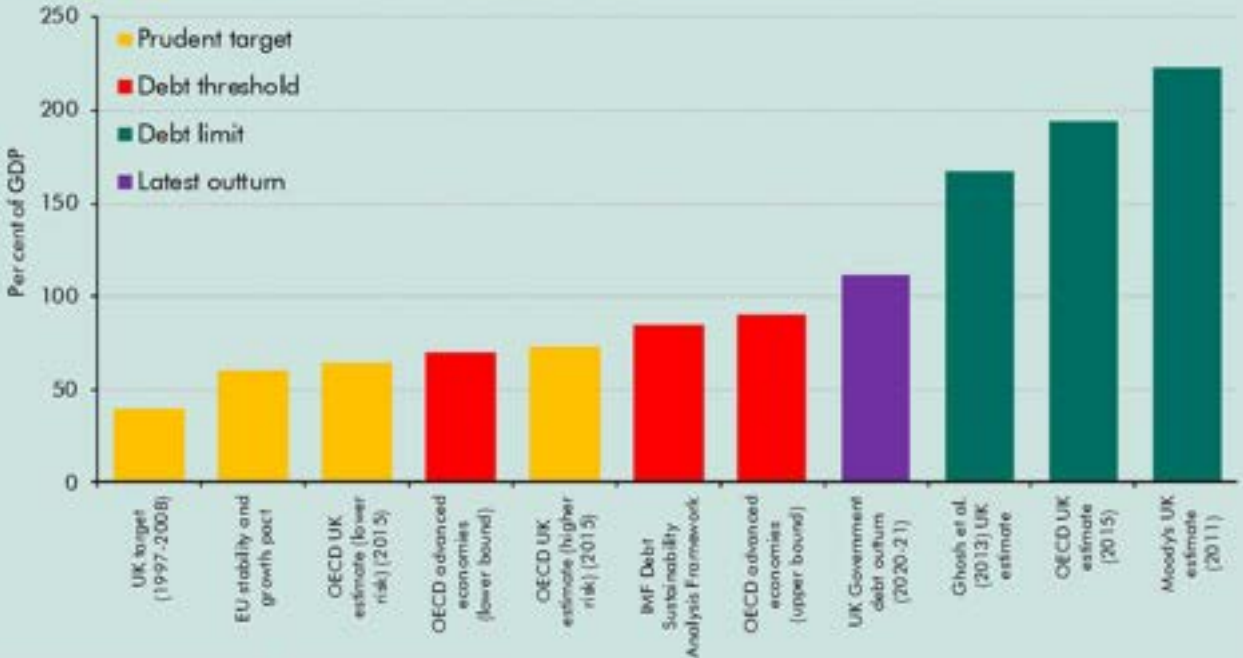
Box 1.1: Assessing 'fiscal space'

Major fiscal shocks are by their nature varied, hard to predict, and difficult or very expensive to mitigate entirely. Because no two shocks are the same, responding to them when they crystallise typically requires the rapid and innovative deployment of government resources on a large scale to support households, businesses, and public services. So maintaining sufficient 'fiscal space' – defined by the IMF as *"the room for undertaking discretionary fiscal policy relative to existing plans without endangering market access and debt sustainability"*[a] – is central to managing fiscal risks. But how can this be translated into a practical guide for policy makers?

In its 2018 *Managing fiscal risks* report, the Treasury employed an OECD framework[b] to review estimates of public debt 'limits', 'thresholds' and 'targets' for the UK (Chart A). But these metrics generally do not allow for more granular factors that also determine a country's fiscal room for manoeuvre such as average debt maturities, share of inflation-linked debt, currency of debt issuance, whether bondholders are mostly domestic or foreign, holdings of off-setting liquid assets, extent of non-debt or contingent liabilities, and capacity to adjust fiscal policy to accommodate rising interest costs. Indeed, the IMF has adopted a multi-faceted approach in which many factors are considered, estimates are allowed to vary across country and time, but which yields only a qualitative assessment.[c] This reflects the importance of taking a broad view of the factors determining fiscal space, the challenges in quantifying some of them, and difficult

judgements required in assigning relative weights to those factors for the purpose of coming up with an overall quantified assessment of fiscal space.

Chart A: Estimates of government debt limits, thresholds, and targets



Source: Ghosh et al. (2013), HMT, IMF, OECD, ONS

However, for many determinants of fiscal space the sign of the impact is clear even if the scale is uncertain. All else equal, fiscal space increases with: lower levels of debt (so the past decade has diminished space in the UK); more borrowing in one's own currency (a strength for the UK); a longer maturity of debt (also a strength, although one complicated by the effects of quantitative easing, as discussed in Chapter 4); holdings of high quality liquid assets; lower non-debt liabilities such as unfunded pension obligations and contingent liabilities such as guarantees; a capacity to rapidly adjust fiscal policy in response to shocks; and a track record of meeting debt obligations (another UK strength). All these factors can vary over time and across countries.

The availability of fiscal space will also depend on the nature of the shock to which policymakers are responding. For a common shock, such as the pandemic, countries with an established reputation for meeting their obligations and whose bonds are traded in deep and liquid markets can benefit from being seen as a 'safe haven'. Beyond some initial market instability in March 2020, this was the UK's experience during the pandemic, in which all advanced economies were affected. For governments whose debt is considered a safe haven, fiscal space can be highly elastic – as risk appetite shrinks, the demand for relatively safe assets increases and so too does the availability of willing lenders to those safe havens, which increases their fiscal space to borrow and respond to the shock.

But continued safe-haven status cannot be guaranteed and the cost of losing it can be significant. In the face of an idiosyncratic shock, governments – particularly those reliant on foreign investors – can see funds drain away into safer assets in unaffected countries, resulting in

higher borrowing costs and a reduction in fiscal space at precisely the moment the government most needs it.

The IMF's latest assessment of fiscal space in the UK was made in December 2020. It concluded that the UK has *"some fiscal space"*, but that a *"credible medium-term fiscal framework and a credible fiscal consolidation plan"* would be needed.

[a] IMF, "United Kingdom: 2020 Article IV Consultation-Press Release; Staff Report; Staff Supplement; and Statement by the Executive Director for the United Kingdom."

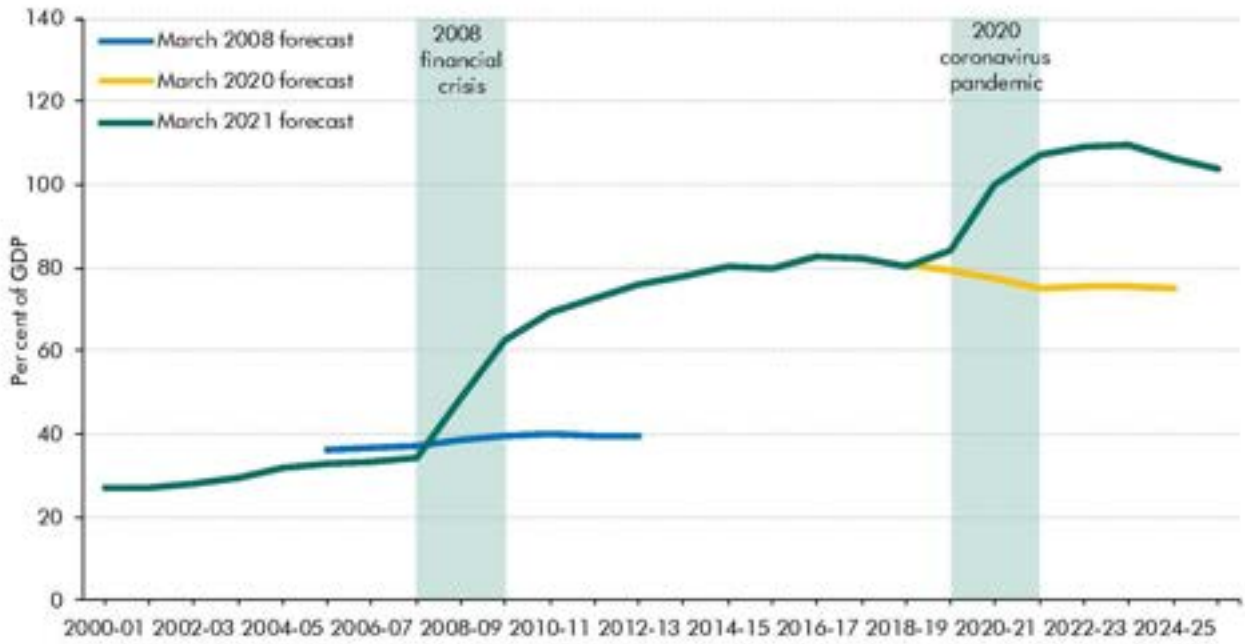
[b] Fallou Fall, Debra Bloch, Jean-Marc Fournier and Peter Hoeller. 2015. "Prudent debt targets and fiscal frameworks." OECD *Economic Policy Paper Number 15*.

[c] IMF. 2016. "Assessing fiscal space – an initial consistent set of considerations." *IMF Staff Paper*. IMF. 2018. "Assessing fiscal space: an update and stocktaking." *IMF Policy Paper*.

Challenges for fiscal forecasters

1.20 Governments' growing financial exposure to potentially catastrophic risks also raises challenges for fiscal forecasters such as the OBR. This challenge can be illustrated by looking at the path of public sector net debt in the UK since the turn of the century. Debt stood at a historically low 27 per cent of GDP in 2000-01 but is expected to reach 107.4 per cent of GDP in 2021-22 in our latest forecast. Of that 80 per cent of GDP increase, two-thirds (just over 50 per cent of GDP) occurred in just four years – at the height of the financial crisis in 2008-09 and 2009-10 and at the height of the pandemic in 2020-21 and 2021-22 (Chart 1.4). Unsurprisingly, neither of these shocks were anticipated in either the pre-OBR forecast prepared by the Treasury in March 2008 or our pre-pandemic forecast in March 2020.

Chart 1.4: Public sector net debt



Source: ONS, OBR

1.21 The tendency to significantly under-forecast debt is by no means a UK-specific phenomenon. A review of IMF and Economist Intelligent Unit projections for 147 countries over the past two decades found that these independent forecasters on average underpredicted the level of debt five years ahead by about 10 per cent of GDP. Consistent with the UK's experience, the underprediction of debt in advanced economies was associated with surprise recessions in the forecast horizon.[22] Occasional large or catastrophic risks present a particular problem for forecasters, as it would make no sense to assume they are always just about to happen, as most of the time they do not. But they do crystallise sometimes and moreover on an unpredictable basis. That means that the analysis and communication of risks, rather than just central forecasts, is key to providing a complete view of economic and fiscal prospects.

1.22 As a further contribution in this area, we therefore hope to enhance the presentation of uncertainty in future *EFOs* through the use of stochastic simulations. These involve producing multiple scenarios that are driven by randomly selected shocks of the sort that have been experienced in the past, so highlighting the distribution of risks around our central forecast. This approach is employed by a number of organisations, including the IMF as part of their 'Article IV' assessments of countries' public debt sustainability. We will set out our own intended approach in a forthcoming working paper.

Structure of this report

1.23 Against this background, our third *FRR* shifts the focus of our analysis onto three larger, and potentially catastrophic, sources of fiscal risk: the coronavirus pandemic, climate change, and the cost of government debt. These three risks emanate from different sources and have their own unique drivers, but they also share some commonalities:

- there is a significant degree of **uncertainty concerning both the timing and the scale** of their associated costs;
- they are characterised by **non-linearities or 'snowball effects'** in which costs can escalate dramatically from the point of crystallisation, with potentially catastrophic consequences for economies and public finances; and
- they may be **global in nature with high potential for rapid contagion** of risk across countries.

1.24 Governments seeking to manage these threats must therefore weigh the known costs of early action to mitigate these risks against the uncertain costs of dealing with them if they crystallise. And they need to weigh the limited but more deliverable benefits of acting unilaterally against the much greater but more elusive gains from acting globally.

[22] CEPR Discussion Paper No. DP16108, *Worse than You Think: Public Debt Forecast Errors in Advances and Developing Economies*, 2021.

The coronavirus pandemic

1.25 Neither we, nor most other fiscal analysts, saw the enormous economic and fiscal consequences of a global pandemic coming. Our 2017 *FRR* noted that the Cabinet Office's 2015 *National Register of Civil Emergencies* had identified an influenza pandemic as *"the most significant civil emergency risk"* and the risk that such an event might pose to health spending, but we did not attempt to quantify the broader fiscal risk that it might pose. The US Congressional Budget Office did look at such risks back in 2005 (in a paper produced at the behest of a Senator with a background in medicine[23]). It focused on an outbreak of avian influenza and drew on the 1918 flu pandemic to calibrate scenarios that have proved remarkably accurate in anticipating the costs of the coronavirus pandemic.

1.26 The economic and fiscal shock associated with the pandemic provides a classic example of a 'tail risk' crystallising – one whose impact is so large and whose likelihood in any given year is so small that it sits in the very tail of the distribution of possible bad outcomes. The shock to the UK's economy was the largest in over three centuries, since the Great Frost of 1709, and the resulting fiscal deficit was the largest the UK has witnessed in peacetime.

1.27 As a case study in the crystallisation of a catastrophic risk, Chapter 2 therefore explores: the impact of the pandemic on the UK economy and public finances in historical and international context; the economic and fiscal support extended by governments in response to the pandemic; the legacy risks that the pandemic poses for the public finances over the medium term; the potential longer-term implications of the pandemic for the economy and public finances; and the lessons that the pandemic carries for understanding other potentially catastrophic risks.

Climate change

1.28 Looking ahead, the catastrophic threat posed by unmitigated global warming and climate change is clear. Governments around the world have recognised this and signed up to the 2015 Paris Agreement that seeks to limit global warming to well below 2 (preferably to 1.5) degrees Celsius above pre-industrial levels. In the UK, the Government has since legislated to achieve net zero greenhouse gas emissions by 2050.

1.29 The UK alone cannot affect the path of global warming to a material extent – we accounted for just 1 per cent of global emissions in 2019. So the catastrophic fiscal risks associated with a global failure to meet the Paris targets are beyond the UK Government's control. But with the world's largest emitters – the US, China and the EU – all setting objectives to get to net zero emissions, we can focus more narrowly on the fiscal risks posed by different paths to net zero in the UK. Reflecting on the similarities and differences between the response to both climate change and the pandemic prompted one study to conclude that *"The climate emergency is like the COVID-19 emergency, just in slow motion and much graver."*[24]

[23] R. Arnold, J. De Sa, T. Gronniger, A. Percy and J. Somers, *A Potential Influenza Pandemic: Possible Macroeconomic Effects and Policy Issues*, US Congressional Budget Office, December 2005 (revised July 2006).
[24] *Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?*, Cameron Hepburn, Brian O'Callaghan, Nicholas Stern, Joseph Stiglitz, Dimitri Zenghelis, Oxford Review of Economic Policy, May 2020.

1.30 In Chapter 3 we therefore consider the potential economic and fiscal consequences of: unmitigated global warming; the array of policy levers available to support the decarbonising of the UK economy; and different scenarios for meeting the Government's target for bringing greenhouse gas emissions in the UK down to net zero by 2050.

Cost of public debt

1.31 The pandemic has caused public debt to jump in the UK and around the world. On average, the IMF expects advanced economies to see gross debt to GDP ratios at the end of the 2021 that are 18.7 percentage points higher than on the eve of the pandemic in 2019.[25] We forecast public sector net debt to rise from 80.4 per cent of GDP at the end of 2018-19 to 107.4 per cent of GDP at the end of 2021-22. Despite that increase in the stock of debt, debt interest spending is expected to fall from £37.5 billion in 2018-19 to £24.8 billion in 2021-22 (from 1.7 to 1.1 per cent of GDP) thanks to falls in interest rates and the near-doubling of quantitative easing.

1.32 Financial market participants currently expect interest rates to remain very low for the foreseeable future, so at face value the stock of debt is cheaper to service despite the large increase due to the pandemic. But higher debt also increases the sensitivity of the public finances to movements in interest rates, so fiscal risks associated with the public debt have risen. These risks are not so much that of a default on government debt – the UK government borrows in its own currency, has an independent central bank, and has an enviable track record of honouring its debts. Rather, as Kenneth Rogoff has put it, *"the problem of carrying very high public debt is not sustainability, but loss of flexibility in responding to unforeseen shocks."*[26] Having experienced two 'once in a century' shocks in a little over a decade, it is clear that medium- and longer-term fiscal prospects are contingent on the ability of the Government to respond flexibly as and when shocks hit.

1.33 In Chapter 4 we therefore: look at the historical drivers of debt levels and interest rates; assess the sensitivity of the public finances to alternative scenarios for the future path of interest rates, inflation, and growth; and explore the fiscal consequences in the more extreme scenario of a loss of investor confidence in UK government debt.

Update on other fiscal risks

1.34 Finally, the crystallisation of one major risk does not mean others have evaporated. Indeed economic shocks can trigger the crystallisation of other fiscal risks. In Chapter 5 we look back at the 98 risks that were identified in our 2019 *FRR*. We describe where and why our assessment has changed, including the role the pandemic has played in those changes. We then add those risks identified in this *FRR* to the 2021 edition of our fiscal risks register.

[25] IMF, *World Economic Outlook*, April 2021.
[26] *Is Higher Debt an (Almost) Free Lunch?*, Kenneth Rogoff, Harvard University, paper for the European Fiscal Board, February 2021.

2 Coronavirus pandemic

Introduction

2.1 In addition to being the most acute public health crisis the world has faced in over a century, the coronavirus pandemic resulted in the largest economic shock that the UK has experienced in three centuries.[1] The Government's efforts to mitigate its impact on businesses, households, and public services also prompted the most dramatic expansion in the size and scope of government activity and the largest budget deficit in peacetime. The global pandemic is still far from over, with worldwide coronavirus cases still averaging over 300,000 a day and economies continuing to face potential risks from new and more vaccine-resistant variants.[2] And even after the immediate public health risks have abated, the pandemic may leave behind a legacy of medium-term pressures on public services and long-term scars on the economy. However, eighteen months on from the start of the pandemic, one can begin to draw some preliminary lessons from UK and international experience of the pandemic for how to understand and manage other potentially catastrophic fiscal risks such as those explored in other chapters of this report.

2.2 This chapter therefore explores:

- the **economic and fiscal impact of the pandemic**, setting it in both historical and international context;
- the **role played by fiscal policy** in mitigating the immediate impact of the pandemic on the economy and public finances;
- the **direct medium-term fiscal pressures** left behind by the pandemic and the government's policy response;
- the **indirect longer-term fiscal risks** that could arise from the impact of the pandemic on the supply side of the economy; and
- some initial economic and fiscal **lessons from the pandemic** for how economic forecasters and policymakers should approach other potentially catastrophic risks.

[1] The coronavirus pandemic has resulted in just under 4 million deaths in 18 months and has been the most disruptive to the global economy over the past century, but it is not the most deadly over this period. HIV/AIDS has killed 30-35 million people and smallpox – eradicated in 1980 – is estimated to have caused around 300-500 million deaths over a century. The 1918 flu pandemic a little over a century ago is estimated to have killed around 50 million people worldwide.
[2] *Daily new confirmed COVID-19 cases, World*, Our world in data, 28 June 2021.

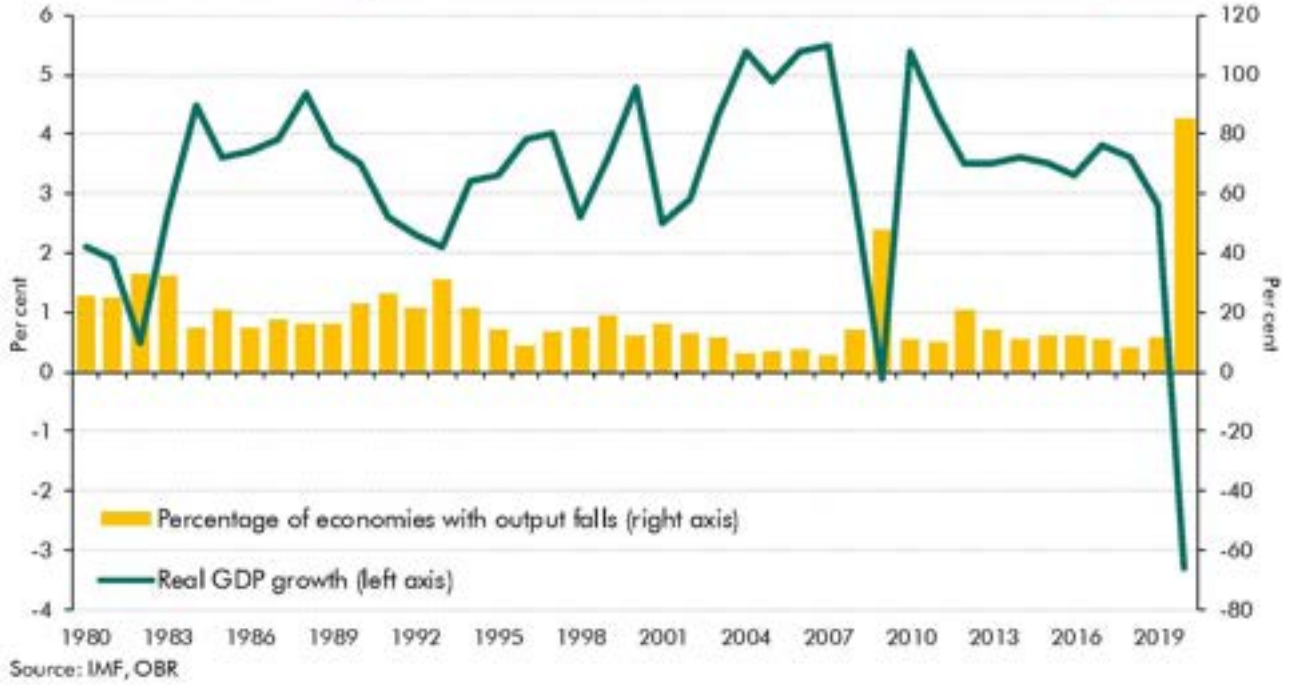
Economic and fiscal impact of the pandemic

2.3 The coronavirus pandemic was different from any other shock that the UK economy and public finances have faced in peacetime. Unlike previous major economic downturns, the source of the disturbance lay outside the economy and its management, and its resolution in the first instance required public health interventions rather than any change in economic policy. Indeed, rather than seeking to stimulate economic activity, the aim of government *public health* policy was to suppress it (and the social contact it involved) as a means of controlling the spread of the virus until a vaccine was available. The focus of economic *policy* at the height of the pandemic was to protect the incomes of households and the survival of businesses while a significant part of the economy was closed. The closest peacetime analogue for a shock of this nature to the UK economy was the more deadly 1918 flu pandemic. The economic impact of this earlier pandemic is, however, difficult to disentangle from the effects of post-World War I demobilisation and its fiscal impact was muted by the fact that both public health systems and the welfare state were in their infancy.

2.4 The coronavirus pandemic has affected not only the UK but nearly every country around the world, bringing about the largest and most synchronised peacetime shock to the global economy since the Great Depression of the 1930s. Global output fell by 3.3 per cent in 2020, far greater than the 0.1 per cent fall seen at the height of the global financial crisis in 2009. And regardless of how successfully they insulated themselves from the global spread of the virus, few countries escaped its economic consequences, as shown in Chart 2.1. Almost 90 per cent of economies suffered a decline in output last year, including every advanced economy except Ireland and Taiwan.[3] By contrast, 2009 saw output fall in only half of all economies, while only a fifth suffered a decline in output in 1999, in the aftermath of the Asian financial crisis and subsequent Russian debt default, and a third saw falls in 1993, in the midst of a period that included the continuing effects of the Japanese and Scandinavian financial crises, as well as Black Wednesday in the UK.

[3] For Ireland, falls in domestic activity were more than offset by strong growth in activity in the multinational company sector (especially pharmaceuticals and the ICT sector, which directly and indirectly benefitted from the pandemic despite the overall drop in global demand). *Quarterly National Accounts Quarter 4 2020*, Ireland's Central Statistics Office, 5 March 2021.

Chart 2.1: World GDP growth and the proportion of economies with falling output



Source: IMF, OBR

2.5 It would be premature to draw definitive conclusions about the economic and fiscal implications of the pandemic while the virus continues to circulate widely, economic activity remains subject to public health restrictions, and extensive fiscal support remains in place. Some economies that were spared the worst effects in the early phases of the pandemic have suffered greatly in recent months. And the risks posed by new, vaccine-resistant variants threaten even the vigorous economic recoveries seen in countries whose vaccination programmes are furthest advanced.

2.6 However, as the largest peacetime shock to the UK economy and public finances in modern memory, it is instructive to consider the UK's economic and fiscal experience of the pandemic in both historical and international context. By comparing it to the last major economic shock, the 2008 financial crisis, we can identify both commonalities and contrasts in the way in which the UK economy and public finances respond to different sources of stress. By comparing the UK's experience during the pandemic with those of other countries, we can better understand our sources of relative fiscal vulnerability and resilience.

Impact of the pandemic on the economy

Economic impact in historical context

2.7 The UK suffered its largest annual economic contraction in over three centuries as a result of the coronavirus pandemic (Chart 2.2). The 9.8 per cent fall in real GDP in 2020 was over twice as severe as the fall during the global financial crisis and over five times greater than the average post-war recession. The economic shock resulted partly from voluntary social distancing on the part of individuals trying to avoid contracting the virus and partly as a

result of government deliberately closing large sections of the economy.[4] At the peak of the first national lockdown in April 2020, economic output fell by 25 per cent relative to pre-pandemic levels, while trips to retail and recreation areas fell by 78 per cent, transit levels were down by around three quarters, and workplace attendance was down 70 per cent.

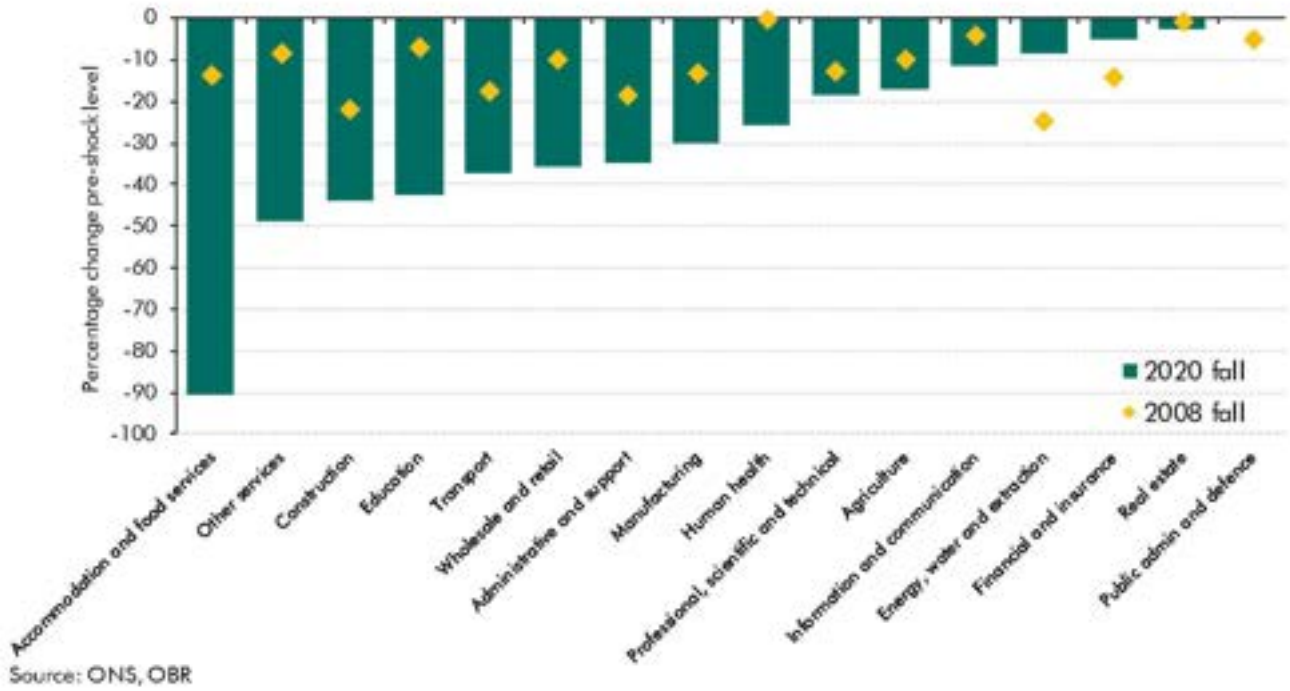
Chart 2.2: Annual GDP growth since 1701

Source: BoE, ONS, OBR

2.8 The coronavirus shock differed from previous UK recessions not only in its severity but also in its degree of sectoral differentiation. While the financial crisis also saw declines in almost every sector, the variation across sectors has been much greater during the pandemic, with accommodation and food services falling by around 90 per cent while financial sector output fell only 5 per cent. Over half of sectors saw declines of over 25 per cent in 2020, while just one sector (mining and quarrying) saw a decline of that magnitude after the 2008 crash, with most sectors seeing falls of between 5 and 20 per cent. Output in the accommodation and food services sector was still down 40 per cent in April 2021.

[4] See, for example, Chapter 2 of the IMF's October 2020 *World Economic Outlook*, 'Dissecting the Economic Effects'.

Chart 2.3: Sectoral peak-to-trough falls in 2008 and 2020

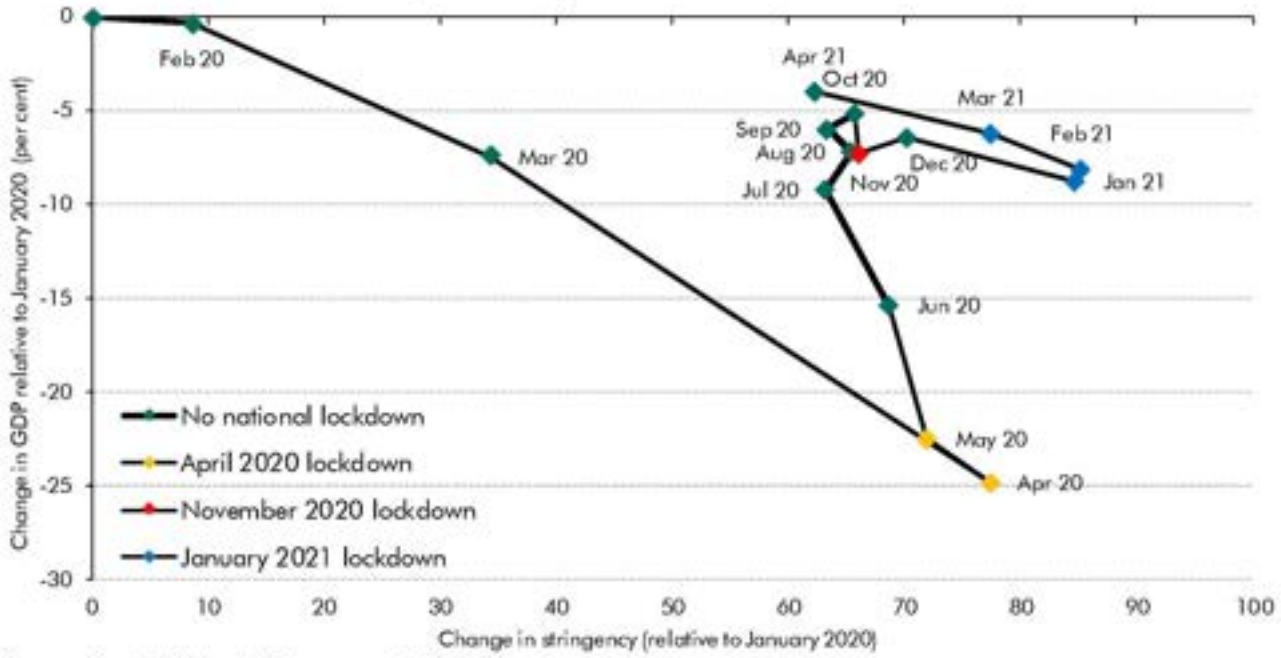


Source: ONS, OBR

2.9 Once businesses and consumers came to terms with the initial shock, the economy then demonstrated a surprising degree of adaptability to each new round of public health restrictions over the course of the pandemic. Following the sharp 25 per cent decline in output under the first lockdown in Spring 2020, economic activity began to recover even before public health restrictions were substantially eased. And subsequent lockdowns in November 2020 and January 2021 saw smaller shortfalls relative to pre-pandemic activity of 7 per cent and 9 per cent respectively, with the relationship between the stringency of public health restrictions and economic output weakening over time (Chart 2.4). The rapid IT-enabled shift to more people working remotely (with the proportion of workers working from home rising from 27 per cent in 2019 to 47 per cent in April 2020) and more goods and services being purchased online (with the share of total retail sales conducted online rising from 20 per cent in January 2020 to 36 per cent in January 2021) greatly facilitated this adaptation.[5,6]

[5] *Coronavirus and homeworking in the UK: April 2020*, ONS, July 2020
[6] *Homeworking hours, rewards and opportunities in the UK: 2011 to 2020*, ONS, April 2021.

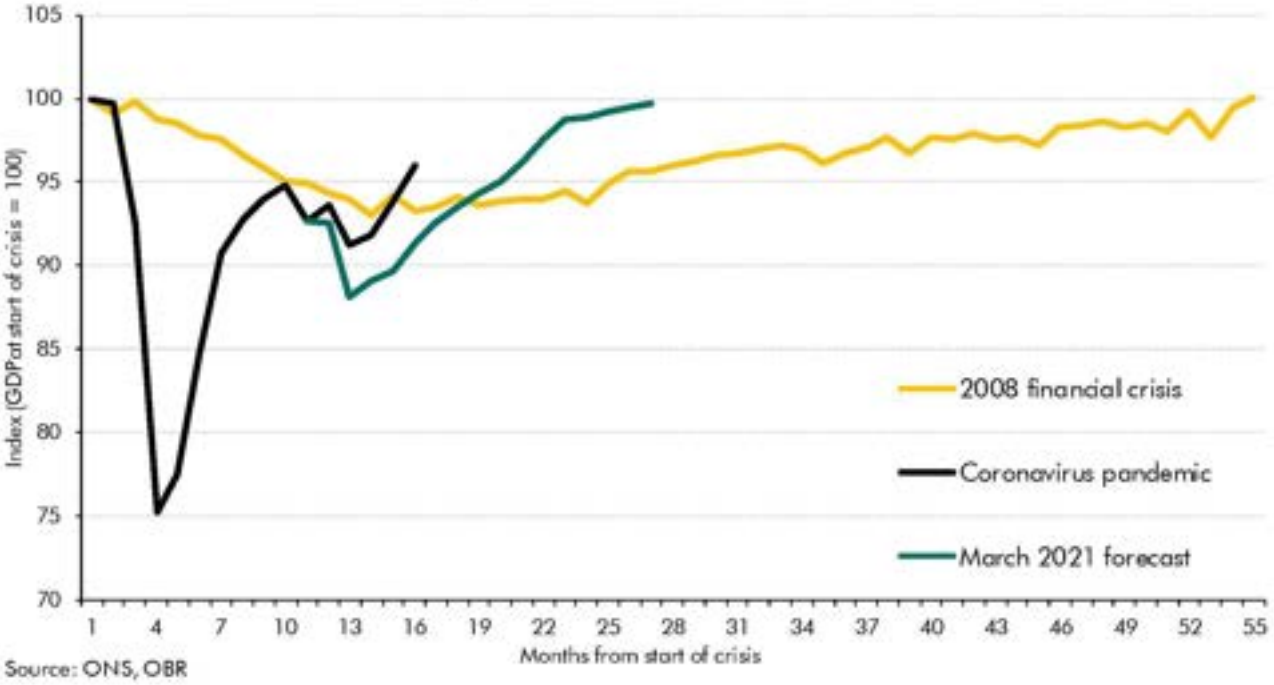
Chart 2.4: The UK economy has adapted over successive lockdowns



Source: Blavatnik School of Government, ONS, OBR

2.10 Economic activity also proved surprisingly resilient once public health restrictions were lifted. At the corresponding stage of the global financial crisis, 15 months following the initial fall in monthly output, output was still close to its lowest point of 7.0 per cent below the pre-crisis level and did not regain that level for another 40 months. By contrast, output was only 4.0 per cent below its pre-pandemic level by April 2021, with 84 per cent of the drop in output at the start of the pandemic having been made up. Our March 2021 forecast assumed that activity would regain its pre-pandemic level within a further 12 months, more than twice as fast as occurred following the 2008 financial crisis. Recoveries in output from lockdowns have typically been sharper than we and various others predicted, driven by a combination of stronger rebounds in both private and public sector activity.

Chart 2.5: UK GDP recoveries: pandemic outturn versus forecast and financial crisis



Source: ONS, OBR

Economic impact in international context

2.11 While the pandemic led to the most synchronised global economic shock in modern history, its impact differed in severity across countries. Countries that were able to contain the spread of virus early have so far typically experienced shorter and shallower downturns and faster recoveries, on average returning to pre-pandemic levels of activity at the start of 2021.[7] Among the advanced economies in 2020, European countries generally suffered the most economically, followed by those in North America and Japan, with other parts of Asia and Australasia experiencing the least damage. But a striking feature of the pandemic has been how much even those countries that did manage to contain the virus last year still suffered economically, underscoring the spillovers that result from the open nature of advanced economies and the consequences of global interconnectedness.

2.12 The UK experienced one of the deepest recessions among advanced economies last year, with UK GDP falling by twice the advanced economy average in 2020.[8] Only Spain, where output contracted by 11 per cent, suffered a sharper fall among advanced economies (top left panel of Chart 2.6).[9] The relative severity of the downturn in the UK, which remains even after allowing for cross-country methodological differences in the measurement of

[7] See for example, *SARS-CoV-2 elimination, not mitigation, creates best outcomes for health, the economy, and civil liberties*, Barton et al, The Lancet (2021), *The 12-month stretch, Where the Government has delivered – and where it has failed – during the Covid-19 crisis*, Resolution Foundation, March 2021, *COVID-19: Lockdowns, Fatality Rates and GDP Growth*, König and Winkler, Intereconomics Vol 56 Number 1, 2021, *Cross-country effects and policy responses to COVID-19 in 2020: The Nordic countries*, Gordon et al, Economic Analysis and Policy Volume 71, September 2021.

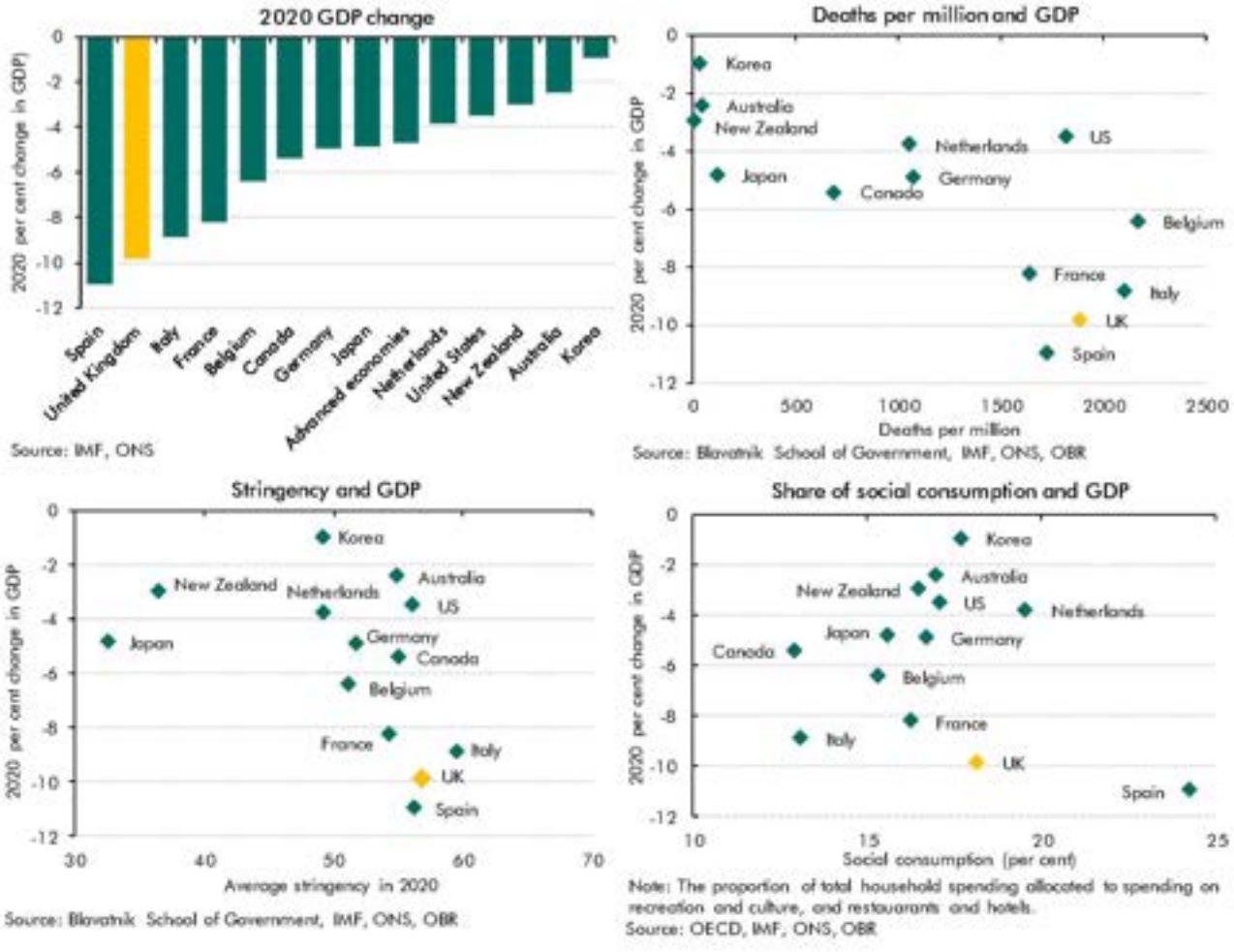
[8] Box 2.4 of our March EFO looked in detail at international comparisons of the economic impact of the pandemic up to the third quarter of 2020. On the current vintages of data, the UK experienced a larger fall in output in 2020 than most other major advanced economies, even after adjusting for differences in the measurement of government output.

[9] *World Economic Outlook*, IMF, April 2021.

government output, is likely to be a consequence of several factors.[10] These include the fact that the UK:

- suffered high rates of coronavirus infections, hospitalisations and deaths among advanced economies in 2020 (top right panel of Chart 2.6);
- spent more time under stricter public health restrictions than most other advanced economies (second only to Italy among major advanced economies) (bottom left); and
- was more economically vulnerable to the pandemic by virtue of its relatively high share of social consumption in output (second only to Spain among major advanced economies) (bottom right).

Chart 2.6: Real GDP loss versus contributing factors: cross-country comparisons



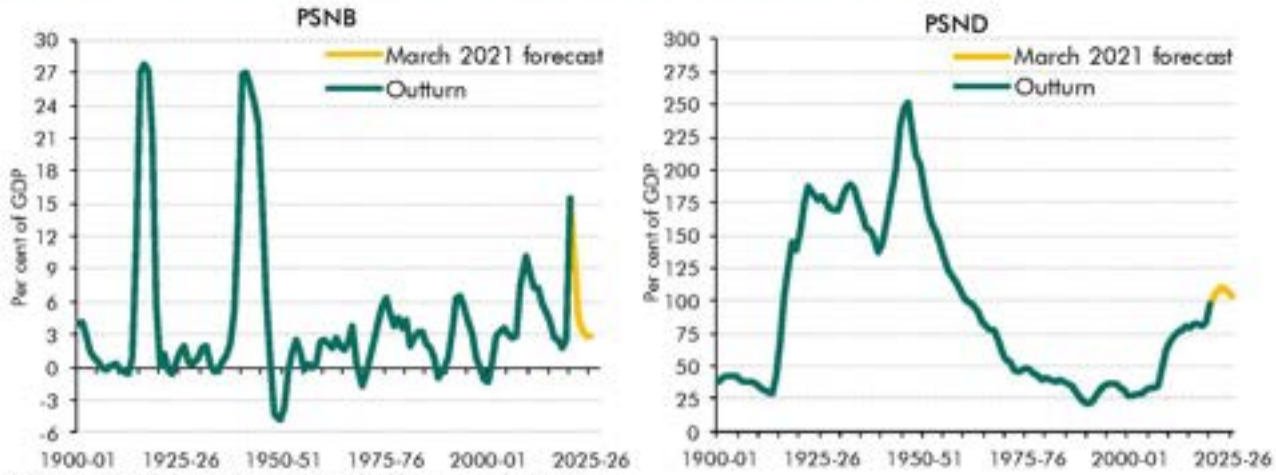
[10] For a more complete discussion of cross-country differences in the measurement of output, see Box 2.4 'International comparisons of the economic impact of the pandemic' in our March 2021 Economic and fiscal outlook.

Impact of the pandemic on the public finances

Fiscal impact in historical context

2.13 The pandemic also imparted the largest peacetime shock to the UK's public finances. Public sector net borrowing rose to 15.6 per cent of GDP in 2020-21,[11] the largest deficit since 1944-45 and around one and a half times larger than the previous peacetime peak of 10.1 per cent of GDP reached in 2009-10 in the wake of the financial crisis. As was the case after the two world wars – but unlike after the financial crisis – borrowing is forecast to fall back quickly to near its pre-pandemic level within a few years. And the medium-term tax rises and spending cuts the Government has announced are sufficient to eliminate all but a £0.9 billion (0.03 per cent of GDP) current budget deficit in 2025-26. As a result of the pandemic, public sector net debt is set to rise by over 20 per cent of GDP, but by substantially less than the total increase in debt following the financial crisis, to peak at 109.7 per cent of GDP in 2023-24, its highest level since 1958-59.

Chart 2.7: Public sector net borrowing and net debt since 1900



Note: 2020-21 estimate includes our estimate of the costs of loan write-offs.
Source: ONS, OBR

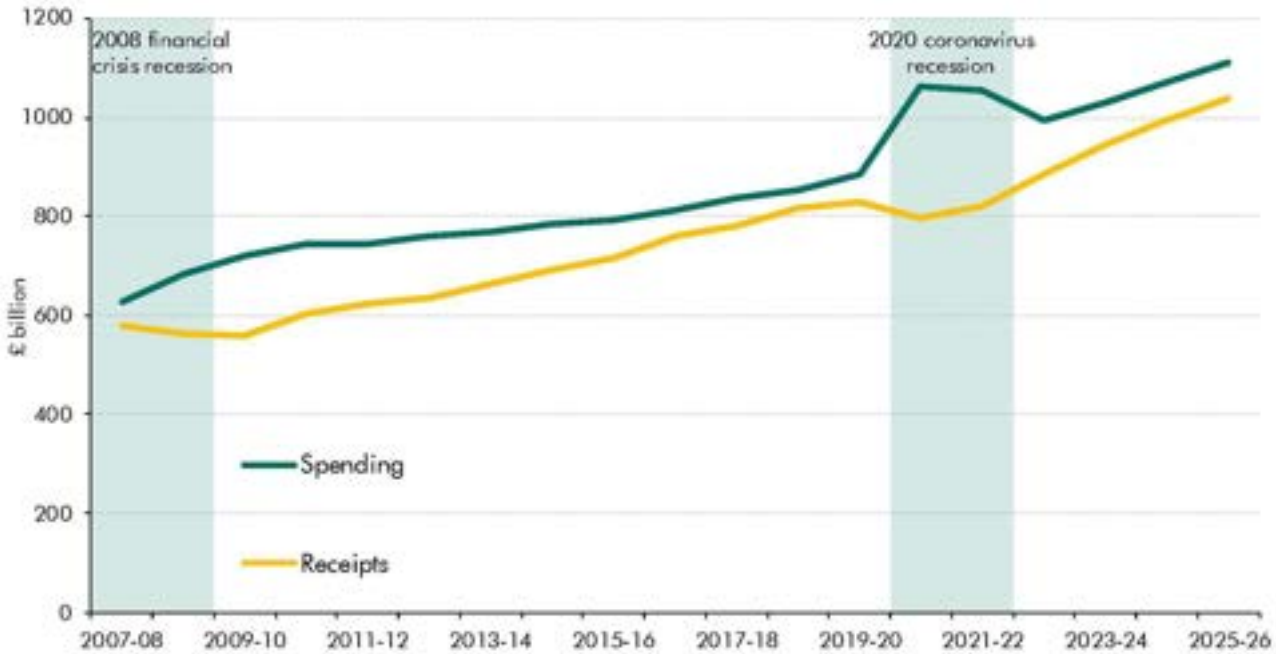
Source: ONS, OBR

2.14 The fiscal shock from the pandemic differed from previous recessions not only in its scale and profile but also in its composition. The rise in borrowing in 2020-21 of 13 per cent of GDP was driven almost entirely by an unprecedented discretionary increase in government spending, rather than by the lower tax receipts we would usually expect to arise from depressed economic activity (Chart 2.8). Higher spending on public services and support for households and businesses was offset slightly by a fall in interest costs, thanks in large part to the simultaneous expansion of the Bank of England's quantitative easing programme and cuts in Bank Rate. The rapid fall in borrowing from 2021-22 onwards primarily reflects the

[11] This figure is based on the latest ONS estimate of PSNB in 2020-21 of £299.2 billion (released on 22 June), plus our March 2021 *EFO* estimate that spending associated with loan guarantees will add £27.2 billion to borrowing in 2020-21. The ONS plans to reach its own estimate of those write-offs to be incorporated in the official statistics later this year. Nominal GDP in 2020-21 is based on the ONS estimate released on 22 June. The figure of 15.6 per cent of GDP is below the 16.9 per cent we estimated in our March 2021 *EFO*, largely due to pandemic-related departmental spending coming in considerably lower than expected. In this section we use this estimate of 2020-21 outturn when discussing the rise in borrowing due to the pandemic, but use our March 2021 forecast as it stood when discussing the composition of the government's rescue package, the deficit reduction that follows, and the degree of fiscal policy tightening in the medium term. This reflects both the provisional nature of the latest 2020-21 outturn and that some of the detail we need to analyse the future path of borrowing is not yet available.

one-off nature of coronavirus rescue spending, which the Government's plans assume will be fully withdrawn over 2021-22. We discuss the risks around this deficit reduction path later in the chapter.

Chart 2.8: Pandemic borrowing was driven more by spending than receipts



Source: OBR

Fiscal impact in international context

2.15 The UK saw the fourth largest increase in government borrowing as a per cent of GDP in 2020 among the 35 advanced economies (after Canada, Norway, and Singapore).[12] The outsized fiscal impact of the pandemic in the UK is attributable to four main factors distinguishing it from other advanced economies:

- First, the UK had a deeper recession than most other countries, for the reasons highlighted above. This both raised the automatic element of the fiscal response, increasing headline borrowing, and reduced the denominator (GDP).

- Second, the UK was hit harder by the pandemic itself, which put greater pressure on health services.[13]

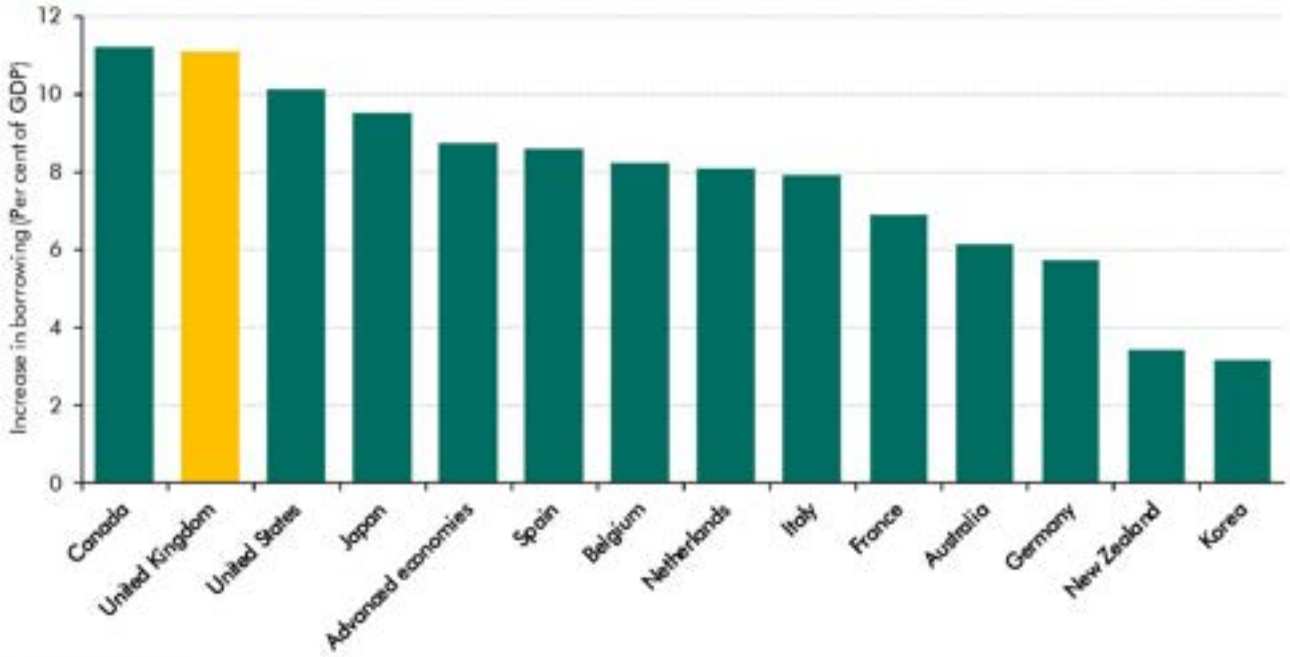
- Third, the UK entered the pandemic with relatively low levels of spare capacity in its health system.[14] This can be seen in the UK's below average levels of acute and ICU beds, nurses, and physicians compared to its peers (Chart 2.10).[15] Additional health-related spending amounted to 5.3 per cent of GDP in the UK, around three times as large as the 1.8 per cent of GDP average across advanced economies. Vaccine

[12] *Fiscal Monitor*, IMF, April 2021.
[13] *Comparing G7 countries: are excess deaths an objective measure of pandemic performance?*, Health Foundation, June 2021.
[14] *Did hospital capacity affect mortality during the pandemic's first wave?*, Health Foundation, November 2020.
[15] OECD Health indicators, 2019.

development and purchases, by contrast, accounted for a relatively small share of additional spending in the UK and elsewhere.

- Fourth, the UK also started off with a working-age welfare system that offered lower income replacement for those facing reduced hours or falling out of work than systems in other large advanced economies.[16] An additional temporary income protection system that also covered better-paid employees and the self-employed (in the form of the CJRS and SEISS) was therefore created from scratch, whereas such support was already provided for in some other countries.

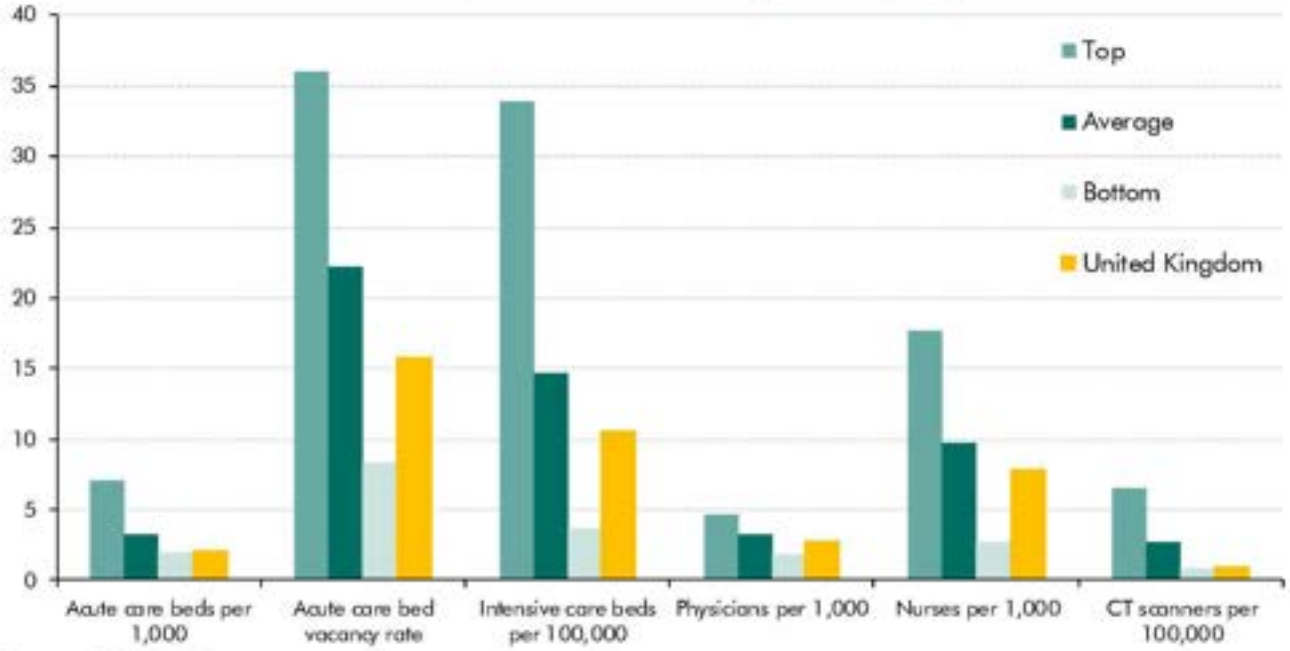
Chart 2.9: Increases in government borrowing in selected advanced economies in 2020



Source: IMF, OBR

[16] The UK has lower replacement ratios for those falling out of work than other large advanced economies, both on average and for most groups. However, the UK is close to the advanced economy average in terms of overall net social expenditure, and non-pensioner cash benefits, as a proportion of GDP. *After shocks, Financial resilience before and during the Covid-19 crisis*, Resolution Foundation, April 2021; *Net replacement rate in unemployment*, OECD, data extracted on 29 Jun 2021; *Social expenditure database*, OECD, data extracted on 29 June 2021; *The shifting shape of social security, Charting the changing size and shape of the British welfare system*, Resolution Foundation, November 2019.

Chart 2.10: International comparisons of health system capacity



Source: OECD, OBR

Fiscal policy response

Fiscal policy response in historical and international context

2.16 The UK's fiscal policy response to the pandemic was very large by both historical and international standards:

- **Relative to the financial crisis**, our March forecast estimated that the UK's coronavirus rescue package cost 16.2 per cent of GDP over 2020-21 and 2021-22, which is almost ten times the 1.7 per cent of GDP in fiscal support provided in 2008-09 and 2009-10 in response to the financial crisis.

- **Relative to other advanced economies**, the IMF estimates that the UK's fiscal policy response to the pandemic was the third largest among 35 advanced economies in per cent of GDP terms after the United States and New Zealand.[17]

2.17 The unprecedented scale of the fiscal policy response was partly a function of the limits on what monetary policy could do given the nature of the pandemic shock and constraints on conventional monetary policy instruments. Interest rates in the UK were already close to all-time lows on the eve of the pandemic at 0.75 per cent but were reduced further to 0.1 per cent in early 2020, while the amount of gilt purchases under quantitative easing was almost doubled. Only fiscal policy could deliver the targeted support necessary during a pandemic, focused on the households, businesses, and public services hit hardest by the pandemic and associated public health restrictions. Broad-based demand stimulus provided by monetary

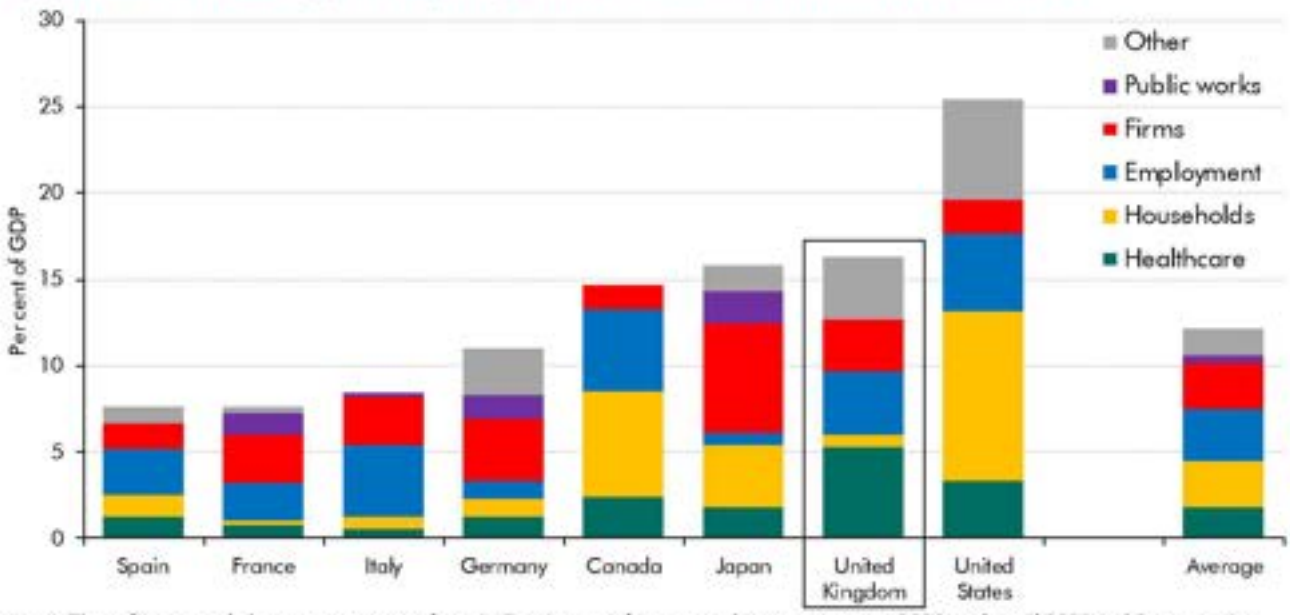
[17] These figures use estimates from the IMF Fiscal Monitor, April 2021.

policy could only ever have played a secondary role in these circumstances where economic activity was being deliberately restrained by government policy.

2.18 Reflecting the proficiency with which it can be targeted, the fiscal policy measures deployed in the UK and other advanced economies were heavily tilted toward spending rather than revenue. The UK's coronavirus rescue package was over 90 per cent spending and less than 10 per cent revenue. That contrasts with the more modest fiscal stimulus during the financial crisis, which was about one quarter spending and three-quarters revenue (as the main rate of VAT was temporarily cut). Across advanced economies, pandemic rescue packages were similarly weighted toward spending as opposed to revenue (Chart 2.12).

2.19 The UK's fiscal policy response was significantly more focused on health spending than other countries, with around one-third of total fiscal support accounted for by health-related costs (Chart 2.11). This was more than twice the average proportion of health spending in other countries' rescue packages, which tended to be dominated by support to either households, employment, or firms. Countries such as the US and Canada spent relatively more on household support, partly reflecting their decision to channel support initially through out-of-work benefits rather than through employment subsidies – though of course both approaches ultimately support household incomes. The low share of public works spending in the UK partly reflects the large increases that were announced in the March 2020 Budget, on the eve of the pandemic hitting the UK, which are therefore not counted as part of the rescue package in the UK.

Chart 2.11: Fiscal support by recipient for selected advanced economies

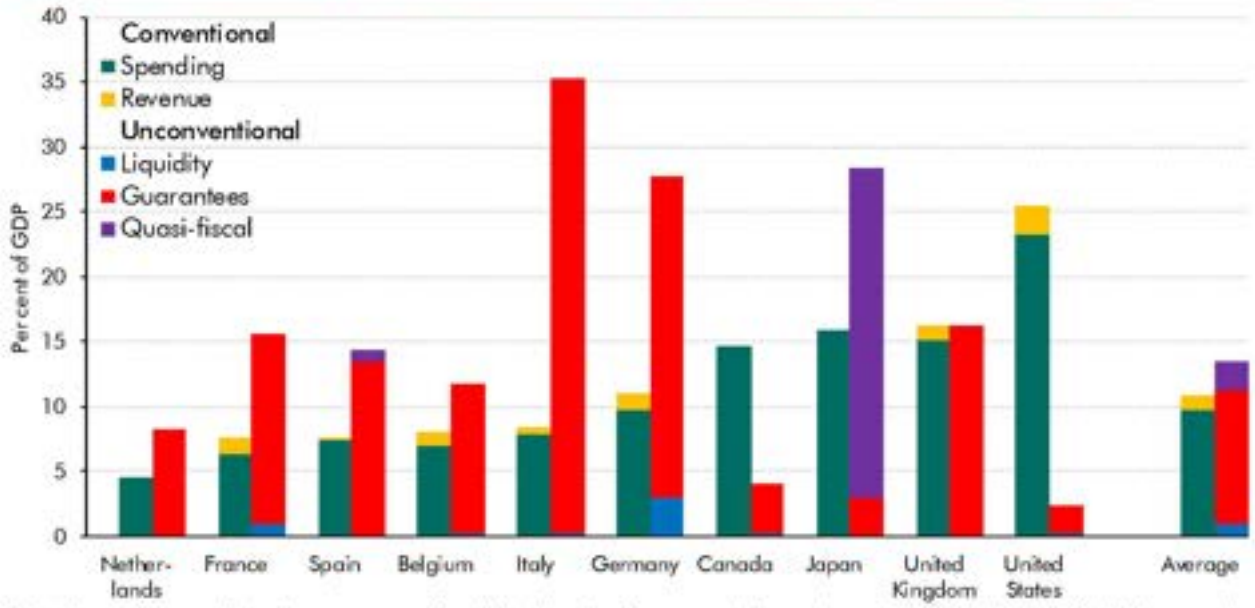


Note: These figures and chart average come from IMF estimates of measures between January 2020 and April 2021 in 10 economies for which detailed data are available.
Source: IMF, OBR

2.20 The policy response to the pandemic was also marked by extensive use of unconventional fiscal instruments, which can expose governments to fiscal risks for many years after they have been deployed. These included loans, guarantees, equity injections, and quasi-fiscal

support provided through state-owned development banks and other public corporations.[18] Chart 2.12 shows that use of these unconventional instruments matched, and in some cases exceeded, more conventional tax and spending measures. Such unconventional support was used most extensively in Italy, with targeted government guarantees for both firms and households, in Germany, through increased lending by its state-owned development bank, and in Japan, through lending by publicly-owned financial institutions. The UK also made relatively extensive use of government-guaranteed loans to support large, medium, and small businesses in the form of the Coronavirus Large Business Interruption Loan Scheme, Coronavirus Business Interruption Loan Scheme, and Bounce Back Loan Scheme. Total exposure under these guarantees totalled 16.1 per cent of GDP, making the UK's package of unconventional fiscal support the fourth largest among 35 advanced economies.

Chart 2.12: Fiscal support by instrument for selected advanced economies



Note: These figures and chart average come from IMF estimates of measures between January 2020 and April 2021 in 16 economies for which detailed data are available.
Source: IMF, OBR

2.21 Comparisons of the scale of unconventional measures are based on total exposures, which may not be a good guide to their ultimate fiscal cost. As discussed later in this chapter, that depends on the terms of the guarantees and other instruments and how recipients of them fare over the lifetime of the support, which in turn will determine the extent to which guarantees are called, or loans and equity investments are written off (or written down). The true direct fiscal cost of these interventions will therefore not be known with any certainty for several years.

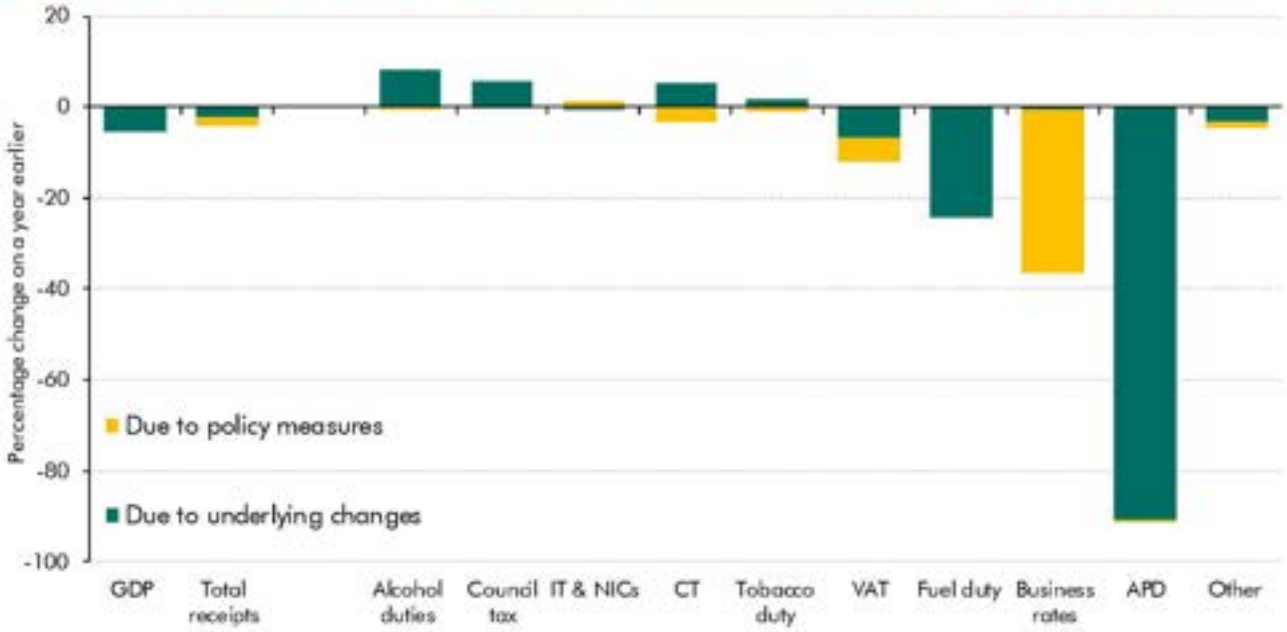
The impact of fiscal policy in supporting revenues

2.22 The provision of fiscal support on an unprecedented scale helped to avert much worse consequences for private sector incomes during the pandemic, and almost certainly for

[18] Quasi-fiscal support through state-owned entities is captured as either public spending or lending in the UK's public-sector-wide fiscal statistics, but comes from outside the general government boundary that forms the basis for the IMF's cross-country analysis.

longer-term economic scarring beyond it, than would have resulted had the Government not intervened. Estimating economic and fiscal costs of doing nothing would require an exercise in counterfactual catastrophising that would stretch credulity. However, as discussed above, one of the striking features of the coronavirus shock from a fiscal perspective has been how much tax revenues have held up despite the dramatic contraction in output during the pandemic (Chart 2.8).[19] While overall, nominal GDP fell by 5.3 per cent in 2020-21, receipts only fell by 4.1 per cent despite tax cuts that on their own would have left receipts down 3.0 per cent and the dramatic falls in receipts from tax bases hit by public health restrictions (with fuel duty down 24.2 per cent and air passenger duty down 90 per cent). Much of the resilience of receipts is likely to be attributable to the extensive fiscal support provided to protect household incomes and facilitate the survival of viable businesses.

Chart 2.13: Percentage change in different tax streams from 2019-20 to 2020-21



Note: Uses 22 June 2021 Public Sector Finances release and 12 May 2021 first quarterly GDP estimate.
Source: ONS, OBR

2.23 As an illustration of the extent to which fiscal support measures also supported receipts, we can compare the actual fall in receipts witnessed last year of £34 billion against a simple baseline in which they fell in line with nominal GDP and the cost of tax cuts. That baseline fall would have been £69 billion (with the 5.3 per cent fall in nominal GDP explaining £44 billion and tax cuts the remaining £25 billion). Tax receipts typically fall slightly faster than nominal GDP in recessions due to the effects of fiscal drag going into reverse and sharper falls in taxes linked to asset prices, which themselves vary more than one-for-one with GDP – so even this baseline could somewhat understate the relative strength of receipts last year.

[19] *How did COVID affect government revenues, spending, borrowing and debt?*, IFS, June 2021

2.24 Chart 2.14 shows the sources of the £35 billion (1.7 per cent of GDP) outperformance of receipts relative to this baseline:

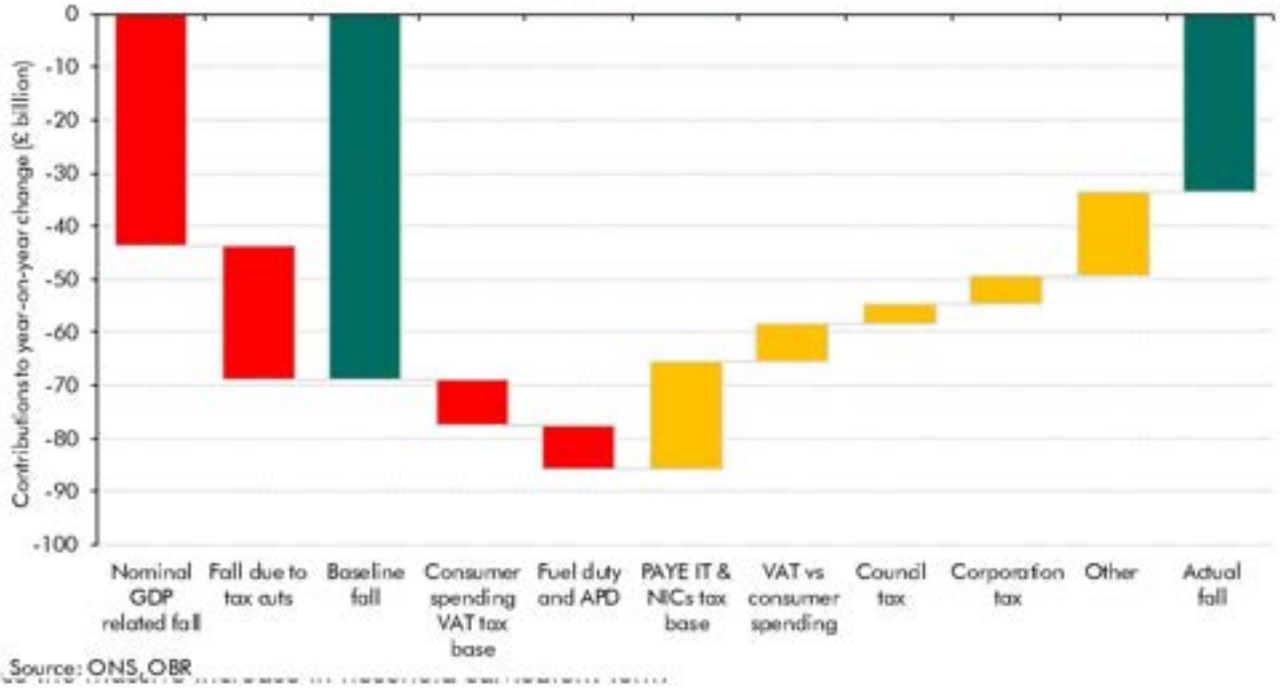
- **Taxes on incomes and profits** (income tax, National Insurance contributions, and corporation taxes) held up much better than would have been expected given the fall in nominal GDP. For personal income taxes, that reflects the fact that wages and salaries grew by 1.4 per cent despite the fall in output thanks in particular to the £58 billion of support provided through the CJRS. For corporation tax, it reflects the support for taxable profits relative to sales delivered by the £16.3 billion of grants and £10.4 billion of business rates relief that were provided in 2020-21. Overall, strength of the PAYE income tax and NICs tax base and corporation tax combined explain three-quarters of the receipts outperformance relative to the baseline (£26 billion).

- **Taxes on consumption** (dominated by VAT) fell broadly in line with output. For VAT, that reflected the main component of the tax base – consumer spending – falling more sharply than nominal GDP (which on its own would have taken receipts down a further £9 billion), but receipts holding up relative to that thanks to the almost fully offsetting impact of VAT paid on higher government procurement, little of which was refundable, and strength in other components of the tax base (such as the financial sector and home improvements). The performance of other consumption taxes varied, with alcohol duties particularly strong (up £1.6 billion relative to baseline).

- **Taxes on transport-related activity** (fuel and air passenger duties) fell much more sharply than GDP due to the effects of public health restrictions, but also account for a much smaller share of total revenues in normal times.

- **Other receipts** also outperformed the baseline. In part that reflects real-world outperformance – as with council tax, where the tax base is relatively fixed, or alcohol duties – but in part it reflects how some components of receipts are measured (for example, much of public sector gross operating surplus simply equals depreciation, which is linked to the public capital stock and is therefore invariant to GDP).

Chart 2.14: Contributions to the strength of receipts in 2020-21



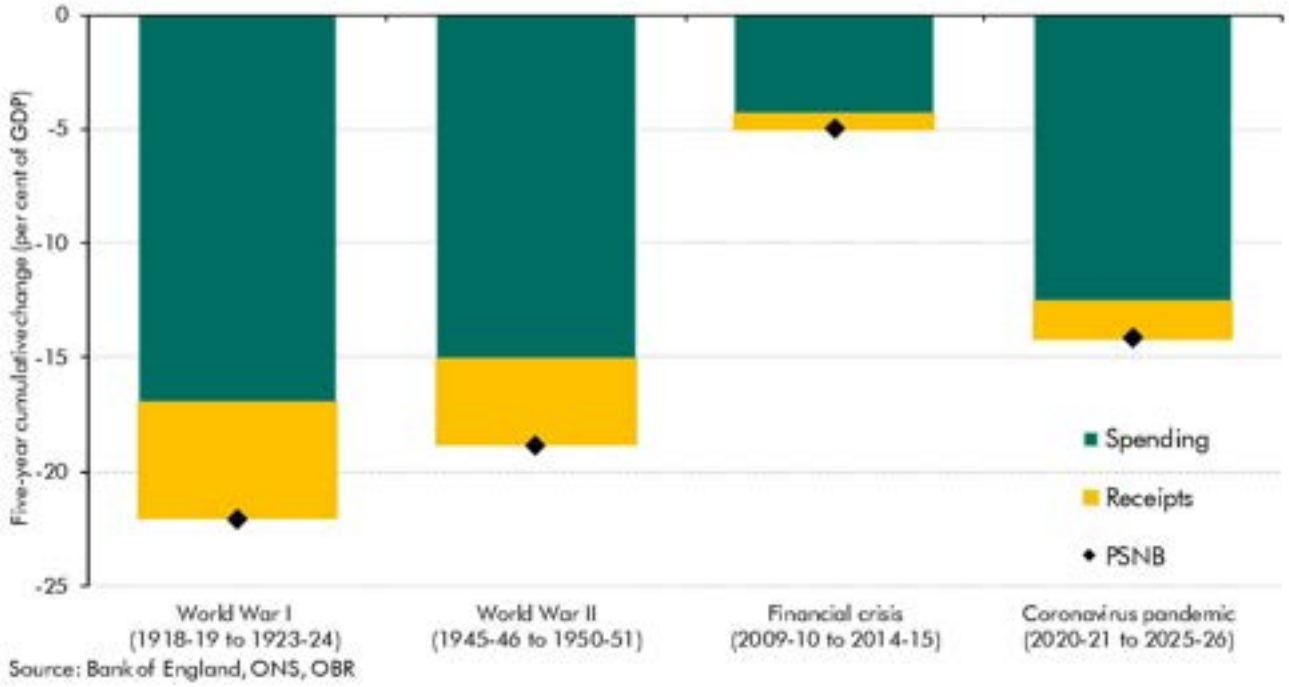
Source: ONS, OBR

Post-pandemic fiscal plans in historical and international context

2.25 With the sharp rise in the deficit due almost entirely to temporary policy interventions, a sharp fall in borrowing is forecast once the pandemic ends and this support is withdrawn.[20] The fall in borrowing implied by the Government's latest plans for the next five years would be the largest and the fastest in peacetime. But there are risks to this planned reduction in the deficit over the medium term, in particular from a potential legacy of additional spending pressures that the pandemic and associated lockdowns could leave for public services. In the face of such pressures, the Government's response to date has been to cut around £14½ billion (0.6 per cent of GDP) a year from Departmental Expenditure Limits (DELs) from 2022-23 onwards relative to its pre-pandemic plans, which contributes to the 2 per cent of GDP in medium-term fiscal consolidation relative to those plans that was announced in the November Spending Review and the March 2021 Budget.

[20] This section is based entirely on our March 2021 forecast, so does not reflect the lower initial ONS outturns for 2020-21.

Chart 2.15: The UK's deficit reduction in historical context



Source: Bank of England, ONS, OBR

2.26 As the economy reopens and emergency fiscal support is withdrawn, government borrowing is forecast to fall from a peacetime high of 16.9 per cent of GDP in 2020-21 to 2.8 per cent of GDP in 2025-26. Of this 14 per cent of GDP in deficit reduction, 12 percentage points comes from the unwinding of pandemic-related support to households, firms, and public services, with the remainder explained by the recovery of the economy and the tax rises announced in the March Budget, which together raise the tax burden to its highest level since the late 1960s. Abstracting from pandemic-related spending, total public spending is broadly flat as a share of GDP between 2020-21 and 2025-26, with modest falls in working-age welfare spending offsetting further rises in investment spending in line with pre-pandemic plans.

2.27 Viewed relative to pre-pandemic medium-term plans, 2 per cent of GDP of fiscal tightening has been announced, reflecting both discretionary spending cuts and tax rises introduced since the start of the pandemic. Of this, 60 per cent of the consolidation comes from taxes, principally the increase in the corporation tax rate from 19 to 25 per cent alongside freezes in the personal allowance and higher rate threshold for income tax, while the remaining 40 per cent comes from unspecified reductions in the envelope for departmental spending. This compares with a post-2008 financial crisis consolidation in which the Coalition Government planned for and delivered a 20/80 split between tax and spending, although over a considerably longer timeframe than initially envisaged.[21]

[21] Table 1.1 of the Coalition's June 2010 Budget documents that the new consolidation measures announced in that Budget were split precisely 20/80 tax and spending by 2014-15, while the overall discretionary consolidation – including the measures inherited from the outgoing Labour Government – were split 23/77 tax and spending by 2015-16. The IFS estimates that in outturn spending contributed between 80 and 90 per cent of the total post-financial crisis consolidation (*Fiscal response to the crisis*, IFS).

2.28 The net effect of the sustained increases in departmental spending planned in the March 2020 Budget and the cuts to those totals announced since then is to leave both total and departmental spending higher in the medium term than they were in 2019-20 – in cash terms, real terms and as a share of GDP. Table 2.1 breaks down the rise in spending as a share of GDP between 2019-20 and 2024-25 (the final year of our March 2020 forecast) into contributions from: pre-pandemic spending plans and forecasts; the effect of nominal GDP being weaker in the medium term; and the effect of changes in cash spending since the March 2020 Budget. It shows that between 2019-20 and 2024-25:

- **Total managed expenditure (TME)** rises by 2.1 per cent of GDP, thanks entirely to higher departmental resource and capital spending. This increase in TME is 1.2 per cent of GDP larger than we forecast in March 2020. This difference is more than explained by weaker nominal GDP (adding 1.6 per cent of GDP), partly offset by the £12 billion downward revision to cash spending in 2024-25 (subtracting 0.4 per cent).

- **Departmental resource spending (RDEL)** rises by 1.0 per cent of GDP, 0.2 per cent of GDP less than it did based on March 2020 Budget plans. On unchanged cash totals, the weaker outlook for nominal GDP would have added 0.8 per cent of GDP to the rise in spending over the medium term, but the £16 billion cut to RDEL totals in 2024-25 announced since the March 2020 Budget offsets most of that (subtracting 0.6 per cent of GDP when combined with the effect of spending in 2019-20 having been revised up).

- **Departmental capital spending (CDEL)** rises by 1.1 per cent of GDP, 0.2 per cent of GDP more than it did on March 2020 Budget plans. This upward revision is split equally between weaker nominal GDP and modestly faster growth in cash spending (as unchanged 2024-25 plans are compared to downwardly revised 2019-20 outturn).

- **Other spending** is flat. Our March 2020 forecast predicted a significant fall of 1.2 per cent of GDP, but that has been lost to the effects of weaker nominal GDP (explaining 0.8 per cent of GDP) and higher cash spending (explaining 0.3 per cent of GDP). The £4.1 billion upward revision to annually managed expenditure in 2024-25 is more than explained by a £5.1 billion upward revision to welfare spending.

Table 2.1: Change in spending between 2019-20 and 2024-25

	Per cent of GDP				
	March 2021 forecast	Difference from March 2020 forecast	of which	Effect of lower nominal GDP	Effect of changes in cash spending
Total managed expenditure	2.1	1.2		1.6	-0.4
of which					
Departmental resource spending	1.0	-0.2		0.6	-0.8
Departmental capital spending	1.1	0.2		0.1	0.1
Other spending	0.0	1.2		0.8	0.3

2.29 The post-pandemic path of public expenditure and its allocation between competing pressures and priorities will be the subject of the 2021 Spending Review, whose conclusions are expected in the autumn. Ahead of those decisions, this section considers the potential legacy of direct fiscal pressures that the pandemic could leave behind. To the extent that these pressures are accommodated by increasing the total level of spending, this constitutes a risk to the borrowing outlook and the Chancellor's principles of balancing the current budget and getting underlying debt to fall as a share of GDP. To the extent that they are accommodated within the spending envelope inherited from the March 2021 Budget, they would imply reductions in the real spending power of 'unprotected' departments whose budgets are not covered by a pre-existing commitment to spend a particular sum of money.

Unwinding the pandemic rescue package

2.30 The Government's plans for rapidly shrinking the deficit over the next five years depend crucially on ending pandemic-related support to individuals, businesses and public services by the end of the 2021-22 fiscal year. Its ability to do so clearly depends on the future course of the pandemic, progress in lifting of remaining public health restrictions, and prospects for a full recovery in different sectors of the economy. The emergence of the delta variant of the virus, and the resulting rise case numbers and hospitalisations, have already prompted the lifting of the final set of public health restrictions in England to be postponed from 21 June to 19 July.

2.31 However, even if the reopening proceeds as now planned in July, there remain significant risks associated with the winding down of support to firms and individuals. Those associated with guaranteed loans to business and support to public services (principally health, education, and transport) are discussed below. Risks associated with the unwinding of the CJRS (furlough) scheme are considered alongside longer-term prospects for the labour market in the next section. The planned withdrawal of the temporary £1,000 a year uplift to the standard allowance in universal credit from October, which will reduce the cash incomes of millions of families when it takes effect, is noted as welfare spending risk in Chapter 5.

Government-guaranteed loans

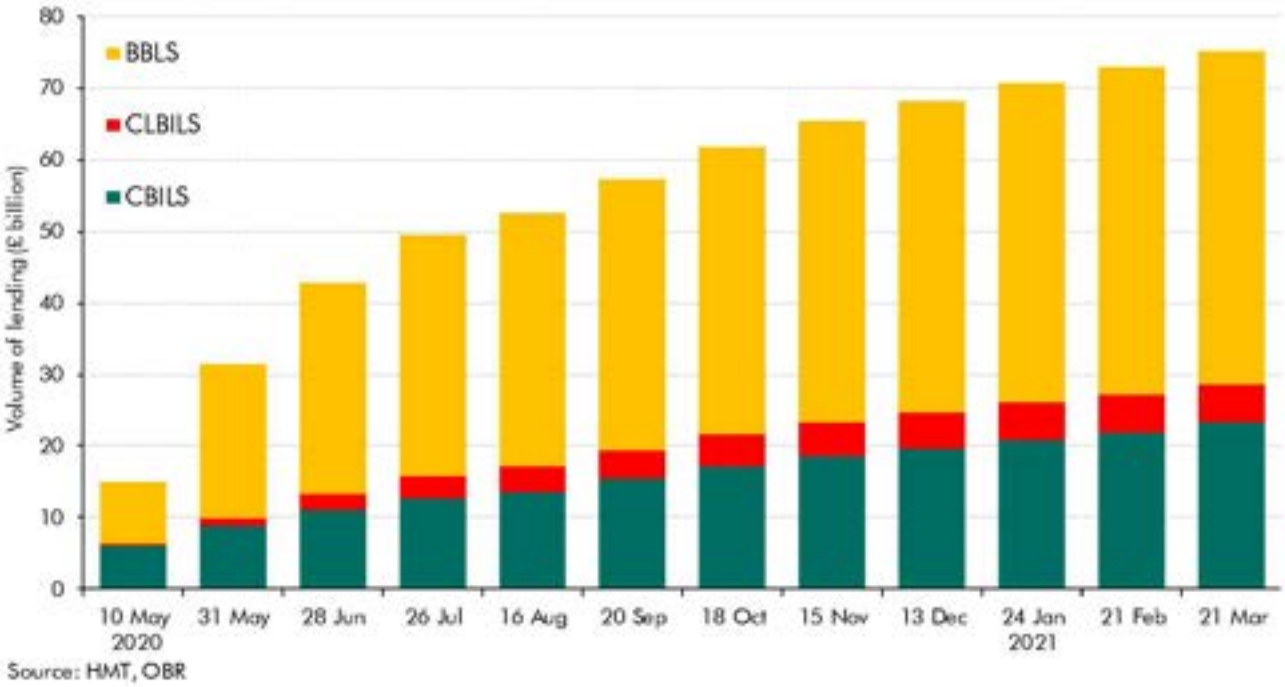
2.32 The Government's coronavirus-related guarantees on business loans present a material source of fiscal risk over the medium term. Through a variety of schemes, the Government has provided a mix of full and partial guarantees against potential losses incurred by creditors worth up to £69 billion (3.1 per cent of GDP).[22] These include:

- £46.5 billion of exposure to potential losses through the **Bounce Back Loan Scheme** (BBLS) for small businesses, which provides full compensation for losses on loans worth between £2,000 and £50,000;
- £18.6 billion through the **Coronavirus Business Interruption Loan Scheme** (CBILS) for small and medium-sized organisations, which provides 80 per cent indemnification for losses on loans worth between £50,000 and £5 million; and

[22] HM Treasury coronavirus (COVID-19) business loan scheme statistics.

- £4.2 billion through the **Coronavirus Large Business Interruption Loan Scheme** (CLBILS) for medium-sized and large businesses, which provides 80 per cent indemnification for losses on loans up to £200 million.

Chart 2.16: Loans issued under the pandemic-related loan guarantee schemes



Source: HMT, OBR

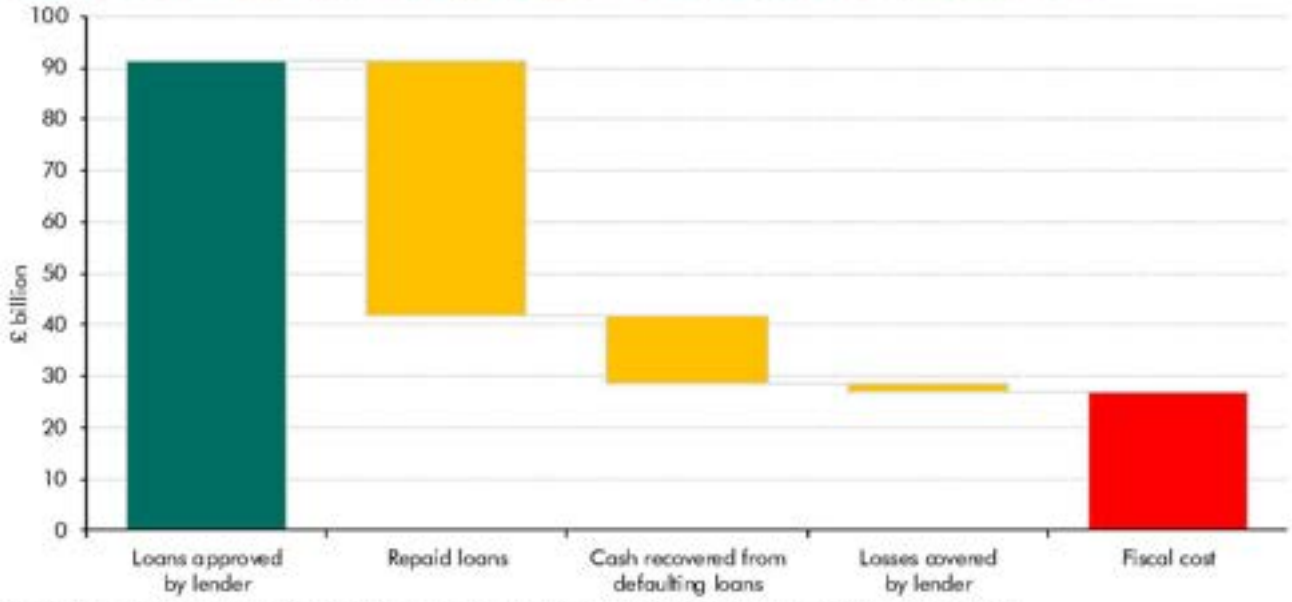
2.33 Through these three schemes, the Government guaranteed nearly half of all lending to small and medium-sized businesses in 2020-21. This government-supported lending helped to keep businesses afloat and avoid the kind of credit crunch that occurred during the financial crisis. This is a different approach than was witnessed during the financial crisis. At that time, the Government intervened to prevent the collapse of financial institutions themselves, effectively providing compensation after the fact for losses that had already crystallised. In this case, the Government acted early, guaranteeing individual lending exposure and effectively providing insurance on losses before the fact.

2.34 As such, the Government's extensive guarantee programme exposes it to potentially significant cash costs in the event of firms defaulting on the underlying loans. For the largest scheme, the BBLS, arrears have so far not arisen because none of these loans have fallen due for repayments. Our forecasts assume future default rates on the loans that try to reflect the inherent riskiness of each of the instruments. As shown in Chart 2.17, the expected cost borne by the public sector is arrived at after taking off cash recovered from the borrower and losses covered by the lender. These expected fiscal costs are reflected in the measure of public sector net borrowing in the year the guarantees were extended (2020-21).

2.35 For CLBILS, aimed at medium and large businesses, which are more resilient to negative shocks, we assumed only 10 per cent of guarantees would be called. For CBILS, aimed at smaller businesses, we assumed 17.5 per cent. For both schemes, lenders bear a fifth of the associated costs. But for BBLS, we assumed 45 per cent of guarantees would be called,

reflecting the greater riskiness of these borrowers – with smaller businesses having a higher likelihood of not repaying their loans – and in the nature of the guarantee scheme – with BBLS guaranteeing all the amounts loaned out, whereas for CLBILS and CBILS only partial guarantees were issued. Our latest estimated cost for lifetime claims on these three schemes, published in our March 2021 *EFO*, is £26.1 billion.

Chart 2.17: Loans approved and expected fiscal costs of loan guarantees



Note: figures based on our March 2021 forecast for loans approved and total losses, with illustrative further breakdown based on assumptions in our 2020 Fiscal sustainability report.
Source: HMT, OBR

2.36 The ONS determined that expected losses on these schemes should be recorded upfront in the public finances when the loans covered by the guarantees were provided. In our forecasts and scenarios over the past year, we have included our best estimate of the size of those expected losses in our PSNB figures. The ONS has not yet included them in the public sector finances statistics it publishes every month. We have estimated these costs based on analysis of similar past loan schemes, but the ONS will come to a view once the British Business Bank's estimates compliant with the financial reporting requirements become available.

2.37 There is, therefore, considerable uncertainty around the £26.1 billion expected loss on these schemes reflected in our estimate of 2020-21 borrowing. The financial health of the businesses that have taken out loans will depend on how the economy recovers as well as risks at the individual company level. There is little evidence to date that would allow us to gauge whether the probability of default implicit in our expected loss assumptions is too high or low given the forbearance measures still in place – including the recent extension of protection for commercial tenants in rent arrears. As of May 2021, company insolvencies were still down 25 per cent on May 2019 (pre-pandemic) and were up only 7 per cent from the very subdued levels of May 2020. In addition to uncertainty around the extent of company failures, it is not yet known the extent to which loans were drawn down fraudulently by those taking advantage of the generous support on offer.

2.38 Future policy changes also pose a risk. The terms of BBLS loans have already been relaxed even before any repayments had to be made, when the Treasury announced the 'pay as you grow' scheme. This allows businesses borrowing under the scheme to extend the term of the loan from six to ten years; to make interest-only payments for six months (up to three times); and to take a full repayment holiday of six months. And while BBLS, CBILS and CLBILS were only in place for 2020-21, the Treasury announced a successor scheme – the Recovery Loan Scheme – in the March 2021 Budget. These actions point to the risk of further forbearance on existing loans and further extensions or successor schemes in future as repayments start to come due.

2.39 The Government's balance sheet is also exposed to risks around its growing portfolio of equity investments. This has been formalised through the Future Fund, which allows companies to apply for equity-convertible loans of up to £5 million. The Treasury progressively increased the amount it was willing to allocate to the convertible loans under the scheme, from an initial £250 million to £1.1 billion for all applications approved by 21 February.[23] Our forecast assumes a 30 per cent loss rate over three years, but even on that basis write-off costs would be small relative to those associated with the larger loan guarantee schemes. It is, however, indicative of the Government's increasing willingness to make active use of its balance sheet to support non-financial corporations, mirroring the approach taken with financial institutions in the wake of 2008-09 crisis. Estimates by Beauhurst[24] point to at least 25 (out of 1,236) loans to companies having already been converted to equity, leaving the Government with stakes in varied companies such as a low-flush toilet maker, a broadband provider, a reusable packaging producer and a satellite company. We asked the Treasury to provide us with the latest position and they told us *"HM Government has not published data on the amount of conversions awarded by the Future Fund, but has regularly published data including value of convertible loans awarded and the diversity statistics of the funding from the scheme"*.

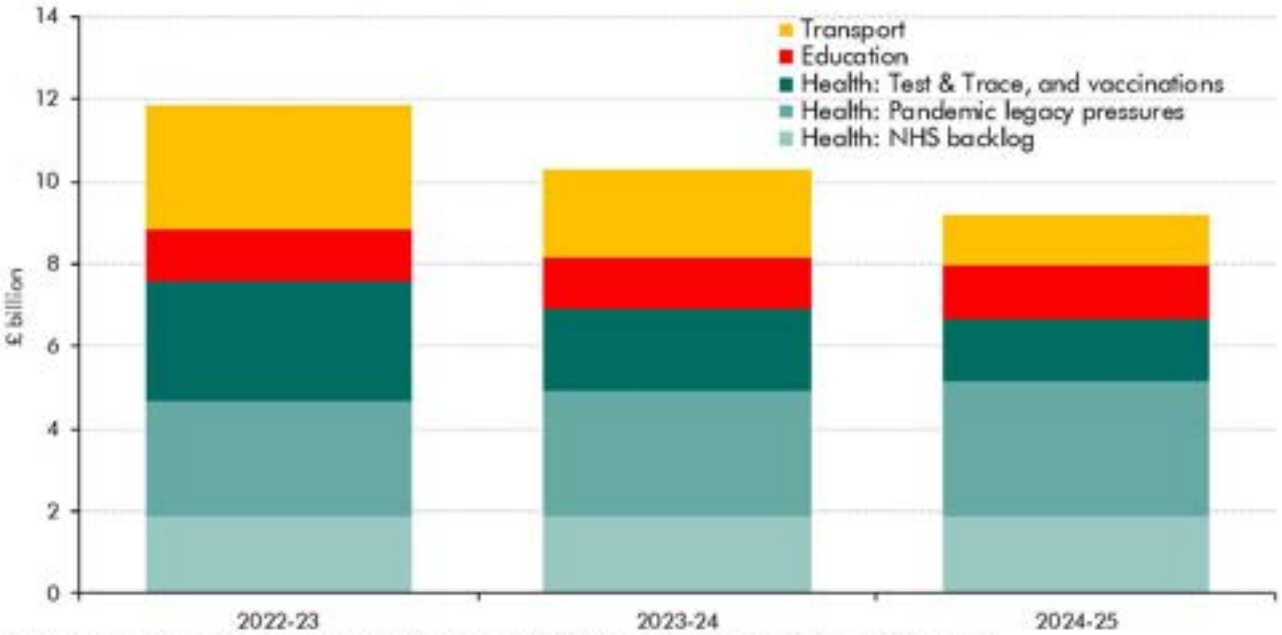
Post-pandemic pressures on public services

2.40 Another key source of direct pressure on the public finances comes from the legacy the pandemic leaves behind for a range of public services. The very large sums allocated to fight the virus mean that departmental resource spending (RDEL) was expected to have risen by up to 39 per cent or £124 billion in 2020-21 in our March 2021 forecast. A smaller £56 billion (equivalent to a 15 per cent increase on pre-pandemic RDEL plans) has been added to fund virus-related activities in 2021-22, but no provision for virus-related spending has been made in 2022-23 and beyond. Instead, core spending totals from 2022-23 onwards were cut by around £14½ billion a year in the November 2020 Spending Review and the March 2021 Budget relative to plans set out in the March 2020 Budget. At the same time, as shown in Table 2.1 above, both total spending and departmental spending is still expected to be higher in 2024-25 than in the year before the pandemic in 2019-20.

[23] Applications closed on 31 January 2021, but processing is still ongoing for those submitted before closure.
[24] Beauhurst, "Future Fund data: what we know so far..."; Financial Times, "UK government becomes shareholder in toilet maker".

2.41 The scale of potential post-pandemic departmental spending pressures, which amount to around £12 billion next year and decline to around £9 billion after three years, are considered in more detail in this section. These unfunded pressures are comprised of approximately £7 billion a year in pressures on the health service, £1¼ billion a year in education, and declining amounts that average £2 billion a year in transport (Chart 2.18). These figures are subject to varying degrees of uncertainty and represent only a subset of the universe of pandemic legacy spending risks for Government departments, but we consider them to be reasonable estimates of some of the larger potential post-pandemic pressures on DEL. They largely draw on external sources in the absence of detailed estimates from the Government. And, in keeping with this report's focus on adverse risks, we have not attempted a comprehensive assessment of potential savings that might stem from the pandemic. Nor has the Government proposed any. Because of the Government's decision to suspend multi-year budget planning and revert to annual spending rounds for most departments in recent years, whether and how the Government chooses to respond to these pressures is not yet known.

Chart 2.18: Illustrative estimates for selected pandemic-related pressures on departmental resource spending



Note: Assumptions and sources underpinning estimates of individual pressures can be found in Chapter 2.
Source: OBR

Health

2.42 Pandemic-related pressures on health spending could amount to £7 billion a year on average over the next three years, with pressures likely to be greatest in the near term. The larger sources of potential pressure include: maintaining a standing capacity for test and trace and vaccinations; addressing the backlog of elective treatments built up during the pandemic; and the implications for NHS productivity of building in greater resilience and the greater capacity for infection control than was allowed for in pre-pandemic plans.

2.43 The most direct virus-related risks to the Government's plans are the health costs associated with coronavirus itself. The Department of Health and Social Care's (DHSC's) 'core' non-virus budget in 2021-22 was set at £147.1 billion in the 2020 Spending Review. While an additional £63 billion was added in 2020-21 and £29 billion was added in 2021-22, there have been no additions to its pre-pandemic multi-year settlement thereafter. There are several potential additional demand pressures as a direct result of the pandemic, including:

- **Controlling the virus as it continues to circulate**. So long as the virus remains prevalent in the UK, there are likely to be ongoing costs from NHS Test and Trace, for which the Treasury has allocated £15 billion in 2021-22. With vaccinations providing some degree of protection against infection, it is very unlikely that ongoing costs would be anywhere near as high as they have been to date – and they might also be expected to become more concentrated in winters rather than spread throughout the year. If we therefore assume that Test and Trace spending will be required for three months a year, but at a monthly cost that halves each year (reflecting some combination of fewer tests being administered and/or unit costs falling), this might cost £2 billion next year, falling to £1 billion in 2023-24 and £½ a billion in 2024-25.

- **Ongoing costs from vaccinations and revaccinations.** The Government noted in its February Roadmap that *"vaccinations – including revaccination… is likely to become a regular part of managing COVID-19"* and the NHS is planning *"a revaccination campaign, which is likely to run later this year in autumn or winter... on the basis that [the NHS] will need to run COVID-19 and seasonal flu vaccination campaigns in parallel."*[25] The relatively low unit cost of purchasing and administering vaccines (around £10 per dose)[26] means that providing two 'booster' doses a year to each adult in the UK (at a take-up rate of 95 per cent) would cost just over £1 billion a year.

- **Greater-than-assumed spending as a result of 'long Covid' cases**. Around 1million individuals in the latest ONS survey self-reported long-Covid symptoms in May 2021, with 376,000 reporting symptoms more than a year after they had had the virus.[27] A more recent DHSC study suggests that the number of people reporting long-Covid symptoms was higher still at over 2 million.[28] Whether and how these cases might subsequently translate into any additional costs for the health (or welfare) system is unknown at this stage. We therefore do not include a long-Covid-related estimate in our summary of pandemic-related pressures on health spending.

- **The consequences for mental health arising from the pandemic and the lockdowns**. The Health Foundation REAL Centre projected that referrals to dedicated mental health services for adults and children could increase by an average of 11 per cent in the aftermath of the pandemic. Absorbing this increase in caseload could cost the health service £1.1 billion next year, rising to £1.4 billion by 2024-25.[29] There may also

[25] NHSCOVID-19 vaccine deployment, NHS England and NHS Improvement Board meetings, March 2021.
[26] COVID-19: *Planning for the vaccine (part 1) Inquiry*, NAO, 2021.
[27] *Prevalence of ongoing symptoms following coronavirus (COVID-19) infection in the UK: 4 June 2021*, ONS.
[28] *New research shows 2 million people may have had long COVID*, DHSC, June 2021.
[29] *Spending Review 2020: Priorities for the NHS, social care and the nation's health*, Health Foundation REAL Centre, November 2020.

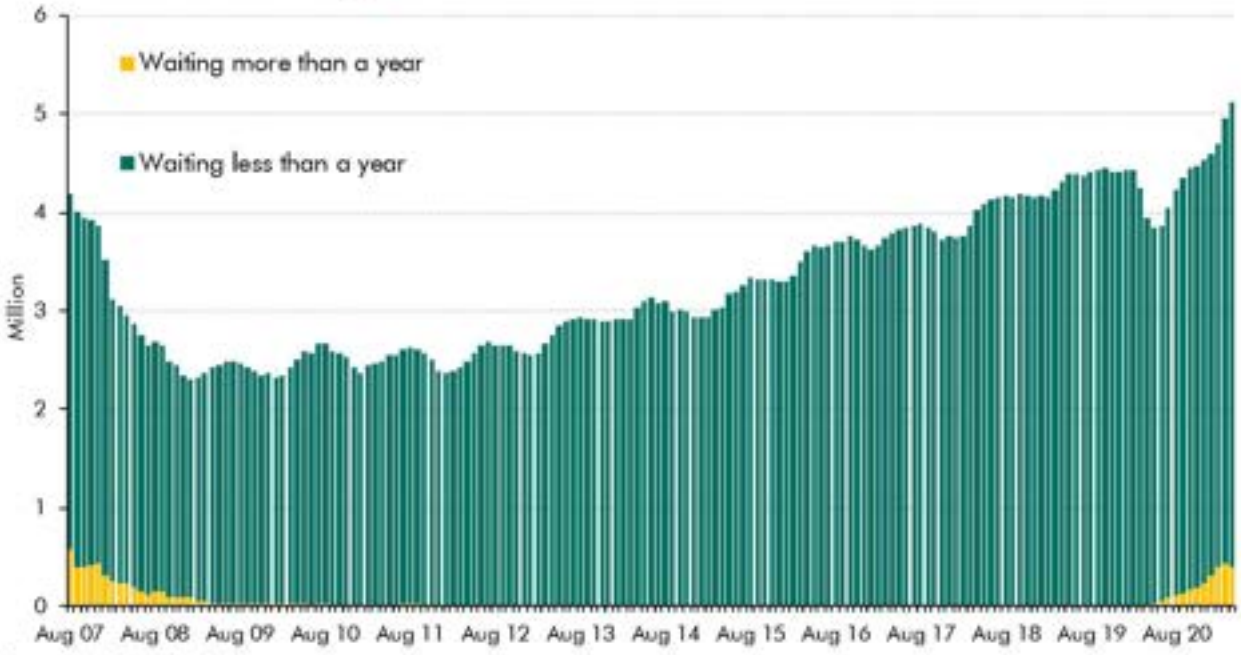
knock-on impacts on future welfare spending (which we do not capture) if the doubling in self-reported prevalence of depression fed through to higher numbers of GP diagnoses as services return to normality and subsequent inflows to universal credit and disability benefits.[30]

2.44 In addition to these direct demands on the health service, the Government stated in the Roadmap that it is *"committed to building resilience for any future pandemics, both domestically and on the international stage."* This could require building **greater spare capacity in the health service** so that it is more resilient to sudden surges in demand of the type experienced over the past year. As discussed above, in comparison to other advanced economies, the UK entered the pandemic with relatively low per capita numbers of critical care beds and relatively high levels of bed occupancy. The NHS estate might also need to be reconfigured so that managing large numbers of infectious patients and segregating them from the non-infected population does not routinely disrupt other treatments. (Health sector output fell by 15 per cent in 2020 as hospitals redesigned infection prevention and control to address the new coronavirus risks.[31]) The Health Foundation notes that continued social distancing and infection control measures could reduce NHS productivity relative to pre-crisis assumptions, calculating that every percentage point of productivity lost could generate £1.4 billion to £1.7 billion a year of spending pressure.[32] If NHS productivity were to suffer a hit of 1.2 per cent – in line with our economy-wide TFP scarring assumption – this would imply around £1.8 billion a year in additional cost pressures.

2.45 In addition to these virus-related pressures, there may be costs associated with clearing the **backlog of non-virus-related treatments in the NHS**. Between April 2020 and May 2021 there were 3.5 million fewer elective procedures and over 22 million fewer outpatient attendances in England than over the same period in 2019-20.[33] At least some of those people not seen last year will need treatment eventually, which can be expected to add to the 5.1 million already on a waiting list for NHS care. Delayed treatment might also mean that their health is now worse and that the cost of treatment will be higher. Waiting times have already risen: the latest figures show that 385,000 people have been on NHS waiting lists for more than a year, compared to just over 1,500 before the pandemic.[34] The Health Foundation estimated that tackling the backlog of demand for elective care and restoring waiting times to pre-pandemic standards would cost £1.9 billion a year over three years (while also warning that the level of increased activity required to do so might not be achievable due to staffing constraints).[35]

[30] *Are we facing a mental health pandemic?*, ONS, May 2021.
[31] *UK Economic Accounts: main aggregates*, ONS, 31 March 2021.
[32] *Spending Review 2020: Managing uncertainty, COVID-19 and the NHS long term plan*, Health Foundation, November 2020.
[33] *Pressure points in the NHS*, British Medical Association, June 2021.
[34] *Consultant-led Referral to Treatment Waiting Times Data 2021-22*, NHS England, June 2021.
[35] The Health Foundation's estimate of clearing the backlog was made prior to the third national lockdown. A more recent estimate factoring in additional elective treatments postponed this year could therefore be higher still. Its estimate was based on the then *"4.7 million fewer patient referrals compared with the same months in 2019. Assuming that 75 per cent [of these 'missing patients'] still need treatment and are referred by the end of 2020/21 [means] the waiting list would grow to 9.7 million by 2023. Clearing this backlog over 3 years, while treating the expected normal growth in referrals by 2023/24, would require treating 1.5 million more patients a year beyond the long-term plan assumptions, at an additional cost of £1.9bn per year"*.

Chart 2.19: NHS waiting lists



Source: NHS England

Education

2.46 The closure of schools and other education establishments for extended periods over the past year has significantly reduced the number of teaching hours received by the current cohort of school-aged children. The Government's Roadmap highlights *"studies suggesting the total loss in face-to-face learning could amount to around half a school year"*. The Prime Minister has stated that *"no child will be left behind as a result of the pandemic"* and the Government's intention to *"develop a long-term plan to make sure pupils have the chance to make up their learning over the course of this Parliament."* Sir Kevan Collins was appointed as an Education Recovery Commissioner in February 2021 *"to oversee a comprehensive programme of recovery aimed at young people who have lost out on learning due to the pandemic"*. He resigned in June 2021 and no such programme has been forthcoming.

2.47 At the time of our March forecast, the Government had already committed £1.7 billion to catch-up education spending. Since then, it has announced a further £1.4 billion to fund extra tuition for some pupils.[36] The Prime Minister subsequently described this as being *"just for starters"*[37] and the Government has said that education recovery will be reviewed further at this year's Spending Review. The extent of further pressures this could pose are highly uncertain given the different types of intervention that could be pursued. In addition to extra tuition the Education Policy Institute estimated that allocating £3.2 billion over the next three years for extended school hours would be sufficient to recover two months' lost learning.[38] At a cost of £600 per pupil per year, this would imply a pressure of around £1 billion a year over the next three years in addition to the amounts already announced.

[36] *Huge expansion of tutoring in next step of education recovery*, Department for Education, June 2021.
[37] *Prime Minister's Questions*, 9 June 2021.
[38] *Education recovery and resilience in England, Phase one report*, Education Policy Institute, May 2021.

Transport

2.48 The pandemic has also significantly disrupted domestic and international transport and generated calls for substantial and lasting fiscal support to the sector. The Government has already intervened in the past year with direct support to the railways and to Transport for London at a cost of £12.8 billion in 2020-21. The National Infrastructure Commission has presented a range of possible scenarios for the enduring impact of the pandemic on public transport numbers out to 2055.[39] These included 'a more flexible future' scenario involving up to 10 per cent fewer public transport trips up to 'a virtual local reality' scenario in which they were 25 per cent lower. As of 28 June, use of the railways remained down 55 per cent relative to pre-pandemic levels and use of London Underground was still down 54 per cent.[40] Given rail income of around £11.6 billion in 2019-20,[41] and accounting for inflation, assuming a 25 per cent shortfall in 2022-23 (in line with the 'virtual local reality' scenario) that eases to 10 per cent by 2024-25 (in line with the 'more flexible future' scenario) would imply revenue losses and thus a spending pressure of £3.0 billion in 2022-23 that would diminish to £1.2 billion a year by 2024-25.

2.49 Public and private providers have typically relied on relatively better-off commuters with limited choice travelling at peak hours to pay the bulk of fares while in effect subsidising the travel of off-peak travellers. Transit on trains, buses and urban metros fell across the world, but it is striking that usage in the UK has stayed lower for longer than other comparator countries, and is currently more than half as much again below pre-pandemic levels as in these countries. The shift to working from home for sections of the economy could threaten this decades-old funding model – first through lower traffic in total, but also through reducing the concentration of passenger numbers at particular times of the day that allows providers to charge higher prices during predictable periods of peak demand.

[39] *Behaviour change and infrastructure beyond Covid-19*, National Infrastructure Commission, May 2021.
[40] *Transport use during the coronavirus (COVID-19) pandemic*, Department for Transport, June 2021
[41] *Rail Industry Finance (UK) 2019-20*, Office of Rail and Road, November 2020.

Chart 2.20: Changes in public transport mobility during the pandemic

Source: Our world in data, accessed on 25 June 2021

Other potential pressures on departmental spending

2.50 The estimates presented above cover some of the larger pandemic-related pressures, but they do not represent a comprehensive assessment of such pressures – or indeed potential savings, for example from greater delivery of public services online. Nor do they cover other pressures that are less directly related to the pandemic. These issues would include:

- Any pressures from '**long Covid**', which as noted above are currently unknown.
- Prospective reforms to **adult social care**, which have been under consideration by successive governments for the past decade, and where the current Government's 2019 manifesto stating that it would *"urgently seek a cross-party consensus in order to bring forward the necessary proposal and legislation for long-term reform"*.
- The cost of addressing **pandemic-related backlogs in the justice system** on the Ministry of Justice's RDEL budget, which was £9.3 billion in 2021-22.
- The cost of restoring **Official Development Assistance** spending to the legislated target of 0.7 per cent of GNI from the 0.5 per cent it was temporarily reduced to in Spending Review 2020. 0.2 per cent of GNI is equal to £4.7 billion a year in 2022-23, rising to £5.2 billion a year in 2025-26 thanks to continuing economic growth.

Long-term economic legacy of the pandemic

2.51 Beyond any direct medium-term pressures, the longer-term fiscal risks associated with the pandemic will depend on its lasting impact on potential GDP and demographic trends. As set out in our last two *EFOs*, we have so far assumed in our central forecast a 'scarring' effect (defined as the shortfall in potential output relative to its pre-pandemic trajectory at the five-year forecast horizon) of 3 per cent. But given the extreme uncertainty about the size of this effect, we also presented two alternative scenarios: an upside path with no long-term scarring on output; and a downside path assuming long-term scarring of 6 per cent.

2.52 This range of scarring estimates was broadly in line with external estimates for the UK economy and official forecasts for other European countries. The range was based on top-down judgement rather than precise bottom-up modelling and did not presume a mechanical connection to specific near-term policies or developments. That notwithstanding, in our November *EFO*, we presented a putative decomposition of our 3 per cent central scarring assumption:

- **Lower investment** during the pandemic and subsequent recovery lessening the amount of capital available per worker and so reducing productivity growth ('capital shallowing'). This accounted for 0.8 percentage points.

- **Lower total factor productivity (TFP)** reflecting reduced investment in R&D during the pandemic, together with the assumption that the ongoing presence of the virus would require some businesses to adopt less efficient ways of operating (such as more distancing within workplaces). Higher business debt and firm failures should also weigh on future innovation. This accounted for 1.2 percentage points.[42]

- **Lower labour supply**, accounting for 1 percentage point. Within this, half was down to lower participation, reflecting the longer-run health consequences for some of those contracting the virus and a decision by some older workers to retire earlier. The remainder was split roughly equally between modestly higher unemployment (as workers moved across jobs, sectors and occupations) and a smaller population (as a result of lower net migration). Average hours worked per person was assumed to return to their pre-pandemic trajectory, so did not contribute to labour market scarring.

2.53 Over the longer term, the loss of face-to-face education by students would also be expected to have an adverse impact on their subsequent productivity and be reflected in lower lifetime earnings.[43] We did not consider this channel for our medium-term forecast as the effect would mostly occur beyond our forecast horizon.

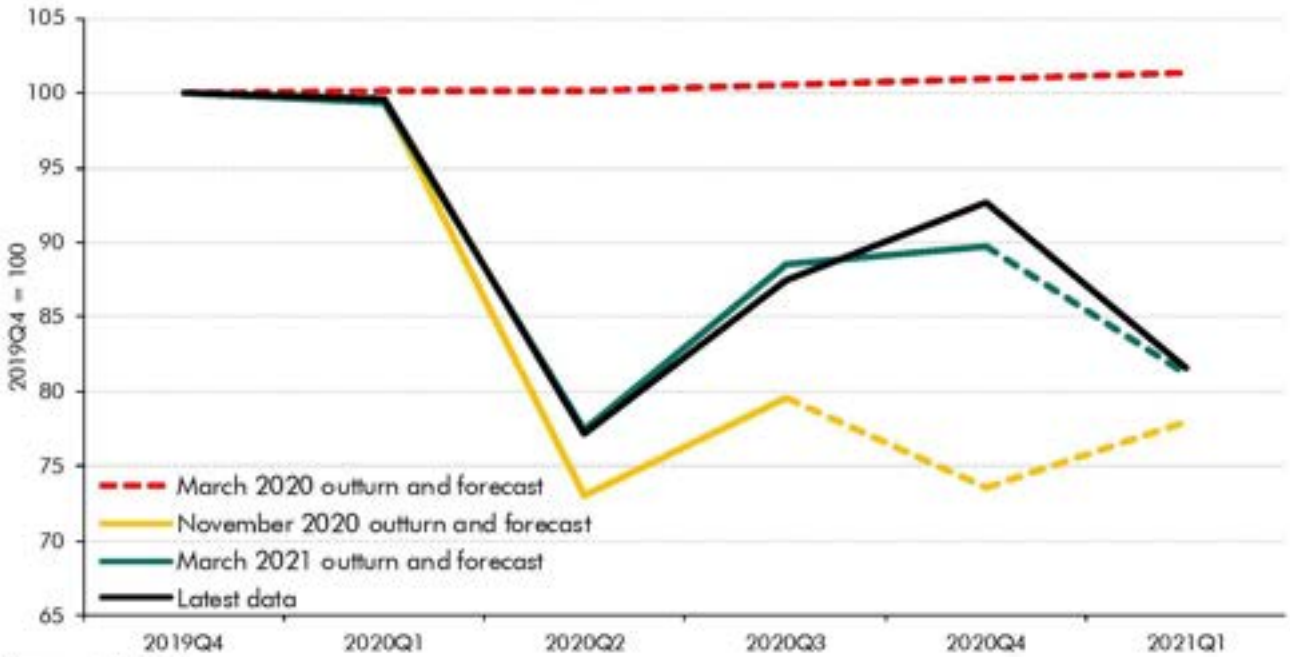
[42] In reality, some of the TFP shortfall would also reflect capital scrapping as a result of business failures or faster depreciation of the remaining capital stock due to the adoption of new – and less efficient – modes of operation as result of the virus. But effects of this sort are unlikely to be picked up in the official capital stock statistics, so would instead show up in measures of TFP.
[43] *Costs of lost schooling could amount to hundreds of billions in the long-run*, IFS, February 2021.

Recent data and analysis

2.54 Data and analysis released since we made our original judgements paint a mixed and incomplete picture on scarring:

- The ONS has revised up its estimates of **business investment**. At the time of our November 2020 forecast, business investment in the second quarter of 2020 was estimated to have been 27 per cent below its level in the fourth quarter of 2019 before recovering to be 20 per cent below in the third quarter (Chart 2.21). These figures have since been revised up to 23 per cent and 13 per cent respectively. Data for the fourth quarter of 2020 and the first quarter of 2021 also point to smaller shortfalls than assumed in our November 2020 forecast – at 7 and 17 per cent rather than 26 and 22 per cent respectively. This suggests the impact of the capital shallowing channel might be less than we originally thought.

Chart 2.21: Business investment during the pandemic



Source: ONS, OBR

- There is little new information regarding the impact on **TFP**, but external analysis of the Bank of England's Decision Makers Panel (DMP) survey that was published between our November and March forecasts suggests that the pandemic could reduce private sector TFP by around 1 per cent in the medium term.[44] While the successful vaccine rollout has facilitated a faster recovery in output in recent months than we expected and might be consistent with a better financial position for firms, the additional lockdown at the start of this year will have led to a further deterioration for some businesses and might lead to the loss of firm-specific knowledge from more firm failures, while additional debt incurred might weigh on future innovation.

[44] N Bloom et al. *The Impact of Covid-19 on Productivity*, NBER Working Paper 28233, December 2020.

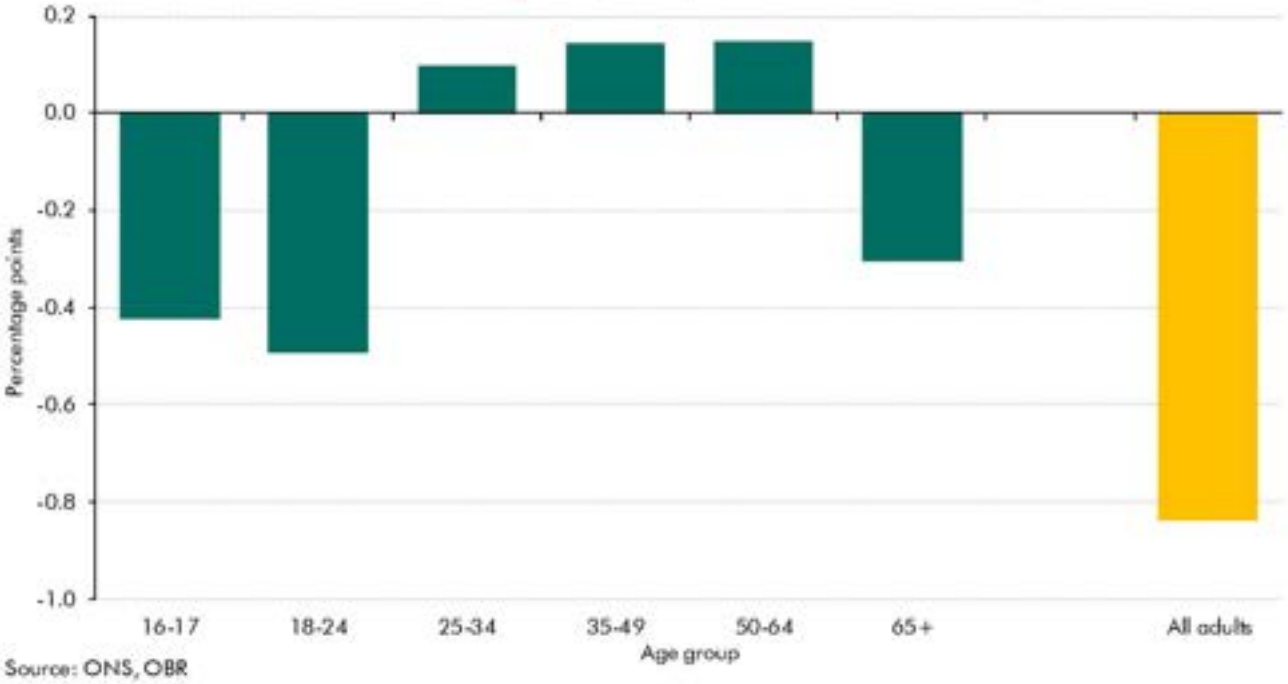
- Analysis of labour market data, discussed in Chapter 2 of our March 2021 *EFO*, suggested that the working-age **population** may be substantially smaller than incorporated into the official statistics. This would be the result of significant numbers of foreign-born nationals returning home during the pandemic and lower levels of immigration than pre-pandemic projections assumed. The ONS has subsequently released new analysis and has set out plans to improve the evidence base in this area.[45] Initial experimental modelling by the ONS suggests that net migration fell during the initial phase of the pandemic, to a net outflow of around 67,000 between March and June 2020.[46] ONS analysis of HMRC's real-time information (RTI) from the PAYE tax system suggests that the population in the fourth quarter of 2020 could be around ½ per cent smaller than currently incorporated into labour market data.[47] This analysis implies that the impact of the population scarring channel might be greater than we originally expected.

- The official Labour Force Survey (LFS) suggests that the **unemployment** rate has been lower than we expected at 4.8 per cent in the first quarter of 2021 compared to 5.1 per cent in our November forecast. RTI data are consistent with a somewhat higher unemployment rate of around 5.5 per cent (with the gap relative to the LFS having narrowed slightly as the number of payrolled employees picked up in April and May). There were also still around 2.6 million people on furlough in May (about 8 per cent of the labour force), some of whom are likely to flow into unemployment over the coming months.

- The **participation rate** was 63.4 per cent in the first quarter of 2021 compared to 63.7 per cent in our November forecast, and is down 0.8 percentage points relative to the first quarter of 2020. The pandemic has so far had a larger impact on labour market participation among both older workers and younger workers relative to those in middle of their working lives (Chart 2.22)[48] While the latest statistics show that the change in participation levels is mainly driven by the young, a significant number of people over 65 have also left the labour market, halting the recent trend of increasing participation for this age group. This could be indicative of older workers taking earlier retirement following the pandemic, which would lower overall participation relative to pre-pandemic assumptions. Relatively few forecasters have included a participation channel in assumptions about medium-term scarring.

[45] ONS, *Population and migration statistics system transformation – overview*, April 2021 and June 2021.
[46] ONS, *Using statistical modelling to estimate UK international migration*, April 2021.
[47] ONS, *Labour Force Survey weighting methodology*, May 2021.
[48] N. Comminetti, *U-Shaped Crisis*, April 2021.

Chart 2.22: Contributions to change in participation between 2020Q1 and 2021Q1



Source: ONS, OBR

- Our putative breakdown did not include an **average hours** effect, but the pandemic could have lasting consequences on working patterns. It has accelerated the movement towards working from home, with the proportion of the workforce who did some work at home rising to 35.9 per cent in 2020, up 9.4 percentage points from 2019. Recent data from the ONS BICs survey suggest around a quarter of businesses plan to continue increased home working. The consequence of this for average hours is presently unclear. One the one hand, full-time workers who mainly work from home tend to work more hours on average than those who never work from home. But on the other, those who mainly work from home are more likely to work part time than those who never work from home.[49]

Outside forecasters' scarring judgements

2.55 In its latest *World Economic Outlook* released in April 2021, the IMF estimated that the pandemic would lower world output in 2024 by around 3 per cent relative to their pre-pandemic forecast, albeit with significant variation across countries. This is significantly less than the IMF estimates of an average 6 per cent loss for past pandemics and epidemics, and the almost 10 per cent loss following the financial crisis. While the shock to global output was much larger in 2020 than in 2008 and 2009 during the financial crisis, the IMF cited several mitigating factors limiting the long-term damage this time around:

- **The economic shock was concentrated in 'high contact' consumer-facing sectors.** These are typically at the end of supply chains and tend to be less influential in affecting economy-wide productivity than upstream businesses.

[49] ONS, *Homeworking hours, rewards and opportunities in the UK: 2011 to 2020*, April 2020.

- **Government support has been far greater.** Advanced economy governments have spent an average of 8 per cent of GDP in supporting households, businesses and public services in 2020,[50] compared to an average of just 2 per cent of GDP in 2009.[51]

- **Financial instability has been largely avoided.** Such instability has historically been associated with deeper and longer-lasting recessions, but it has been avoided through a combination of post-2008 reforms to financial regulation alongside the provision of prompt and extensive support by governments and central banks.

2.56 Differences in the share of 'high-contact' sectors, scale of government support, and speed of vaccine rollout explain much of the cross-country variation in the IMF's estimates of scarring, with the average loss of output running from less than 1 per cent in the advanced economies to 4 per cent in emerging markets and 6 per cent in developing countries. For the UK, the latest WEO projection includes a scarring effect of 4 per cent – 1 percentage point greater than our own scarring assumption.

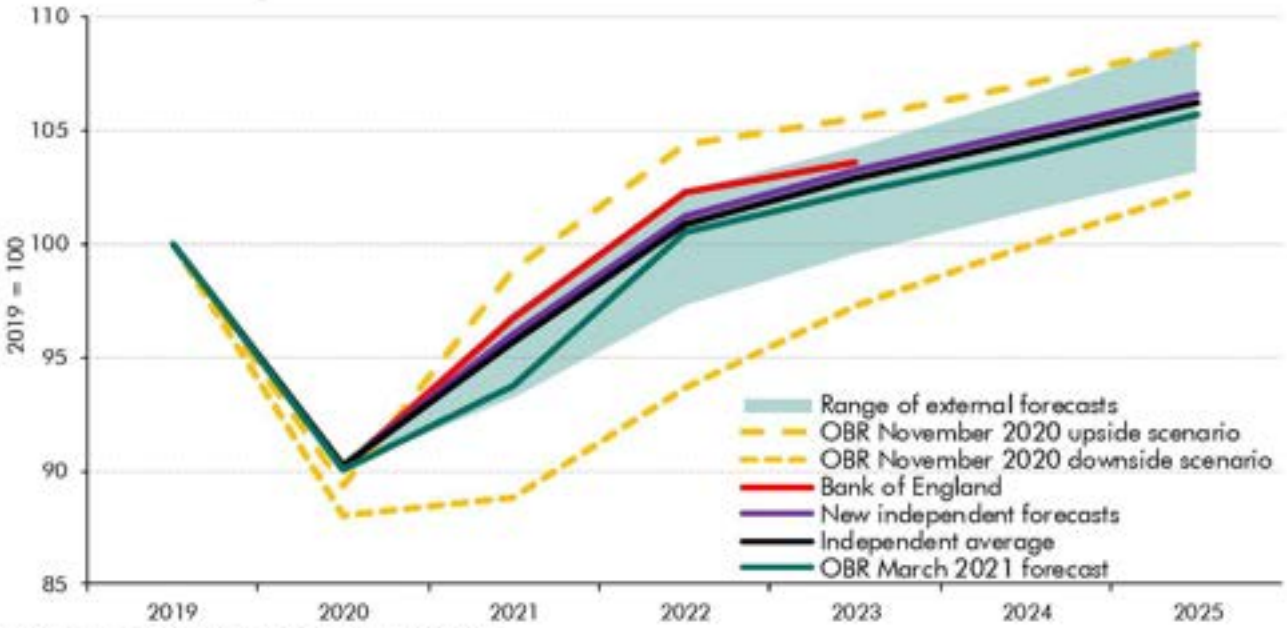
2.57 In its May 2021 *Economic Outlook*, the OECD estimated that potential output in the UK would be 2 per cent lower in 2022 than its pre-pandemic forecast. The OECD also calculated that external forecasters had revised down the level of GDP in the UK in 2025 by an average 3.8 per cent relative to pre-pandemic projections.

2.58 The Bank of England expects scarring of around 1¼ per cent at its three-year forecast horizon. This is expected to come mainly through the productivity channel, which partly comes through weaker business investment lowering the capital stock. The Bank also expects weaker TFP growth as a result of the lower investment and the lack of skills improvement by those who have not been working during the pandemic. As outlined in our March 2020 *EFO*, the Bank had a weaker projection for potential output than we did before the onset of the pandemic. This lessens the gap between our overall potential output forecasts relative to the gap between our respective scarring assumptions.

2.59 Of course, what matters for the sustainability of the public finances is the overall outlook for GDP rather than the specific effect of the pandemic. Different organisations' medium-term GDP forecasts will reflect a combination of pandemic effects, Brexit effects, and assumptions about underlying potential output growth – all of which are highly uncertain. Comparing our GDP forecast from March to the five-year forecasts compiled by the Treasury in May, our central forecast is towards the bottom of the range in the near term – reflecting the smaller shortfall in output in recent months than we assumed in March (Chart 2.23). In the medium term, our forecast remains towards the middle of the range of forecasts and, after five years, is only 0.5 per cent below the overall average and 0.8 per cent below the average of those new forecasts produced in May. This difference is relatively small given the uncertainty surrounding economic forecasts in the current environment, as illustrated by our upside and downside scenarios. In 2025, our upside scenario is close to that of the most optimistic external forecaster and our downside scenario is slightly below the most pessimistic one, suggesting they continue to provide a plausible range for future outcomes.

[50] Figure 1.7 of IMF, *Fiscal Monitor: A Fair Shot*, April 2021.
[51] Table 3.4 of IMF, *Fiscal Implications of the Global Economic and Financial Crisis*, June 2009.

Chart 2.23: Comparison of GDP forecasts



Note: Bank of England forecast excludes the backcast.
Source: Bank of England, HM Treasury, ONS, OBR

Future developments

2.60 The eventual extent of scarring is still highly dependent on the path of the pandemic in the coming months and on policy responses to it. We outlined some of the risks to the epidemiological assumptions that underpinned our latest forecast in Box 2.1 of our March 2021 *EFO*, most of which are still relevant. Indeed, the delta variant has led to the Government announcing a four-week delay – to 19 July – to the final step in its 'Roadmap' for lifting the remaining public health restrictions in England, which underpinned our March forecast. Another major scarring-related uncertainty is how businesses and households respond to the withdrawal of government support measures, much of which currently remains in place.

2.61 As is our usual practice, we will review our potential output assumptions, including pandemic-related scarring, and revise them, if appropriate, in our next *EFO* and in subsequent forecasts as more information accrues. As time goes by, however, it will become increasingly difficult to distinguish the effects of the pandemic on the economy from those caused by other factors such as Brexit or the general stagnation in productivity since the financial crisis. Nonetheless, some of the information we will be reviewing in coming months to inform our potential output forecasts are set out in Table 2.2. It includes:

- Data on the performance of the **labour market after the CJRS closes** at the end of September. The latest data show that in May 2021 there were still 2.6 million people on the CJRS. While this is significantly down from the peak of 8.7 million in April 2020, it is still around 5 per cent of the adult population (see Box 2.1). While unemployment and inactivity have so far not risen significantly, the extent to which those on furlough flow into each could materially affect the extent of labour market

scarring. However, the full extent of labour market scarring will depend on the ability of the jobless to subsequently move into new jobs, sectors and occupations.

- The extent and composition of **firm insolvencies**. Since the beginning of the pandemic, insolvencies have been remarkably subdued. Some of this will be a product of the Government's support package to firms, including grants and business rates holidays, guaranteed loans, and in large part paying the wages of furloughed workers. The Government also introduced a temporary directive in April 2020 restricting the use of winding-up petitions, which has been subsequently extended until the end of September 2021, reducing the possibility of insolvencies until then. Eviction protection for commercial tenants has since been extended to March 2022. These factors help to keep some otherwise viable firms from failing, supporting productivity by maintaining firm-specific capital and knowledge. However, these protections may also have had an offsetting adverse impact on productivity by keeping otherwise unviable businesses operating (so-called 'zombie' firms). So, once government financial support and these additional protections end, both the extent and composition of firm insolvencies may provide some indication of the scarring of productivity.

- The recovery in **business investment** and any revisions to historical data. Business investment data are always prone to revision and the ONS has emphasised the increased uncertainty around data caused as a result of the pandemic. The latest vintage of data show that business investment in the first quarter of 2021 was still 17 per cent below the pre-pandemic peak, lagging the recovery in GDP, which was only 9 per cent below. The outlook for the continued recovery is further clouded by the uncertainty around the effect of the temporary super-deduction capital allowance and increase in the corporation tax rate that were announced in the Budget in March. The former is likely to have a significant effect on the timing of investment, although the size is particularly uncertain given its lack of precedent. Evidence from the Bank of England's Decision Maker Panel survey is broadly consistent with the peak impact of a 10 per cent increase that we incorporated in our forecast.[52] Business investment data will give an indication of the productivity scarring effect through capital shallowing, but its volatility and tendency for to be revised significantly between releases will inevitably cloud the picture.

- Data on **net migration** during the pandemic and indications about the extent to which those 'missing migrants' will return to the UK. In July, the ONS will be reweighting its labour market statistics using RTI data to give a timelier view of the UK population. They will also be updating their modelling of net migration estimates later this year and providing 2020-based mid-year population projections. These will give additional information on migration, but it is unlikely that we will have a robust estimate of the UK population until the latest Census results are released in 2022. Even then, there will still be considerable uncertainty on the prospects for net migration in the medium term, including how many of those who left will return to the UK. This is compounded by the fact that any catch-up immigration will need to take place under the new post-Brexit

[52] Bunn *et al*, *Influences on investment by UK businesses: evidence form the Decision Maker Panel*, 25 June 2021.

immigration system, which is tighter than its predecessor for those entering the UK from EU member states.

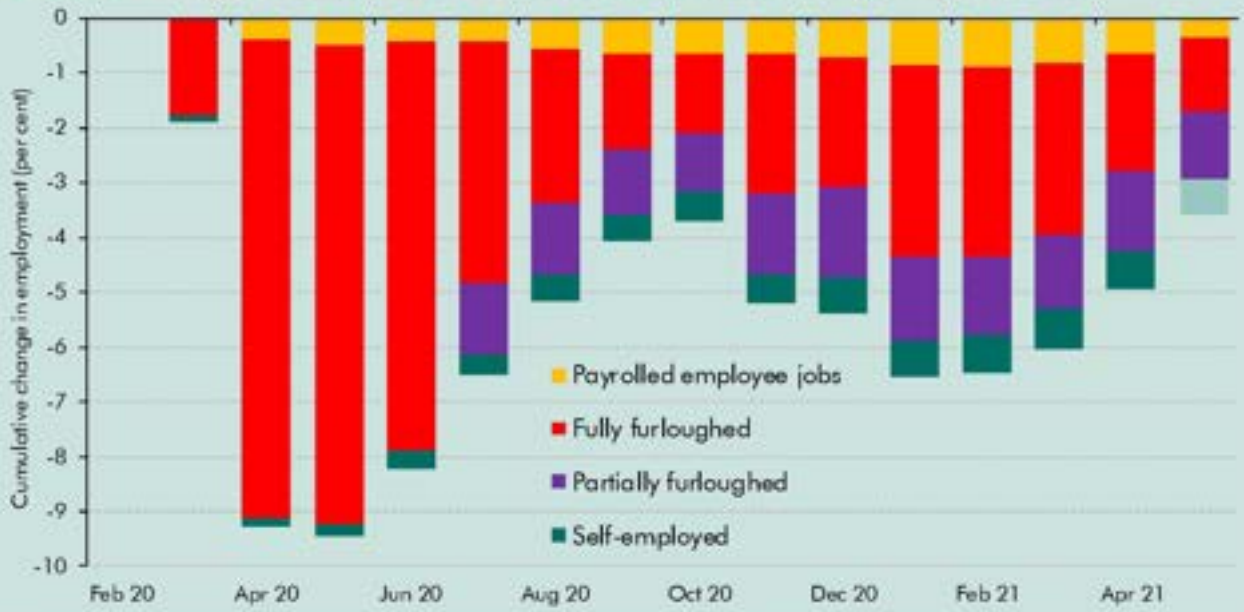
Table 2.2: Forthcoming scarring-related data releases

Release	Information	Date
May Labour Force Survey (LFS)	Population scarring based on RTI data	15 July 2021
1st estimate of Q2 2021 GDP	Business investment recovery (capital shallowing)	12 August 2021
Q2 2021 Quarterly National Accounts, incorporating 2021 Blue Book revisions	Pace of recovery and capital shallowing	30 September 2021
September real time information (RTI)	Labour market during last month of CJRS	12 October 2021
August 2021 GDP	Output post lifting of final covid restrictions	13 October 2021
September LFS	Labour market during last month of CJRS	16 November 2021
October RTI	1st data on labour market post-CJRS	16 November 2021
Monthly Insolvency Statistics	Capital scrapping and TFP effects as government support fades	16 November 2021
October LFS	Detailed data on labour market post-CJRS	14 December 2021
ONS migration modelling and 2020-based population projections	Indication of population scarring	Late-2021

Box 2.1: The CJRS and unemployment

In the March 2021 Budget, the Chancellor announced that the CJRS will be fully withdrawn at the end of September, and that employer contributions will increase in monthly steps from July onwards. Our forecasts for GDP, unemployment, and other key fiscal determinants assume that the vast majority of those still on furlough will be able to return to their jobs or find alternative employment. The latest data show that there were still 2.6 million people on the CJRS in May 2021, with the number falling quickly in recent months as the economy has reopened and activity rebounded. Even so, jobs fully or partly furloughed still account for shortfall in labour utilisation relative to the month prior to the pandemic.

Chart A: Change in employment-related indicators during the pandemic



Note: May 2021 self-employment data (shaded) is estimated based on BICS data, as LFS is not yet available.
Source: HMRC, ONS, Resolution Foundation, OBR

While the numbers furloughed are down by 5.1 million from the peak of 8.7 million at the height of the first lockdown in April 2020, it is still a very large programme, paying a large proportion of the wages of 9 per cent of all payrolled employees in the UK. The latest ONS BICS data suggest that this proportion has fallen a little further to 7 per cent by mid-June.

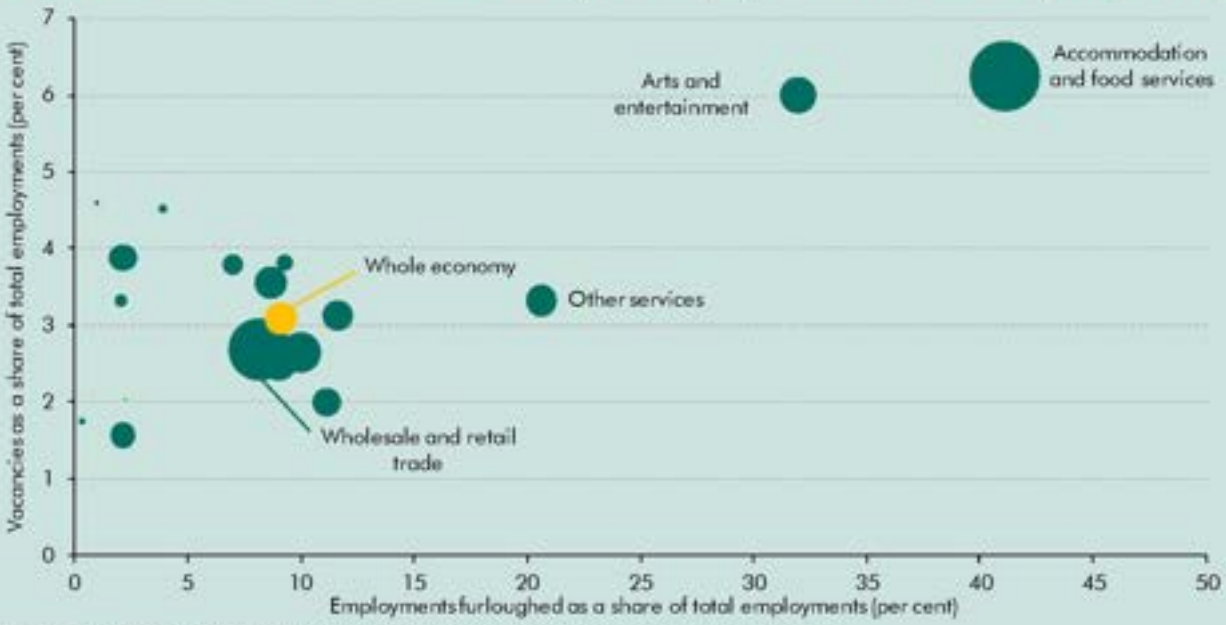
Given the large number of people still on the scheme, and their growing concentration in a few of the hardest hit sectors, there remains considerable uncertainty as to how many will be able to return to their previous roles or employers, and how many will need to look for other employment. Chart B shows the proportion of furloughed employees and the vacancy rate in each sector as of May 2021. It shows that furloughed employees are increasingly concentrated in a few sectors, with accommodation and food services and arts and entertainment being the most affected. Together, these two sectors accounted for over a third of the 2.6 million furloughed employments in May 2021, up from around a quarter during the first lockdown.

The capacity for these sectors to fully reabsorb furloughed workers over the next few months as the scheme is wound down will depend, in part, on how quickly the remaining public health

restrictions affecting these sectors and international travel can be lifted. It will also depend on how sustainable the rebound in social consumption seen in the wake of the third lockdown proves. The rush to fill positions as these sectors reopened has led to them registering the highest vacancy rates at over 6 per cent, higher even than before the pandemic. This is encouraging, if tentative, support for our assumption that most furloughed employees will find work quite quickly, though considerable uncertainty remains.

As of May 2021, over 30 per cent of employees in both sectors remained on furlough, so a significant part of the reabsorption process has yet to occur. And economy-wide, the vacancy rate remains below the 3 per cent pre-pandemic average, while around 9 per cent of all payrolled employees were still furloughed in May 2021. All these indicators point to this still being a relatively early stage of the post-pandemic adjustment in the labour market.

Chart B: Sectoral breakdown of furloughed employees and vacancies (May 2021)



Note: The size of the bubbles represent the sectoral share of total employees furloughed.
Source: ONS, HMRC, OBR

Longer-term fiscal legacy of the pandemic

2.62 The most important long-term fiscal impacts of the pandemic are likely to be those that flow from any scarring of potential output. But there are other factors that could have long-term fiscal implications. Here we discuss two: demographic developments; and receipts-specific scarring.

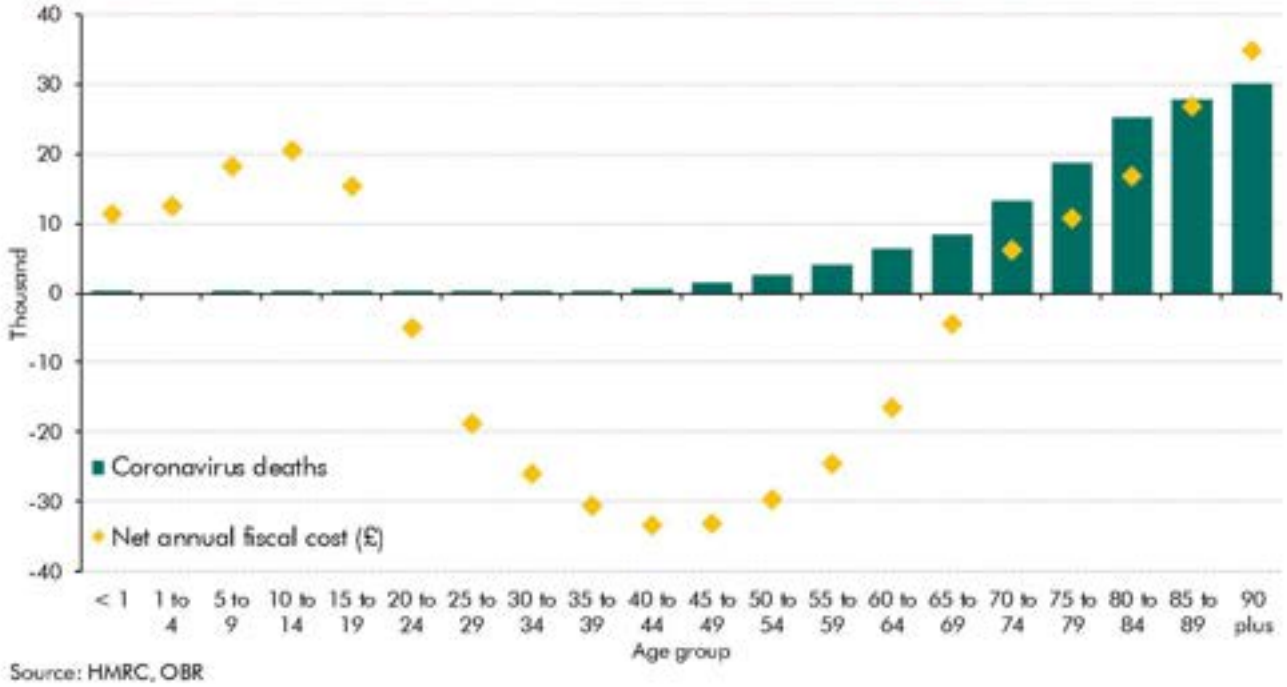
Longer-term fiscal risks from demographic developments

2.63 Excess deaths due to coronavirus have a direct effect on public spending. The state pensions caseload is estimated to be 0.8 per cent lower as a result, which reduced pensioner spending by £0.9 billion in 2021-22 in our March forecast. Our medium-term forecast

assumes that these excess deaths reflect lives being cut short, rather than a permanent change in mortality rates at older ages, with correspondingly fewer deaths occurring in subsequent years until mortality rates get back to pre-pandemic assumptions. This process is assumed to take eight years, so extends beyond our medium-term forecast horizon.[53]

2.64 The pandemic and Brexit may also have implications for the size and age profile of the UK population, which could have long-run fiscal implications. The age profile of the 128,000 coronavirus deaths recorded to date has been heavily concentrated among people of ages that are associated with net fiscal costs (Chart 2.24). That reflects them paying less tax and no National Insurance, while receiving more in health and social care services, and state pensions and other social security benefits. Indeed, the ONS estimates that around 42,000 coronavirus deaths were care home residents.[54]

Chart 2.24: Coronavirus deaths versus net fiscal costs by age group



Source: HMRC, OBR

2.65 There is uncertainty over the pandemic's lasting impact on all aspects of demographic change:

- The previous section discussed what we know so far about the effect of the pandemic on **net migration** and what that means for potential output. Changes in net migration also have longer-term fiscal consequences due to the different age profile of net migrants relative to the native population, which means that net inward migration typically lowers the old-age dependency ratio and improves fiscal sustainability. In our 2018 *Fiscal sustainability report (FSR)*, raising or lowering annual net inward migration by 80,000 a year (in line with the high and low migration variants of the ONS

[53] *Living with Covid-19: balancing costs against benefits in the face of the virus*, Miles, Stedman and Heald, July 2020.
[54] *Care home resident deaths registered in England and Wales, provisional*, ONS, June 2021.

population projections available at the time) led to debt being 11 per cent lower after 50 years in the high variant and 14 per cent higher in the low variant.

- The number of **births** fell sharply in December and January, nine months after first lockdown, but picked up again in February and March of this year, nine months after that lockdown was eased. It is therefore not clear at this stage whether the pandemic will have lasting effects on the existing downward trend in fertility rates. The fiscal consequences of changes in birth rates change as the affected cohorts age – fewer births would initially lower spending while they are children, then lower receipts (and output) when they are in work, then finally lower spending again when they retire.

- Potentially the greatest long-term uncertainty relates to any legacy impact on **mortality rates**. As noted, our forecast assumes that excess deaths to date were all brought forward from future years, with no lasting effects on the pre-pandemic trend for mortality rates to continue declining steadily over time. Ageing is a key long-term pressure on the public finances, so if coronavirus continues to circulate and, despite high vaccine take-up and efficacy, leads to higher than previously assumed mortality at older ages, that pressure would be reduced – though only modestly unless the lasting effects on mortality rates were very severe. In our 2018 *FSR*, we tested the sensitivity of spending on state pensions and other pensioner benefits to different assumptions about life expectancy. Varying it by roughly 10 years either side of the baseline assumption (in line with the ONS old-age and young-age structure population variants at the time) left spending on these items in 2067-68 up or down by around ¾ per cent of GDP relative to baseline spending of 8.2 per cent of GDP.

2.66 Similarly to the challenge of estimating scarring of potential output while fiscal support measures remain in place, it will be difficult to determine whether any of the demographic changes witnessed during the pandemic will have lasting effects. This makes the next (and probably subsequent) ONS population projections much more important and uncertain than usual, with the potential to affect our assessment of both the medium- and long-term fiscal outlook materially when they are published. They have been delayed so that they can reflect the Census. This will add to forecast uncertainty in the intervening period and will mean there is a risk of significant revisions when they can be incorporated in our forecasts.

Longer-term receipts-to-GDP ratio scarring

2.67 In addition to the permanent effect on receipts from long-term economic scarring, some long-term pressures on revenue from tax bases have been accelerated by structural shifts brought about by the pandemic. These include a move to online retail reducing demand for 'bricks and mortar' retail premises, and the shift towards working from home reducing demand for office-based space. Both these trends could hit future business rates receipts, which our latest forecast predicts will raise £35.0 billion in 2025-26. Even a relatively modest 5 per cent shortfall would therefore take £1.8 billion off receipts in that year.

2.68 The accelerated digitalisation of economic activity also poses difficulties in what can be taxed and where – a subject we discussed in Chapter 4 of our 2019 *FRR* and where

lockdowns prompted several years' worth of the pre-pandemic trend towards online retail to take place in a single year. The share of retail sales taking place online jumped by 16 percentage points between February 2020 and a peak of 36 per cent in February 2021, before declining to 28 per cent in May as retail settings reopened. But that 8 percentage point rise relative to the pre-pandemic position is still six times greater than the average annual rise of only 1.3 percentage points recorded over the preceding decade. This shift online could be associated with a rise in the tax gap for VAT. A 5 per cent rise in the VAT gap (equivalent to 0.4 percentage points in 2025-26 in our latest forecast) would lower receipts by £0.6 billion in 2025-26.

2.69 Other tax bases at risk include:

- **Fuel duty**. Less use of public transport could boost fuel duty if it results in an increase in driving to work, whereas more working from home could have the opposite effect. If receipts were to settle 5 per cent lower than our forecast assumes, the shortfall would be £1.6 billion in 2025-26. That said, pandemic-related risks are modest relative to trends towards electric vehicles as a result of regulations to help deliver a net-zero economy by 2050 (see Chapter 3). They are also small relative to the policy risk signalled by fuel duty rates having been frozen at every Budget of the past decade.

- **VAT**. Receipts could be permanently reduced relative to GDP if, for example, people do not return to eating in restaurants, cafes, and pubs to the same extent as pre-pandemic, instead consuming shop-bought food that is more likely to be zero-rated rather than standard-rated for VAT. If 5 per cent of VAT declared in the 'food and beverage services' sector were permanently lost to zero-rated spending, VAT receipts in 2025-26 would be around £0.4 billion lower.

- **Air passenger duty**. Our forecast assumes that restrictions on overseas travel, and reduced consumer and business preferences for air travel, will result in air passenger duty receipts remaining around 10 per cent below the pre-pandemic path in five years' time. Scarring effects are particularly uncertain here, though the tax itself is a small revenue source. Even a further shortfall of 10 per cent relative to our central forecast would only take £0.4 billion off receipts in 2025-26.

2.70 Table 2.3 summarises these potential sources of revenue scarring and how they would affect the receipts-to-GDP ratio were they all to crystallise in this way.

Table 2.3: Potential long-term impacts on the receipts-to-GDP ratio

	Effect in 2025-26	
Revenue risk	£ billion	Per cent of GDP
Business Rates - 5 per cent shortfall	1.8	0.07
VAT gap - 5 per cent rise	0.6	0.02
Fuel Duty - 5 per cent fall	1.5	0.06
VAT in Food and beverages service sector - 5 per cent fall	0.4	0.02
Air passenger duty - 10 per cent fall	0.4	0.02
Total	4.7	0.18

Lessons from coronavirus for other large fiscal risks

2.71 As the largest fiscal risk to have crystallised in the post-war era, the coronavirus pandemic also provides valuable insights as to the nature of catastrophic risks and how economic forecasters and policymakers can better understand and respond to them. The experience of the past eighteen months points us to the following lessons for the handling of other large fiscal risks, including those discussed elsewhere in this *Fiscal risks report*.

1 **Catastrophic risks are real and may have become more frequent.** Just two decades into this century, the UK and other advanced economies have now experienced two 'once in a century' economic shocks. The combination of growing financial leverage, economic interdependence, and other manmade risk factors may make future shocks both more frequent and more severe. Producers and users of economic and fiscal forecasts tend to focus on a central view of medium-term prospects in which output returns to a judgementally determined trend as the effects of past shocks dissipate. But it is equally – arguably, more – important to focus on the risks around that forecast that arise from inevitable future shocks. Forecasters should do more to emphasise the uncertainty surrounding both near- and longer-term economic and fiscal prospects.

2 **Economic shocks affect both supply and demand.** Macroeconomic forecasting and analysis rely on being able to evaluate the effect of a shock – or indeed any news – on both supply and demand and whether those effects are likely to be persistent or transitory. While conventional cyclical shocks affect mainly demand, recent shocks – the financial crisis, Brexit and the pandemic – have materially affected both supply and demand. This has exposed how poorly supply-side developments are understood, measured and modelled relative to textbook business cycle fluctuations in demand. Forecasters need to raise their capacity to assess and monitor both the immediate and longer-term supply-side impact of novel shocks and any policy response.

3 **Global interconnectedness can be both an asset and a liability.** As one of the most globally connected economies, the UK is highly exposed to risks emanating from abroad in the form of not only pandemic disease but also other forms of economic and financial contagion. However, the UK's openness to international talent and investment also made it a world leader in development, production, and rollout of one of the vaccines that will hopefully bring about an end to this pandemic. The UK's high degree of internal and external digital connectivity enabled the UK's largely service-based economy to continue to operate through the pandemic and the Government to deliver timely fiscal support, but also renders the economy vulnerable to cyberattacks on critical IT infrastructure – the potential fiscal risks of which are discussed in Box 5.1.

4 **While it may be difficult to predict when catastrophic risks will materialise, it is possible to anticipate their broad effects if they do**. The risk of a global pandemic was on the top of government risk registers for a decade before coronavirus arrived but attracted relatively little (and in hindsight far too little) attention from the economic community. However, both the experience from previous epidemics such as the 1918 flu, Ebola, and SARS, and modelling by the US Congressional Budget Office and the World Bank,

provided clear indications of where and how badly economies might be affected, even though both modelled an influenza rather than coronavirus pandemic. In 2008 the World Bank estimated that a severe and moderate flu pandemic could reduce global GDP by 4.8 per cent and 2 per cent respectively,[55] compared to the 3.3 per cent fall in 2020 due to the coronavirus pandemic. The CBO estimated US GDP losses of 4¼ per cent in a severe flu pandemic compared to the 3.5 per cent fall recorded last year.[56]

5 **When investing in risk prevention, governments tend to only 'fight the last war'**. In the decade following the 2008 financial crisis, significant resources were dedicated to improving the oversight and resilience of the financial sector, which paid dividends during the pandemic by helping to prevent it from triggering another financial crisis. And East Asian countries that invested in epidemic surveillance following the SARS and MERS outbreaks were more capable of combating the pandemic from the beginning. However, the 2016 report of the UN High-level Panel on Global Response to Health Crises described the world's preparedness and capacity to respond to a future pandemic as *"woefully insufficient"*.[57] The difficulty in anticipating the precise timing and nature of the 'next crisis' puts a premium on governments engaging in horizon-scanning and investing in generic risk management systems and structures.

6 **There are significant advantages in preventing or halting a process that involves rapidly escalating costs early**. While economic theory and practice emphasises the option value of delaying decisions, this can be suboptimal in the face of rapidly escalating costs. Countries that acted quickly to contain the spread of the virus experienced fewer deaths, shallower recessions, and earlier economic recoveries. These countries did not necessarily see lower fiscal costs from the pandemic, but more of their increase in borrowing was due to discretionary fiscal policy rather than as a result of the decline in output or pressures on their health systems and is therefore more likely to prove reversable.

7 **People appear willing to make sacrifices for a clearly-defined public good**. In the early stages of the pandemic, there was concern about defiance or fatigue in relation to public health restrictions and requirements. In fact, compliance with public health restrictions remained high throughout the pandemic in the UK and vaccine take-up also exceeded expectations. In total, the UK experienced a 10 per cent loss of output and committed 12 per cent of GDP in public funds in order to combat the pandemic in 2020. The annual economic and fiscal costs of tackling other potential catastrophic risks, like climate change, are likely to be just a fraction of this.

8 **Economies can sometimes adapt remarkably quickly to structural changes.** While the initial shock associated with the pandemic and initial lockdowns was greater than many economists predicted, they were also surprised by the speed and strength of the subsequent recovery in economic activity (including its resilience during subsequent

[55] *Evaluating the Economic Consequences of Avian Influenza*, World Bank, 2008
[56] *A Potential Influenza Pandemic: Possible Macroeconomic Effects and Policy Issues*, Congressional Budget Office, 2006
[57] *Protecting humanity from future health crises: Report of the high-level panel on the global response to health crises*, United Nations, 2016.

lockdowns). The contribution of prior investments in information technology that enabled people to work, shop, learn, and be entertained online was critical to enabling this transition, as was fiscal policy in allowing households and firms to maintain consumption, employment, and liquidity through the transition.

9 **Fiscal policy can and needs to be more nimble than was previously thought.** Before the pandemic, one of the central preoccupations among macroeconomists was that monetary policy had been exhausted as the principal instrument for managing fluctuations in aggregate demand but fiscal policy could not act with the speed and scale necessary to prevent lasting damage to the economy. In fact, across advanced economies the pandemic induced a fiscal policy response unprecedented in its speed, scale, and novelty. While this added 18.7 per cent of GDP to the debts of the average advanced economy by the end of 2021, it also prevented the much greater economic costs associated with the deeper, longer, and more disruptive economic contraction that could have resulted from not intervening.

10 **In the absence of perfect foresight, fiscal space may be the single most valuable risk management tool.** Throughout its history, the UK government has relied on its ability to borrow large sums quickly in order to respond comprehensively to major economic and security threats. It was able to do so courtesy of its relatively low levels of public indebtedness, deep and liquid domestic capital market (supported by monetary policy), and by benefitting whenever there has been a general flight to safety. Fiscal policymakers must trade-off making significant investments in the prevention of specific potential threats with preserving sufficient fiscal room for manoeuvre to respond to those risks which it did not anticipate or could not prevent.

3 Climate change

Introduction

3.1 Climate change threatens lives and livelihoods around the world. While its effects are unevenly distributed, even countries such as the UK that will be relatively less affected in the first half of this century would still suffer greatly if unmitigated global warming continued indefinitely.[1] The United Nations has described climate change as *"the defining crisis of our time"* and argues that *"No corner of the globe is immune from [its] devastating consequences… environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption, conflict, and terrorism."*[2]

3.2 Governments and public alike have acknowledged these threats. Targets for limiting global warming were agreed in Kyoto in 1997, in Copenhagen in 2009, and most recently and comprehensively in Paris in 2015. The UK Government has since legislated to achieve net zero emissions by 2050 – one of 131 countries that have either made net zero commitments or have targets under discussion, but one of only six to have so far put that commitment into legislation.[3] This has not yet translated into falling global emissions (with the exception of years of economic crisis), although the rate of emissions growth has slowed somewhat since the 1980s relative to the rapid increases recorded in the post-war decades. Emissions in major advanced economies are either broadly flat or have started to fall, but emissions from emerging markets continue to rise, in part reflecting the relocation of industrial production from the advanced economies who continue to consume its outputs.[4]

3.3 The fiscal implications of climate change for the UK are complicated and depend upon the policy response at home and abroad. Global trends that are largely beyond the UK Government's control will determine the extent of global warming and the costs associated with *adapting* to the changes that brings. Unmitigated climate change would ultimately have catastrophic economic and fiscal consequences, but even meeting Paris goals implies some further warming. But with the world's largest emitters all now committed to significant emissions reductions, the fiscal risks from being left behind in the global decarbonisation process have also risen. The UK Government's own policy choices will also influence the costs of *mitigating* emissions in the transition to net zero by 2050 and the extent to which opportunities from associated technological advances can be grasped. There are many

[1] For instance, Swiss Re estimates that out of 48 major economies, the UK will be the 15th least affected by climate change by the middle of the century, Swiss Re Institute, *The economics of climate change: no action not an option*, April 2021. And a World Bank study reached the same conclusion, scoring the UK in the bucket of countries most resilient to, and most insulated from, the transition to a low-carbon economy – due to relatively low levels of dependence on the domestic consumption and export of fossil fuels, World Bank, *Diversification and cooperation in a decarbonizing world: climate strategies for fossil-fuel dependent countries*, World Bank, 2020.
[2] United Nations, *The Climate Crisis – A Race We Can Win*, 2020.
[3] Energy & Climate Intelligence Unit, *Net Zero Emissions Race: 2021 scorecard*, 2021.
[4] European Commission, *Fossil CO_2 emissions of all world countries*, 2020.

possible paths ahead, each with different fiscal implications. Uncertainty around them all is pervasive and will depend on choices made at each stage.

3.4 With that in mind, this chapter:

- discusses the **science of climate change, its potential economic impact, and the key policy levers** available to mitigate it;
- illustrates **the potential physical, economic, and fiscal risks to the UK from different paths for global warming**;
- outlines **costs of decarbonising the UK economy by 2050**, drawing on projections presented by the Climate Change Committee;
- considers the potential **implications of making the transition to net zero emissions** for public spending and revenues;
- presents a set of **fiscal scenarios for achieving net zero emissions** under different assumptions; and
- draws **conclusions**.

3.5 It is important to stress that the quantification of fiscal risks in this chapter is largely illustrative. This represents the first step in a programme of work to refine our understanding of how climate-related fiscal risks propagate and the size of their potential effects.[5] One key area of uncertainty relates to the Government's future policy actions to achieve its net zero emissions target, which it plans to describe more fully in a Net Zero Strategy later this year.[6] Where long-term policies have yet to be set – and consistent with the *Charter for Budget Responsibility* – we have made assumptions about the tax and spending implications of different climate paths and different scenarios for bringing emissions to net zero.[7]

Climate change science, economics, and policy

3.6 In our 2019 *Fiscal risks report* (*FRR*), we developed a framework for assessing the fiscal risks to the UK from climate change that drew on the Bank of England's approach to assessing climate-related risks to financial stability. It split risks into those stemming from climate change itself ('physical risks'), and those relating to the transition to a decarbonised economy, including the policies necessary to achieve that ('transition risks'). In applying this

[5] The Congressional Budget Office – our equivalent in the US – has launched a similar programme. In September 2020 it published *CBO's Projection of the Effect of Climate Change on U.S. Economic Output*, a sophisticated, if partial, assessment of how different climate paths in the US might affect real GDP in the period to 2050. In April 2021 it published *Budgetary Effects of Climate Change and of Potential Legislative Responses to It*, an initial and largely descriptive discussion of how the US federal budget might be affected.
[6] See Department for Business, Energy and Industrial Strategy, *Impact Assessment for the sixth carbon budget*, April 2021, which states that *"The government will publish the Net Zero Strategy later this year, setting out its vision for transitioning to a net zero economy. This will build on the Prime Minister's Ten Point Plan for a Green Industrial Revolution and ambitious plans across key sectors of the economy. These sectoral plans include the Energy White Paper published last December, the Industrial Decarbonisation Strategy published in March, as well as the Transport Decarbonisation Plan, Hydrogen Strategy and Heat and Buildings Strategy to be published shortly."*
[7] Paragraph 4.15 of the Charter that was passed by Parliament in January 2017 stipulates that, *"where a long-term policy has not yet been set by the government, the OBR will set out the assumptions it makes in its projections regarding policy transparently"*.

framework, it is helpful first to consider some fundamental features of the science of global warming (which underlies the physical risks), the microeconomic determinants of emissions (which influence the transition risks), and their combined macroeconomic impact (which reflects both risks in different combinations depending on the path taken).

Greenhouse gas emissions and global warming

3.7 The UN's Intergovernmental Panel on Climate Change (IPCC) estimates that human activity has led to a rise in average temperature of roughly 1°C relative to pre-industrial levels ('anthropogenic warming')[8] due to the effects of greenhouse gases emitted into the atmosphere.[9] But this *past* activity is unlikely to generate significant further warming in the future as it is the stock of greenhouse gases in the atmosphere, rather than the annual flow of new emissions, that determines the average temperature. Since the atmospheric lifetime of most greenhouse gases is very long, it follows that the net flow of new emissions must be eliminated if the temperature is to be stabilised. So it is *future* human activity and emissions that will largely determine how much further temperatures rise. That is why the Paris goal of limiting warming to 1.5°C to 2°C above pre-industrial levels requires emissions to be reduced to 'net zero' – thereby stabilising the stock of emissions and global temperatures.[10]

3.8 Chart 3.1 plots the levels of carbon dioxide (CO_2, the most important greenhouse gas in terms of its aggregate effect on global temperatures) emitted in three of the scenarios produced by the Network for Greening the Financial System (NGFS),[11] plus a benchmark IPCC scenario in which global warming is completed unmitigated. It shows that even though currently implemented policies may be enough to stop the *flow* of emissions increasing, they are not enough to stop the *stock* of CO_2 in the atmosphere increasing. The stock only begins to be reduced in the two scenarios containing sharp cuts to net emissions – it is only these emissions trajectories that would imply a high probability of limiting warming to the Paris target of 1.5°C to 2°C above pre-industrial levels.

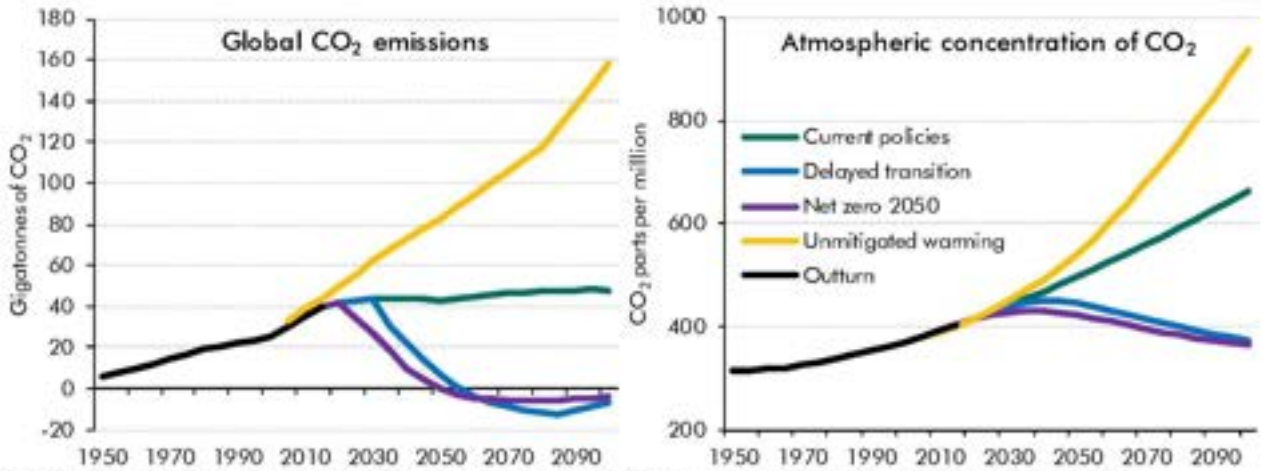
[8] IPCC, *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, 2018.

[9] The main gases responsible for the greenhouse effect include carbon dioxide, methane, nitrous oxide, and water vapor (which all occur naturally), and fluorinated gases (or 'F-gases', which are synthetic). Their effects on global warming depend on their concentration in the atmosphere, how long they remain in the atmosphere after being emitted, and their effectiveness at trapping heat in the atmosphere.

[10] See Article 4 of United Nations, *Paris Agreement*, 2015.

[11] The NGFS is a network of central banks and supervisors of financial institutions launched in 2017 to contribute to the development of climate risk management in the financial sector. One of its workstreams has been overcome what was seen as a major obstacle to undertaking climate risk analysis: the lack of detailed scenarios that consider both the physical and transition risks from climate change, and their economic impacts. The challenges and costs of creating such scenarios were felt to be beyond most individual firms or institutions (as they would be for most fiscal watchdogs too). The NGFS has developed a common set of scenarios to fill that gap.

Chart 3.1: Carbon dioxide emissions and atmospheric concentration



Source: Our World in Data, NGFS Climate Scenarios Database, GCAM model, International Institute for Applied Systems Analysis RCP database, Joint Global Change Research Institute GCAM database, and OBR calculations.

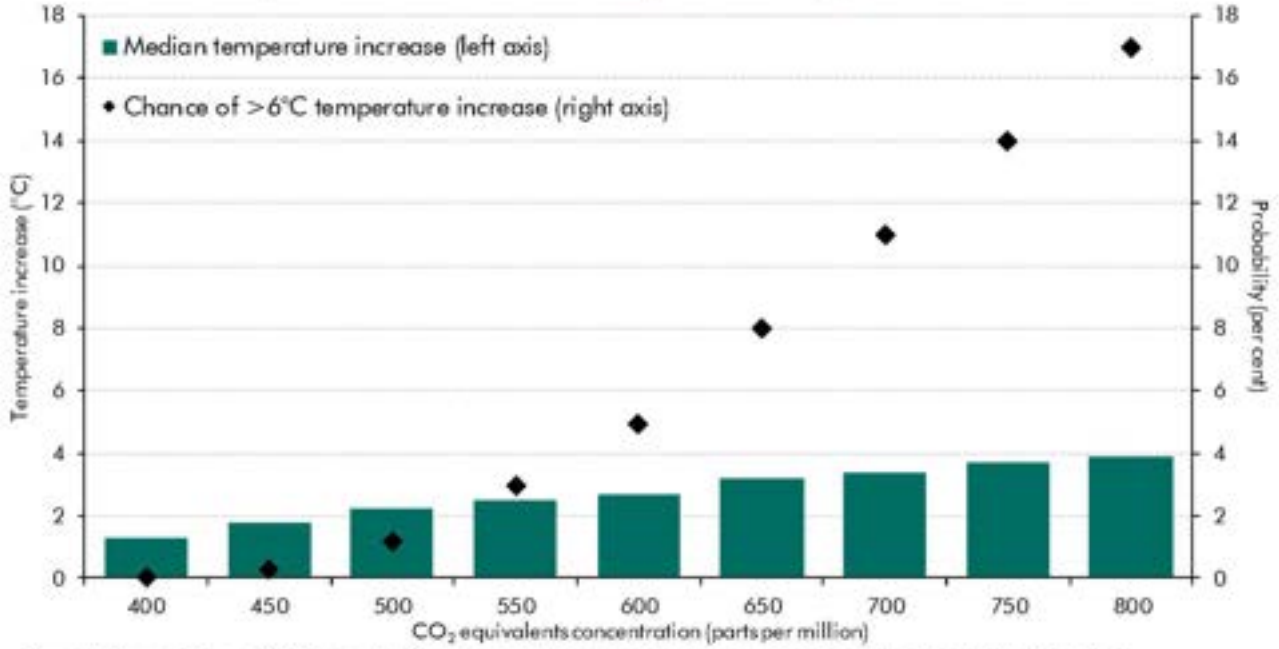
3.9 Predicting future warming using the change in the stock of greenhouse gases in the atmosphere is not straightforward. In particular, the further temperatures rise, the greater the increased risk of triggering tipping points at which adverse feedback loops and cascade effects kick in. This could involve, for example, accelerated melting of the Greenland ice cap causing temperatures to rise faster as it reflects less heat back out of the atmosphere, thereby triggering faster degradation of the Siberian permafrost, in turn releasing more greenhouse gases into the atmosphere and causing further temperature rises.[12] The associated uncertainty is illustrated in Chart 3.2, which plots median temperature rises and the risk of temperature increases of 6°C or more against a measure of the stock of greenhouse gas (in this case, carbon dioxide).[13] In the extreme climate scenarios that these tipping points and cascade effects could generate, it would be nature, rather than human action, that ultimately brings net emissions towards zero by leading to depopulation.[14]

[12] Steffen, W., Rockström, J., Richardson, K., Lenton, T., Folke, C., Liverman, D., Summerhayes, C., Barnosky, A., Cornell, S., Crucifix, M., Donges, J., Fetzer, I., Lade, S., Scheffer, M., Winkelmann, R. and Schellnhuber, H., *Trajectories of the Earth System in the Anthropocene*, July 2018.

[13] As reported in Wagner, G., and Weitzman, M., *Climate shock: the economic consequences of a hotter planet*, 2015, Table 3.1. The median temperature increases are based on an assumed climate sensitivity – that global temperatures increase by 2.6°C every time the atmospheric concentration of greenhouse gases doubles. The probabilities that temperature rises exceed 6°C are calculated by taking the 2 to 4.5°C range of "likely" climate sensitivity estimates presented in the IPCC's 2013 *Fifth Assessment Report*, assuming that this parameter has a log-normal distribution, and then interpreting "likely" as meaning 'lying within this range 78 per cent of the time' (a midpoint based on the IPCC's own probabilistic definition of the word "likely" as meaning 'exceeding 66 per cent' and 'very likely' as meaning 'exceeding 90 per cent'). This log-normal distribution's median value is 2.6°C.

[14] Ekins, P. and Zenghelis, D. *The costs and benefits of environmental sustainability*, Sustainability Science, March 2021.

Chart 3.2: Median temperatures versus the risk of exceeding 6°C temperature rises at different atmospheric concentrations of greenhouse gases



Source: Wagner, G., and Weitzman, M., *Climate shock: the economic consequences of a hotter planet*, 2015, Table 3.1

Market failures and greenhouse gas emissions

3.10 Greenhouse gas emissions represent a textbook example of a 'negative externality'.[15] As the global cost of emissions to current and future generations is not borne by the producers of those emissions, too much is generated from a social perspective. If that were the only market failure present, then a solution would be to impose an appropriate carbon tax to internalise the costs for producers, with the main challenge for policymakers being choosing the appropriate tax rate, imposing it domestically, and implementing it consistently across the world. In practice, the presence of other market failures and distortions, together with uncertainty about the effectiveness of different policy interventions and their impact across society, means that a mix of policies is warranted.

3.11 These other market failures and distortions include:[16]

- **Positive externalities**. The developers of new technologies are rarely able to capture all the gains, potentially leading to underinvestment in what is essentially a quasi-public good. That is particularly likely to be the case when the technologies in question have long horizons. Indeed for removals technologies, the benefits of investment may be so hard to capture that development would be minimal without government involvement.

- **Incomplete markets**. Future generations are unable to participate in today's markets but would bear the costs of future global warming. Consequently, their preferences may be insufficiently reflected in today's prices.

[15] Pigou, A.C., *The Economics of Welfare*, 1920. In addition to their effects on global warming, emissions may also lead to other negative externalities, such as the impacts on health outcomes from air pollution caused by burning fossil fuels.
[16] See, for example, Annex B of HM Treasury, *Net Zero Review: Interim report*, December 2020.

- **Information failures.** The costs and benefits of some technologies are poorly understood, such as the savings to households' fuel bills from energy efficiency measures, potentially leading to underinvestment (as discussed later in Box 3.3).

- **Credit constraints.** Frictions in financial markets that limit access to finance to fund investment by prospective producers in unproven green technologies or by poorer households in the deployment of proven ones.

- **Network effects and coordination failures.** Many green technologies will be cheaper and more effective if widely adopted, but achieving widespread adoption requires breaking out of the existing-technology equilibrium. Since no individual actor has a sufficiently strong incentive to achieve that, it may be desirable for governments to steer businesses and households towards particular models and standards. Some commentators have therefore emphasised how the structure of the industries involved in the transition to net zero might lead to path dependencies and multiple equilibria, enabling the state to help society coordinate on better outcomes than market actors would reach by themselves.[17] For instance, provision of charging infrastructure to induce innovation in electric cars and influence drivers' behaviour, preferences, and expectations. Or temporary investments to overcome initial costs and inertia in the power sector, enabling a permanent shift in economies to greener networks.

The macroeconomic impact of climate change

3.12 Beyond a certain point, hotter temperatures potentially seriously damage the economy. And warming in general can affect the economy through numerous channels, including by lowering crop yields and impairing the productivity of the workforce. A study published in the scientific journal *Nature* estimates that productivity peaks at an average annual temperature of around 13°C, and that in the extreme, unmitigated emissions scenario shown above (where average temperatures rise by 4°C by 2100) the average level of per capita global GDP in 2100 would fall by 23 per cent (as the average annual temperature in most regions is already in excess of the optimal 13°C).[18] While the direction of this effect is relatively clear, the size is uncertain – an IMF study looking at an identical climate scenario estimated losses of 'only' 7 per cent of global per capita GDP over the same horizon.

3.13 As we highlight in this report, policymakers also need to take the consequences of the crystallisation of catastrophic risks into account, rather than only focusing on most likely outcomes. The effects of climate change in other countries are certainly large enough to trigger catastrophic risks elsewhere, which small open economies like the UK would not be insulated from – for instance, if hotter temperatures in already-hot countries were to lead to conflict over increasingly scarce water resources, triggering mass migration to more temperate countries and affecting global supply chains. And climate change is likely to increase the frequency of extreme weather events, rather than simply raising average temperatures. We discuss these channels further in paragraphs 3.24 to 3.27.

[17] For instance, Ekins, P. and Zenghelis, D. *The costs and benefits of environmental sustainability*, Sustainability Science, March 2021.
[18] Burke, M., Solomon, H.,and Miguel, E., *Global non-linear effect of temperature on economic production*, 2015.

3.14 In addition, mitigating climate change – the policy measures taken to reduce net emissions – will also affect GDP. Taxing or banning polluting activities raises the implicit price of activities that emit greenhouse gases (sometimes described as increasing the 'shadow price of carbon'). Importantly, the definition of GDP does not incorporate any future benefits from reducing global warming. So, all else equal, a higher shadow price of carbon reduces GDP as businesses are encouraged to move away from (privately) efficient carbon-intensive methods of production towards (socially preferable) lower-carbon methods. This is the case in both the Bank of England scenarios discussed from paragraph 3.99 onwards.

3.15 While the behavioural response of any particular individual or business to a higher carbon price may be relatively straightforward to assess, it is difficult to evaluate with any confidence the impact on the economy as a whole of a structural change as large as the transition to net zero. There are several channels through which a successful transition could actually enhance productivity, possibly by more than enough to offset the direct adverse impact on carbon-intensive activities. For instance, stimulating large-scale investments in green technologies may have dynamic effects, boosting productivity for all as technology costs fall.[19] In addition, establishing an early dominant position in new green technologies could create a source of comparative advantage internationally, benefitting future exports. For this reason, we also include a scenario later in this chapter in which the transition to net zero raises GDP modestly by 2050.

3.16 We focus in this report on the level of real GDP, rather than the full range of economic variables affected by climate change. This is to highlight two of the most important channels through which climate change affects the public finances: the direct fiscal costs of the transition; and its indirect fiscal impacts via the size of the economy. But of course this provides only an incomplete picture of the impact of climate change on individuals. First, the composition of GDP matters, not just its level: the investment required to transition to net zero is captured in GDP, but requires resources that could otherwise be used for today's consumption. Second, GDP is measured gross of depreciation, so captures the benefit of higher investment spending, but not the cost of any resources wasted by prematurely scrapping parts of the capital stock. Third, climate change and the transition to net zero may affect prices and interest rates, as well as quantities such as GDP. And finally, and perhaps most importantly, economic statistics largely capture the economic costs of climate change only as they crystallise, rather than recognising them upfront. And they do not fully capture the amenity and common pool value of the climate and other natural resources. But work to improve the way natural assets are recognised in accounting frameworks is underway, as Box 3.1 discusses.

[19] Again, see Ekins, P. and Zenghelis, D. *The costs and benefits of environmental sustainability*, Sustainability Science, March 2021.

Box 3.1: Accounting for natural capital

As discussed in Chapter 4, there are clear benefits from taking a wider view of the public sector balance sheet of assets and liabilities when thinking about long-term fiscal sustainability – broader measures like public sector net worth provide a more complete picture than narrow ones like net debt. But even the broadest of these measures fail to recognise natural assets – the very assets affected by climate change – and therefore the costs associated with their depletion.

Asset coverage in economic statistics and commercial accounting is typically limited to those from which economic or production value can be drawn, and where ownership rights can be assigned. This means a significant proportion of natural capital (such as air, oceans) is excluded from balance sheet metrics, while their depletion is also excluded from measures of economic flows such as GDP.

Recognising this, the ONS publishes the UK Environmental Accounts and the UK Natural Capital Accounts in addition to the National Accounts on which GDP is based. Both are produced in accordance with the UN's System of Environmental Economic Accounts (SEEA),[a] which encompasses a broader asset boundary in physical terms (such as air emissions and water) than the System of National Accounts (SNA), but are recognised and valued in the same manner as the SNA.

These frameworks and statistics provide a building block for developing economic accounting that considers the impacts of climate change. For example, the Environmental Accounts allow for the assessment of economic activities and household consumption in generating emissions or tracking government expenditure (and taxes) related to mitigation or prevention activities. The Natural Capital Accounts are based on the experimental SEEA Ecosystem Accounting framework, which although still fully aligned with SNA, is more loosely connected to it than the Environmental Accounts.

While the central framework for Environmental Accounts looks at environmental assets as individual resources (such as timber, water, soil), the ecosystem framework for Natural Capital Accounts considers them within ecosystems. Therefore the scope of the latter covers those services that contribute to the economic benefits measured in the National Accounts as well as others not accounted for but that relate to the general functioning of ecosystems (measuring ecosystem conditions, contributions made to society and wellbeing, as well as ecosystem asset stocks), which addresses the overarching relationship between the economy, society, the environment, wellbeing and social progress.

Another building block in the recognition of national capital was provided in the Treasury's 2021 review of the economics of biodiversity, led by Professor Sir Partha Dasgupta[b]. His review concluded that *"nations need to adopt a system of economic accounts that records an inclusive measure of their wealth"*, where 'inclusive wealth' comprises produced, human, and natural capital. Its conclusions were echoed by calls from G7 finance ministers and central bank governors for improved corporate financial reporting standards to capture the costs and risks associated with climate change.[c] International accounting bodies such as the Financial Stability Board, IFRS and IPSAS are working on relevant standards for the public and private sector entities, while bodies such as the UN and OECD are working on standards for national statistics.

In its response to the Dasgupta Review, the Government committed to *"delivering a 'nature positive' future, in which we leave the environment in a better state than we found it, and ensure economic and financial decision-making is geared towards delivering that."*[d] In relation to the latter, the Treasury and ONS committed to improve their natural capital estimates and examine the feasibility of developing expanded public sector asset measures, accounting for environmental assets that yield services (such as carbon sequestration). The Government has also committed to integrating environmental principles into policy making through a number of initiatives including regulatory evaluation, cost-benefit analysis, and financing decisions.[e]

Although broader accounting standards are not yet available, some countries are making progress in capturing environmental impacts in their policy making processes. Several years ago, New Zealand began publishing a 'Wellbeing Budget' and a Living Standards Framework, which is based on a concept of four capitals: natural capital; human capital; social capital; and financial and physical capital. Their Budget is presented with a focus on the contribution that budget policies make to each of these capitals.[f]

[a] System of Environmental-Economic Accounting (SEEA) 2012 Central Framework and SEEA Ecosystem Accounting.

[b] Professor Sir Partha Dasgupta, *The Economics of Biodiversity: The Dasgupta Review – Final report*, February 2021.

[c] HM Treasury, *G7 Finance Ministers and Central Bank Governors Communiqué*, June 2021.

[d] HM Treasury, *The Economics of Biodiversity: The Dasgupta Review – Government Response*, June 2021.

[e] These include: the new Environment Bill; reforming the Better Regulation Framework; Green Book review; funding for the Taskforce on nature-related Financial Disclosures; and the Green Financing Framework.

[f] New Zealand Government, *Wellbeing Budget 2021*, May 2021.

What can policymakers do to mitigate climate change?

3.17 In light of the market failures and distortions discussed above, what instruments can policymakers use to overcome them, mitigating climate change by putting economies on a path to net zero? From the perspective of the fiscal risks they might pose, it is useful to split them by policy lever:

- **Carbon taxes.** A carbon tax is the most straightforward route to internalise the wider costs of emissions by placing a uniform price on carbon. The IMF has noted that carbon taxes are *"the most powerful and efficient, because they allow firms and households to find the lowest-cost ways of reducing energy use and shifting toward cleaner alternatives"*.[20] There are several international examples of carbon taxes at the sector level, but very few apply to almost all emitting sectors.[21] South Africa provides an example of a country that prices carbon solely via a relatively widely-applied carbon tax, but even this comes with substantial tax free allowances. In the UK, the carbon price floor only applies to emissions from power generation, but has been quite successful in reducing emissions in that sector (see paragraph 3.41).

[20] IMF, *Fiscal Monitor, October 2019: How to Mitigate Climate Change*, October 2019.

[21] World Bank Group, *State and Trends of Carbon Pricing*, May 2020.

- **Emissions trading schemes** (ETS). These provide an alternative to carbon taxes, with the IMF arguing that they can be *"equally effective if applied to as wide a range of economic activities"*. Whereas a carbon tax might have to be continually adjusted in order to deliver a particular emissions path, that can be achieved quite precisely with an ETS. The EU ETS, which was first introduced in 2005, covers power generation, energy-intensive industry and aviation. 'Traded emissions' under the scheme covered 39 per cent of all emissions in 2020. The traded carbon price has varied enormously, even over just the nine years it has been in operation in its current 'Phase III' form, from as low as €3 per tonne in April 2013 to €57 per tonne in May 2021.

- **Other tax incentives.** Fuel duty in the UK is levied on the use of a fossil fuel, while vehicle excise duty rates vary by fuel type and (for the first year in which a vehicle is registered) by emission intensity too. Fuel duty in particular is essentially a carbon tax on motoring. Landfill tax is levied on waste sent to landfill, thereby in effect taxing the methane it emits. Other tax-like levers in the UK are the environmental levies that are added to domestic and business customers' electricity bills and that finance certain technologies. Perversely, these levies incentivise the use of gas over electricity for household and business customers, thereby slowing the transition to cleaner energy.[22]

- **Public spending.** As discussed later in the chapter, estimates of the costs of mitigating emissions include the additional investment and operating costs (and savings) associated with a wide range of activities that reduce or capture carbon emissions. Some or all of these could be borne by government. For example, the public sector will inevitably need to cover costs associated with public buildings and vehicles. But it may also invest in R&D (either directly or via subsidies to the private sector) or subsidise the installation of low-carbon technologies like heat pumps in homes or carbon capture and storage (CCS) facilities.[23] Governments might also decide to compensate people or businesses that lose out from the transition – for example, poorer or credit-constrained families, or emitting sectors of the economy like agriculture that it already chooses to subsidise. Some or all of these costs might be met by carbon tax revenues.

- **Regulation and other non-fiscal policies.** Fiscal levers can be complemented by non-fiscal policies that require particular outcomes to be met by particular dates. These are particularly useful when the desired outcome is for an activity to cease altogether, which is more efficiently achieved via a ban than a tax. Examples in the UK include the Government's ban on the sale of new petrol and diesel cars from 2030 and on the sale of hybrid cars and vans from 2035,[24] and the Future Homes Standard that will require new homes built from 2025 to be 75 per cent less emitting than homes built under existing regulations and to be net zero compliant once electricity generation is decarbonised.[25] Unlike a carbon tax, regulations do not yield revenue that can be used

[22] As discussed in CCC, *Progress in reducing emissions 2021 Report to Parliament*, 2021. BEIS, *Quarterly Energy Prices, 2020 Annual Domestic Bills Estimates Supplement*, January 2021 shows that in the first half of 2020 industrial customers in the UK faced the highest electricity prices among EU15 countries but the fourth lowest gas prices, while for domestic consumers in the UK electricity prices were just above the EU15 average but gas prices were the third lowest.
[23] And spending on mitigation comes on top of public spending on adaptation, such as the costs of investment in flood defences.
[24] See 'Point 4: Accelerating the shift to zero emission vehicles' in Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, *The Ten Point Plan for a Green Industrial Revolution*, November 2020.
[25] Ministry of Housing, Communities and Local Government, *The Future Homes Standard: 2019 Consultation on changes to Part L*

to meet other costs of the transition, but they can hit existing tax bases, as with the fuel duty implications of banning new petrol and diesel car sales.

Which policy levers have worked so far to reduce emissions?

3.18 There is a growing body of evidence examining the effectiveness of environmental policies. Research in this area has faced the challenge of isolating the effects of individual policies, since they tend not to be introduced one at a time and are confounded by other factors. And most studies have focused on broader criteria than solely emissions impacts.

3.19 Case studies have therefore reached varying conclusions on the effectiveness of carbon taxes.[26] But several support the argument that countries that deploy carbon taxes tend to have lower emissions than those that do not, and that, if set at the right level, this instrument can have a significant effect.[27] One case study looked at CO_2 emissions in the transport sector of Sweden, which is subject to one of the world's highest carbon tax rates. Annual emissions were on average 11 per cent lower between 1990 and 2005 relative to the study's counterfactual, with more than half the decline (6 percentage points a year on average) attributed to the carbon tax.[28] An OECD summary of recent research suggests that raising energy prices by 10 per cent (as would be the case with the imposition of a carbon tax with that impact) would result in a 5 to 10 per cent decline in the use and carbon intensity of energy.[29] One cross-country study cited within this suggests that the EU ETS had reduced carbon emissions by 10 per cent between its introduction in 2005 and 2012. Some studies go further and suggest that even a low carbon price can have some impact, especially when it is known that that it will increase over time.[30]

3.20 An IMF multi-country review of the impact of a range of environmental policies on the power sector concludes that both non-market levers (like regulation, emissions limits, and R&D subsides) and market ones (such as emissions trading and feed-in tariffs) have been effective.[31] These policies are estimated to have contributed to 30 per cent of global clean energy innovation and 55 per cent of the increase in the share of renewables power generation. They find less evidence of an impact from a carbon tax in this sector, but note that the limited take-up of carbon prices globally has held back its effectiveness. (A common theme across many studies is the importance of pricing carbon correctly to its effectiveness and that prices may currently be too low. Indeed, one carbon tax that has proved effective is the carbon price floor in the UK, which has been credited with helping to spur the sharp reduction in use of coal for power generation.[32])

(conservation of fuel and power) and Part F (ventilation) of the Building Regulations for new dwellings. Summary of responses received and Government response, January 2021.

[26] Green, J., *Does carbon pricing reduce emissions? A review of ex-post analyses*, Environmental Research Letters, March 2021.

[27] Best, R., Burke, P. J. and Jotzo, F., *Carbon Pricing Efficacy: Cross-Country Evidence*, Environmental and Resource Economics, June 2020 November 2019. Also, Green J. provides a table summarising the results of 37 ex-post studies of carbon taxes.

[28] Andersson J.J., *Carbon Taxes and CO_2 Emissions: Sweden as a Case Study*, American Economic Journal: Economic Policy, November 2019.

[29] OECD, *Assessing the Economic Impacts of Environmental Policies: Evidence from a Decade of OECD Research*, 2021.

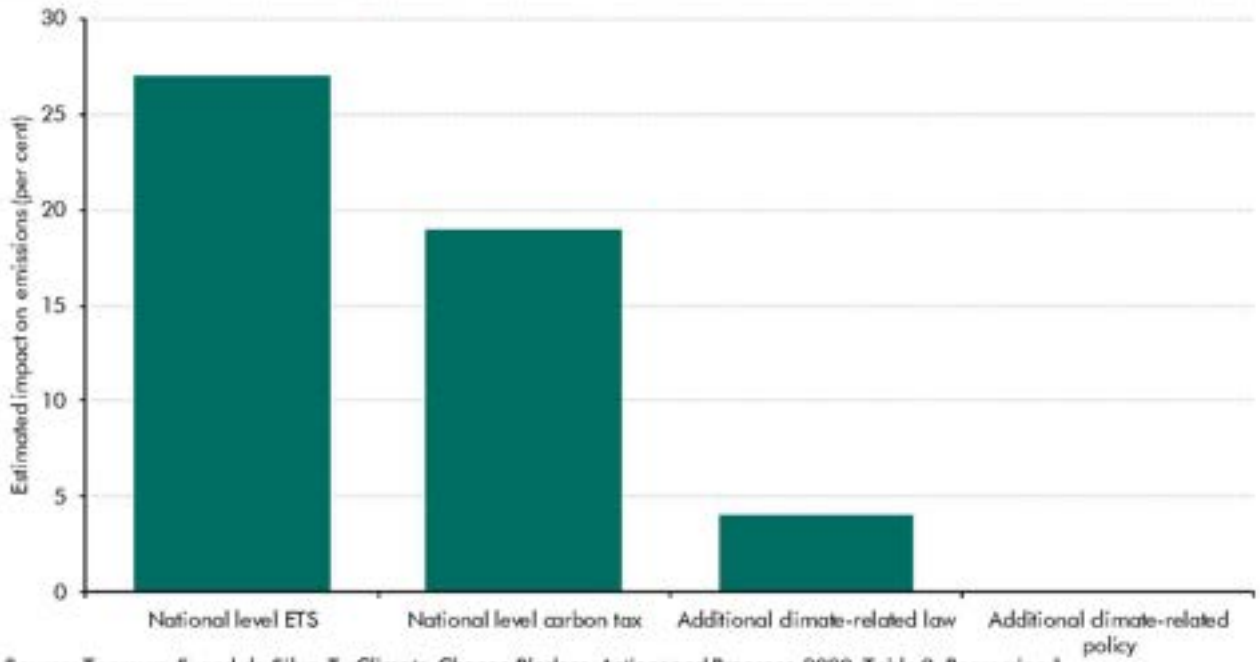
[30] Bayer P. and Aklin M., *The European Union Emissions Trading System reduced CO_2 emissions despite low prices*, Proceedings of the National Academy of Sciences of the USA, April 2020.

[31] IMF, *World Economic Outlook*, October 2020. See Chapter 3, '*The Mitigation Toolkit: How have policies worked so far?*'.

[32] Castegneto Gissey, G., Guo, B., Newbery, D., Lipman, G., Montoya, L., Dodds, P., Grubb, M., Ekins, P., *The value of international electricity trading*, University College London and University of Cambridge.

3.21 One recent cross-country study by Tenreyo and de Silva quantifying the relative impact of different types of climate-related policy intervention on individual countries' emissions suggests that carbon taxes and ETSs have been the most effective levers.[33] Specifically, it found that countries with a national carbon tax had emissions 19 per cent less than countries without one, while the presence of a national ETS reduced emissions by 27 per cent (considerably greater than the EU ETS impact in the study cited above). By contrast, emissions were found to decrease by 4 per cent for each additional climate-related law enacted – although it is possible that the aggregate effect of such laws could exceed the effect of carbon taxes and ETSs given their larger number. This suggests that legal steps can have an important complementary role alongside carbon taxes (as one would expect when multiple market failures and distortions are at play). The study found no statistical relationship between additional climate-related policies (as opposed to laws) and emissions, which could be because they are typically smaller in scale, or that the impact of effective policies is balanced out by the lack of impact of ineffective ones.

Chart 3.3: Estimated impact on emissions of the existence of different interventions



Source: Tenreyro, S. and de Silva, T., *Climate-Change Pledges, Actions and Progress*, 2020, Table 8, Regression 1

Physical, economic, and fiscal risks of global warming

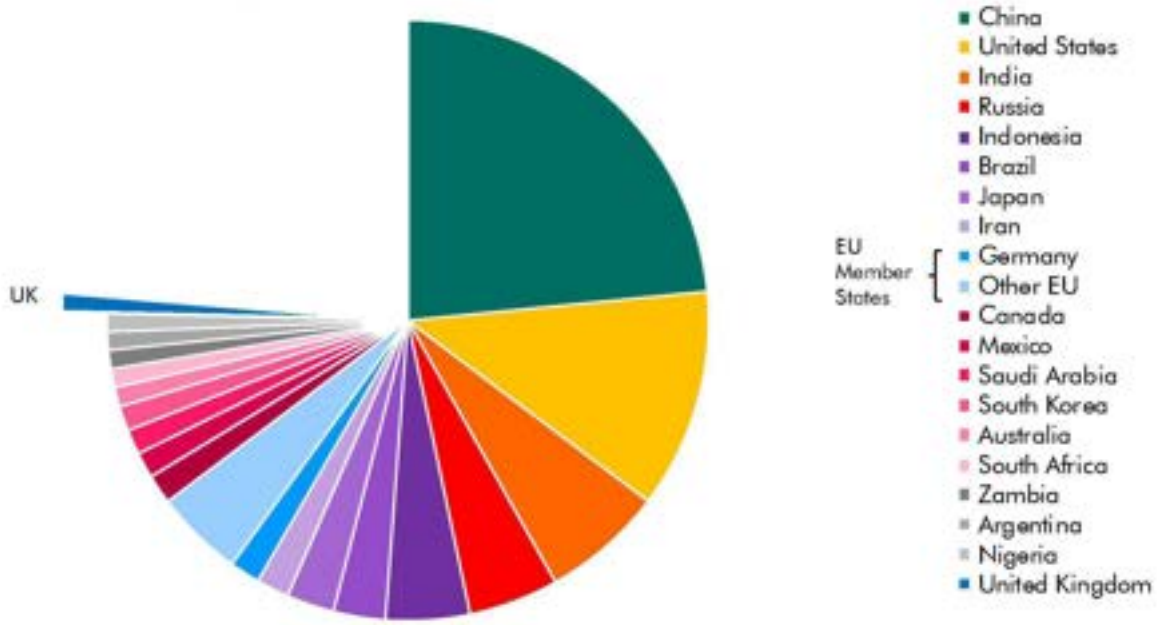
The nature of climate-related fiscal risks to the UK

3.22 The UK accounts for just 1 per cent of global emissions (Chart 3.4), which means the actions we take to reduce emissions will have little direct influence on global temperatures. That said, the UK can influence others' contributions to achieving this goal through its participation in global fora such as this year's 'COP26' UN climate change conference, and via the positive spillovers that can accrue when its investments in green technologies drive

[33] Tenreyro, S. and de Silva, T., *Climate-Change Pledges, Actions and Progress*, London School of Economics and University of Moratuwa, October 2020.

costs down, thereby incentivising greater deployment and decarbonisation in other countries (the UK has already contributed significantly to offshore wind technologies, for instance).

Chart 3.4: Global greenhouse gas emissions in 2016: top 20 emitters



Source: Our World in Data

3.23 The UK's small share of global emissions means that if the world fails to bring global warming under control, we will inevitably be hit by the consequences even if the UK has successfully decarbonised. While physical risks from this may be outside the UK's control, transition risks emanating from decarbonising activity at home will be influenced by the Government's own choices. In the taxonomy used in our previous *FRRs*, physical risks are largely exogenous, whereas transition risks are more, though not completely endogenous.

3.24 Global developments will not only determine the extent of global warming, they will also affect the size and frequency of extreme weather events.[34] The associated costs represent the physical risks from climate change. In the absence of policy to *mitigate* global warming, all the fiscal risks from climate change would stem from the costs of *adapting* to these changes.

3.25 These physical risks include risks to existing spending programmes, such as additional pressures on health systems generated by more intense summer heatwaves (net of reduced pressures due to less cold winters). And they would include the costs of new programmes, such as the need to build flood defences as sea levels rise or to install cooling systems in buildings. Finally, any impacts on the economy, such as higher unemployment or lower productivity, would feed through to lower tax revenues, thereby increasing borrowing and public debt or reducing the quantity of public services that could be afforded.

3.26 One US study analysing the potential fiscal costs of unmitigated climate change suggests that government consumption might increase by 0.32 per cent of GDP for every 1°C

[34] Field, C., et al., *Managing the risks of extreme events and disasters to advance climate change adaptation*, IPCC, 2012.

temperature rise (which in the US is partly due to more frequent hurricanes and wildfires, rather than the flooding that is the greater risk in the UK).[35] And a 2010 EU analysis suggested that while the annual direct costs of gradual climate change on a typical member state might be between €5 and €15 billion (equivalent to 0.3 to 0.8 per cent of 2010 UK GDP), these figures could rise as high as €60 billion (3.2 per cent of GDP) if impacts from extreme events and indirect effects are taken into account.[36]

3.27 But in practice the impacts on the economy and public finances may increase with temperature in a non-linear way, not just because of a higher probability of extreme events at higher temperatures, but also because of the changing nature of the macroeconomic and fiscal risks involved. At higher temperatures an increasing number of catastrophic risks could be faced. Competition for scarce resources could lead to conflict and war, which could prompt mass migration as habitable land becomes uninhabitable, for instance due to rising sea levels or desertification. A changing climate will also affect disease patterns, with mass movements of people potentially fuelling global disease outbreaks, and both the increase in temperature and new disease patterns precipitating health crises. These factors could lead to the emergence of energy geopolitics, civil unrest and governance breakdown, insurance system failures, systemic financial crises, and economic instability.[37]

Adapting to *mitigated* climate change in the UK

3.28 Changes to the climate in the UK are significant even under scenarios where emissions are successfully eliminated. Under the UK Met Office's optimistic scenario, where the world achieves net zero emissions by 2050, the average surface temperature and the sea level in the UK will continue to rise until at least the middle of the century (around 1.3°C warmer and 10 to 30cm higher, respectively, than their 1981 to 2000 averages). Hotter and drier summers will lead to more frequent heatwaves, droughts and increased wildfire risk (as experienced in 2020). And warmer, wetter winters will lead to more flooding, and more extreme storm events (as has also been evident in recent years).

3.29 Adapting the UK economy to these changes that are already in train will require significant additional action. Every five years, the Climate Change Committee produces a wide-ranging independent assessment of climate risk in the UK. Its 2021 report details 61 risks and opportunities for the UK by 2050 due to a changing climate that the Government will need to respond to in its third Climate Change Risk Assessment (due in 2022).[38] It reports that the gap between the level of risk from climate change and the level of adaptation has widened in the five years since its previous advice, and that action on adaptation has not kept pace with climate change: for example, it notes that new-build homes could require costly future retrofits if, as now, they are not built to address overheating as well as energy efficiency needs. Overall, it argues that *"The UK has the capacity and the resources to*

[35] Barrage, L., *The fiscal costs of climate change*, AEA papers and proceedings, 2020.
[36] Centre for European Policy Studies, *The fiscal implications of climate change adaptation: Final Report - Part I*, August 2010.
[37] See, for example: Raleigh, C., Jordan, L. and Salehyan, I., *Assessing the Impact of Climate Change on Migration and Conflict*, World Bank Group, 2008; Sawas A., Workman, M. and Mirumachi, N., *Climate change, low-carbon transitions and security*, Grantham Institute Briefing paper No 25, March 2018; the International Military Council on Climate and Security, *The World Climate and Security Report 2021*, 2021; BIS, *The green swan: Central banking and financial stability in the age of climate change*, 2020 and Ministry of Defence, *Climate Change and Sustainability Strategic Approach*, 2021.
[38] CCC, *Independent Assessment of UK Climate Risk Advice to Government for the UK's third Climate Change Risk Assessment*, 2021.

respond effectively to these [climate-related] risks, yet it has not done so. Acting now will be cheaper than waiting to deal with the consequences. Government must lead that action."[39]

3.30 The CCC notes that successfully adapting to the risks from global climate trends will require adjustments in multiple areas, including:

- **Land use and soil health**. For example, appropriate tree-planting to enhance biodiversity and minimise species loss, as well as protecting and expanding peatlands (one of the UK's largest natural stores of CO_2).
- **Buildings**. Retrofitting houses to prevent them overheating at hotter temperatures and ensuring new builds are fit for the future climate.
- **Flood defences**. Boosting defences to protect infrastructure and land from rising sea levels and increasing flooding due to heavy rainfall.
- **Supply chains and the power system**. Investment to mitigate disruptions and make supply chains resilient to extreme weather events. Making the power system robust to the variability of renewable energy presents a further challenge.

3.31 It is, of course, very challenging to quantify the costs of adaptation. Indeed, the Government's Impact Assessment of the CCC's advice on the sixth Carbon Budget states that, due *"to the complexity of calculating costs of adaptation, a national assessment on adaptation costs in the UK does not exist."*[40] In preparing its latest independent assessment, the CCC commissioned a monetary valuation, which put the costs of adapting to different risks and opportunities in broad ranges. It argued that the benefits of adapting to almost all climate risks outweighed the costs – sometimes significantly.[41]

An illustration of potential catastrophic risks from *unmitigated* global warming

3.32 The likelihood of emissions and temperatures rising inexorably has receded progressively as Governments around the world have taken steps to address climate change – and will do so further if policies are put in place to meet the latest targets. But there remains some value in illustrating the scale of the potential fiscal risks that the UK might face in such a scenario given the ebb and flow of collective resolve to tackle global emissions since the turn of the century and the limited progress made in reducing global emissions to date. Chart 3.5 shows the Met Office's projections for UK temperature rises to the end of the century under different 'representative concentration pathways' (RCPs) for global emissions scenarios compiled by the IPCC.[42] They show that it is not until later in the century that material differences emerge between them.

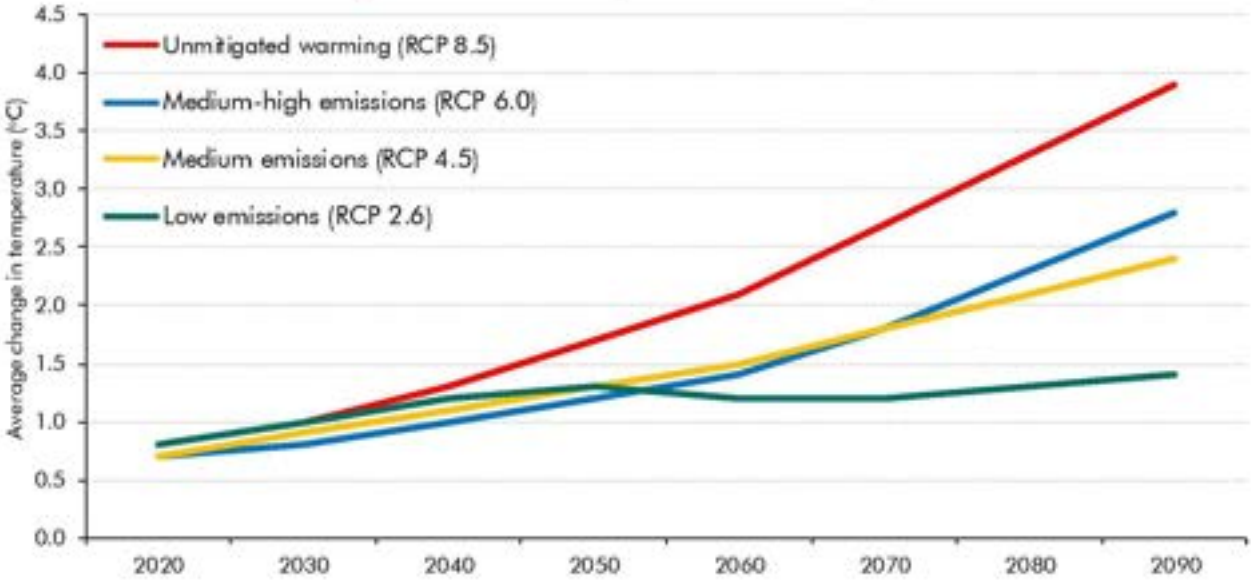
[39] The CCC's report also argues that, *"adaptation remains the Cinderella of climate change, still sitting in rags by the stove: under-resourced, underfunded and often ignored"* and that, *"Without action on adaptation we will struggle to deliver key Government and societal goals, including Net Zero itself."*

[40] Department for Business, Energy and Industrial Strategy, *Impact Assessment for the sixth carbon budget*, April 2021.

[41] Paul Watkiss Associates, *Monetary Valuation of Risks and Opportunities in CCRA3*, 2021.

[42] The IPCC's 'representative concentration pathways' for atmospheric CO_2 concentrations are used as benchmarks for international climate modelling. RCP 8.5 corresponds to the unmitigated warming scenario shown in Chart 3.1 above. Unfortunately, the other RCPs do not directly correspond to the NGFS scenarios presented elsewhere in this chapter.

Chart 3.5: The effect of global emissions paths on UK temperatures



Note: Year shown is the mid point of the average temperature taken over 20 years. The low scenario (RCP 2.6) is consistent with the Paris Agreement and implies acheiving global net zero by 2100 - all other scenarios fail to meet Paris Agreement goals.
Source: BEIS, DEFRA, Hadley Centre, Met Office

3.33 Illustrating the fiscal impact of unmitigated climate change requires a departure from our usual approach to scenario analysis. The past decade demonstrates that the public finances are all but certain to be subject to significant shocks over a long enough time frame. To focus on more gradual and predictable pressures on public spending, like those from population ageing, our long-term projections abstract from such shocks. But given the very long timescales involved, we have taken a different approach to illustrate the potential fiscal impacts of accommodating both the increased costs from unmitigated global warming and, more importantly, the larger and more frequent shocks that it would bring (Chart 3.6).

3.34 The baseline for this illustration assumes the Government balances the current budget, maintains net public investment at the 2.7 per cent of GDP level reached at the end of our March 2021 forecast in 2025-26, and adds stock-flow adjustments worth 0.65 per cent of GDP a year. On that basis, holding all else equal and total borrowing at 2.7 per cent of GDP, public sector net debt falls gently as a share of GDP (the 'stable deficit baseline'). But based on historical experience in the UK and around the world, layering on the additional impact of periodic fiscal shocks from recessions and similar events,[43] would see debt climb slowly from around 100 per cent of GDP today to around 170 per cent by the end of the century (the 'historical shocks baseline').

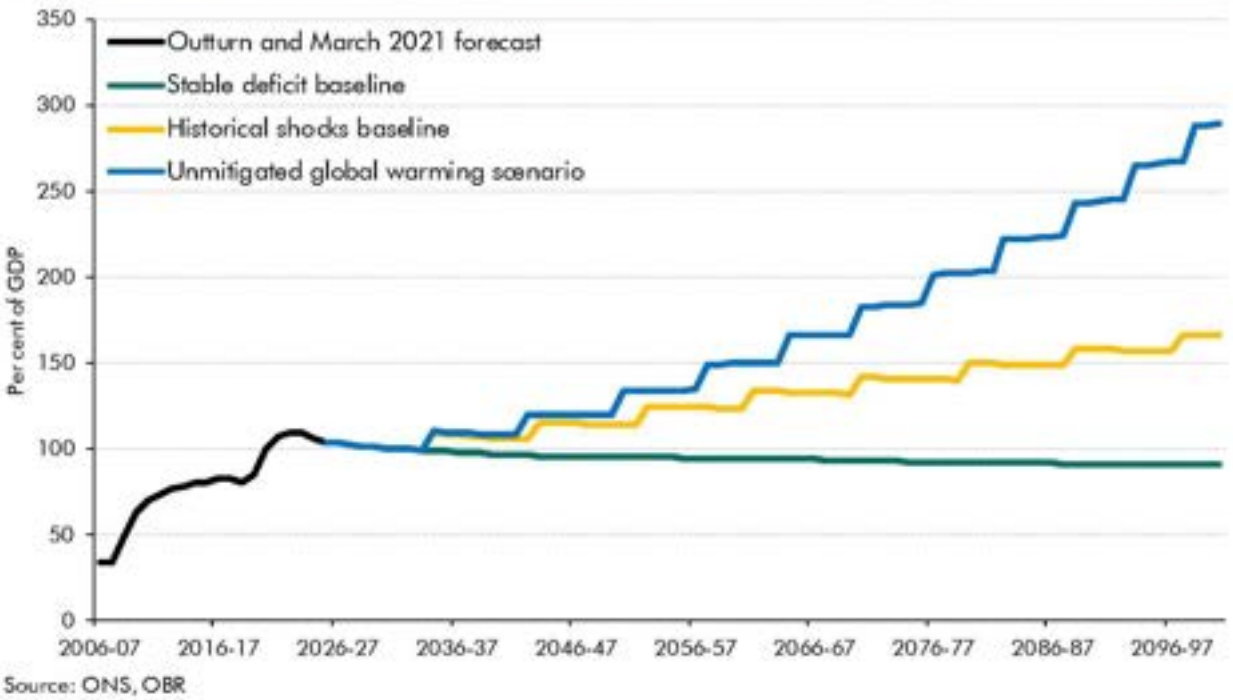
3.35 It is, of course, difficult to quantify with any confidence the potential long-run economic and fiscal damage wrought by unmitigated global warming, let alone how that might alter public debt's 'sawtooth' trajectory. But we might expect the 4°C increase in average UK temperatures by the end of the 21st century set out in the most pessimistic Met Office

[43] In our 2019 *Fiscal risks report*, we found there had been seven recessions in the previous 63 years, or one every nine years on average. International and historical evidence suggests that a typical recession could add around 10 per cent to the debt-to-GDP ratio (see, for example, IMF, *Analyzing and Managing Fiscal Risks—Best Practices*, June 2016). The 'historical shocks baseline' therefore assumes a 10 per cent of GDP shock every nine years.

projection to have severe consequences for the public finances. To illustrate the orders of magnitude that might be involved, we have assumed that that the cost of adaptation to each degree of warming raises spending by 0.3 per cent of GDP a year (informed by the estimates set out above) and that the size and frequency of shocks progressively increases with rising temperatures to reach twice as large and twice as frequent by the end of the century (relative to the historical shocks baseline).[44]

3.36 On these simple, broad-brush assumptions, unmitigated global warming would cause debt to ratchet up sharply to reach 289 per cent of GDP by the end of the century, as the hit from each shock increases and the period between them to get debt back down diminishes. At that point, net debt interest payments might have risen to around 10 per cent of GDP (from 0.9 per cent in 2025-26) and to around 28 per cent of primary revenues (from 2.5 per cent). And of course these risks would add to, rather than replace, the significant long-term pressures that we describe in our biennial *Fiscal sustainability reports* – the increased spending demanded by an ageing society and the non-demographic cost pressures in the health system – pressures that would also be affected, positively or negatively, by such significant warming (for instance, higher mortality reducing pressures on spending or higher morbidity due to increased air pollution damaging growth and increasing health spending).

Chart 3.6: Public sector net debt: an illustrative unmitigated global warming scenario



Source: ONS, OBR

[44] This is an illustrative assumption but is supported by other studies. For example, in Kahn, M., Mohaddes, K., Ng, R., Hashem Pesaran, M., Raissi, M. and Yang, J-C., *Long-Term Macroeconomic Effects of Climate Change: A Cross-Country Analysis*, IMF Working Paper WP/19/215, the authors note that adding the effect of greater climate volatility to their main results that are driven only by the level of temperatures roughly doubles estimated GDP losses at the global level.

Costs of decarbonising the UK economy by 2050

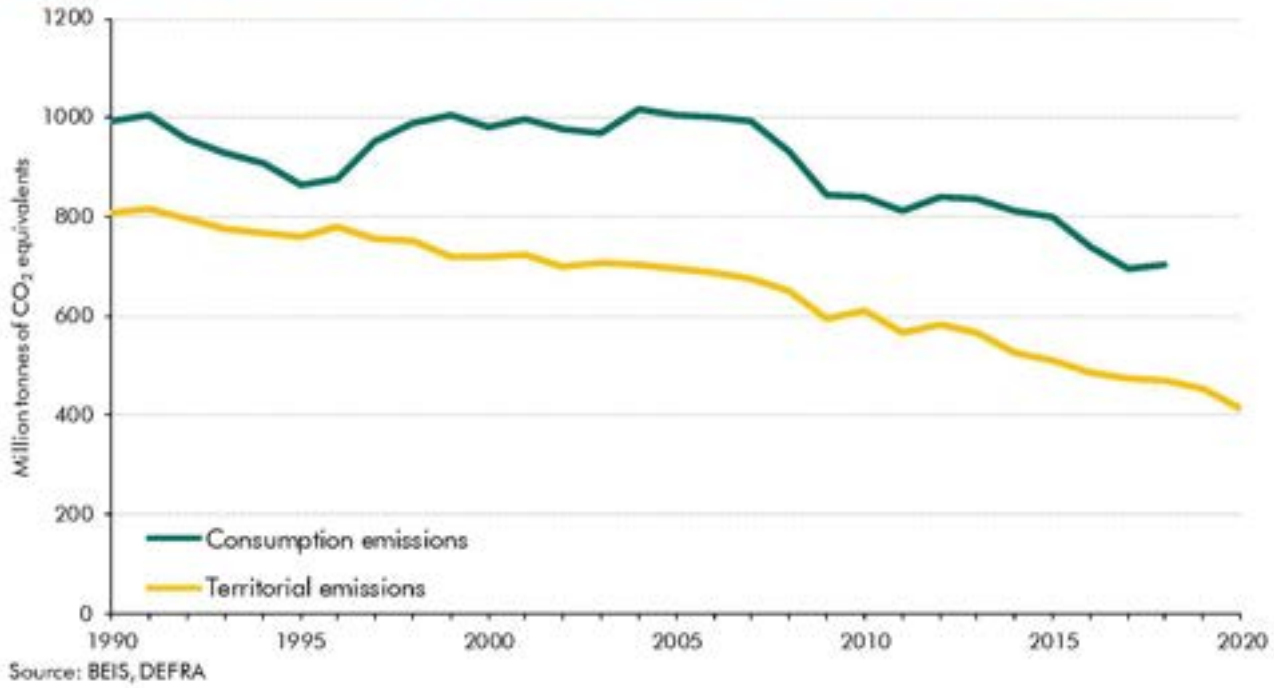
3.37 The UK has legislated to reduce net emissions to zero by 2050. This section discusses the emissions reductions that have been achieved to date and what is left to do by 2050, before exploring the actions and whole economy costs that might be necessary to achieve that. The next section then delves into the transitions costs that might be directly borne by the state.

What has the UK achieved so far?

3.38 There are two main ways of measuring a country's greenhouse gas emissions: 'territorial emissions' refer to those produced within a country's geographical borders; while 'consumption emissions' refer to those embodied in the goods and services consumed by the residents of that country, which adds the greenhouse gases emitted to produce imported goods and services and subtracts those in exports, and also adds residents' share of international aviation and shipping emissions. International agreements like the Kyoto Protocol, as well as the UK's Carbon Budgets, have been set in terms of territorial emissions. International aviation and shipping are also covered in the sixth Carbon Budget and the net zero target. The UK has done well in reducing territorial emissions since 1990, although up until the late 2000s this came partly at the expense of higher imported emissions.

3.39 As Chart 3.7 shows, between 1990 and 2019, the UK's territorial emissions (covering all greenhouse gases) fell by 44 per cent (with a sharper, but temporary, pandemic-related drop last year leaving emissions down 49 per cent on 1990 levels in 2020). Consumption emissions fell by less, down 29 per cent between 1990 and 2018 (the most recent year for which data are available).

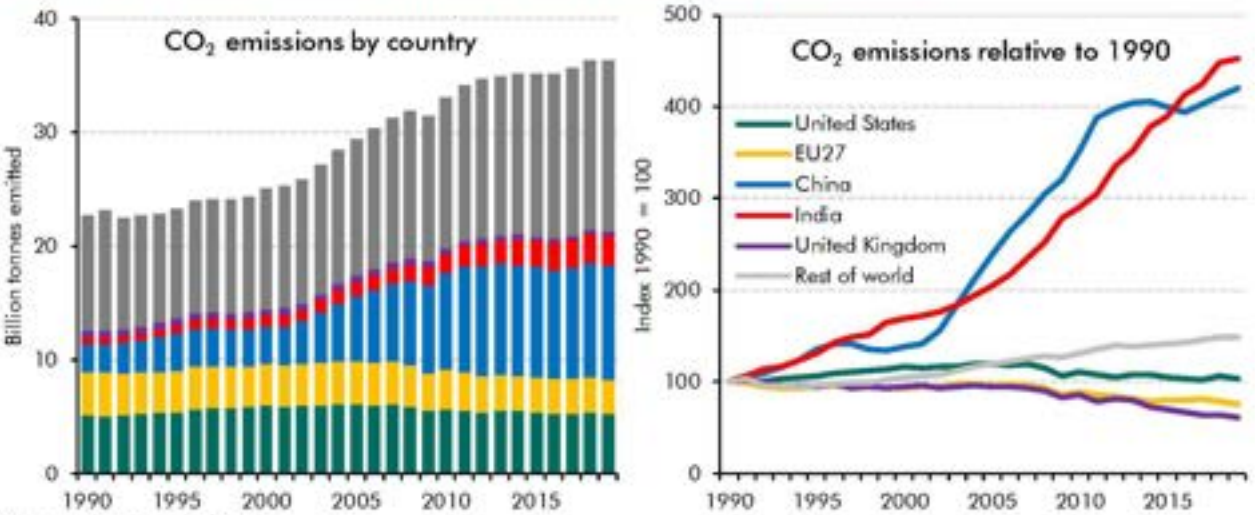
Chart 3.7: UK greenhouse gas emissions: territorial versus consumption basis



Source: BEIS, DEFRA

3.40 One cross-country study (which looks at just CO_2 emissions rather than all greenhouse gases) estimates that the emissions reduction in the UK since 1990 has been the largest among the G7 economies and has been faster than the EU average (Chart 3.8).[45] The UK therefore represents a declining share of global emissions.

Chart 3.8: Cross-country territorial CO_2 emissions since 1990



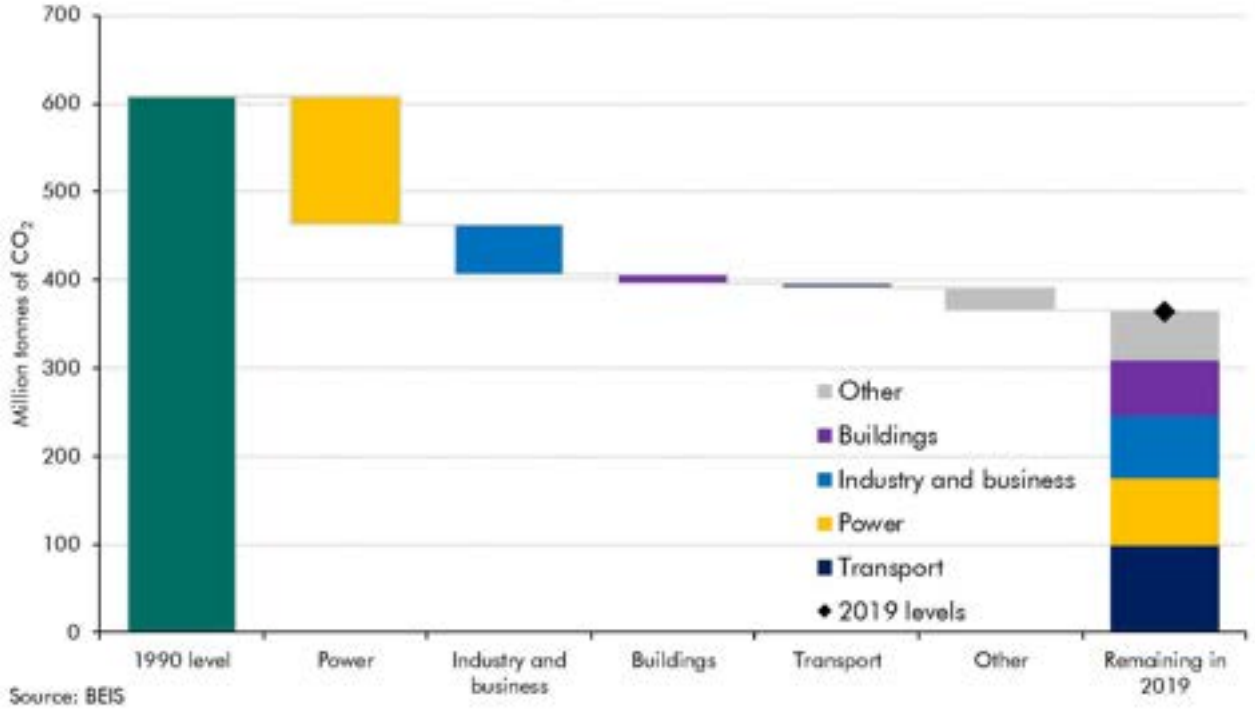
Source: Our World in Data

3.41 The fall in CO_2 emissions in the UK mainly reflects lower emissions from power generation (Chart 3.9, again on a CO_2-only basis, which are available by sector). This reduction was initially as a result of the 'dash for gas' in the 1990s, but more recently due to the near-total replacement of coal with renewable power sources. In turn, this partly reflects tax and regulatory interventions that have raised the cost of coal prohibitively (notably the introduction of the carbon price floor, a carbon tax that overlays the ETS so that power stations pay a minimum price per tonne of CO_2[46]). And it partly reflects sharp falls in the cost of renewable energy, particularly from wind, thanks to both technological advances and to further policy interventions, including feed-in tariffs (which subsidise small-scale generation) and 'contracts for difference' (which incentivise larger-scale generation by guaranteeing producers a fixed price, with any costs or savings passed to consumers).[47]

3.42 Lower emissions from businesses have also contributed materially to the economy-wide reduction in territorial emissions. This reflects both efficiency gains per unit of output in individual industries, as well as a structural shift in the UK economy away from high-emissions sectors like heavy industry towards less emissions-intensive activities.[48] Reductions in other sectors have generally been smaller. For example, modest gains in energy efficiency have lowered residential emissions by 13 per cent between 1990 and 2019; while improvements in fuel efficiency have offset increases in miles driven to leave road transport emissions more or less constant (as discussed later in Box 3.2).

[45] Global Carbon Project, *Global Carbon Budget 2020*, 2020.
[46] Castegneto Gissey, G., Guo, B., Newbery, D., Lipman, G., Montoya, L., Dodds, P., Grubb, M., Ekins, P., *The value of international electricity trading*, University College London and University of Cambridge.
[47] See *Wind and solar are 30-50% cheaper than thought, admits UK government*, Carbon Brief, August 2020, and BEIS, *Electricity generation costs 2020*, August 2020.
[48] See *Reducing UK emissions: progress report to Parliament*, CCC, 2020, and *Analysis: Why the UK's CO_2 emissions have fallen 38% since 1990*, Carbon Brief, February 2019.

Chart 3.9: Reduction in territorial CO_2 emissions between 1990 and 2019



Source: BEIS

3.43 The different paths for territorial versus consumption emissions is partly due to the fact that although the level of UK manufacturing output in 2019 was roughly the same as in 1990, the volume of goods consumed in the UK more than doubled, and goods imports almost trebled, over that period. This raised the emissions-intensity of consumption relative to production in the UK. Most estimates suggest that the UK's consumption emissions (or 'carbon footprint') did not fall until the late 2000s: i.e. while territorial emissions fell by 17 per cent between 1990 and 2007, that was more than offset by the emissions embedded in the UK's net imports. But consumption emissions fell sharply during the recession induced by the financial crisis and have fallen in step with territorial emissions in recent years.

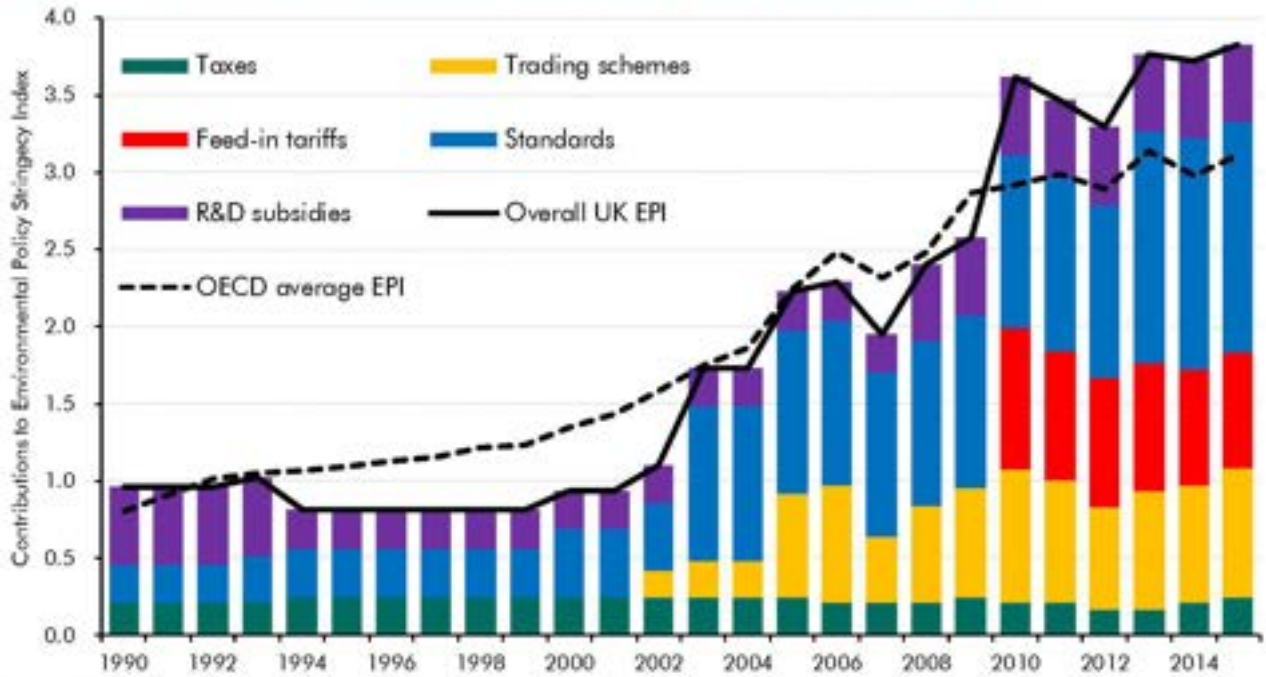
3.44 The pandemic and associated global recession have had an even sharper effect on emissions than the financial crisis did a decade ago: territorial emissions in the UK dropped by 11 per cent in 2020, taking them back to a level last seen in the Great Depression of the 1930s (and last seen on a sustained basis in the late nineteenth century). That reflected both the effects of lower economic activity on energy demand and the limits placed on travel by stay-at-home advice and social distancing. This was partly offset by energy use in homes, which increased. As economic and social activity recover, emissions can be expected to rebound significantly in the near term.[49]

3.45 Policy interventions have clearly helped in reducing territorial emissions in the UK, with the carbon price floor cited as an important driver of the drop in emission from power

[49] The CCC notes that, *"Lockdown measures led to a record decrease in UK emissions in 2020. Most of the falls in sectoral emissions observed in 2020 are likely to be transient, as they do not reflect structural changes in the underlying economic, social, energy, transportation or land systems. In the absence of underlying changes, emissions are likely to rebound in most sectors in 2021."* CCC, *Progress in reducing emissions, 2021 Report to Parliament*, 2021.

generation.[50] But there is considerable uncertainty around the overall effect of policy measures on economy-wide emissions to date. The OECD maintains an index of the stringency of environmental policies that summarises how those adopted in the UK might have contributed to the emissions reductions outlined above (Chart 3.10).[51] These have been tightened over time, including via the introduction of emissions trading, the strengthening of various regulations in the early 2000s, and the introduction of feed-in tariffs in the 2010s. On this basis, policies in the UK are now somewhat more stringent than the OECD average, having been tightened somewhat more quickly over the past decade or so. According to this metric, less than a third of the overall increase in stringency comes via revenue-raising measures (taxes and emissions trading), while a fifth comes via feed-in tariffs that are production subsidies financed by tax-like costs added to consumers' electricity bills. The remainder of the effect is achieved via standards, regulations, and R&D subsidies.

Chart 3.10: OECD environmental policy stringency index for the UK



Source: OECD, OBR

What needs to happen to reach net zero by 2050?

Climate Change Committee advice and Government targets

3.46 Having almost halved our emissions since 1990, the Government has legislated to eliminate any remaining net emissions (i.e. to ensure that gross emissions are offset by gross removals) by 2050. The 2008 Climate Change Act provides the legislative framework within which the UK's climate targets must be set. It specifies that alongside an overarching target for emissions in 2050, the Government must also set out via 'carbon budgets' the envelopes

[50] CCC, *Net Zero: The UK's contribution to stopping global warming*, 2019.

[51] The index is compiled by assigning stringency scores to various different environmental policies based on things like tax rates, carbon prices or caps set in regulations, which are then aggregated using a weighted average across policy levers. For a full explanation, see Botta, E. and Kožluk, T., *Measuring Environmental Policy Stringency in OECD Countries: A Composite Index Approach*, OECD Economics Department Working Papers No. 1177, 2014.

within which it will seek to constrain emissions over successive five-year periods. In doing, so it must take account of the advice of the independent Climate Change Committee (CCC).

3.47 The sixth Carbon Budget (CB6) is the UK's latest interim climate target on the path to net zero, covering the period from 2033 to 2037. In December 2020, the CCC set out its advice to the Government on setting CB6 to deliver a 78 per cent reduction in emissions of greenhouse gases relative to 1990 levels by 2035, and demonstrated how its proposals would be consistent with achieving net zero by 2050.[52] The Government accepted that advice, publishing an Impact Assessment on it in April 2021,[53] and draft secondary legislation has been laid in Parliament that will give CB6 legal force.

3.48 The CCC's modelling was not fully updated in light of the pandemic – it only includes some of the short-term fluctuations in emissions associated with the recession and recovery, and it does not allow for any economic scarring over the long term.[54] But over a 30-year horizon, these omissions are unlikely to change the broad shape of the projections.[55] They are certainly likely to be small relative to the uncertainty around any projection.

3.49 In the remainder of this section we look first at the contribution of different sectors to the projected decline in emissions to net zero. The CCC's reports provide more granular outputs than the Government's Impact Assessment, so we focus on the CCC's 'balanced pathway' scenario (the central scenario underpinning its CB6 advice). We then consider the whole economy net costs of achieving that transition as enumerated by the CCC, before looking more closely at five sectors that contribute the most to the transition to net zero: surface transport (in particular electric vehicles); buildings (in particular domestic heating); power generation; industry; and removals. We use the CCC's 'headwinds' and 'tailwinds' scenarios to illustrate the uncertainty around these costs. These reflect scenarios in which societal and behavioural changes, and the pace of innovation, are respectively slower and faster than in the balanced net zero pathway. Table 3.1 summarises some of the different assumptions across these scenarios.

[52] Climate Change Committee, *The Sixth Carbon Budget: The UK's path to Net Zero*, December 2020.
[53] Department for Business, Energy and Industrial Strategy, *Impact Assessment for the sixth carbon budget*, April 2021.
[54] The CCC's scenarios factor in pandemic-related effects on emissions from aviation and shipping, where the impact was immediately more clear, and assume that demand in those sectors *"gradually starts to return to pre-pandemic levels over the next few years"*. See, CCC, *The Sixth Carbon Budget – Methodology Report*, 2020.
[55] Indeed, in its latest progress report on the path to net zero, the CCC noted that, *"The temporary fall in emissions in 2020 will have practically zero impact on the UK's past and future contribution to global warming. Sustained reductions are needed."* CCC, *Progress in reducing emissions, 2021 Report to Parliament*, 2021.

Table 3.1: Selected assumptions on the CCC's different net zero scenarios

	Tailwinds	Balanced net zero pathway	Headwinds
Transport	• Electric vehicles (EVs) reach 100 per cent of sales in 2030 • Electric and hydrogen (H_2) HGVs	• EVs reach 100 per cent of sales in 2032 • Lowest cost HGVs deployed	• EVs reach 100 per cent of sales in 2035 • H_2 HGVs
Buildings	• Buildings fully electrified outside of industrial clusters • 11 per cent of homes use H_2 for heat	Mixed scenario • 11 per cent of homes use H_2 for heat • Electrified heat network	• 71 per cent of homes uses H_2 for heat • H_2 heat networks
Power	• 90 per cent of electricity from renewables	• 80 per cent of electricity from renewables	• 75 per cent of electricity from renewables • Lower power demand due to H_2 use in homes
Industry	• Electrification and green H_2 • Higher CCS capture rates	• Balanced H_2 (mix of blue and green) and electrification	• More H_2 (blue) than electrification • Wider CCS use
Removals	• More BECCS in power and H_2 production • Large DACCS utilisation	• BECCS in power, H_2, biojet, energy-from-waste and industrial heat • Some DACCS utilisation	• More BECCS across sectors • No DACCS
Other	• 50 per cent reduction in meat and dairy • 70,000 hectares per year trees planted by 2035 • 15 per cent reduction in flying, with 95 per cent use of low-carbon fuels	• 20 per cent reduction in dairy and 35 per cent reduction in meat • 30,000 hectares per year trees planted to 2025, 50,000 after 2035 • 25 per cent growth in aviation with 25 per cent use of low-carbon fuels	• 20 per cent reduction in meat and dairy • 30,000 hectares per year of trees planted • 25 per cent growth in aviation with 20 per cent use of low-carbon fuels

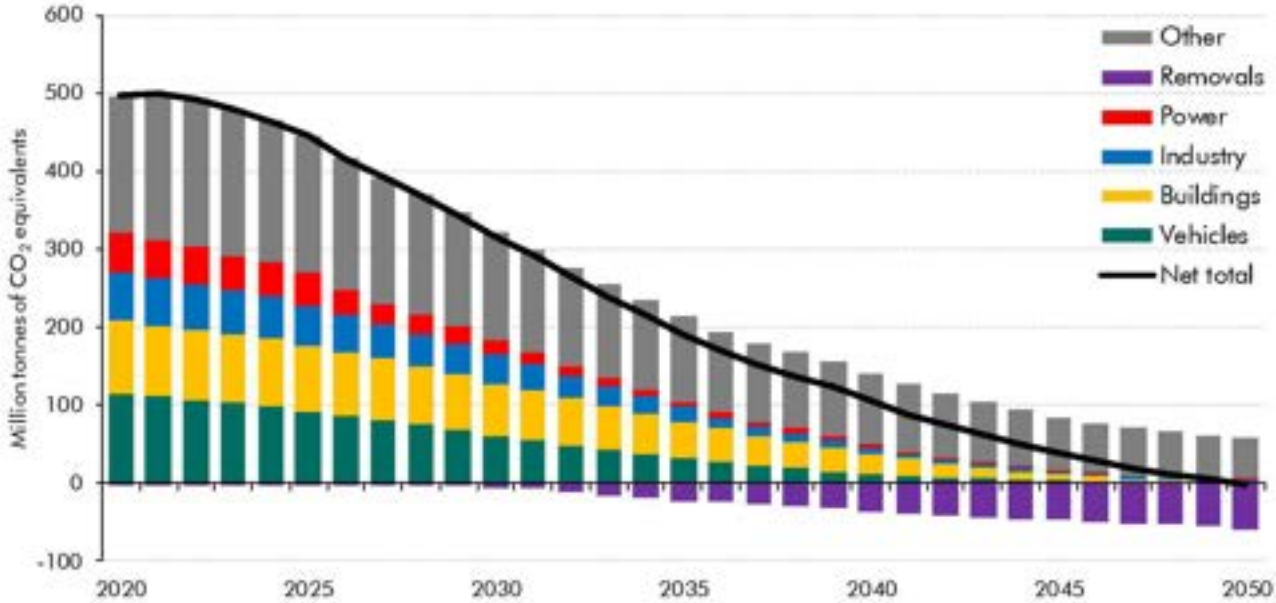
The path of emissions to net zero

3.50 Although territorial emissions have fallen since 1990, these reductions – such as switching from coal to gas in power generation – were relatively easy to deliver. The remaining emissions will become increasingly difficult to abate because more of the market failures and other policy challenges described at the start of the chapter apply – for example, technological solutions are more uncertain, while more of the transition must happen in people's homes and daily lives rather than (largely) out of sight in power stations. On top of this, the rate of abatement must rise if the CB6 target and net zero are to be met.

3.51 Chart 3.11 shows the contributions of the four largest emitters and future removals to net emissions between now and 2050 in the CCC's balanced pathway. In its 2020 baseline, the CCC estimates the biggest emitters to be vehicles (23 per cent of the total), buildings (19 per cent, with residential buildings accounting for 15 per cent and non-residential buildings for 4 per cent), industry (13 per cent) and power generation (10 per cent). By extension, these four sectors plus the yet-to-be-developed 'removals' sector – are also the largest

sources of future abatement. The remaining gross emissions in 2050 in other sectors are largely made up of those from agriculture and land use, and from international aviation.

Chart 3.11: CCC balanced pathway for reduction in emissions by sector



Note: The CCC reports emissions on a slightly different basis to BEIS. Emissions shown here include emissions from international aviation and shipping and are reported on the basis set out in the IPCC's Fifth Assessment Report, including peatlands.
Source: CCC balanced net zero pathway

The whole economy net cost of the transition to net zero

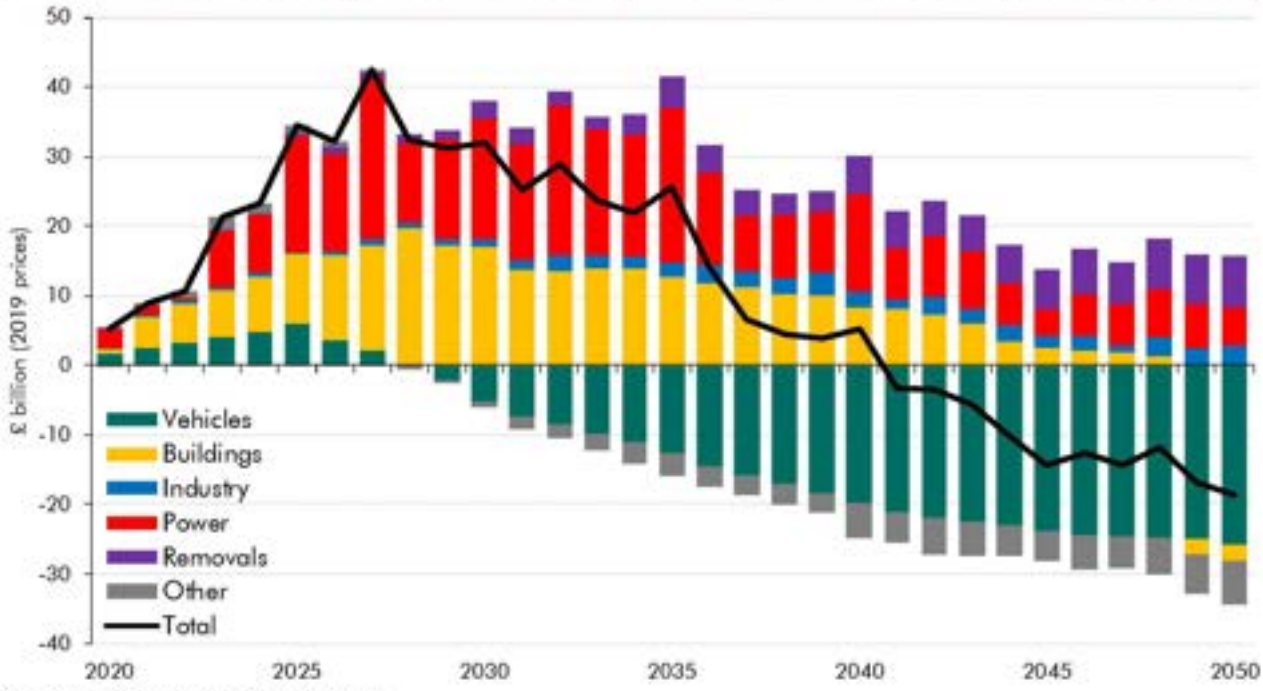
3.52 The CCC reports costs in two ways: as either 'in-year' costs (which records them in the year they take place) or as 'annualised' costs (which are discounted cumulative costs up to a given year, with investment costs averaged over the lifetime of the corresponding assets, including the costs of borrowing to finance those investments). Costs are estimated net of those that would be incurred in the baseline – for example, the cost of installing heat pumps is net of the cost of replacing gas boilers. For some aspects of the transition, operating costs are expected to be lower than those of the fossil-fuel technologies that are being replaced, so they represent a net saving relative to the baseline (this is particularly so for electric cars).

3.53 The annualised approach provides the CCC's headline figure for the net cost of the transition. It is useful for placing a single figure on any chosen scenario for reaching net zero and is a key input to the Government's cost-benefit analysis of CB6 and the path to net zero. In order to generate fiscal scenarios, we need a time profile over the next 30 years as well as an overall cost, so we use the in-year costs and savings. This is important because the investment costs are front-loaded, while significant operating savings are projected for later in the period: for example, the annualised cost in the balanced pathway stands at £16 billion in 2050, compared to an in-year *saving* of £19 billion in that year (thanks in large part to cheaper purchase and running costs for vehicles); similarly, the peak annualised cost is £19 billion and occurs towards the end of the period, in 2047, whereas the peak in-year cost is £42 billion and occurs much earlier, in 2027. Finally, all costs are presented in real 2019 prices – following the CCC's approach in its CB6 advice.

3.54 In the balanced pathway, the CCC estimates the total net cost of abatement across all sectors of the economy between 2020 to 2050 at £321 billion – with £1,312 billion of investment costs mostly offset by £991 billion of net operating savings. These figures reflect the whole economy cost of the transition, so exclude transfers between the private and public sectors (such as fuel duties paid or subsidies received). We discuss the proportion of the costs and savings that might be borne by the public sector in the next section.

3.55 As noted, net costs peak in 2027, when investment in power generation peaks and investment in buildings is ramping up. Net costs then fall steadily as operating savings from improved energy efficiency grow and running costs fall. From 2040 onwards, net operating savings are projected to outweigh investment costs. And by 2050, the CCC projects a £19 billion annual saving relative to its baseline emissions scenario (Chart 3.12).[56]

Chart 3.12: Net cost by sector of reaching net zero in the CCC's balanced pathway

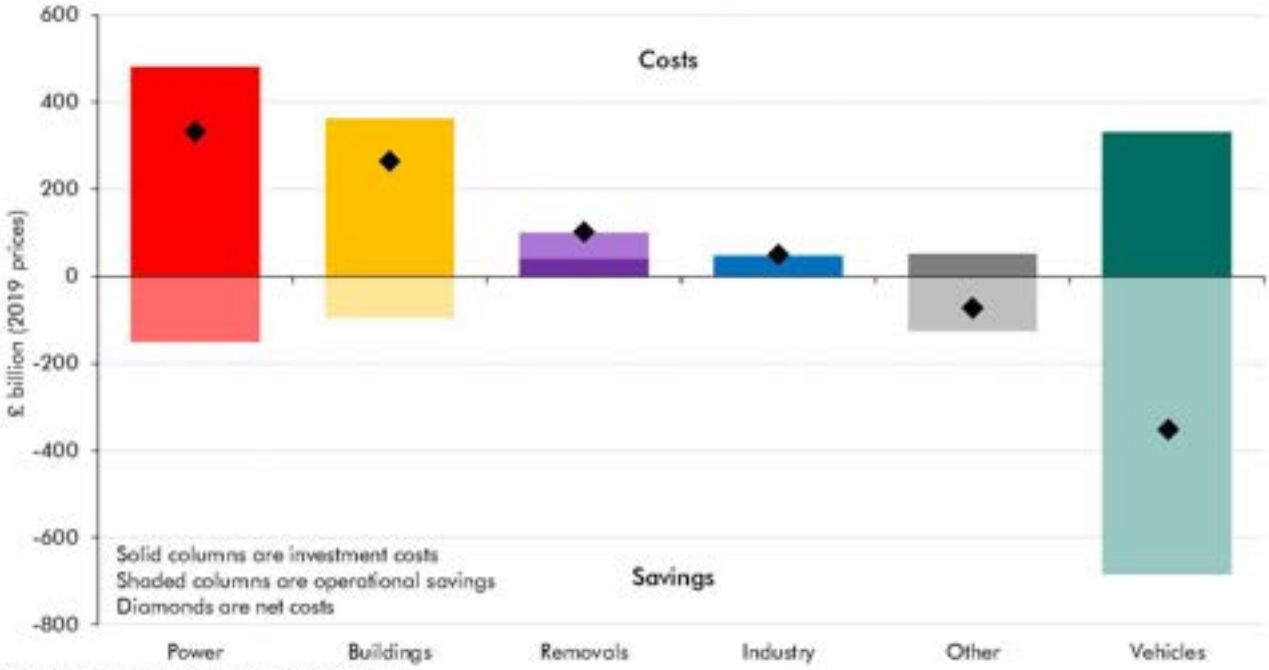


Source: CCC balanced net zero pathway

3.56 Over the whole period, the power sector and the buildings sector contribute most to investment costs (37 and 28 per cent respectively), while vehicles dominate net operating savings (accounting for 69 per cent of the total savings). The large contributions from power and buildings reflect different drivers, with power due to the big increase in electricity generation required to decarbonise energy use in other sectors, whereas decarbonising buildings must occur at high costs per unit of CO_2 abated. Net costs of £321 billion across the whole economy are more than explained by the power sector alone (£331 billion) and almost fully explained by the buildings sector (£265 billion). This reflects the large offsetting effect on net costs from the £352 billion saving in the vehicles sector (Chart 3.13).

[56] To present costs on a more comparable basis to emissions, we have adjusted the CCC's figures by reallocating the removals-associated costs within the industry, waste and power sectors into the removals sector.

Chart 3.13: Whole of economy transition costs by sector over 30 years



Source: CCC balanced net zero pathway

Surface transport

3.57 Surface transport is currently the largest emitting sector in the UK, accounting for 22 per cent of the UK's total emissions in 2019. Almost all (97 per cent) surface transport emissions arise from exhaust emissions from road vehicles. The rest is mostly down to rail. Since 1990, surface transport emissions have been largely flat, reflecting offsetting forces: improvements in new car fuel efficiency have reduced emissions, but that has largely been offset by mileage, which has risen by 17 per cent (broadly in line with population growth). The recent popularity of SUVs caused emissions to rise between 2017 and 2019, largely offsetting the benefit from higher sales of electric vehicles.

3.58 From 2020 to 2050 surface transport makes up 27 per cent of emissions reductions in the CCC's balanced pathway, with an investment cost of £332 billion (25 per cent of the total). But the reduced running costs of electric vehicles relative to fossil-fuel-powered vehicles, mean the sector sees a net *saving* from emissions abatement out to 2050 of £352 billion.

3.59 The transition to net zero is expected to deliver net savings from 2030 onwards as additional investment is more than offset by lower running costs. Investment costs peak during the 2020s and are dominated by the purchase of new cars, vans and motorcycles. Additional investment in new vehicles slows from 2030 onwards (as costs fall), but investment in infrastructure increases steadily and investment in HGVs picks up, leaving overall investment costs on a gently rising path. Operating savings rise steadily across the period to reach a maximum of £30 billion a year in 2050.

3.60 Decarbonising surface transport in the balanced pathway reflects a combination of:

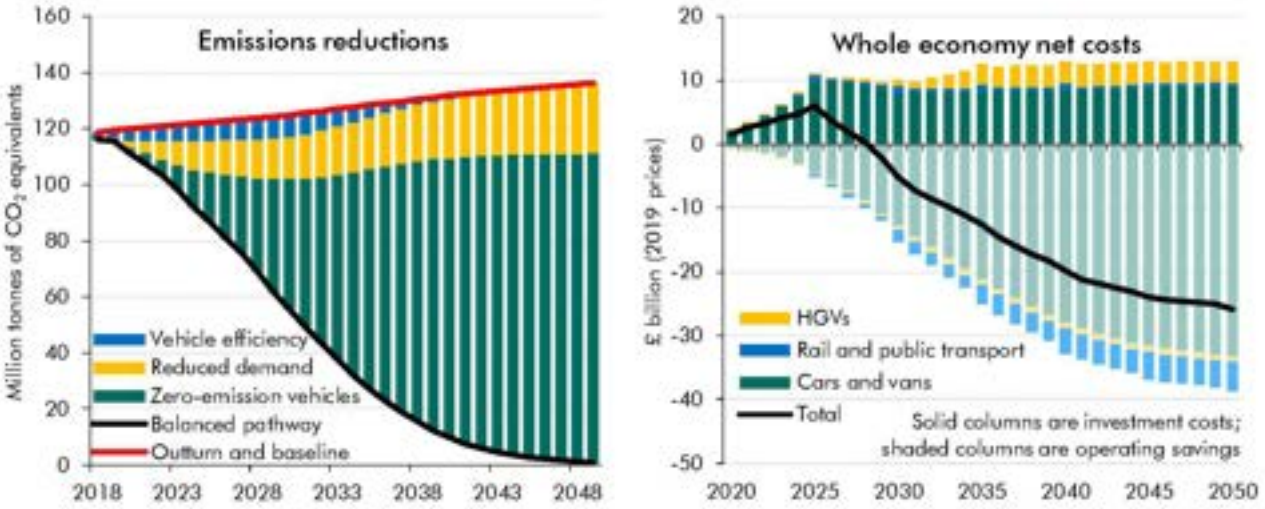
- **Zero-emission vehicles.** These account for 80 per cent of emissions abatement in the sector. Uptake in low-carbon technology is already growing rapidly from a low base – a trend that can be expected to accelerate thanks to the Government's decision to ban the sales of new petrol and diesel cars and vans by 2030 (see Box 3.2). But electric vehicles are currently a third more expensive than conventional vehicles. This largely reflects the high cost of batteries, which account for a third of the total cost.[57] Over the next decade, battery prices are projected to fall rapidly thanks to the technological advances and economies of scale that come with mass deployment. By 2025, lower running costs are projected to result in electric vehicles costing less than fossil-fuel powered vehicles over a vehicle's lifetime. From 2030 onwards, they are projected to cost less to purchase too – although the effect of this on consumers' choices is superseded by the forthcoming ban on the sales of new petrol and diesel cars.

- **Conventional fuel efficiency improvements** in new vehicles. Ambitious targets brought in under EU regulations have led manufacturers to reduce new vehicle emissions.[58] Over the next decade, this will continue to help to reduce surface transport emissions.[59] But beyond 2030, this channel will no longer operate due to the sale of new fossil-fuel cars and vans in the UK being banned, with the sale of new hybrids banned from 2035. However, conventional efficiency gains will remain important for reducing HGV emissions for longer as low-carbon technologies are further from reaching the market.

- **Behavioural changes reducing transport demand** are projected to lower surface transport emissions by 19 per cent between 2019 and 2050. This can be achieved by a combination of reducing the need to travel and changing the mode of transport used. Public transport, walking and cycling offer low or zero-carbon alternatives to private car travel, for example. Currently, a quarter of mileage is for the purpose of commuting and, as the pandemic has demonstrated, increased home working can significantly reduce road usage. Trials have demonstrated that logistical improvements for freight transport, such as urban consolidation centres (facilities located on the outskirts of cities that connect long-haul freight with more efficient last-mile deliveries into a city), can reduce the number of vehicle movements by up to 85 per cent.[60]

[57] Climate Change Committee, *The Sixth Carbon Budget. Sector summaries: Surface transport*, 2020.
[58] See Box 3.1 in our March 2020 *Economic and fiscal outlook*.
[59] In addition to these EU regulations, the Government has committed to introducing post-Brexit standards in the UK that are "*at least as ambitious*" as EU standards. See Department for Transport, *Consultation outcome: CO2 emission performance standards for new passenger cars and light commercial vehicles*, 2020.
[60] Transport Systems Catapult, *Consolidating public sector logistics operations*, 2018.

Chart 3.14: Surface transport: emissions reductions and whole economy net costs



Source: CCC balanded net zero pathway

3.61 There are several key uncertainties around the balanced pathway:

- The **infrastructure** required to enable a smooth transition to zero-emission vehicles and to support motorists' confidence in being able to charge their vehicle as easily as they can currently fill up with petrol or diesel poses a significant challenge. The CCC estimates that up to 270,000 public charging points will need to be installed before 2030 (up from 25,000 in June 2020), but some estimates are almost double that.[61]

- Around a fifth of the required reduction in emissions in 2050 is assumed to stem from **behavioural changes reducing transport demand**. This is despite rising car ownership and a falling cost of driving, so it is possible other sources of abatement could need to be greater if mileage continues on the upward trend of recent years.

- The projected uptake of electric vehicles is contingent on their **affordability** and price relative to conventional vehicles. Sustained reductions in battery prices are assumed over the next decade following technological advancements, although volatility in raw materials costs could represent a risk to such projections. Were battery prices to fall by 25 per cent less than assumed, upfront vehicle costs in 2030 would be 6 per cent higher. Alternatively, if oil prices were lower it would reduce the scope for operating savings from switching to electric vehicles, lessening the financial incentive to do so. For example, the CCC has estimated that 150,000 fewer electric vehicles would be purchased by 2030 if fossil fuel prices were 10 per cent lower.[62]

3.62 The best option for **decarbonising HGVs** is not yet clear and the technology is not at present operational. Over the next decade, the CCC has recommended that the Government should run large-scale trials to demonstrate industry viability and determine the most suitable technology. For example, hydrogen fuel-cell vehicles provide one possible solution

[61] Transport and Environment, *Recharge EU: How many charge points will Europe and its member states need in the 2020s*, 2020.
[62] Climate Change Committee, *The sixth carbon budget. Sector summaries: Surface transport*, 2020.

for long-range HGVs that appear unsuitable for battery electric solutions, whereas electric battery solutions could be supported by the use of cateneries.[63] To achieve net zero, the CCC recommends phasing out new HGV sales by 2040. Until then, there is a greater role for conventional efficiency gains.

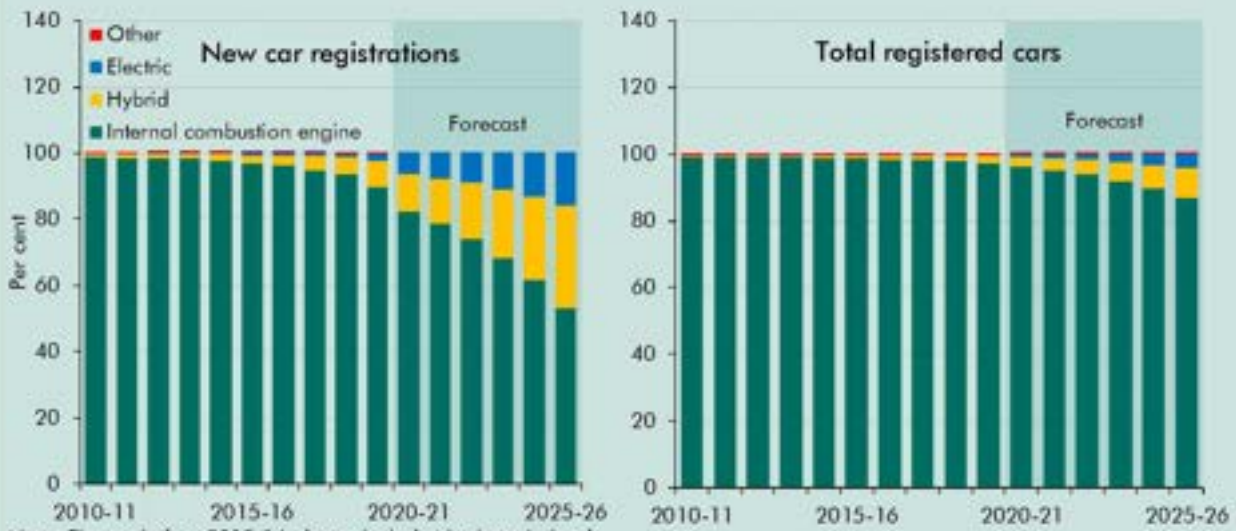
Box 3.2: The transition to electric vehicles

Growth in electric and hybrid vehicles

The transition from fossil fuel to electric vehicles is a key element in the UK's path to net zero emissions, accounting for 23 per cent of the total reduction in emissions by 2050. Unlike domestic heating (Box 3.3), this transition is already well underway. Alternatively-fuelled vehicles made up more than a fifth of new car sales and around 3 per cent of all cars in 2020. Hybrid cars were still only 1.1 per cent of new car sales in 2010, but had risen rapidly to reach 14.2 per cent of total sales last year. Pure electric vehicle sales grew very slowly at first, just reaching 1 per cent of new car sales in 2019, but leapt to 6.5 per cent of sales last year.[a]

Because the average car stays on the road for 14 years, the share of electric cars in the total stock of cars is much lower. By 2025-26, our latest forecast assumes that hybrids will make up 31 per cent of sales and 9 per cent of all cars, with the corresponding figures for fully electric vehicles being 16 and 4 per cent (Chart A).[b]

Chart A: New car registrations and total car stock by power type



Note: Figures before 2015-16 do not include Northern Ireland.
Source: DfT, OBR

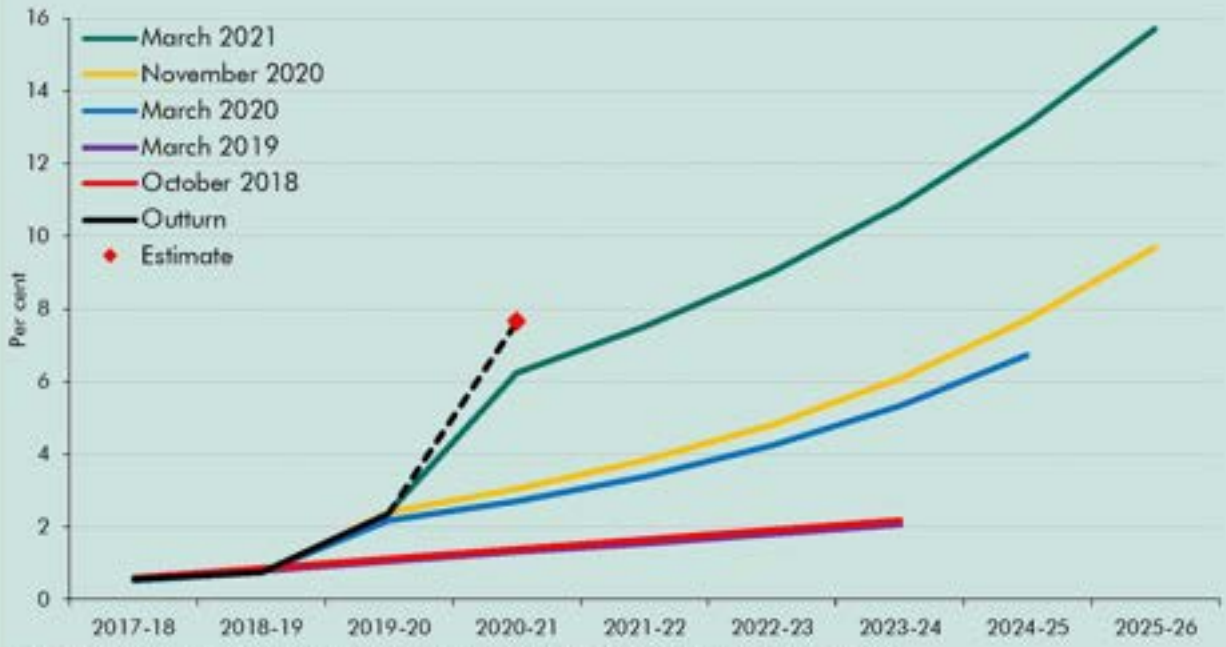
Fiscal implications of electric vehicles

The share of electric vehicles in new car sales has important implications for government revenues from fuel duty and vehicle excise duty (VED), as purely electric vehicles pay neither, and the pace at which that share has risen has consistently outpaced that assumed in our *EFO* forecasts (Chart B). Indeed, if the pace of increase in 2020-21 assumed in our March 2021 forecast of 3.8

[63] The Department for Transport is currently funding the designs of trials to test potential solutions to reducing freight emissions. See KTN, *Zero emission road freight – funding opportunity*, 2021.

percentage points were to persist over the next five years, rather than the 1.9 percentage points a year the forecast assumes, fuel duty and VED receipts would be £0.5 billion lower in 2025-26. We will revisit this assumption ahead of our next forecast.

Chart B: Successive assumptions for electric vehicles as a share of new car sales



Note: 2020-21 estimate combines registration data from DfT for 2020 and SMMT for 2021Q1.
Source: DfT, OBR

The sale of new fossil fuel cars will be banned from 2030, with hybrid car sales banned from 2035. On unchanged fuel duty and VED policies, once the entire vehicle stock has turned over, that will result in a revenue loss of 1.5 per cent of GDP (equivalent to £31 billion in today's terms). This is a key component of the fiscal cost of getting to net zero emissions.

The role of policy in incentivising the transition

The switch to electric vehicles has so far been slower for private buyers than for businesses – which accounted for two thirds of electric vehicle registrations in 2020.[c] But public attitudes are changing – a recent Ofgem survey found a quarter of consumers intend to purchase an electric vehicle in the next five years.[d] Indeed, following the sales ban announcement in the Prime Minister's *10 Point Plan*, UK consumer internet searches for electric vehicles doubled overnight.[e]

Other policy measures can play a role in accelerating this transition in the interim. There is evidence that countries offering greater financial incentives have higher take-up of electric vehicle, with the accelerated shift seen across Europe attributed to generous incentives and more stringent emissions regulations.[f,g] In the UK, the Government set up the Office for Zero Emission Vehicles in 2009 to support the transition. Since 2011, the Government has utilised a range of policy incentives, and has put aside funding of £2.8 billion to support the transition, including:

- **Demand incentives.** These include grants that contribute up to £2,500 to the purchase of a new battery electric vehicle. These subsidies are in place until 2022-23 but have been successively scaled back since their introduction as vehicle prices have fallen. Demand for

hybrids temporarily fell following their exclusion from the scheme in 2018, but sales quickly picked up again.[h] The tax system also encourages electric vehicles, as they are exempt from VED and fuel duty. As well as these financial incentives, the Government, in conjunction with industry, has set up the 'Go Ultra Low' campaign to inform consumers of the benefits of electric vehicles, such as their lower running costs.

- **Infrastructure investment.** £1.3 billion has been committed to installing public, home and workplace charging points over the next four years. The number of public charging points more than trebled between 2016 and 2020 to reach 21,000 in 2020.[i] Yet this is still less than 10 per cent of the projected need for public charging points by 2030.
- **Regulations to discourage use of conventional vehicles.** These include the introduction of emissions-linked charges to drive into some cities by local administrations, such as the Ultra Low Emission Zone in London from 2019 and Clean Air Zones in Bath and Birmingham introduced this year. EU legislation has imposed increasingly stringent emissions targets for car manufacturers since 2015, and these were transferred into UK law following the end of the Brexit transition period. From 2020, these require stretching reductions in manufacturers' average new fleet emissions, with fines levied for non-compliance. Registering electric vehicles gains manufacturers 'super credits' that lower their average fleet emissions for the purposes of the targets. This is thought to have played a key role in the uptick in electric vehicle registrations across Europe last year.[j]
- **Supply-side measures.** These include measures to support technological innovation, design, and manufacturing of electric vehicles, such as the £30 million of public investment in battery technology research, as well as proposals for a UK-based lithium extraction plant. The Government has also stated its ambition to develop a UK Gigafactory producing electric vehicle batteries at scale.

In contrast to many aspects of the transition to net zero, the need for policy measures to encourage the switch to electric vehicles is projected to fall away relatively quickly. The CCC projects that the combined purchase price and lifetime running costs of an electric car will be lower than for a fossil-fuel one by 2025, and cheaper in terms of purchase price alone from 2030. But much of this depends on further falls in battery prices, which have tumbled over the past three decades. For example, the current Tesla Model S battery, which costs $13,600, would have cost more than $500,000 in 1991 – a 97 per cent fall in the space of thirty years.[k]

[a] The pandemic meant that 2020 was an unusual year for the car market. Total new car sales fell 29 per cent but electric vehicle sales were up 184 per cent. The latter in part reflected waiting lists and order backlogs, whereas temporary closures of car salesrooms hit sales of conventional cars far harder.
[b] SMMT, *Automotive sustainability report*, 2020.
[c] SMMT, *Business buyers in pole position on Race to Zero as consumers stuck on the grid for electric vehicle adoption*, 2021.
[d] Ofgem, *Consumer Engagement Survey: Insights into consumer attitudes to decarbonisation and future energy solutions*, 2021.
[e] AutoTrader, *Electric engagement surges on Auto Trader as 2030 announcement doubles new car EV leads*, 2020.
[f] Tietge, U, et. al, *Comparison of leading electric vehicle policy and deployment in Europe*, 2016.
[g] Oxford Economics, *The shift to driving on electricity is speeding up*, 2021.
[h] National Audit Office, *Reducing carbon emissions from cars*, 2021.
[i] ZapMap, *EV Charging Stats 2021*, 2021.
[j] Transport and Environment, *Mission (almost) accomplished! Carmakers' race to meet the 2020/21 CO2 targets, and the EU electric cars market*, 2020.
[k] Our World in Data, The price of batteries has declined by 97% in the last three decades, 2021.

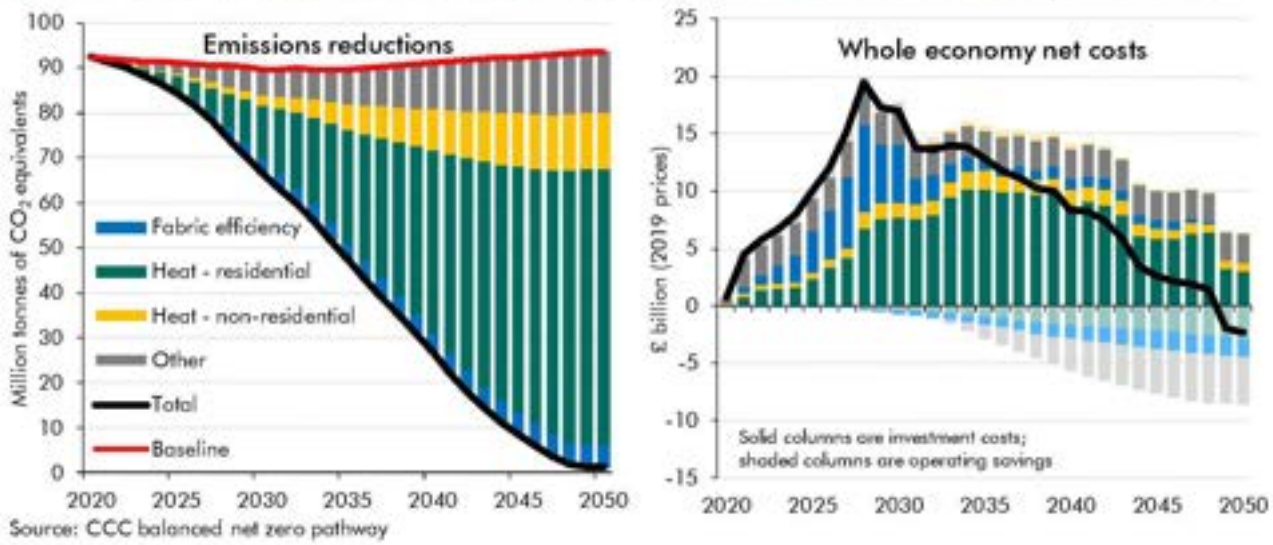
Buildings

3.63 The buildings sector is broken down into residential and non-residential buildings. In 2019, total direct emissions from buildings made up 17 per cent of territorial emissions (largely from heating homes, with 85 per cent of dwellings using gas central heating), while indirect emissions (which include electricity use) made up 23 per cent.

3.64 From 2020 to 2050 buildings make up 14 per cent of emissions reductions in the CCC's balanced pathway, with an investment cost of £362 billion (28 per cent of the whole economy total). The net cost of abatement out to 2050 is £265 billion, accounting for 83 per cent of the whole economy net cost of reaching net zero (much higher than its share in investment costs, thanks to the large vehicles operating savings described above). Most of these costs are from decarbonising heating in residential buildings (alongside improving their fabric efficiency through better insulation), as heating is both the largest source of emissions in buildings and suffers high average carbon abatement costs (see Box 3.3).

3.65 The CCC breaks down the path to reducing emissions from buildings into three main categories: behavioural change; improvements in energy efficiency; and switching from fossil fuels to low-carbon alternatives. Over the 2020s, the CCC assumes a large share of abatement comes from improvements in energy efficiency (in line with the Government's plans to upgrade all buildings' energy efficiency to EPC C, the third highest 'energy performance certificate' rating). But the vast majority (80 per cent) of abatement eventually comes from switching to low-carbon fuels, of which 77 per cent in turn represents the decarbonisation of residential heating. The balanced pathway begins with the phasing out of the highest-carbon fossil-fuel boilers from 2028, followed by the phasing out of gas boilers from 2033. No new gas boilers should be installed from 2035, reflecting the roughly 15-year average life of a boiler and the desire to avoid premature scrapping before 2050.

Chart 3.15: Buildings sector: emissions reductions and whole economy net costs



Source: CCC balanced net zero pathway

3.66 Some of the important uncertainties around the balanced pathway stem from:

- **Choices around the technologies to decarbonise domestic heating, and lock-in effects of past choices**. The process of decarbonisation is expected to combine heat pumps, flexible electric heating, hydrogen-compatible gas boilers and district heating. Under the balanced pathway, only 11 per cent of homes use hydrogen for heat by 2050, and the network is fully electrified; in the headwinds scenario, up to 70 per cent of homes use hydrogen for heat; and in the tailwinds scenario all heating is electrified. This uncertainty creates a potentially large option value for households in waiting to find out which technology wins out – incentivising continued investment in existing technologies in the meantime.

- **The disruptive process of installing heat pumps and improving the heat efficiency of people's homes**. Heat pumps are significantly more expensive than existing boiler technologies. They are also unfamiliar in the UK and require better-insulated homes to function efficiently. This creates a very large delivery challenge.

- **Uncertainty over the role of hydrogen**. There are uncertainties over how low-carbon hydrogen production can be, as well as its price and scalability. If it is produced from natural gas, it will need to be combined with CCS (so-called 'blue hydrogen') as producing hydrogen this way emits CO_2. If it is generated from water ('green' hydrogen) it will emit only oxygen, but this process requires over twice the energy input of direct electric heating, and seven times the energy of heat pumps.[13] There is further uncertainty over the safety and feasibility of converting the current gas network to hydrogen, since hydrogen is more volatile than natural gas (methane) and conversion of the network would need to be coordinated within local areas. And the future prices of hydrogen are themselves highly uncertain.[64] Hydrogen may also be reserved for industries that are unable to be electrified, such as aviation, shipping and HGVs.

[64] Ueckerdt et al., *Potential and risks of hydrogen-based e-fuels in climate change mitigation*, 2021.

Box 3.3: Decarbonising domestic heating: lessons from the switch to natural gas

For the UK, achieving net zero by 2050 in domestic heating is perhaps the greatest challenge of all the sector transitions. It will require the installation of new equipment and better insulation in most existing homes, with often high upfront costs and much uncertainty over which technologies are most appropriate for which homes. This will not, however, be the first time the UK's housing stock has been switched from one form of fuel use to another – the decade to 1977 saw 13 million homes converted to use natural gas in a centrally coordinated process.[a] This box considers the similarities and differences between that episode and the net zero transition.

In the early 1960s, the predominant fuel source for heat slowly shifted from coal and oil to 'town gas' (which was produced from either coal or oil) and electric boilers, so that by 1966 gas and electric boilers combined outnumbered all other domestic heat sources.[a] This shift was made possible by the introduction of narrow bore pipes in central heating, which were developed by the coal industry in the 1950s but were compatible with a range of fuels. Following the discovery of North Sea gas in 1965, the Government sought to exploit this indigenous fuel supply that was cleaner and more efficient than either coal or 'reformed' town gas (which was produced from imported liquid natural gas) and invested rapidly to convert houses to using natural gas.[b]

A huge number of buildings had to be converted. A contemporary study noted that, *"the process [of conversion] was particularly arduous […] since it involved converting 13.5 million domestic and 650 thousand commercial and industrial consumers."*[c] The process took almost precisely 10 years to complete, with Sir Dennis Rooke, Chairman of the British Gas Corporation, claiming it as *"perhaps the greatest peacetime operation in this nation's history"* at a ceremony to mark its completion.[b] Today, the Climate Change Committee (CCC) estimates that around 28 to 29 million houses will need converting to be net zero compatible, over twice the number.[d]

Not only was the scale smaller, but the average cost of conversions to natural gas was a fraction of the cost of switching to zero-carbon domestic heating, even adjusting for inflation and GDP growth in the intervening decades. The average cost of converting one house in 1966 was estimated at £30 (around £1,700 in 2019 terms), with the conversion of all 13 million properties costing just under £400 million (1.0 per cent of GDP in 1966, equivalent to £23 billion in terms of nominal GDP in 2019).[b,e] In contrast, the CCC estimates the additional investment in energy efficiency and heat decarbonisation required to reach net zero in the balanced pathway (in which heat pumps are the dominant technology deployed) to be approximately £12,000 per house (around 7 times greater than the natural gas conversions). Combined with more houses to convert, that gives a total investment of £362 billion in 2019 prices (16 times more than the natural gas conversion, and equivalent to 17 per cent of 2019 GDP).[f,g]

While significantly less expensive per household, the conversion to gas heating was still a major logistical undertaking. Moving 13 million properties to natural gas involved the 12 regional gas boards, parts of industry (to make new appliances or the parts necessary to convert existing ones), contractors (to enter people's homes and carry out the conversions), public relations (to sell the idea) and the public (to embrace it).[b] The Government took a central coordinating role, with a nationalised Gas Council giving the state direct control of the required investment.[h]

The transition to natural gas and to net zero are superficially similar, in that they both involve millions of private homes converting to a new technology. But in almost every respect, the transition to net zero is more challenging. It presents an even greater coordination challenge, covering investment in both heat efficiency and low-carbon technologies, across a larger number of properties, and over a longer period. This is evident in each aspect of the transitions:

- **Low-carbon technologies**. The switch to natural gas involved a proven technology (natural gas central heating) with a clear long-term cost advantage over existing heat sources (coal and oil). By contrast, there is considerable uncertainty around the appropriate technology for achieving net zero for domestic heating, and thus the option value in waiting to see how that uncertainty is resolved is high. With net zero there are (at least) two alternative approaches to decarbonising domestic heating: hydrogen and heat pumps (both domestic and district). Switching to hydrogen would involve less upfront investment (attractive for consumers) and would be delivered through the existing gas network (attractive for existing producers[j]) – and the heating would operate similarly to existing gas central heating. But there are significant technological and cost uncertainties around the production and use of hydrogen, and its deployment for use in heating would require large-scale coordination.[k] Heat pumps are rare in the UK but are being increasingly used in several countries across Europe.[k] But they are more expensive to purchase and require more heat-efficient buildings to work effectively since they cannot heat a cold space as quickly as gas central heating. There is also currently a running cost disincentive to switching to heat pumps because the electricity that they use is more expensive than gas used by conventional boilers because the cost of environmental levies is added to electricity bills but not to gas bills.[l]
- **Heat efficiency**. While there was no heat efficiency element to the natural gas transition, this is instrumental to decarbonising domestic heating. Of the UK's current house stock, around 70 per cent have an efficiency rating of EPC D or worse.[m,n] The Government has set a target to upgrade existing houses to EPC bands B and C by 2035,[n] and for all new builds from 2025 to meet higher efficiency standards according to a new Standard Assessment Procedure.[o] To an even greater extent than with the transition to natural gas, retrofitting and upgrades to existing homes will be invasive and costly to achieve (for example, requiring the installation of cavity-wall insulation, double/triple glazing, and/or draught proofing), with estimates for the average cost to upgrade a single home ranging from approximately £10,000 to £19,000.[g] The process is likely to be most challenging for homes with uninsulated solid walls, which make up 28 per cent of homes in the UK.[p] Recent experience with Government schemes to promote heat efficiency has not been encouraging: the 2012 Green Deal was scrapped in 2015 with just 15,000 loans having been taken out (versus the 14 million by 2020 originally targeted); while last year's Green Homes Grant was scrapped early with less than 2 per cent of the £1.5 billion earmarked for the scheme having been allocated in 2020-21, with the Treasury anticipating a further £295 million (20 per cent) will be allocated during 2021-22.
- **Workforce and skills**. 80 per cent of houses will also need to replace their heating systems, installing either hydrogen-compatible equipment and/or an electric heat pump. The Government has a target for residential heat pump installations to reach 600,000 a

year by 2028,[q] up from just 27,000 achieved in 2018. If that target were reached through steady annual rises, converting the remaining 25 million dwellings by 2050 would require around 1 million installations a year from 2029 onwards. The scale of this investment programme could support a sizeable skilled industry over several decades. For example, the Construction Industry Training Board estimates that by 2028 an additional 86,000 plumbers will be required, with an extra 350,000 full-time equivalent construction sector jobs needed overall in the next decade, dropping back to around 200,000 between 2030 and 2050.[r] This echoes experience in the move to natural gas, where outside contractors were relied upon, and extensive training was required before they entered the field – 13 dedicated training schools were set up for this purpose.[b]

The Government is due to publish a new *Heat and buildings strategy* on the transition soon.

[a] Hanmer & Simone, *Actors, networks, and translation hubs: gas central heating as a rapid socio-technical transition in the United Kingdom*, 2018.
[b] Williams, *A History of the British Gas Industry*, 1981.
[c] Tiratsoo, *Natural gas: a study (3d ed.)*, 1979. These 13.5 million and 650,000 industrial consumers, "were using some 35 million appliances of about 8,500 different types, many of which were obsolete. The number of burners eventually converted was actually about 200 million".
[d] Element energy, *Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget: A study for the Committee on Climate Change*, 2021 and CCC, *UK housing: Fit for the Future?*, 2019.
[e] UKERC, *Natural gas network development in the UK (1960-2010): coping with transitional uncertainties and uncertain transitions*, 2011.
[f] CCC, *Carbon Budget 6 – the UK's Path to Net Zero*, 2020.
[g] UK Parliament, Environmental Audit Committee, *Energy Efficiency of Existing Homes*, 2021. There is a range of estimates for costs to upgrade house energy efficiency, with the upper estimates giving total costs of over £24,000 per dwelling.
[h] Jenkins, *Government intervention in the British gas industry, 1948 to 1970*, 2004.
[i] Lowes et al., *Heating in Great Britain: An incumbent discourse coalition resists and electrifying future*, 2020.
[j] Ueckerdt et al., *Potential and risks of hydrogen-based e-fuels in climate change mitigation*, 2021.
[k] IEA, *Heat Pumps*, 2020.
[l] CCC, *Progress in reducing emissions, 2021 Report to Parliament*, 2021, and Tony Blair Institute for Global Change, *£10,000 to increase your energy bill: making the economics of heat pumps stack up*, 2021.
[m] MHCLG, *Live tables on Energy Performance of Buildings Certificates*, last update 14 May 2021.
[n] UK Parliament, *Energy efficiency: building towards net zero – Delivering Residential Energy Efficiency*, 2019.
[o] MHCLG, *The Future Homes Standard*, 2019.
[p] BEIS, Household Energy Efficiency National Statistics: Detailed Report, 2017.
[q] BEIS, Energy White Paper, *Powering our Net Zero Future*, 2020.
[r] CITB, *Building Skills for Net Zero*, 2021.

Power generation

3.67 Electricity generation accounted for 10 per cent of total UK emissions in 2019. As outlined above, this is the sector that has been most successfully decarbonised in recent years, with emissions down 70 per cent since 1990 as the UK switched from coal to gas and renewables. Decarbonising and expanding electricity generation is central to achieving net zero, since abatement in most other sectors involves switching from fossil fuels to zero-carbon electricity as the means of power. This results in power generation being the costliest sector in the transition to net zero, due to the large expansion of the electricity network.

3.68 From 2020 to 2050 electricity decarbonisation makes up 19 per cent of emissions reductions in the CCC's balanced pathway, at an investment cost of £481 billion (37 per cent of the whole economy total). The net cost of abatement out to 2050 is £331 billion, somewhat more than the whole economy net cost of reaching net zero (as with buildings, this is higher than its share in investment costs thanks to the net savings from vehicles). Operating costs become progressively cheaper than the baseline fossil-fuel technologies

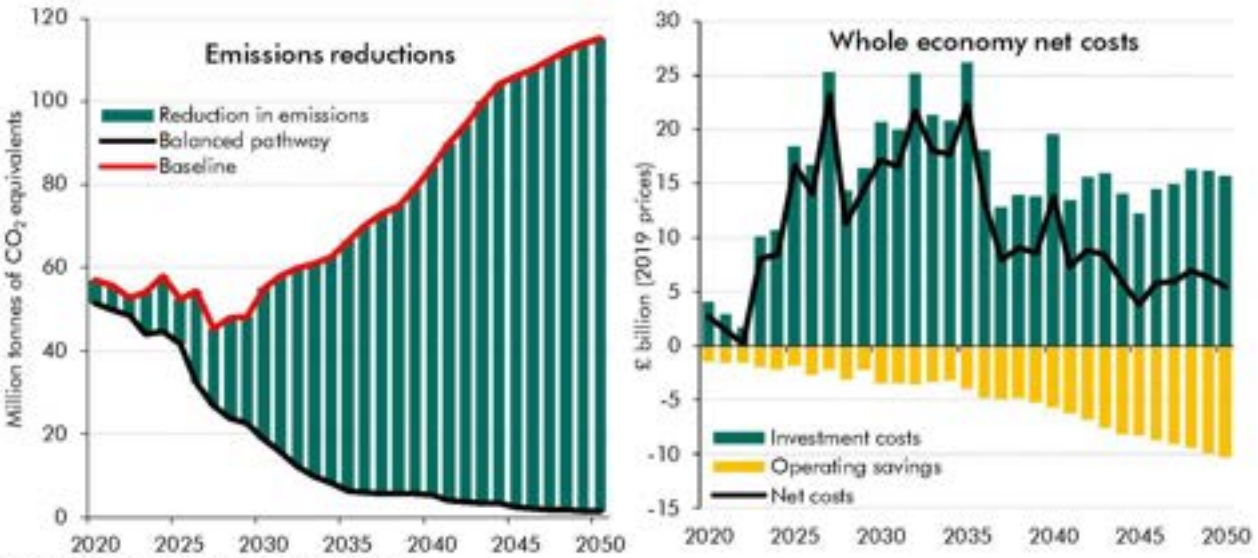
thanks to the significantly lower cost of running low-carbon technologies (for example, due to power generation from renewables having no fuel input costs).

3.69 The CCC's path to a net zero electricity system involves two key milestones:

- By 2035, **fully decarbonising electricity generation** by investing in low-cost renewables and developing markets for gas CCS and hydrogen plants. In power terms, this represents 400 terawatt hours of new low-carbon generation (compared with 134 terawatt hours generated by renewables in 2020), and a further 50 terawatt hours of dispatchable, flexible generation to balance fluctuations in generation from renewable and nuclear sources. As a result, the renewables share of total electricity generation will need to increase to 70 per cent by 2050 from its 2020 level of 28 per cent.

- Also by 2035, **phasing out unabated gas**, while ensuring security of supply. The CCC argues that a smooth transition will require *"the support of a carbon price and/or other policy mechanism"* to encourage low-carbon alternatives to fossil-fuel generation, such as gas CCS, hydrogen production and bioenergy CCS.

Chart 3.16: Electricity supply: emissions reductions and whole economy net costs



Source: CCC balanced net zero pathway

3.70 The main risks with the balanced pathway assumptions for electricity generation include:

- **Delays to required investment**. Power generation projects are typically large and subject to the time and cost overrun risks that are common to large projects.[65]

- The pace at which renewable generation can be ramped up has **implications for other sectors' transitions to net zero**, where achieving net zero relies on electrification of existing activities and then powering them with zero-carbon electricity. For example,

[65] Indeed, the tendency for cost overruns is sufficiently well-established that the Treasury issued 'Supplementary Green Book Guidance: Optimism Bias', which states that *"There is a demonstrated, systematic, tendency for project appraisers to be overly optimistic. To redress this tendency appraisers should make explicit, empirically based adjustments to the estimates of a project's costs, benefits, and duration."*

electrification contributes 81 per cent of the reduction in emissions in the vehicles sector in 2050 and 79 per cent of the reduction in the buildings sector.

- **Space available for wind or solar power generation**. In October 2020, the Government increased its target for offshore wind capacity by 2030 from 30 gigawatts to 40 gigawatts, for which current leasing of the seabed is believed to be sufficient.[66] The balanced pathway requires a further 55 gigawatts of offshore wind capacity. The required space for this has yet to be identified, meaning the UK will need to hold new leasing rounds for future developments.[67] And the extent to which floating offshore capacity can remove the space constraint – and at what cost – is also uncertain.

Industry

3.71 Industry was the third largest source of emissions in 2019, accounting for 12 per cent of total UK emissions. From 2020 to 2050 decarbonisation in industry contributes 10 per cent of emissions reductions in the CCC's balanced pathway, at an investment cost of £46 billion (4 per cent of the whole economy total). The net cost of abatement out to 2050 is £50 billion (16 per cent of the whole economy cost of reaching net zero). Of the decline in emissions, 55 per cent is due to switching to less carbon-intensive sources of energy, such as hydrogen, electricity, and bioenergy. Carbon capture, utilisation, and storage (CCUS) contributes a further 15 per cent, in part by capturing some of the residual gross emissions that cannot be reduced through switching to low-carbon fuels. Reductions also come from improving the energy efficiency of production (notably in the iron and steel, chemicals, and cement and lime sectors).

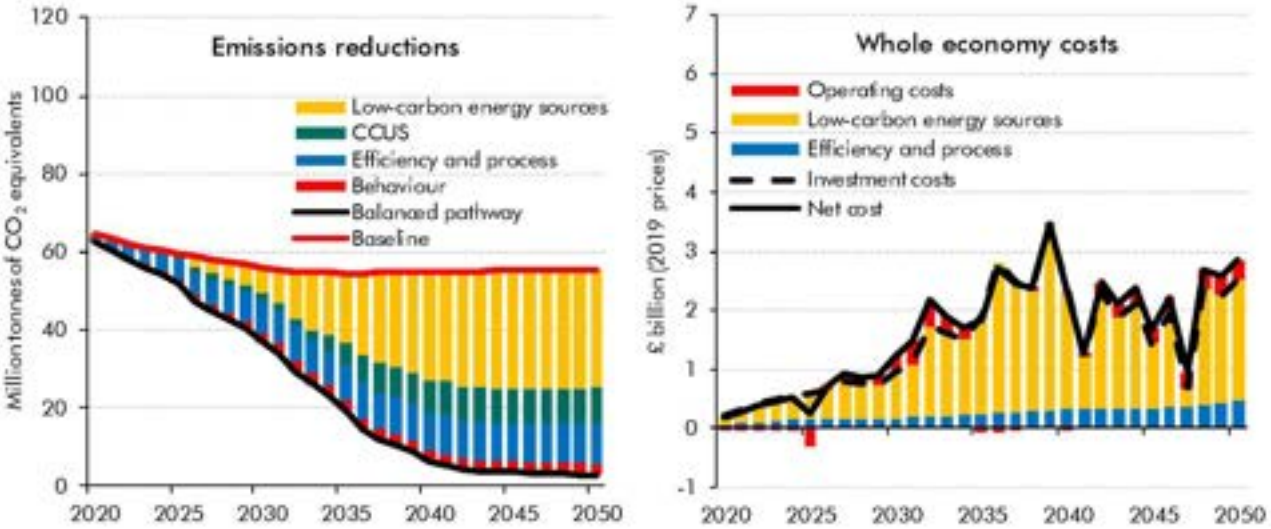
3.72 By 2050, the net cost of taking industry to net zero is £61 billion (22 per cent of the total net cost across all sectors). This consists of £46 billion in investment costs (three quarters of which are due to switching to low-carbon energy sources) and £15 billion in operating costs (which unlike most sectors remain higher than in the baseline scenario throughout the period).[68] By 2050, the increase in operating costs is only £1 billion a year. But if costs that are passed on to downstream sectors via higher prices are included, this figure rises to £2 billion a year. In terms of additional operating costs, switching to hydrogen as a fuel source costs £1.4 billion, electrification adds a further £900 million, and this is only partly offset by £1.1 billion worth of operating savings from increased energy efficiency.

3.73 The key elements of the transition to net zero for industry are:

- in the early 2020s, **improvements in resource and energy efficiency**;
- from 2025, **incentivising industry to switch energy sources** (as the costs of switching to hydrogen combined with CCUS is above those of current power sources); and
- investment in **CCUS, electrification and hydrogen**, which contributes steadily increasing amounts to emissions abatement between 2025 and 2040, and stabilises thereafter.

[66] Prime Minister's Office, *New plans to make UK world leader in green energy*, October 2020.
[67] The Crown Estate, *The Crown Estate Operational Report*, 2019.
[68] As discussed below, to present the costs of removals on a more comparable basis to their emissions, we have moved some removals-related costs from the industry to the removals sector.

Chart 3.17: Industry sector: reduction in emissions and whole economy net costs



Source: CCC balanced net zero pathway

3.74 Key uncertainties around the balanced pathway for industry include:

- **The pace and scale of switching to low-carbon fuels.** Industry is reliant on switching to greener fuels in order to reach net zero but, unlike in most other sectors, the switch is projected to raise future operating costs. Without adequate investment in electrified industrial processes or sufficiently strong incentives to prompt the move to other low-carbon alternatives, progress could be slower than projected.

- **Carbon leakage.** The combined effect of upfront investment costs and higher future operating costs could result in 'carbon leakage' for internationally exposed sectors, as production is shifted to countries with less stringent emissions policies – reducing the UK's territorial emissions, but simply by raising emissions-intensive imports instead.

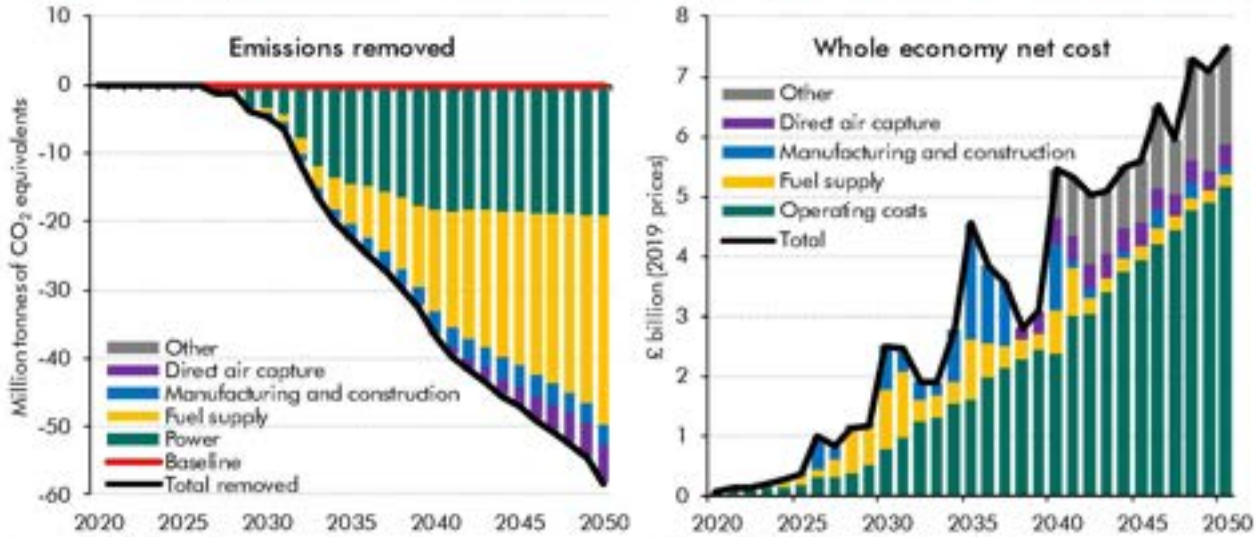
Removals

3.75 Given the rising cost of eliminating each additional unit of emissions (known as the 'abatement cost curve'), none of the CCC's scenarios rely on getting *gross* emissions to zero. Instead, some carbon continues to be emitted in most sectors and is offset by 'negative emissions' whereby CO_2 is also removed from the atmosphere to bring net emissions down to zero. The technologies required for these removals are not currently available at the scale required to achieve net zero – indeed removals had no impact on UK territorial emissions in 2019. From 2020 to 2050 removals contribute 7 per cent of emissions reductions in the CCC's balanced pathway, at an investment cost of £39 billion (3 per cent of the whole economy total). The net cost of the removals sector out to 2050 is projected to total £101 billion thanks to operating costs of £61 billion, thereby accounting for 31 per cent of the whole economy net cost of reaching net zero.[69]

[69] Of this £101 billion total cost, only the £4 billion costs of direct air capture are recorded by the CCC as a cost of the removals sector, with the remaining £97 billion being recorded as costs for the sectors that use removals technologies (such as the power stations and industrial plants that utilise bioenergy with CCS technologies). To present them on a more comparable basis to emissions, we have therefore moved all removals-related costs into the removals sector.

3.76 In the balanced pathway, direct air carbon capture and storage (DACCS) is not developed until 2040, but bioenergy with carbon capture and storage (BECCS) starts having a material impact on emissions in the 2030s. These work by converting biomass, biogas, and biowaste into energy and, in the process, capturing the carbon sequestered in them so that it is not emitted into the atmosphere. (This is achieved by, for instance, extracting hydrogen from them, burning them in power stations, or using them in industrial processes.)

Chart 3.18: Negative emissions and whole economy costs from the removals sector



Source: CCC balanced net zero pathway, OBR

Source: CCC balanced net zero pathway

3.77 The upfront capital costs from direct capture are supplemented by ongoing operating costs (i.e., the market price of each tonne of CO_2 is unlikely to cover the cost of removing it from the air), so unless it is entirely paid for by the state, its costs are likely to be passed on to consumers in the sectors with residual emissions in 2050 (like aviation and agriculture) via higher prices. If this cost were higher than any carbon tax that was in place, it would be expected to prompt further changes in behaviour in these sectors.

3.78 Given that removals technologies do not yet exist at the scale required to deliver net zero, there is a material risk that removals arrive later or turn out significantly more expensive than expected. This would force a move to more expensive methods of abatement. But it is also possible that the costs of removals could be lower than anticipated: the CCC's average abatement cost for DACCS is £179 per tonne of CO_2 (in 2019 prices), but some estimates are much lower.[70] In essence, the cost of DACCS sets a ceiling on the abatement costs that should be paid in other sectors, so this hugely uncertain area could be critical to the path taken elsewhere (for example, in domestic heating, where abatement costs per tonne of CO_2 are high and the volume of emissions to abate is also high).

[70] For instance, one study estimates that the costs could eventually fall under £70 a tonne in some scenarios: Keith D., et al., *A Process for capturing CO_2 from the atmosphere*, 2018.

Other sectors

3.79 The remaining sectors are agriculture, aviation, shipping, waste, land use change, F-gases (which are synthetic 'fluorinated' greenhouse gases) and fuel supply. From 2020 to 2050, decarbonisation in these sectors makes up the remaining 23 per cent of the reduction in emissions in the CCC's balanced pathway, at an investment cost of £52 billion (4 per cent of the whole economy total). The transition to net zero by 2050 for these remaining sectors delivers a net *saving* of £74 billion thanks to various factors, including increasing reductions in operating costs in the fuel supply sector, as well as smaller reductions in operating costs assumed in the aviation and waste sectors.

3.80 These other sectors represent some of the larger sources of residual gross emissions in 2050 in the balanced pathway. Of the 96 million tonnes of residual greenhouse gas emissions the CCC projects across the whole economy in 2050, agriculture accounts for 37 per cent, aviation for 24 per cent, and land use, land-use change and forestry for 21 per cent.

Fiscal implications of the transition to net zero emissions

3.81 An assessment of the fiscal risks posed by the transition to net zero must take account of four different ways in which this transition can affect the public finances:

- First, government is likely to be called upon to bear some of the **direct cost of transition** described above, at the very least for the buildings it occupies and vehicles it operates.
- Second, it faces a **direct loss of tax revenues** linked to fossil fuels and emissions.
- Third, it could derive a **direct revenue benefit** by taxing carbon more heavily.
- Fourth, it must contend with the **indirect effects (which could be negative or positive)** of the transition on the public finances via wider economic outcomes.

3.82 In this section we explore the three direct channels. We combine these with a set of economic scenarios based on those published by the Bank of England to capture the indirect consequences and generate a set of alternative fiscal scenarios for making the transition to net zero.[71]

The share of the costs borne by public spending

3.83 The Government has not taken a view on the extent to which public spending should bear the cost of the transition to net zero. As such, we need to make some assumptions to underpin the scenarios we present later in the chapter. The extent to which these assumptions can be based on firm evidence varies considerably, and this is a key area where further analysis, and future Government statements, will help us to refine our climate-related fiscal analysis in the future.

[71] Bank of England, *Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change*, 2021.

3.84 With those caveats in mind, Table 3.2 summarises our assumptions about the share of costs borne by government for the next three decades in each sector. The central variant would result in the state bearing around a quarter of the cost in each decade, as the public shares of individual lines typically fall over time but the costs become increasingly concentrated in areas where the public share is relatively high. In the low spending variant, costs are somewhat less than half those in the central case and the overall share does fall over time. In the high spending variant, they are somewhat less than twice the central case and are more uneven across the decades. These assumptions result in overall net impacts on public spending across the period from 2020 to 2050 of £152 billion in the low variant, £344 billion in the central variant and £553 billion in the high variant (all in real 2019 prices).

3.85 The key assumptions underpinning the figures for the central variants in each sector are:

- **Vehicles**. Policy is reasonably well defined for electric cars and vans given the sales ban and their falling costs relative to fossil-fuel vehicles. We assume that modest grant funding for electric cars continues until the mid-2020s, resulting in 20 per cent of investment costs being borne by the public sector. Investment in car charging infrastructure is relatively modest at 50 per cent of the total until 2025, and 20 per cent thereafter (a path that is assumed to cover commercially unviable routes, with higher spending initially to speed up the transition). For other vehicles (including railways, buses and HGVs), the shares for both vehicles and infrastructure are considerably higher. For the purchase of these other vehicles, the public share is assumed to fall progressively from 100 per cent at the start of the period to 25 per cent by the end as private investment picks up. For infrastructure, it is 50 per cent throughout (with the private sector being charged for some of the costs). Finally, government bears the investment costs of the 3 per cent of all vehicles that are estimated to be owned by the public sector, while also accruing 3 per cent of the large operating savings relative to fossil-fuel vehicles.

- **Buildings**. Given large upfront costs in terms of insulation and heating equipment (which would otherwise be a barrier to many households making the purchase, despite the net recovery of costs over the investment's lifetime due to improved efficiency), some public sector cost in terms of grants and other subsidies seems plausible, but at what scale is presently unknowable. For simplicity, we assume the state meets all the costs for residential households in the lowest 15 per cent of the income distribution, half the costs of the middle 70 per cent of households, but none of the costs for the top 15 per cent of the distribution. This yields an overall figure of 50 per cent of residential costs that is stable across the whole period. For non-residential buildings, we assume the government bears the cost for all public buildings (25 per cent of the total by value), and bears 20 per cent of the costs for private non-residential buildings (for example, those for which future operating savings would not be sufficient to make the investment viable in terms of private returns to the building owner). We also assume that the state will initially meet 90 per cent of the costs of district heating systems that meet the needs of several buildings (including both public and private owned), but that this falls to 60 per cent by 2050 as private investment builds up. The public sector also

benefits from operating savings as a result of improved energy efficiency of public buildings (5 per cent of residential and 25 per cent of non-residential buildings).

- **Power**. As is currently the case, costs of low-carbon power generation are assumed to be largely privately funded thanks to the additional certainty over future returns offered by contracts for difference (the cost of which are borne by consumers, not government). But we assume the state initially covers 10 per cent of investment in strengthening the electricity network, dropping to 5 per cent from 2030 onwards.

- **Industry**. Drawing on the detailed sector-level output assumptions underlying the Bank of England's early action scenario described later, we assume that the state initially meets the full costs for all the industries that see growth reduced by more than 2.5 percentage points relative to the baseline as a result of the burdens imposed to reduce emissions (which amounts to 60 per cent of the initial costs). In effect this assumes the state provides sufficient offsetting subsidies to ensure industries do not relocate or decline more rapidly due to competition from countries with less stringent carbon abatement policies. Costs are assumed to decline to cover only those industries facing more than 5 per cent output losses by 2050 (amounting to 25 per cent of costs).

- **Removals**. We assume the state initially meets all the capital and operating costs of removals, with the share dropping to 50 per cent of both by 2050. The public share is assumed to be non-zero in 2050 as the state is assumed to continue subsidising some activities, like agriculture and land use change, which make up 57 per cent of residual emissions in 2050, and which it currently subsidises in other ways. It also reflects the fact that emissions from industry account for 25 per cent of capital and 18 per cent of operating costs of removals in 2050, for which, as described above, 25 per cent falls to the state. In all, funding 50 per cent of agricultural removals, 100 per cent of land use change associated removals, and 5 to 6 per cent of industry associated removals, means around half of all removal costs in 2050 fall to the state.

- **Other sectors**. We assume the state initially meets 80 per cent of costs in other sectors, comprising all the costs associated with land use and waste, and roughly half the costs associated with aviation, shipping, agriculture, fuel supply, and F-gases. This share falls progressively to 50 per cent by 2050, at which point the state only covers costs related to land use and waste.

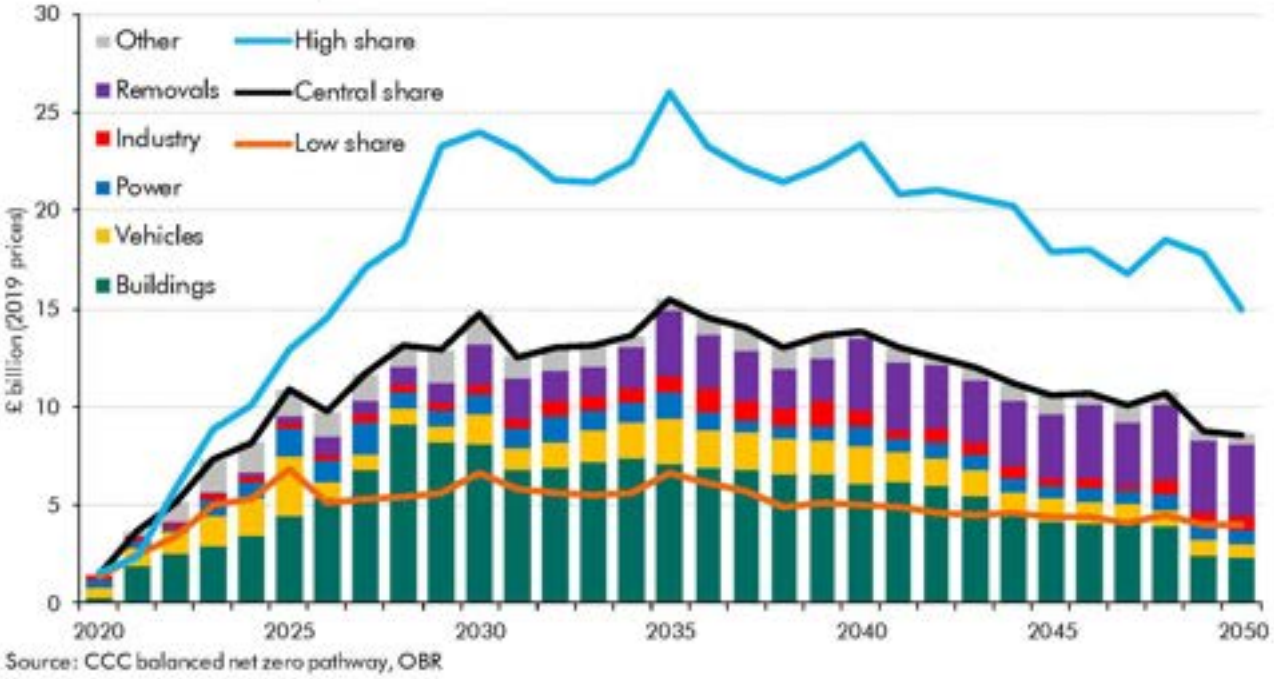
3.86 To illustrate the range of outcomes that might be consistent with the CCC's projection for whole economy costs, we have also produced high and low public spending variants for each assumption. In broad terms, the low variant is intended to represent a lower bound in which the public sector deals only with its own assets. By contrast, the high variant seeks to represent the upper end of costs the public sector might plausibly bear, with, for example, the state taking on almost all infrastructure costs in the vehicles, residential buildings, industry, and removals sectors. The 27 per cent of the £1,408 billion costs over the whole period that is borne by the state in the central variant therefore falls to just 13 per cent in the low variant, but rises to 41 per cent in the high variant.

Table 3.2: The share of costs borne by public spending

	Whole economy cost/saving	Public share of costs (per cent)									
		2020s			2030s			2040s			Total
	£ billion (2019 prices)	Low	Central	High	Low	Central	High	Low	Central	High	Central
Costs											
Vehicles											
Cars	213	11	11	20	3	3	13	3	3	3	6
Car infrastructure	35	20	29	70	20	20	60	20	20	50	21
Other vehicles	69	71	85	94	25	62	85	0	39	76	52
Other infrastructure	15	25	50	75	25	50	75	25	50	75	50
Total	332	16	18	28	11	21	38	6	18	33	19
Buildings											
Residential	254	7	44	65	7	44	82	7	44	89	44
Non-residential	142	28	43	47	27	42	53	25	43	59	42
Total	396	15	43	58	14	43	72	13	44	79	45
Power	481	4	7	10	0	5	10	0	5	10	6
Industry	46	24	54	89	21	42	77	19	31	66	38
Removals	101	85	89	93	69	75	81	50	59	67	64
Other	52	59	72	84	41	58	75	30	50	65	60
Total costs	1408	15	26	36	12	27	44	12	26	43	27
Savings											
Vehicles	-684	3	3	3	3	3	3	3	3	3	3
Buildings	-131	5	5	5	5	5	5	5	5	5	5
Other	-272	1	1	1	1	1	1	1	1	1	1
Total savings	-1086	2	2	2	3	3	3	3	3	3	3
Memo: Net cost (£ billion)	*321*	*46*	*84*	*115*	*58*	*138*	*228*	*45*	*113*	*195*	*344*

3.87 Combining the whole economy costs assumed in the CCC's balanced pathway with these public shares would see public spending on the transition to net zero ramp up through the 2020s, stabilise at a high level in the 2030s, and then fall back in the 2040s (Chart 3.19). The majority of the costs to the state come from decarbonising buildings, which costs net £164 billion over three decades (48 per cent of the total).

Chart 3.19: Costs to public sector of the transition to net zero



Source: CCC balanced net zero pathway, OBR

3.88 The *Charter for Budget Responsibility* requires us to base our analysis on current government policy where it is stated. In the scenarios presented later in the chapter, we therefore assume costs to the public sector are covered by the departmental spending totals up to 2025-26 that were set out in the March Budget, and so do not increase spending relative to the baseline, which is based on our March *EFO* forecast. (In effect, this spending therefore adds to the medium-term spending pressures described in Chapter 2.) From 2026-27 onwards, we assume that the costs are in addition to our assumed baseline. In all three variants, this means around 10 per cent of the cost across the whole period is treated as being allocated from within the baseline, while the bulk of it adds to borrowing.

Direct impact on receipts

Receipts losses associated with decarbonisation

3.89 The Government currently taxes carbon indirectly by levying several duties on motoring, aviation and waste. As these sectors decarbonise, the tax bases underpinning these revenues will gradually erode. Based on the assumptions set out in the CCC's balanced pathway, overlaid with standard assumptions on the uprating of these duties,[72] we estimate that receipts that are forecast to be worth 1.6 per cent of GDP in 2025-26 could be lost as a result of decarbonisation by 2050.[73] As Chart 3.20 shows, this comprises:

- **Fuel duties** (which are directly levied on the consumption of fossil fuels). These account for by far the largest share of revenues lost. Revenues that are worth around 1.2 per

[72] We assume that all duty rates are raised in line with RPI inflation, as detailed in the 'long term economic determinants' published on our website and the Government's default policy assumptions that it publishes annually alongside the Budget.
[73] These estimates are relative to a counterfactual in which the revenues would otherwise have remained constant as a share of nominal GDP from 2025-26 onwards at the level reached at the end of our March 2021 *Economic and fiscal outlook* forecast.

cent of GDP in 2025-26 are halved by the mid 2030s and fall to virtually zero by 2050. The overwhelming driver of this change is the gradual electrification of the road vehicle fleet. The CCC scenario assumes that sales of new conventional cars, vans and plug-in hybrids are ended by 2032 at the latest (three years ahead of the date the Government has stipulated in its sales ban). This leads to the electrification of around a third of the car and van fleet by 2030, rising to around two-thirds in 2035, almost 90 per cent in 2040 and close to 100 per cent in 2050. The HGV fleet is assumed to decarbonise almost 97 per cent of the stock by 2050 through the transition to both battery electric and hydrogen fuel cell vehicles. The CCC also assumes that behavioural change will reduce mileage, which further weighs on receipts.

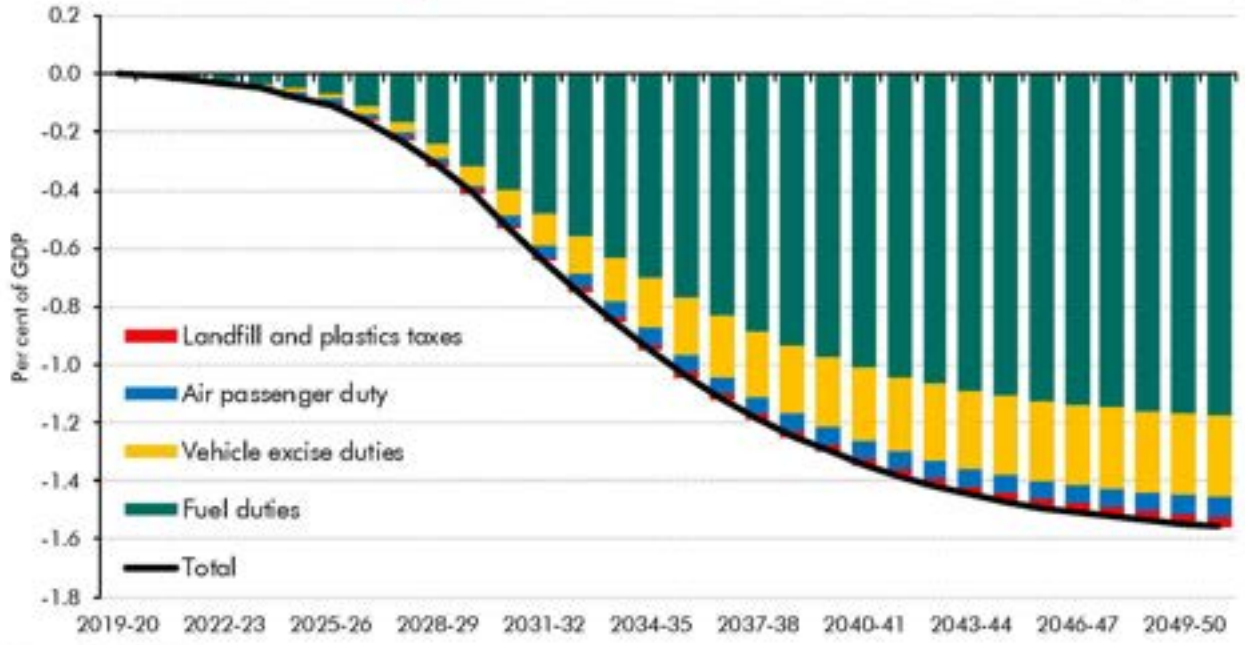
- **Vehicle excise duties** (VED) are levied on vehicles using public roads in the UK, but battery electric vehicles are exempt. VED receipts therefore follow a similar path to fuel duty, falling to almost zero by 2050 as the fleet is electrified. This accounts for around 0.3 per cent of GDP of the overall tax loss relative to our 2025-26 forecast.

- **Air passenger duties** (APD) are levied on passengers flying from UK airports to domestic and international destinations. The CCC assumes that carbon abatement is largely achieved by a reduction in passenger numbers, with only 25 per cent growth by 2050 relative to 65 per cent in the baseline. The fiscal cost of this would be tiny, lowering APD receipts by 0.07 per cent of GDP relative to our 2025-26 forecast.

- **Landfill tax and the plastic packaging tax** are charged per tonne of waste and production respectively. The CCC assumes that emissions from the waste sector fall by 75 per cent in 2050 relative to today's levels, thanks to a combination of waste prevention, increased recycling and bans on sending biodegradable waste to landfill. We assume this has a uniform effect on both tax bases, generating large reductions in small tax bases, thereby lowering receipts by 0.03 per cent of GDP by 2050.

3.90 One conclusion from this analysis is that achieving the CCC's balanced pathway would represent a risk to our most recent medium-term receipts forecast of 0.1 per cent of GDP (£1.8 billion) in 2025-26. In large part, this reflects our less aggressive assumptions about the pace at which new car and van sales will switch to electric vehicles (with the CCC's assumptions faster than would be implied by the dates set by the Government's ban on petrol and diesel, then hybrid, car sales). That said, as discussed in Box 3.2, we have repeatedly revised up the pace of this transition and may need to do so again.

Chart 3.20: Loss of motoring, aviation and waste revenues in the balanced pathway



Source: ONS, OBR

3.91 We have not made any adjustment for North Sea oil and gas revenues. Our latest forecast assumes that oil and gas production respectively fall by 6 and 7 per cent a year on average over the medium term. In the longer term, production is expected to continue to decline as resources are depleted and the cost of extracting them rises. The rate of decline is uncertain and could be affected by decisions on future licensing rounds that are expected to be subject to a 'climate compatibility checkpoint' to ensure that they are consistent with the Government's net zero target. The timing and cost of decommissioning existing installations is also uncertain and could affect future repayments of previous years' taxes.

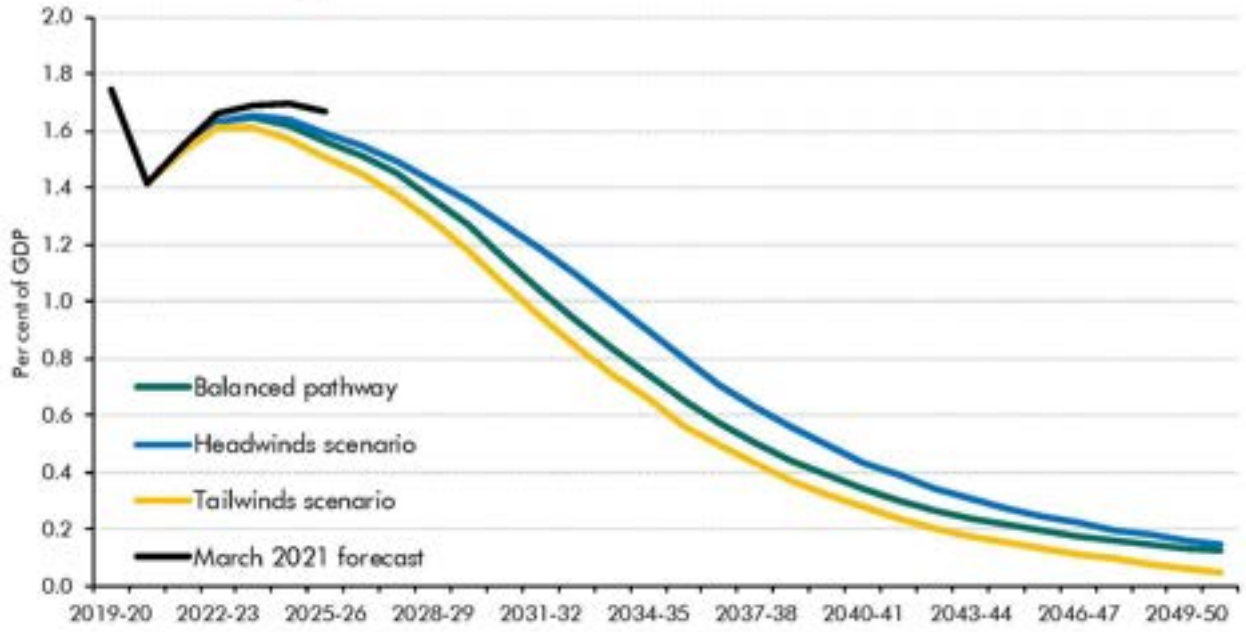
Alternate scenarios for receipts losses from decarbonisation

3.92 There is some uncertainty over the speed at which these revenues will be lost, but if the whole economy net zero emissions target is met, there is little uncertainty over their ultimate disappearance. We can illustrate the uncertainty around the time profile using the assumptions underpinning the CCC's headwinds and tailwinds scenarios (Chart 3.21):

- In the **headwinds scenario**, revenues are sustained for longer, primarily due to slower take-up of electric vehicles. Conventional car and van sales are only ended by 2035. Fuel duty revenues halve a year later than in the balanced pathway.

- In the **tailwinds scenario**, revenues fall faster. Fuel duty revenues halve a year earlier than the balanced pathway, driven by faster take up of electric vehicles and the ending of conventional car and van sales by 2030. Behavioural change is also much greater, with car mileages down by 34 per cent relative to the baseline (compared to 17 per cent in the balanced pathway). Demand for air travel is assumed to *fall* by 15 per cent between 2018 and 2050 (relative to the 25 per cent rise in the balanced pathway).

Chart 3.21: Motoring, aviation and waste tax revenues under alternative scenarios



Source: ONS, OBR

Receipts gains from levying a carbon tax on all emissions

3.93 The Government currently runs an emissions cap-and-trade scheme, the UK Emission Trading Scheme (ETS). It was launched earlier this year as the post-Brexit successor to the EU ETS, in which the UK had previously taken part as a member of the EU. It covers only a subset of emissions, as is typical for such schemes[74] – covering power generation, energy-intensive industry, and commercial aviation. In 2019 the EU ETS covered 25 per cent of UK emissions. The 'carbon price floor' is a conventional carbon tax levied on fossil fuels used in electricity generation (in addition to them being covered by the ETS). It is currently set at £18 per tonne of CO_2. Extending the coverage of carbon taxation to all emissions, and at a higher and rising rate per tonne, therefore has the potential to yield significant additional tax revenue. This could be achieved in different ways – for example, by extending coverage of the UK ETS and pushing the traded price of CO_2 higher by auctioning progressively fewer permits, or by imposing a full carbon tax and raising the tax rate progressively over time. For simplicity in the rest of the chapter we refer to this as a 'carbon tax'.

3.94 To generate illustrative paths for carbon tax revenues in the scenarios presented later in this chapter, we need to make assumptions for the emissions that will be taxed and the rate at which they will be taxed. For emissions, we simply use gross emissions from the CCC's balanced pathway (i.e. excluding the negative emissions from removals and land sinks). For the tax rate, in the absence of any Government statements about use of a full carbon tax, we combine elements from Bank of England and CCC scenarios:

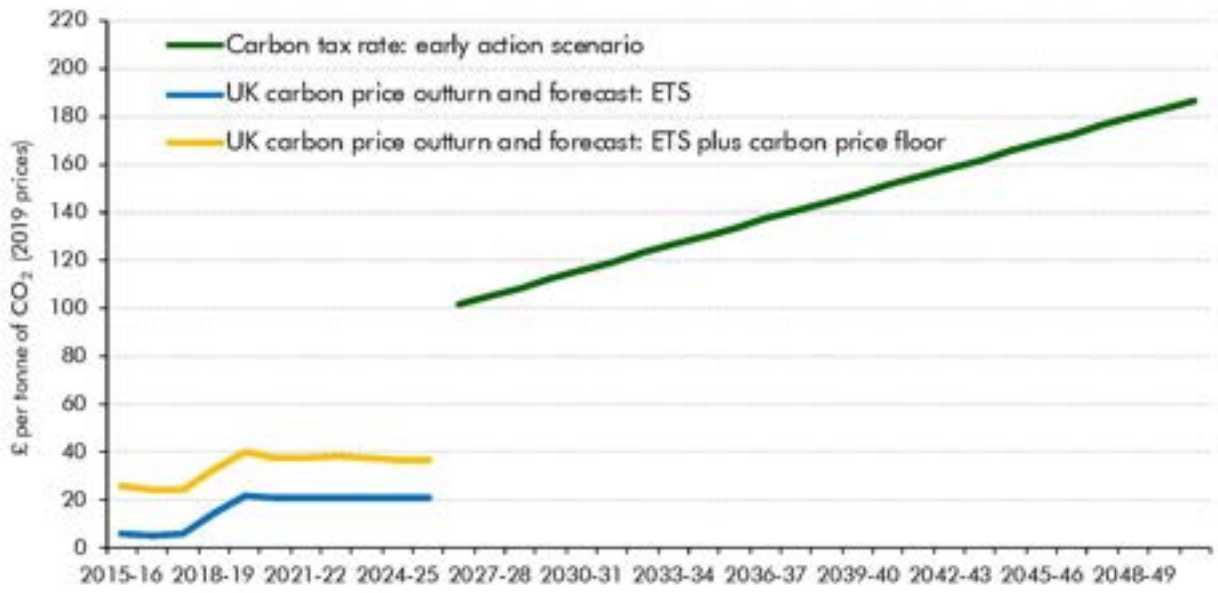
[74] As of 2020, 22 per cent of emissions around the world were covered by a carbon pricing system, either a carbon tax or a cap and trade system. See World Bank, *State and Trends of Carbon Pricing 2020*, 2020.

- **Overall 'shadow carbon price'**. The Bank of England scenarios that form the basis of our net-zero fiscal scenarios (described from paragraph 3.99) assume a rising path for the shadow carbon price. This price covers both the explicit price set by a carbon tax and the implicit or shadow price that captures the tax-equivalent effects of other mitigation policies like bans on certain activities and other regulatory interventions. It rises over time reflecting the need to incentivise progressively more costly forms of carbon abatement as the lower-hanging fruit are picked off.[75]

- **The proportion of the shadow price delivered by a carbon tax**. For simplicity, the Bank has assumed that half the shadow price is delivered via a carbon tax. We use that as the starting point for the tax rate in our scenarios. In the longer term, the amount raised in tax per tonne would be unlikely to exceed the cost of removals via direct air CCS (which in effect puts a ceiling on marginal abatement costs, as firms could, in theory, choose either to pay for the cost of removal or pay the tax). So to keep the tax rate from rising above these costs in the CCC's balanced pathway, we assume the proportion of the shadow carbon price delivered by taxing emissions falls to a quarter in 2050-51. This would be consistent with a rising share of the shadow price being delivered by non-tax policies such as outright bans.

- **The resulting carbon tax rate**. The assumptions described above yield a tax rate (in real 2019 prices) that starts at £101 per tonne in 2026-27 (the first year beyond our March *EFO* forecast horizon). That would be significantly higher than the rates underpinning our March forecast, which were based on EU ETS carbon price futures and existing policy with respect to the carbon price floor (five times higher than the ETS alone and three times higher than the ETS plus carbon price floor). The tax rate then rises steadily further to reach £187 per tonne at the scenario horizon in 2050-51 (Chart 3.22).

Chart 3.22: Real-terms carbon tax rates: outturn and scenario assumption



Source: Bank of England, Datastream, HMRC, OBR

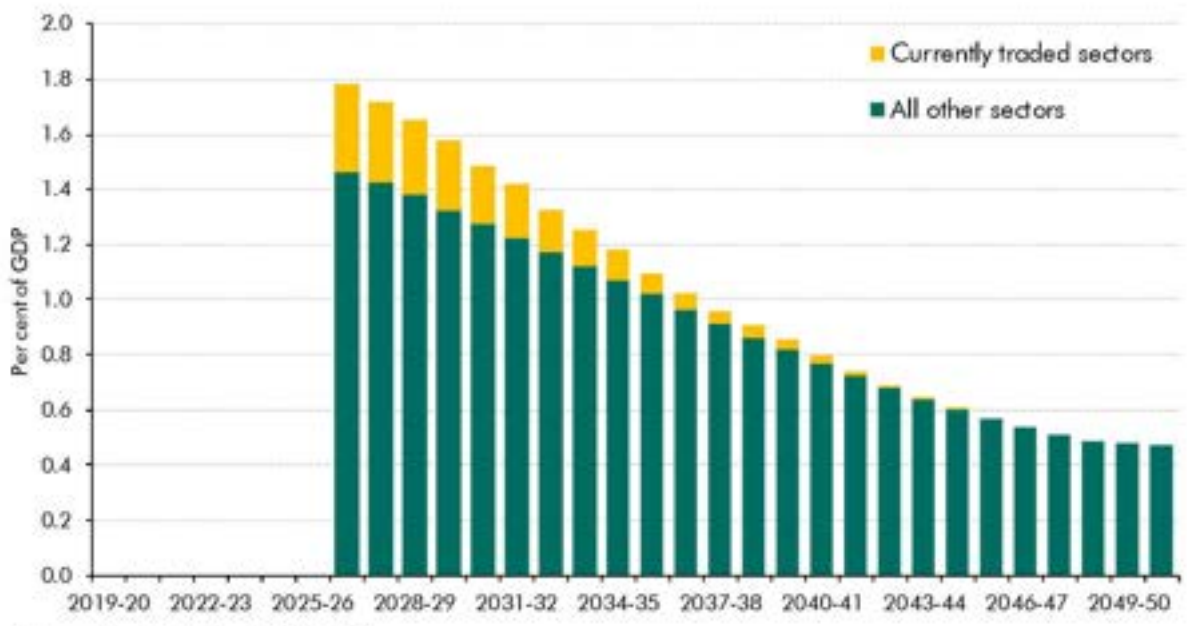
[75] See, for example, Burke, J., Byrnes, R. and Fankhauser, S., *How to price carbon to reach net-zero emissions in the UK*, 2019.

3.95 We base the first five years of our scenario on tax policy as set by the Government at the time of our March forecast, so assume for these projections that all emissions become subject to carbon taxes at higher rates from 2026-27 onwards. (In effect, this means that more than half of the Bank's shadow price of carbon is delivered by regulatory or other policies in the first five years of the scenario.) On this basis, additional carbon tax revenues start at 1.8 per cent of GDP in 2026-27 (a step change that in reality one might expect to be phased in over time). Thereafter revenues fall steadily to reach 0.5 per cent of GDP in 2050-51, as falling emissions more than outweigh the positive effect of the continuously rising tax rate. These additional revenues come from two sources:

- **Sectors that already pay a carbon price under existing policy** (electricity supply, industry and aviation). Less than 10 per cent of the additional revenue comes from levying a higher carbon price on these sectors. This raises 0.3 per cent of GDP in 2026-27 and falls to less than 0.1 per cent from 2035-36 onwards as emissions decrease, primarily in the electricity supply and industry sectors.

- **Sectors that currently do not pay a carbon price**. Over 90 per cent of the additional revenue comes from expanding the tax base to cover all other emissions. This raises 1.5 per cent of GDP in 2026-27, falling to 0.5 per cent of GDP in 2050-51 as emissions fall at a faster rate than the tax rate rises.

Chart 3.23: Additional carbon tax revenues



Source: Bank of England, CCC, OBR

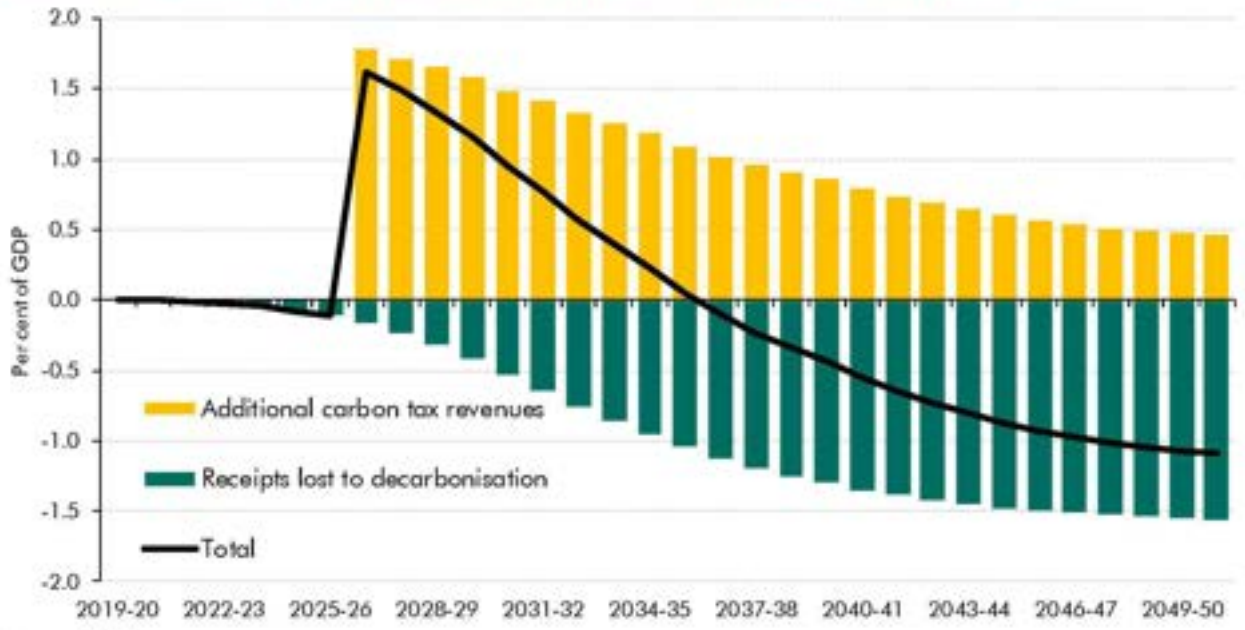
3.96 Carbon tax revenues would be sensitive to the pace of decarbonisation and the choice of tax rate. The effect of differences in either would be linear – with the response to differences in emissions being one-for-one, while the response to a higher tax rate would less than one-for-one due to its effect on emissions. The risks posed by these sensitivities could be expected to rise over time. In 2026-27, carbon tax revenues would be relatively certain as

they would be spread across many sectors of the economy. By contrast, in 2050-51 around 80 per cent of revenues come from the agriculture, aviation and land-use sectors in which decarbonisation of activity is least successful. Revenues would be highly uncertain at this stage since the narrow tax base and high tax rate would mean even small differences in the pace of emissions abatement could have large effects on revenue.

Total direct impact on receipts

3.97 Combining the receipts lost due to emissions reductions and those gained from taxing all emissions delivers a net increase in revenue from 2026-27 through to 2035-36 (peaking at 1.6 per cent GDP in 2026-27), but a net reduction thereafter (eventually reaching 1.1 per cent of GDP in 2050-51) (Chart 3.24). Over the full period, the early gains are ultimately outweighed by the subsequent losses – and in steady-state they would leave the public finances in a weaker position in the absence of offsetting policy measures.

Chart 3.24: Total direct impact of the transition to net zero on receipts



Source: OBR

Fiscal scenarios for achieving net zero emissions

3.98 Fiscal risks (both positive and negative) come not only from adapting to whatever global warming is allowed to occur, but also from our efforts to prevent further climate change. Other than for the very largest emitters, these efforts will be small relative to the sum of global mitigation activity. So while the UK Government has considerable control over the effort that is put into decarbonising activity at home, the fiscal risks posed by the transition will also depend to a significant extent, on the success or otherwise of other countries' efforts to get to net zero and how low-emissions technologies and their costs evolve.

3.99 In this section, we begin by exploring the economic and fiscal implications for the UK of a smooth global transition to net zero by 2050, as illustrated in the 'early action' scenario constructed by the Bank of England for the purpose of exploring its implications for the financial system.[76] The Bank's scenario adapts a global scenario produced by the NGFS,[77] in which global carbon prices are raised progressively over the next three decades leading to global CO_2 emissions being reduced progressively to net zero by 2050, and is consistent with limiting warming to 1.8°C by that point. Within this global path, the UK is also assumed to eliminate all net greenhouse gas emissions by the middle of the century.

3.100 This scenario is consistent with the world and the UK putting in place the policies necessary to achieve ambitious emissions targets, and doing so in a timely manner, thereby meeting the objectives of the Paris agreement with a minimum of disruption to economic activity. It is therefore in some senses an optimistic scenario, since such policies are largely yet to be set.[78] On existing policies alone, much greater warming is in prospect, as outlined in paragraphs 3.8 to 3.9, and 3.32 above. It is by no means clear yet that net zero will be achieved.

3.101 After detailing the economic and fiscal implications of this early action scenario, this section then explores the sensitivity of our results to varying key assumptions in order to illustrate some of the trade-offs and uncertainties inherent in the transition to net zero. We consider:

- **action versus inaction** in tackling climate change;
- **early action versus late action** in the transition to net zero;
- **the uncertain implications for productivity** of the substantial amounts of investment necessary to bring emissions down to net zero;
- **high versus low public spending shares** of this investment; and
- **alternative ways of calibrating long-term policy assumptions** in respect of the tax burden on motoring and the degree to which public investment in decarbonisation is additional or is allocated from the amounts implicit in our baseline assumptions.

3.102 There are, of course, many other sources of uncertainty that could be explored in future work. For example, increased whole economy investment could have implications for interest rates, which, as we document in Chapter 4, the public finances have become more sensitive to in recent years. But a successful transition will reduce the economy's sensitivity to fluctuations in oil prices, which have been the source of macroeconomic shocks in the past.

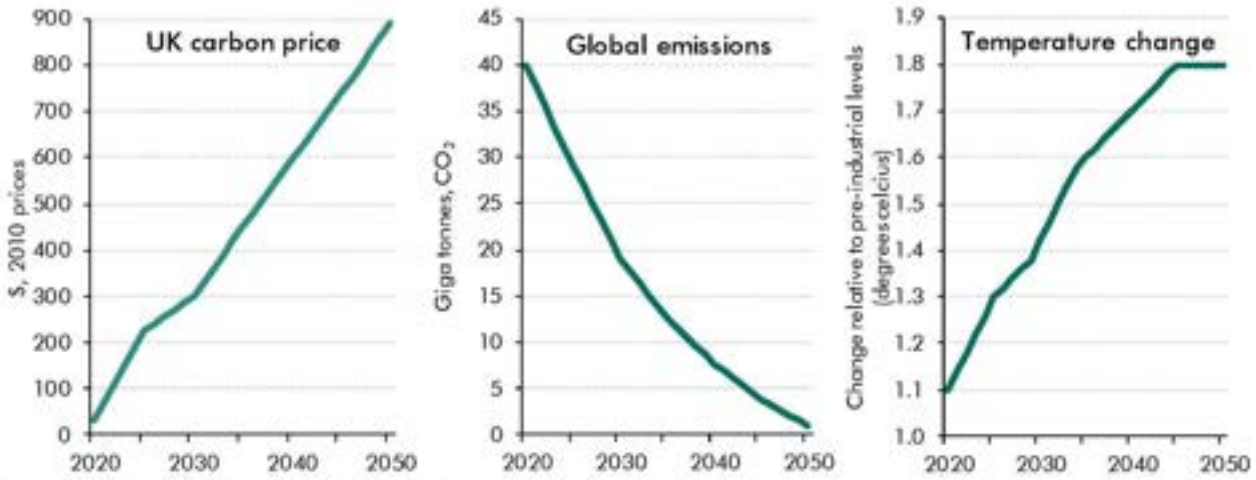
[76] Bank of England, *Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change*, June 2021.
[77] Specifically, the orderly 'Net Zero 2050' scenario, as described in Network for Greening the Financial System, *NGFS Climate Scenarios for central banks and supervisors*, June 2021.
[78] See Climate Action Tracker, *Climate summit momentum – May 2021*, 2021 and CCC, *Net Zero: The UK's contribution to stopping global warming*, May 2019.

Early action scenario

Climate and economic assumptions

3.103 As noted, this scenario is based on the Bank's early action scenario, with the assumed 'shadow carbon price'[79] and the path for emissions drawn from the corresponding NGFS scenario. The shadow carbon price rises steadily over the next 30 years from $30 a tonne to $889 a tonne (in real 2010 US dollars), such that global CO_2 emissions drop to close to net zero by 2050.[80] This is assumed to keep global warming to 1.8°C above pre-industrial times at the scenario's 2050 horizon and within 1.5°C of warming by the end of the century.

Chart 3.25: Scenario assumptions: global carbon price, emissions and temperature



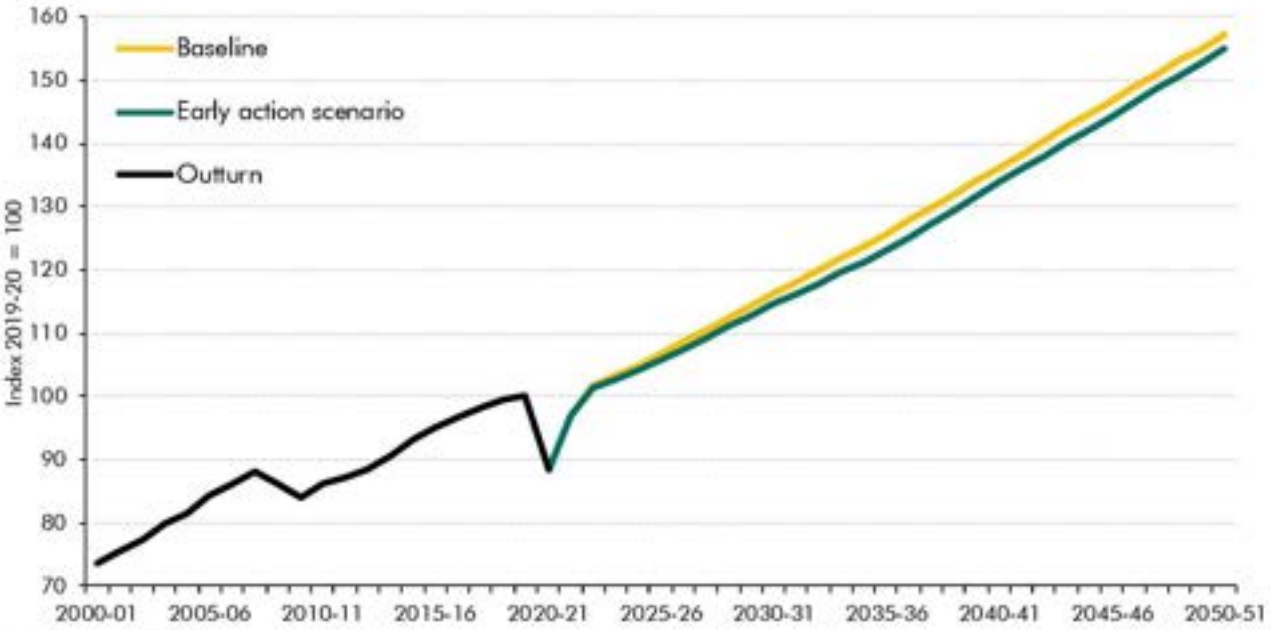
Source: Bank of England, NGFS Climate Scenarios Database

3.104 The Bank's scenario is presented in terms of real GDP differences from a purely hypothetical baseline without further global warming, but also with none of the costs of achieving that. So the baseline is emphatically not a 'do nothing' scenario, which would involve a greater degree of warming and all the economic and fiscal costs that that would bring.

3.105 Real GDP ends up 1.4 per cent below the baseline by 2050, with that loss having been incurred by 2030 and with a peak loss of around 2 per cent in the mid-2030s. These are modest differences when set against expected growth over the period (Chart 3.26). Higher carbon prices and other policies at the global level are introduced early and gradually over the next 30 years, so that the world transitions smoothly to net zero over that period. Consumers, businesses and financial markets gradually align their activities to a low-carbon economy, so there is only a moderate crystallisation of transition risks. Successfully stabilising global temperatures means that physical risks remain limited too, though they do increase from current levels due to the additional warming that takes place.

[79] The 'shadow price of carbon' covers both the explicit price set by a carbon tax and the implicit or shadow price that captures the tax-equivalent effects of other mitigation policies like bans on certain activities and other regulatory interventions.
[80] As they are producing a globally consistent scenario for emissions, the NGFS do not provide a path for emissions in the UK. Also, the global reductions assumed by the NGFS are slightly more frontloaded than assumed in the UK in the CCC's balanced net zero pathway (although as both scenarios assume emissions fall from current levels to zero over 30 years the average pace is broadly consistent).

Chart 3.26: Early action scenario: real GDP



Source: ONS, OBR

3.106 To construct a fiscal scenario from the starting point of these Bank assumptions, we take the percentage shortfall in real GDP and apply it to the baseline path for nominal GDP set out in our latest long-term economic determinants.[81] The scenario uses a path for long-term interest rates that converges to our long-term economic determinants.[82]

Revenue and spending assumptions

3.107 The fiscal scenarios are constructed using differences from a baseline path that is identical to our March 2021 *EFO* forecast until 2025-26. Beyond that point, the baseline assumes net investment is held at its 2025-26 level as a share of GDP, the current budget is held in balance, and stock-flow adjustments (loans and other financial transactions that affect debt but not the deficit) are stable at less than 1 per cent of GDP. This baseline abstracts from the large long-term fiscal pressures that feature in our *Fiscal sustainability reports*, although of course climate change will need to be addressed alongside those pressures, not instead of them. The baseline therefore assumes that public sector net borrowing (PSNB) is constant at 2.7 per cent of GDP and that public sector net debt (PSND) falls gently from 104 per cent of GDP in 2025-26 to reach 95 per cent of GDP in 2050-51.

3.108 Constructing the fiscal scenarios involves three steps. First, we add the direct fiscal costs of the transition to the baseline using assumptions detailed in the preceding section:

- **Net zero public spending**. The direct effects of the transition on public spending are based on whole economy costs from the CCC's balanced pathway and our central variant for the public spending share of those costs (shown in Chart 3.19 above).

[81] As published as a supplementary release to our March 2021 *Economic and fiscal outlook*, available on our website.
[82] Specifically, it uses the same path as Chapter 4's 'higher R and G' scenario.

- **Net zero receipts losses**. These losses of existing tax revenues that are somehow linked to emissions are based on the CCC's balanced pathway assumptions and our own modelling of their implications (shown in Chart 3.24).

- **Additional carbon tax revenues**. These are based on the CCC's balanced pathway for emissions, and a carbon tax rate that draws on elements of the Bank's and the CCC's scenarios (the tax rate and revenues are shown in Charts 3.22 and 3.23 respectively).

3.109 Next, we add the indirect fiscal consequences of the different path for real GDP. We have used a very simple approach to model these effects:

- **Non-climate-related receipts** are assumed to move one-for-one with nominal GDP, so the non-climate-related receipts-to-GDP ratio is invariant between scenarios. This is similar to the assumption we use in our long-term fiscal sustainability analysis. It is also consistent with historical evidence that the fiscal drag inherent in the tax system, which means that, all else equal, receipts move by more than one-for-one with GDP in the short term, has historically been offset by the consequences of tax policy changes (or other factors weighing on tax receipts) over the longer term.[83]

- For **non-climate-related public spending**, we assume that the volume of public services and public investment is held constant, while all other spending moves in line with nominal GDP. This is a bespoke assumption for the purposes of these climate scenarios that illustrates the extent to which spending would rise (or fall) as a share of GDP to maintain the volume of public services and investment in the baseline. It differs from our standard long-term approach of assuming that all spending moves one-for-one with GDP, which in effect assumes that policy settings are adjusted to reflect the amount of revenue the economy can generate. This results in an elasticity of a half on total public spending relative to GDP, since public services and investment spending make up roughly half of total spending. This means that the spending-to-GDP ratio varies inversely with differences in the real GDP path across the scenario.

3.110 Finally, we add the **debt interest** consequences of any differences in borrowing (positive or negative) between the scenario and the baseline.

Fiscal scenario results

3.111 The fiscal implications of the early action scenario are modest in the first half of the period, thanks to the largely offsetting effects on receipts and spending, but they become increasingly negative in the second half of the period (Chart 3.27). This path reflects:

- **Receipts**. Existing emissions-related receipts (mainly fuel duty) fall below the baseline, but additional carbon tax revenues more than offset these losses initially. This leaves receipts higher as a share of GDP until 2035-36. But the combination of declining carbon tax revenues (as emissions fall) and the continuing falls in emissions-related tax bases means that by 2050-51 receipts are 1.1 per cent of GDP lower.

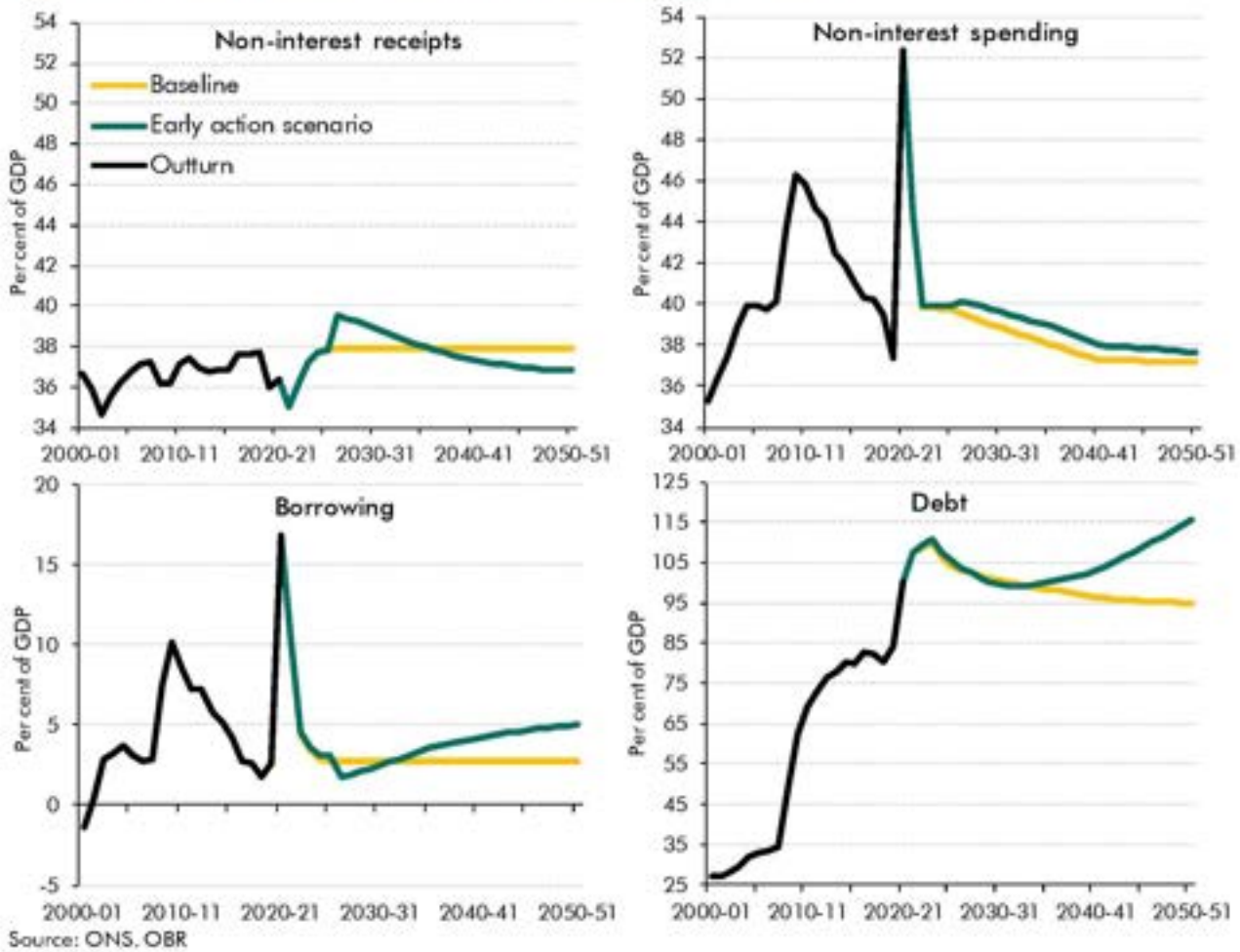
[83] See Table 1 in Belinga, V., Benedek, D., de Mooij, R. and Norregaard, J., *Tax buoyancy in OECD countries*, IMF Working Papers No 14/110, International Monetary Fund, June 2014.

- **Spending**. Public spending is higher than the baseline throughout, peaking at 0.9 per cent of GDP higher in 2035-36 when investment costs and indirect effects of the real GDP loss are both near their peaks. By 2050-51, spending is 0.5 per cent of GDP higher. Of this difference, around two-fifths reflects mitigation-related public spending and three-fifths comes from the smaller economy requiring higher public spending as a share of GDP to maintain a constant volume of public services and investment.

- **Borrowing**. Higher spending on decarbonisation and the loss of some existing tax receipts initially raises borrowing, then briefly falls below the baseline between 2026-27 and 2031-32 thanks to additional carbon tax revenues exceeding the various fiscal costs. The adverse effect on borrowing then becomes progressively larger as the receipts consequences of the transition grow, leaving borrowing 2.3 per cent of GDP higher than the baseline in 2050-51.

- **Debt**. The cumulative effect of this path for borrowing on the debt-to-GDP ratio leaves it close to the baseline in the first half of the period, but places it on a rising path thereafter. By 2050-51, PSND is 21 per cent of GDP higher than the baseline (somewhat less than the overall increase as a result of the pandemic).

Chart 3.27: Early action scenario: key fiscal aggregates

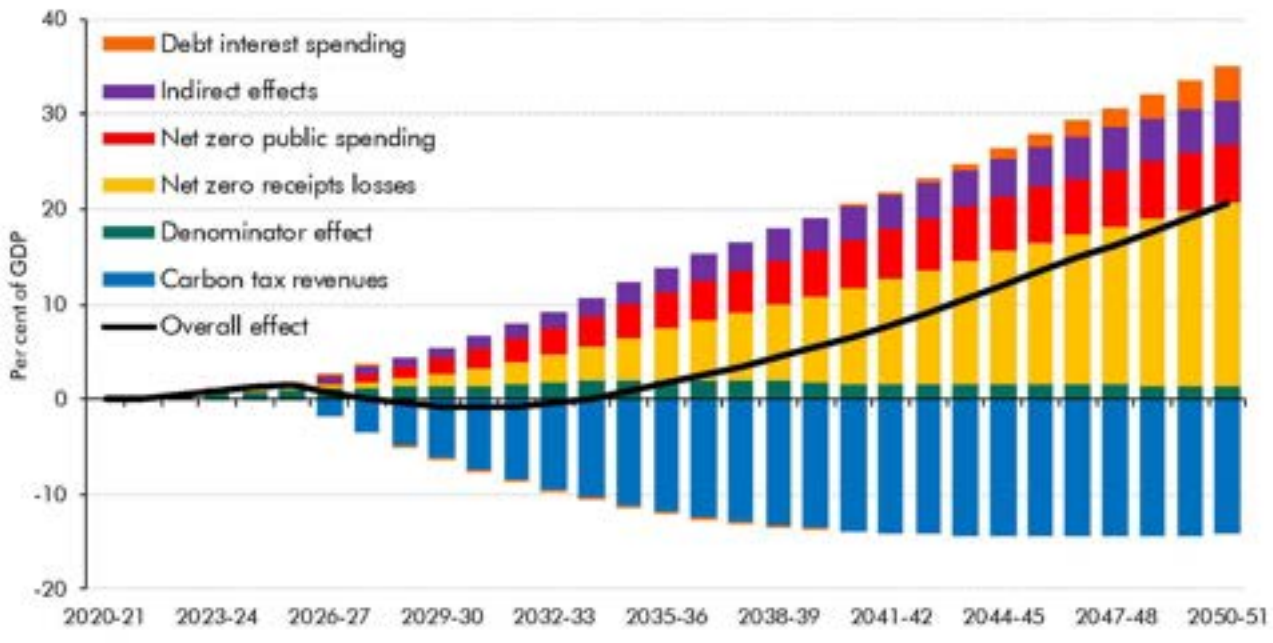


Source: ONS, OBR

3.112 Chart 3.28 breaks down the contributions from various sources to the difference between the debt-to-GDP ratio in the early action scenario and the baseline. It shows how the variation across time is dominated by tax-related assumptions, as emissions-related revenues fall away progressively while carbon tax revenues initially step up sharply before declining progressively too. The direct public spending consequences of the transition build up steadily, as do the indirect effects on public spending as the volume of public services and non-climate-related investment is maintained in a smaller economy. The debt interest consequences of all these factors combined build slowly initially, but faster later.

3.113 By 2050-51, the cumulative contribution of higher carbon tax revenues (14.2 per cent of GDP) offsets around three-quarters of the cumulative loss of existing receipts due to decarbonisation (19.4 per cent), so these receipts in total explain a quarter of the 21 per cent of GDP increase in debt (adding 5.2 per cent of GDP). Public spending on decarbonisation itself explains almost a third of the rise (6.0 per cent of GDP), while maintaining public services in a smaller economy explains around a quarter of it (4.7 per cent of GDP). The remainder is largely higher debt interest spending (3.5 per cent of GDP), with a smaller GDP denominator also raising the debt-to-GDP ratio slightly (1.4 per cent). It is notable that additional carbon tax revenues over the period as a whole are greater than the 10.7 per cent of GDP cost of net zero public spending and the smaller economy combined.

Chart 3.28: Early action scenario: differences from the baseline debt-to-GDP ratio



Source: OBR

3.114 This early action scenario provides a plausible net-zero consistent reference scenario against which to test sensitivities to different assumptions. In what follows, we use the same economic and fiscal assumptions as in the early action scenario unless otherwise stated.

Action versus inaction in tackling climate change

3.115 Illustrating the fiscal costs to the UK of global inaction in tackling climate change relative to our 30-year early action scenario is not straightforward. The costs of mitigation show up within this horizon, but the benefits of preventing warming largely do not, even though choices taken by the middle of the century will have lasting influences on the trajectory of global warming beyond that point. In addition, severe climate change does not just alter a given central outcome in any given year, it is also likely to increase the likelihood and magnitude of tail-risk events occurring, due to extreme weather events here and/or the resulting mass migration and conflicts that might result in hotter, drier parts of the world.

3.116 To address these issues, the Bank of England produced a 'no additional action' scenario that provides some insight into this question. In this scenario, it assumes that no action is taken to tackle climate change beyond the policies already in place before 2021. To highlight the potential physical risks that would eventually crystallise in this scenario, significant warming is assumed to take place immediately and reach 3.3°C by 2050. This is outside the temperature changes implied by most climate models, reflecting a 30-year *"shifting forward in time"* of temperature increases in order to explore more extreme risks.

3.117 Physical risks in this scenario are therefore 'high' (compared to 'limited' risks in the early action scenario). This means there are both greater pressures (from rising temperatures and sea levels) and also larger and more frequent shocks (such as heatwaves, wildfires and severe flooding). As a result, although transition risks are lower than in the early action scenario, the crystallisation of more severe physical risks lowers the level of GDP to around 8 per cent below the baseline in 2050 (more than five times greater than in the early action scenario). Moreover, inaction is assumed to result in permanently lower *growth*, so the GDP shortfall would continue increasing thereafter.

3.118 Given the temporal shift underpinning the Bank's no additional action scenario, we have not produced a corresponding fiscal scenario. Instead, earlier in the chapter we showed the illustrative fiscal consequences of completely unmitigated warming in which atmospheric CO_2 concentrations double (the international benchmark 'RCP 8.5' scenario). This would result in both higher average temperatures and a much greater risk of crossing climate tipping points that lead to even more extreme outcomes. (Of course, such a scenario now appears increasingly unlikely – it would fail to take into account mitigation policies already in place and factored into the Bank's no additional action scenario.)

3.119 Our illustration of the potential costs of completely unmitigated global warming was shown in Chart 3.6 above, reflecting not only increased pressures on the public finances, but also that by 2100 shocks occur twice as often as historically and are twice as costly when they do. This increases debt by over 100 per cent of GDP by 2100, relative to a stylised baseline without climate change. These figures are based on extremely broad-brush assumptions, but do serve to highlight the magnitude of the fiscal costs that might be avoided by successfully stabilising global temperatures in line with the Paris targets.

3.120 A true 'current policy' fiscal scenario that incorporates only actions underpinned by firm policies that have already been announced would therefore lie somewhere between this illustration of catastrophic unmitigated warming and the early action scenario. Introducing the policies necessary to meet the climate targets that are set out in legislation in the UK and increasingly being adopted elsewhere would shift the 'current policy' outcome further away from the catastrophic scenario. But this is very much still work in progress.

Early versus late action in tackling climate change

The costs and benefits of early and late action

3.121 When considering the fiscal implications of net-zero transition risks it is useful to consider how the potential impacts of early action might compare to acting later:

- **Early action**. The costs of new technologies tend to fall rapidly once deployment has reached critical mass, leading to changes in expectations that drive increased demand and the pressure for innovation. Acting early could place the economy on a better path than will be available later, for example by increasing productivity and capturing global market share by being the originator of successful low-carbon technologies, or from lower input costs associated with being an early adopter – giving time for supply chains to develop and the costs of technology to fall (particularly for domestically focused markets, where the scope for relying on other countries is more limited). And some elements of the transition involve very large volumes of activity – such as electrifying thousands of miles of railway or the heating systems in millions of private homes. In these areas, early and sustained action can mean less pressure on supply chains and costs than would happen in a later and hurried transition. But these potential gains need to be weighed against the uncertainties that come with early action, such as the possibility of investing in what proves to be the wrong technologies, or of a larger share of investment taking place while unit costs are high.

- **Delayed action**. Waiting provides the opportunity of freeriding on other countries' investments in new technologies, so that they bear the costs of initial uncertainties and of any trial and error along the way, after which a successful technology can be adopted at lower cost at a later date. But it also poses risks, with continued investment in emissions-intensive assets in the meantime increasing the amount of premature scrapping of those assets in a later and faster transition. A greater share of low-emissions technologies might also have to be imported, with foreign direct investment in net-zero industries having flowed to other markets. And if delayed action in the UK were to take place in the context of early climate action by our major trading partners, there would be an additional risk of losing export market share if they chose to impose carbon tariffs at the border.

3.122 One cannot be certain as to which path poses the greatest fiscal risks or opportunities given the many global and domestic factors at play. Either could be delivered in more predictable or disruptive ways, with respectively smaller and larger economic costs. One thing is clear – developments since we last looked at climate-related risks in our 2019 *FRR* point to inaction

in the race to net zero increasing the risk of being an outlier in the global transition. Not only have 131 countries now committed to net zero emissions targets or have them under consideration, those countries now include each of the top three emitters: the United States (committed to net zero by 2050),[84] China (by 2060, peaking by 2030),[85] and the European Union (by 2050).[86] Together they made up 49 per cent of global GDP in 2019, before the pandemic struck, and were the destination for 68 per cent of the UK's goods exports. This momentum is also apparent in the actions of investors and courts in bolstering the emissions reduction strategies of some of the world's major oil and gas companies in the light of more ambitious official targets.[87] Moreover, the EU is already at an advanced stage in its consideration of a carbon border adjustment mechanism that one study estimates could, in a 'maximum divergence' scenario, affect up to a third of UK exports to the EU, with the steel sector particularly hard hit due to the high share of its output that is sold to the EU.[88]

A late action scenario

3.123 In the context of these uncertainties, the Bank of England's 'late action' scenario helps provide a guide to the potential costs of acting late – and in particular of doing so abruptly, preventing households, businesses and financial markets from adjusting their activities gradually. In this scenario, the UK and the rest of the world do not take decisive steps to cut emissions until the 2030s and subsequent action must be more aggressive as a result to bring global emissions down more sharply to get to net zero by 2050. The sharp rise in the carbon price necessary to achieve this results in a period of macroeconomic disruption and leads to carbon-intensive capital being scrapped before the end of its economic life. Physical risks increase more rapidly than in the early action scenario, but remain modest relative to an unmitigated climate change scenario. In this scenario, real GDP settles 3.2 per cent below the early action scenario in 2050, following a period of disruption in which the loss of output relative to this scenario peaks at 6.6 per cent in 2033-34.

3.124 In addition to this different GDP path, we vary our assumptions about tax and spending:

- We make four adjustments to **net zero public spending**. First, the whole economy costs from the CCC's balanced pathway are concentrated in a period of two decades rather than three. Second, they are increased by 25 per cent in aggregate during the period 2030 to 2050 to reflect cost savings associated with large-scale deployment being realised more slowly, as well as pressures on supply chains being greater from a faster transition. Third, further additional costs are included to reflect higher cost removals in respect of higher residual emissions from sectors where it proves impossible to decarbonise fully by 2050, such as domestic heating. Finally, operating savings are concentrated into a period of two decades in line with deployment, but unlike for costs, we do not vary the amounts saved. All told this raises the whole economy investment by 21 per cent relative to the balanced pathway. We assume that half of the additional

[84] The White House, *Executive Order on Tackling the Climate Crisis at Home and Abroad*, 27 January 2021.
[85] Ministry of Foreign Affairs of the People's Republic of China, *Statement by H.E. Xi Jinping President of the People's Republic of China at the General Debate of the 75th Session of The United Nations General Assembly*, 22 September 2020.
[86] European Council, *European Council conclusions*, 12 December 2019.
[87] Financial Times, *Defeats for Big Oil mark 'sea change' in climate battle*, 27 May 2021.
[88] Burke, J., Sato, M., Taylor, C. and Li, F., *What does an EU Carbon Border Adjustment Mechanism mean for the UK?*, April 2021.

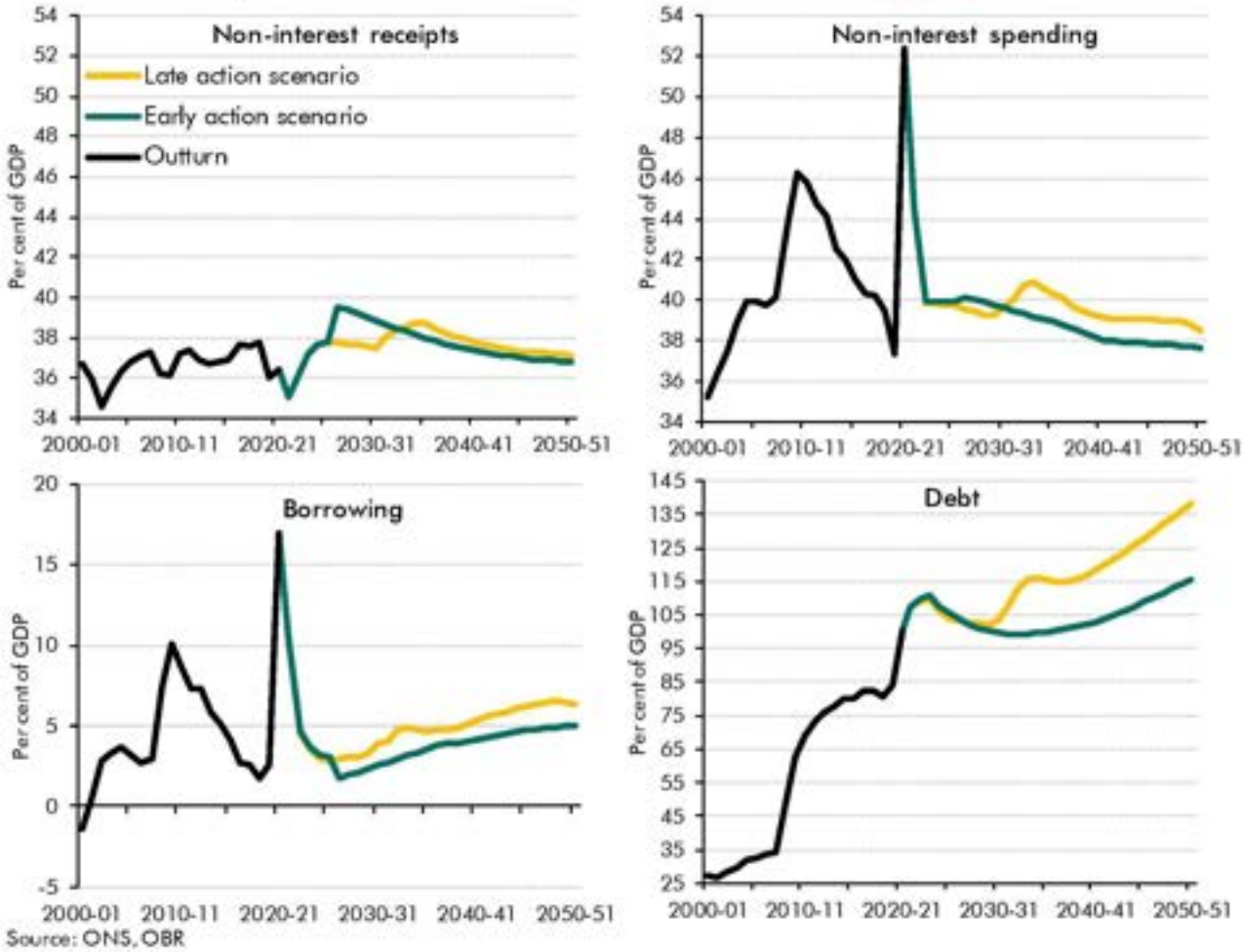
whole economy cost is borne by the public sector, almost doubling net zero public spending over the full period.

- **Receipts from emissions-intensive activities** only begin to fall rapidly after 2031-32 reflecting the slower initial progress. This is based on the CCC's headwinds scenario in which the transition to electric vehicles takes place more slowly, so that receipts from fuel duty and vehicle excise duty fall a little less quickly than in the balanced pathway.

- **Carbon tax revenues** are lower across the whole period due to full emissions coverage at higher tax rates not coming into effect until 2031-32, though the tax rate quickly rises to above that in the early action scenario. But this leaves five years' worth of emissions untaxed relative to that scenario. On an annual basis, additional revenues move above the early action scenario from 2034-35 onwards thanks to the higher tax rate and the higher path for gross emissions, with the latter falling more slowly than in the early action scenario and remaining higher in 2050-51.

3.125 The debt-to-GDP ratio in the late action scenario is fractionally lower than the early action scenario until the mid-2020s thanks to the slower pace at which emissions-related receipts are lost. It then moves a little above the early action scenario in the second half of the 2020s because of the lack of additional carbon tax revenues. But the material differences begin in the 2030s as a result of the economic disruption caused by the disorderly imposition of more stringent policies, the higher cost of the transition that is borne by public spending, and the lower long-term path for GDP. These combine to raise public spending to 1.2 per cent of GDP above the early action scenario on average in the two decades to 2050-51. This higher primary spending is partly offset by additional carbon tax revenues, leaving borrowing between 0.9 and 1.8 per cent of GDP higher than the early action scenario between 2031-32 and 2050-51. This leaves debt 23 per cent of GDP higher in 2050-51, roughly doubling the fiscal cost of bringing emissions down to net zero.

Chart 3.29: Early action versus late action scenarios: fiscal aggregates



Source: ONS, OBR

The potential consequences for productivity

3.126 Over the long term, productivity growth is the key determinant of fiscal sustainability since it underpins growth in all the major tax bases, which in turn provide the resources to meet demands for public spending. Even small differences in productivity growth cumulated over extended periods can have material consequences for the public finances. The effects of global warming and decarbonisation on productivity are uncertain, as discussed in paragraphs 3.121 to 3.122 above. There are examples of low-carbon technologies whose costs have fallen so far and so quickly that they are now cheaper than the fossil-fuel technologies they replace (as with solar and wind power, for example)[89], and others where that is expected to be the case in the relatively near future (as with electric cars). So an optimistic scenario in which decarbonisation actually boosts productivity is not impossible.[90] But equally, the costs of such a major structural change over a sustained period could easily

[89] Our World in Data, *Why did renewables become so cheap so fast? And what can we do to use this global opportunity for green growth?*, 2020.

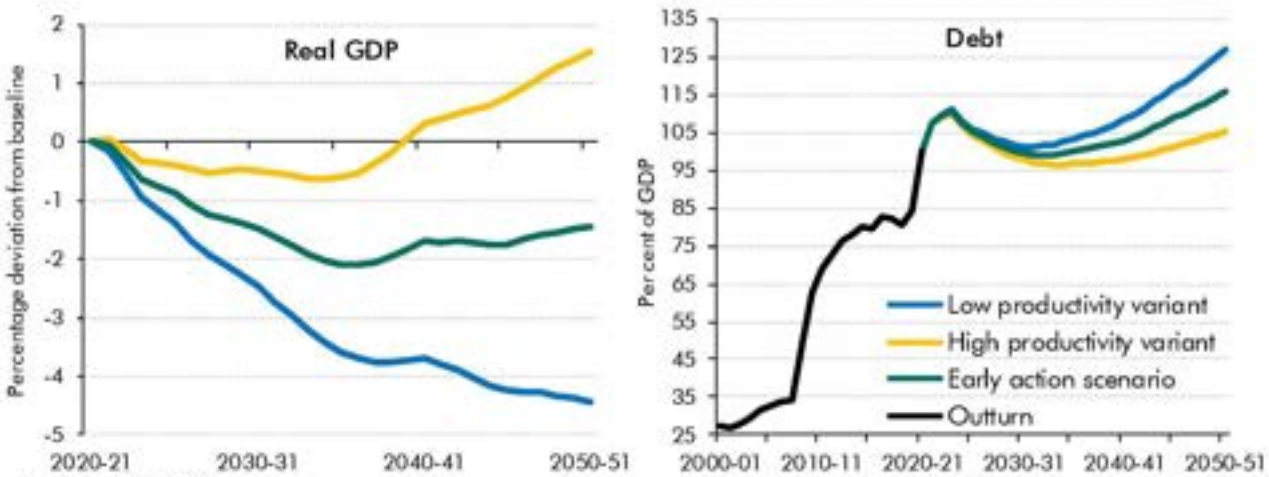
[90] Several studies have considered channels along which the transition to greener technologies could raise productivity. For example, Mealy, P. and Teytelboym, A., *Economic complexity and the green economy*, 2021, uses network analysis to demonstrate that it is easier for countries to become competitive in new green products that require similar production capabilities and know-how to existing sectors, while Martin, R., Unsworth, S., Valero, A. and Verhoeven, D., *Innovation for a strong and sustainable recovery*, 2020, compare broad categories of green technologies and find that the UK is relatively specialised in ocean and wind energy.

be greater than assumed – for example, if policy needs to change course unexpectedly or if a technology that has been heavily invested in proves unsuccessful.

3.127 The Bank's early action scenario assumes a modest hit to real GDP from physical and transition risks over the next 30 years, with real GDP growth over the coming decade a little over 0.1 per cent points a year lower than in the baseline. To test the sensitivity of our fiscal scenario results to different productivity paths, we therefore vary real GDP growth by 0.1 percentage points a year to either side of the early action scenario – giving 3 per cent differences in the level of GDP in 2050-51. This means real GDP settles at 1.6 per cent *above* the Bank's hypothetical baseline in the upside productivity variant, but 4.4 per cent below it in the downside variant. The latter is in line with the late action scenario in 2050, but involves none of the intervening macroeconomic disruption, nor any of the additional direct fiscal consequences included in that scenario.

3.128 In the high productivity variant, the larger economy, and the lower spending as a share of GDP that results, lowers debt by 11 per cent of GDP relative to the early action scenario by 2050-51. This difference includes the modest debt interest savings associated with lower primary spending. The results are broadly symmetrical in the low productivity variant.

Chart 3.30: Alternative productivity variants: real GDP and the debt-to-GDP ratio



Source: ONS, OBR

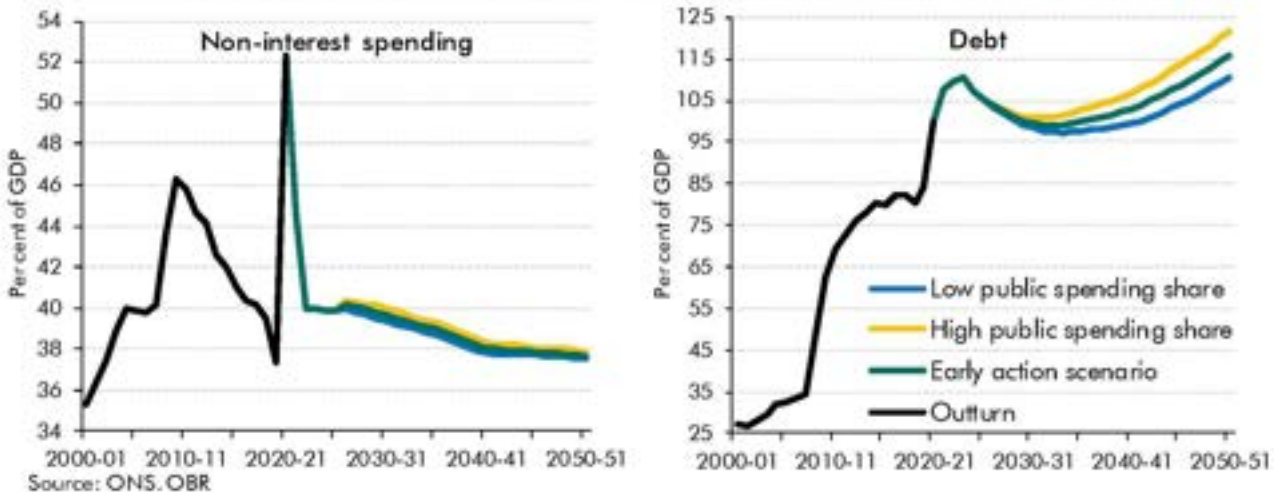
High versus low public sector share of net zero investment

3.129 As discussed earlier in the chapter, there is considerable uncertainty over the whole economy investment costs of the transition and the degree to which those costs will be borne by the public sector. Even holding the whole economy costs constant at those implied by the CCC's balanced pathway, our high variant for the public share of the total results in debt in 2050-51 being 5.9 per cent of GDP above the early policy action scenario; while the low variant results in debt being 5.2 per cent of GDP below that scenario (Chart 3.31).

3.130 This simple sensitivity analysis does not incorporate any feedback from the higher or lower paths of public investment to GDP growth or the cost of low-carbon technologies. Given the various market failures and distortions that hold back private investment in decarbonisation,

it could be the case that early public investment yields future fiscal benefits from more rapid deployment, lower costs and higher productivity than would otherwise have been achieved. But, as with early action in general, it could also be the case that investment is wasted on the wrong technologies or on those whose costs fall rapidly due to global developments.

Chart 3.31: Net zero public spending variants: spending and debt-to-GDP ratios



Potential for offsetting fiscal policy adjustments

3.131 Two important assumptions in our early action scenario relate to future policy settings where there is currently no clear statement of long-term government policy – namely, those relating to public investment and to taxes on motoring. In essence, our scenario reflects both in their most costly form – all net zero public investment is additional to the baseline and all loss of fuel duty and vehicle excise duty is reflected in higher borrowing. So, another sensitivity worth illustrating is the effect of potential offsetting policy adjustments. We can do this by instead defining long-term policy assumptions in their least costly way, with all net zero public investment allocated from within existing budgets and with the tax burden on motoring maintained as existing taxes fall away. (The former might be more plausible at the current juncture than it would have been in recent decades since the Government plans to sustain public investment at multi-decade highs in the coming years.)

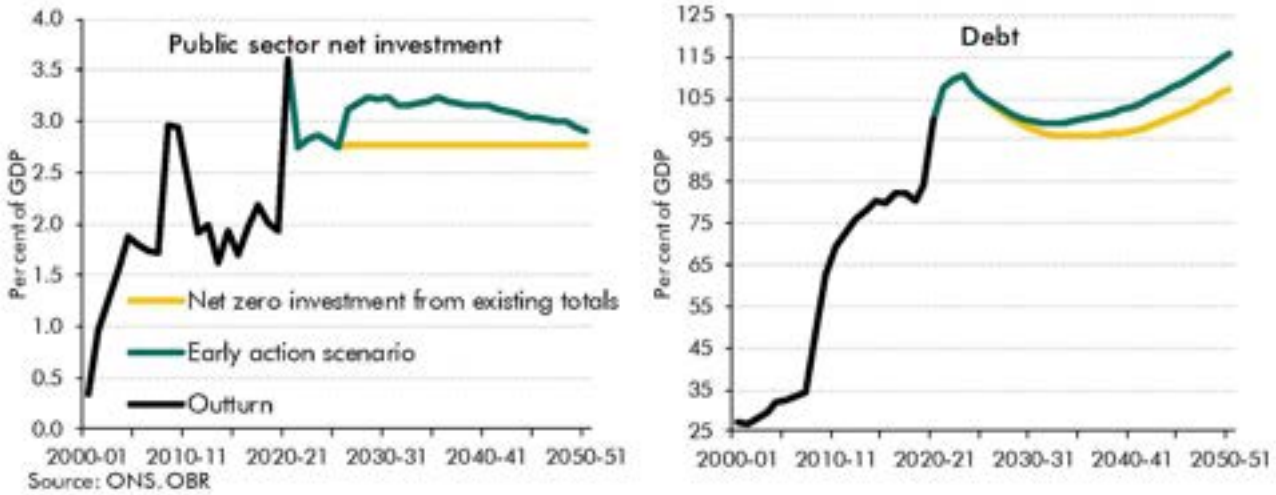
Public investment

3.132 Our baseline assumes that public sector net investment (PSNI) will continue throughout the period at the 2.7 per cent of GDP it reaches in 2025-26. As net zero public investment averages 0.4 per cent of GDP across the period and peaks at 0.5 per cent of GDP in 2028-29, it need not all be additional to existing totals. Indeed, if, at the other extreme, all net zero investment were allocated from within the baseline it would make up only 13 per cent of PSNI on average over the period, peaking at 17 per cent in 2028-29.

3.133 If net zero public investment were all allocated from within the baseline instead of being additional, PSNI would remain at 2.8 per cent of GDP throughout the period (a little higher than the baseline due to the indirect effects from a smaller economy) rather than averaging 3.1 per cent of GDP. As a result, PSND would be 8.4 per cent of GDP lower by 2050-51

than in our early action scenario, including the effects of lower debt interest spending (Chart 3.32). This would reduce the increase in debt at that point by around two-fifths.

Chart 3.32: Public investment additionality sensitivities



Source: ONS, OBR

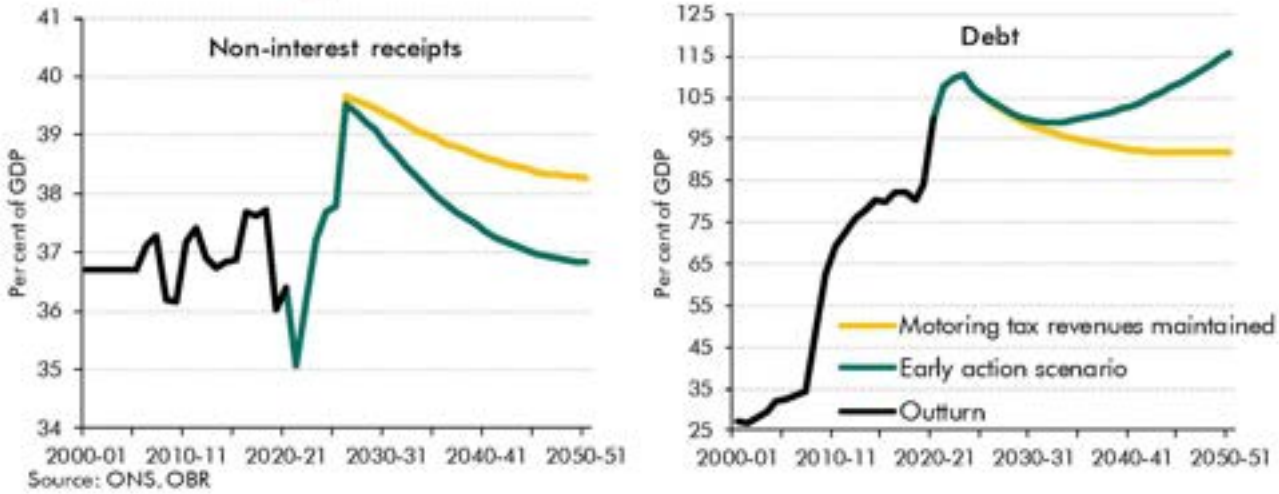
Taxes on motoring

3.134 Our scenarios assume that receipts lost through the decarbonisation of motoring lead to progressively higher borrowing and debt. But since this is a predictable tax cut for motoring, the Government could instead choose to levy a different tax to maintain revenues from motoring even as the tax bases for fuel duty and VED are eroded. For example, the CCC's sixth Carbon Budget advice noted that this loss of tax revenues would have the side effect of increasing congestion, and that to address both the fiscal cost and the greater congestion *"some form of road pricing is likely to be necessary"* and that road-user charges *"could apply to all vehicle types and be set at a level to fill the gap left by fuel duty"*.[91] Indeed, the Government's *Ten Point Plan for a Green Industrial Revolution* states that *"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"*.[92]

3.135 If lost receipts from fuel duty and VED were replaced by an equivalent yielding levy on motoring (of whatever form), receipts in 2050-51 would be 1.5 per cent of GDP higher and PSND would be 24 per cent of GDP lower than in the early action scenario (Chart 3.33). This would more than offset the net impact of the transition on debt at that point, leaving the debt-to-GDP ratio lower than the baseline. This illustrates how additional carbon tax revenues in the early action scenario are sufficient to pay for the transition and its economic consequences, so long as the tax burden on motoring is maintained.

[91] See Box 6.5, Climate Change Committee, *The Sixth Carbon Budget: The UK's path to Net Zero*, December 2020.
[92] Department of Business, Energy & Industrial Strategy and the Prime Minister's Office, *The Ten Point Plan for a Green Industrial Revolution*, November 2020.

Chart 3.33: Motoring tax sensitivities

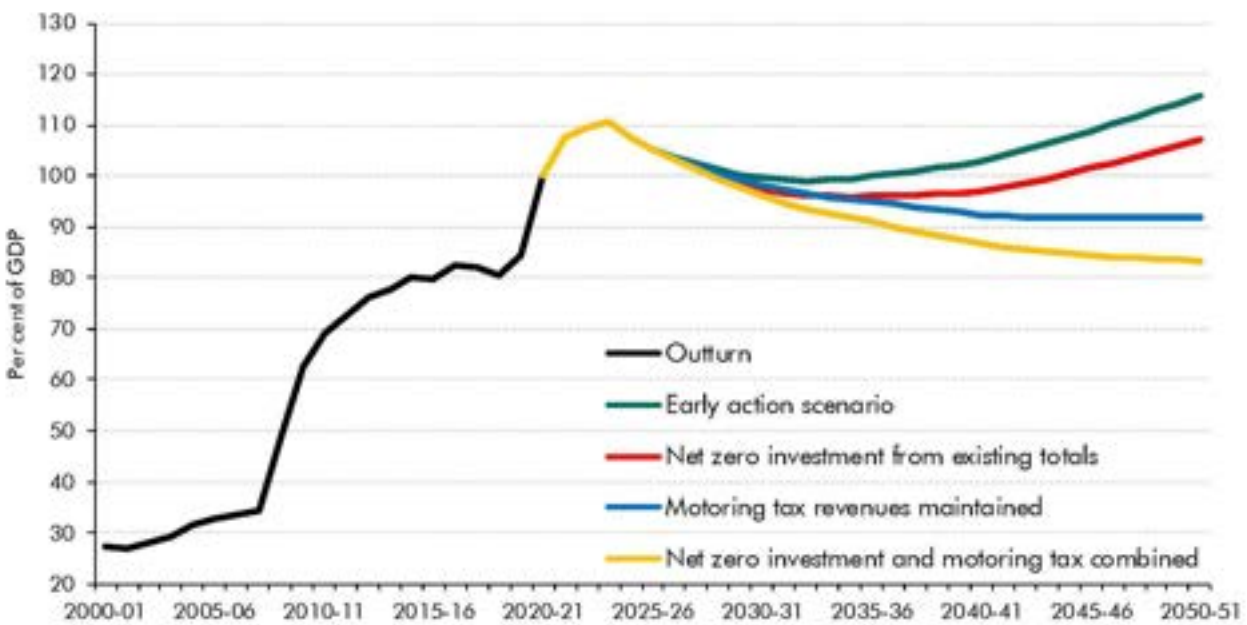


Source: ONS, OBR

Combined sensitivities

3.136 Combining these two alternative formulations of our long-term policy assumptions (such that net zero investment is allocated from within existing totals and fuel duty and VED replaced by an alternative tax on motoring), PSND would be 32 per cent of GDP lower in 2050-51 than in the early action scenario (Chart 3.34). This would be 12 per cent of GDP lower than the baseline, illustrating the extent to which additional carbon tax revenues and use of the existing public investment envelope to fund net zero investment could limit the fiscal consequences of early action to reduce the UK's emissions to net zero.

Chart 3.34: Long-term policy assumption sensitivities: debt-to-GDP ratio

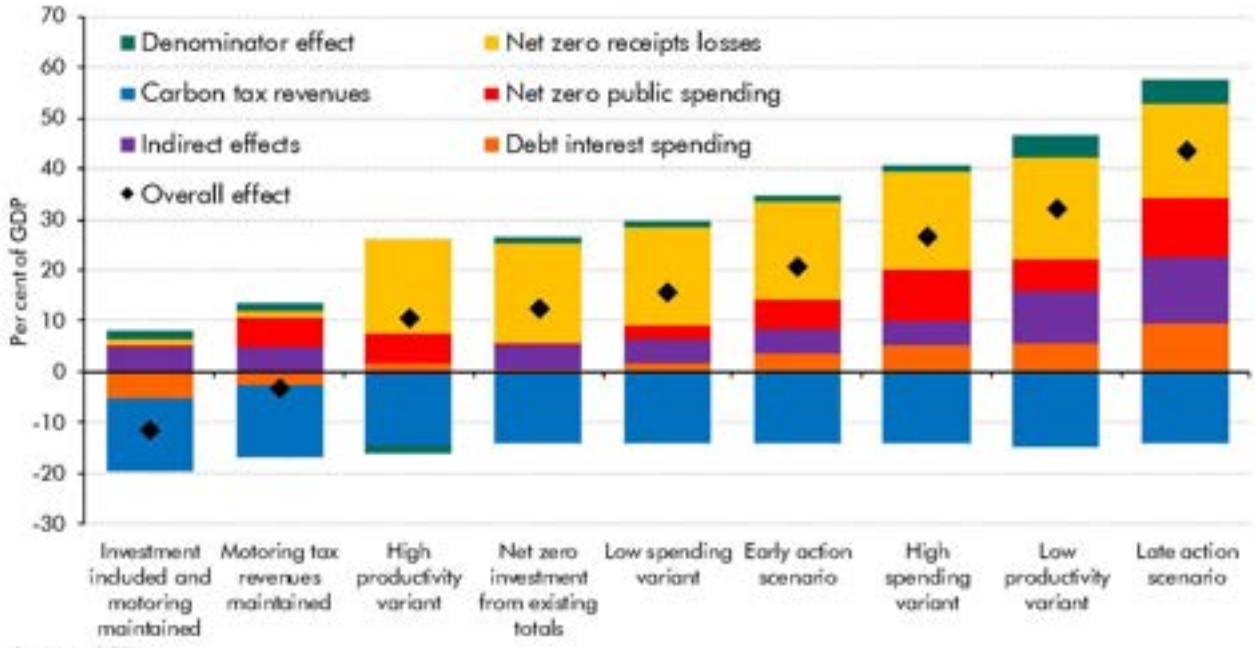


Source: ONS, OBR

Summary of alternative scenarios and sensitivities

3.137 The fiscal implications of different paths to net zero vary widely. The impact on public sector net debt in 2050-51 ranges from a decrease of 12 per cent of GDP in the most fiscally favourable scenario (in which early action is combined with funding net zero investment from existing totals and maintaining the tax burden on motoring), up to an increase of 43 per cent of GDP in the most fiscally costly one (in the late action scenario that combines both higher investment costs and economic disruption due to policy measures being introduced abruptly) (Chart 3.35). In virtually all variants, the largest moving parts relate to revenues – the receipts lost from decarbonisation and those gained from taxing all emissions and at higher rates. The direct cost of public spending on the transition is modest by comparison in all but the late action scenario and the high spending variant. But in terms of the largest source of difference between the scenarios relative to the early action reference point, it is the path of GDP and the indirect fiscal consequences from maintaining public services and non-climate-related investment in real terms that is most important. This illustrates once more the vital importance of productivity growth for fiscal sustainability.

Chart 3.35: Contributions to PSND scenario differences from baseline



Source: OBR

3.138 Our fiscal scenario results and their relative positions reflect the assumptions that underpin them, which vary in their sophistication. Refining them will form part of our future work on climate change, including as the Government sets out the further policy measures that will be necessary to meet its net zero target. Table 3.3 records the key assumptions that underpin each scenario. The components of each are available on our website to allow users to vary them or to combine elements from different scenarios to prepare their own.

Table 3.3: Summary of climate-related scenario assumptions

	Real GDP (per cent deviation from baseline)	CCC scenario for whole economy costs[1]	OBR public spending share variant	OBR carbon-related revenue loss variant	OBR carbon tax variant
Early action scenario	-1.4	Balanced	Central	Central	Early
Late action scenario	-4.6	Late	Late	Headwinds	Late
High productivity variant	1.6	Balanced	Central	Central	Early
Low productivity variant	-4.4	Balanced	Central	Central	Early
High spending variant	-1.4	Balanced	High	Central	Early
Low spending variant	-1.4	Balanced	Low	Central	Early
Net zero investment from existing totals	-1.4	Balanced	Central	Central	Early
Motoring tax revenues maintained	-1.4	Balanced	Central	Central	Early
Investment included and motoring maintained	-1.4	Balanced	Central	Central	Early

[1] *'Balanced' is the balanced net zero pathway*

Conclusions

3.139 Over the past year, we have seen how a pandemic and the policy measures necessary to bring it under control have changed our daily lives. We all hope that these changes will prove to have been temporary. Unmitigated global warming has the capacity to deliver catastrophic changes to lives and livelihoods – and would be essentially irreversible.

3.140 Twenty-four years on from the Kyoto climate agreements, global emissions have yet to peak and global temperatures have been rising unusually quickly. Against this backdrop, the 2015 Paris agreement, and the national targets flowing from it, are designed to limit further global warming and to mitigate against the worst of its effects. The UK is among 131 countries that now have in place or are considering net zero emissions targets. But even on more optimistic paths that assume policies come on stream for those targets to be met, some further warming, and some associated economic costs, can be expected – as well as some new growth opportunities. What might this mean for the UK's public finances?

- **Between now and 2050, the fiscal costs of reducing net emissions to zero in the UK could be significant but not exceptional.** The CCC puts the cumulative 30-year investment cost for the whole economy, plus the operating costs of removals, at £1.4 trillion in real terms, with our central variant assuming that the Government picks up around a quarter of that cost. When combined with savings from more energy-efficient buildings and vehicles, the net cost to the state is £344 billion in real terms. But spread across three decades, this represents an average of just 0.4 per cent of GDP in additional public spending each year. Factoring in the costs of lost fuel duty and other emissions-related revenues, and the fiscal impact of a modestly smaller economy, partly offset by the yield from taxing carbon more heavily, the fiscal impact of achieving net zero would add 21 per cent of GDP to public sector net debt in 2050-51 (£469 billion in today's terms). That would be somewhat less than the 23 per cent of

GDP (£520 billion in today's terms) rise between 2019-20 and 2021-22 that we expect as a result of the pandemic.

- **By international standards, the UK has made good progress in reducing emissions, but there are greater challenges ahead.** As of 2019, UK emissions were down 44 per cent relative to 1990. In particular, the source of power generation with the highest emissions – coal – has disappeared from the energy mix thanks to concerted policy efforts, notably the imposition of the 'carbon price floor' that taxed coal-fired power generation very heavily. Decarbonising other sectors will present many technological and delivery challenges. As regards technology, the challenge is perhaps greatest in removals – particularly the direct air capture variety that is not yet available at scale. As regards delivery, the challenge is perhaps greatest in domestic heating thanks to the need to upgrade insulation and replace gas boilers and other fossil-fuel heating systems in more than 28 million homes. This accounts for a fifth of whole economy investment costs – and the limited success of subsidy schemes introduced over the past decade suggests that cost is not the only challenge for policymakers to overcome.

- **The costs of failing to get climate change under control would be much larger than those of bringing emissions down to net zero.** Our stylised unmitigated warming scenario shows debt spiralling up to around 290 per cent of GDP thanks to the cost of adapting to an ever hotter climate and of more frequent and more costly economic shocks (as the spillovers from increased conflict and mass migration are added to the cost of more extreme weather events). Viewing the costs of achieving net zero in this context, it is clear the net benefits of a successful global response would be huge.

- **But the UK's direct contribution to reducing global emissions can only ever be small.** The UK accounted for just 1 per cent of global emissions in 2019, whereas China accounted for 24 per cent and the United States for 12 per cent. So, the fiscal risks from unmitigated global warming are largely beyond the UK Government's control (though the UK can influence others' mitigation efforts through its participation in global fora such as this year's 'COP26' UN climate change conference).

- **There could be significant fiscal benefits from transitioning to net zero sooner rather than later, not least the additional revenues that would come from taxing all emissions at higher rates.** Our early action scenario assumes that additional carbon tax revenues start in 2026-27 and the resulting revenues to 2050-51 are sufficient to cover the cost of the public investment to get to net zero more than twice over. Early publicly led action could also overcome the inertia that slows decarbonisation in some sectors. But it would come with risks too – such as backing the wrong technologies or paying more for the right ones than would be the case if global developments push costs down.

- **In the longer term, the largest fiscal cost of achieving net zero is the loss of fuel duty receipts.** In effect, this is a large and predictable tax cut on motoring – one that would, all else equal, increase congestion on the UK's roads. Maintaining the tax burden on motoring – as the Government has suggested it will need to do – would therefore address both the fiscal and congestion risks from this aspect of the transition.

3.141 Finally, while there is no uncertainty around the fact that climate change is happening or what drives it, there is considerable uncertainty around the precise path for global temperatures and their economic consequences, and the trends and policies that will influence the transition to net zero over the next three decades. Will policy settings in the UK and globally evolve to match the emissions targets that are being set? How quickly will technologies evolve and their costs fall? What will prove to be the right balance between taxing carbon and pulling other policy levers in incentivising decarbonisation? How effectively can the large-scale, multi-year processes involved in decarbonising millions of buildings and other infrastructure be managed? As understanding of these and other issues improves, the uncertainty around the fiscal risks from climate change should abate.

4 Cost of public debt

Introduction

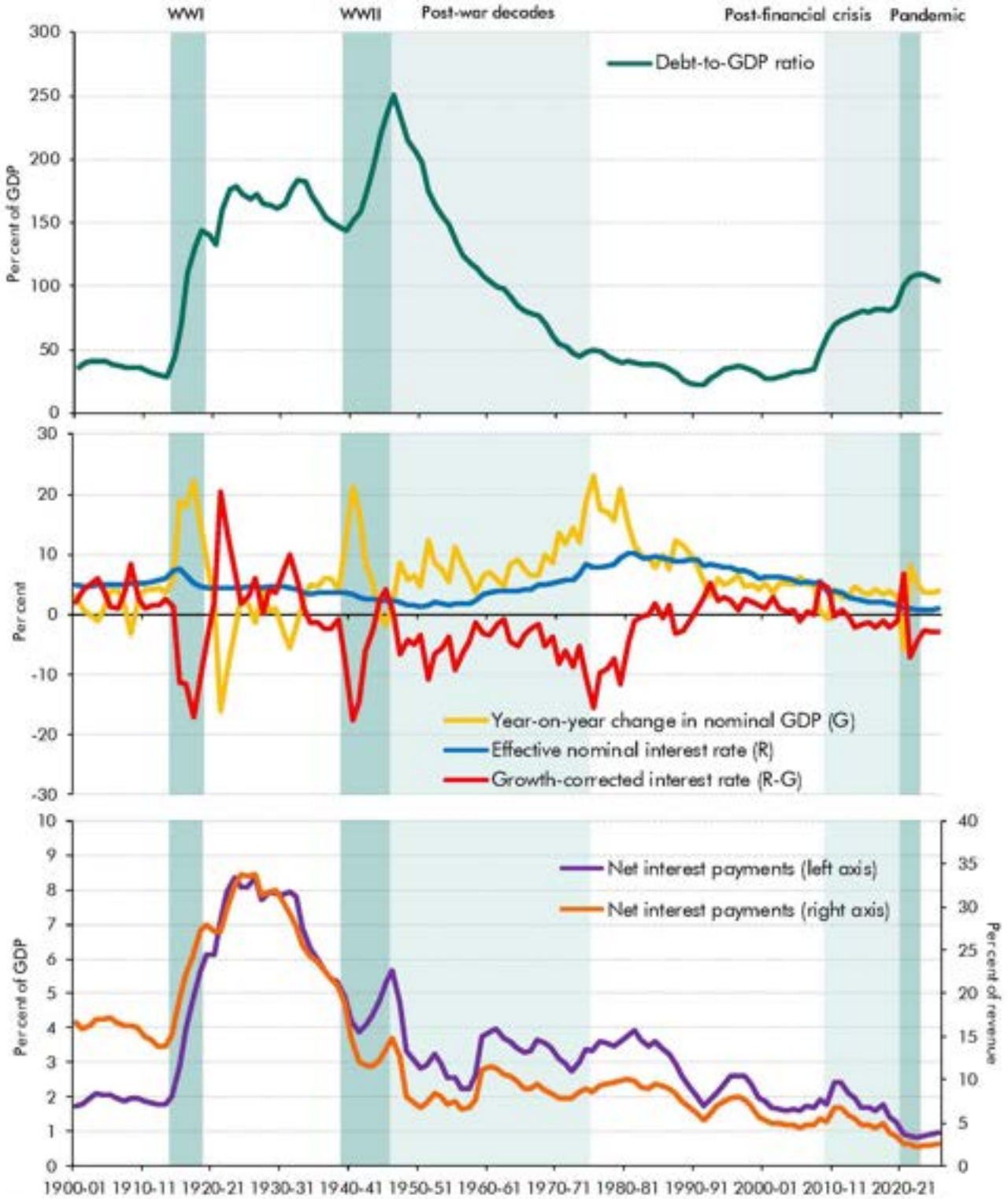
4.1 The stock of government debt is both the result of past fiscal risks crystallising and a source of future fiscal risks. As noted in the introduction to this *Fiscal risks report* (*FRR*), UK public sector net debt has almost quadrupled since the turn of the century, rising from 27 per cent of GDP in 2000-01 to an expected 107 per cent of GDP by the end of 2021-22.[1] This partly reflects discretionary decisions on the part of previous governments to run a looser fiscal policy in normal times, often justified as a means of increasing public investment, which has risen from 0.3 per cent of GDP in 2000-01 to 2.7 per cent of GDP this year. However, about two-thirds of that 80 per cent of GDP increase in debt occurred in the immediate aftermath of two major economic shocks: the 2008 financial crisis and the 2020 coronavirus pandemic.[2] The risks that this elevated stock of debt itself poses to the fiscal outlook depends in part on the future path of interest rates and the speed with which any change in interest rates is reflected in the public sector's financing costs.

4.2 Debt interest costs amounted to 4.1 per cent of total public spending in 2019-20, down from 9.8 per cent in 1980-81.[3] They fell to 2.1 per cent in 2020-21, as debt interest costs fell and fiscal support measures pushed spending up dramatically, but we expect them to remain at a historically low 3.0 per cent of spending in 2025-26 once the pandemic's effects have largely passed. Debt interest costs reflect the stock of debt in issue and the interest paid thereon, which tends to vary with the maturity of each debt instrument. The debt maturity structure also determines how quickly changes in market interest rates feed through to debt interest costs. The Government also receives interest on its financial assets, which is determined by similar factors. Over the past three decades net interest payments by the Government have fallen sharply as a share of GDP, from 3.8 per cent in 1980-81 to 0.9 per cent in 2020-21, despite the debt-to-GDP ratio rising sharply from 40.4 per cent to 100.2 per cent (Chart 4.1). This reflects the downward drift in short and long-term interest rates to historically low levels, both in absolute terms and relative to the growth rate of GDP, a phenomenon common to many advanced economies in recent years.

4.3 Despite this decline in interest rates and costs over recent decades, there is considerable uncertainty around their future path. And higher post-pandemic government debt, combined with a shortening of its effective maturity as a by-product of quantitative easing, leaves the UK's public finances more exposed to increases in government borrowing costs. Were rates to return to levels that were more normal in the past, it would raise the cost of servicing a given stock of debt and could – in extreme circumstances – push the debt-to-GDP ratio onto an unsustainable path.

[1] All figures for 2020-21 onwards used in this chapter are as forecast in our March 2021 *Economic and fiscal outlook*.
[2] Increase in the debt-to-GDP ratio in 2008-09 and 2009-10 for the financial crisis and in 2020-21 and 2021-22 for the pandemic.
[3] Measured as central government debt interest net of the Asset Purchase Facility as a percentage of total managed expenditure.

Chart 4.1: Debt to GDP, the growth-corrected interest rate and net interest payments



Notes: For all charts, 2020-21 onwards shows our March 2021 forecast. The debt-to-GDP ratio is PSND. The effective nominal interest rate is net interest payments divided by PSND. Net interest payments are interest payments less interest received. Revenue is net of interest receipts.
Source: Bank of England, ONS, OBR

4.4 Indeed, having fallen sharply at the onset of the pandemic, long-term interest rates have subsequently begun to rise as the successful rollout of effective vaccines has raised the prospect of a rapid re-normalisation of economic activity. Since the start of this year, UK Government 10-year bond yields have risen by around 0.6 percentage points. In part reflecting the particularly expansionary monetary and fiscal stance in the US, market participants have also increasingly focused on the risk of a reignition of inflation, although to date the rise in inflation expectations appears to have been much less here than in the US.[4]

4.5 Against this backdrop, in this chapter we cover:

- the **risks from high government debt and the dynamics of its evolution**, including the central role played by the 'growth-corrected' interest rate;
- **drivers of the recent fall in real interest rates** and implications for **future trends in government bond yields**;
- the **fiscal implications of a rise in global real interest rates**;
- the **fiscal implications of higher UK inflation**; and
- the **fiscal implications of a loss of investor confidence** in UK sovereign debt.

4.6 In the later parts of this chapter, we present several scenarios illustrating the consequences of assuming different paths for borrowing costs, inflation and GDP growth for the public finances. The purpose of these scenarios is to expose the mechanisms at work and the approximate quantitative magnitudes involved, rather than to provide precise modelling of specific events. In addition, although the risks are in most cases two-sided, we focus mainly on scenarios that lead to a deterioration in the public finances, as these would be likely to present greater challenges for the Government. The loss of investor confidence scenario illustrates the crystallisation of an extreme tail risk, in line with the focus of this report on such events.

Government debt risks and dynamics

4.7 Higher levels of debt expose governments to greater fiscal risks. Financing spending by borrowing rather than taxes enables governments to spread the burden of responding to shocks – such as wars, financial crises and pandemics – over time and thus share it with future generations of taxpayers. But the willingness of investors to hold a government's debt will depend on their confidence in its ability and willingness to undertake the fiscal actions necessary to meet its debt obligations as they fall due. Other things equal, the fiscal costs of meeting those obligations (and risk the Government might not be able to meet them) will be greater the higher the debt stock relative to the size of the economy. The willingness of investors to hold a given country's public debt will also depend on the attractiveness of

[4] Vlieghe, G., *What are government bond yields telling us about the economic outlook?*, Bank of England Speech 27 May 2021.

holding other assets, such as the debts of other countries' governments, corporate bonds, equities or real estate. So there will be a limit on the capacity of a government to borrow and high debt may constrain that government's willingness and ability to undertake desirable fiscal actions for fear of reaching this limit (see Box 1.1 for a discussion of 'fiscal space').

4.8 Well before that upper limit on borrowing is reached, however, investors are likely to become more concerned about the risk that the Government will fail to meet its obligations, through either outright default, artificial suppression of nominal interest rates via regulatory channels ('financial repression'), or reducing the real value of its debt obligations through higher inflation (where the country has its own currency in which its debt is denominated). The UK Government has never formally defaulted on its marketable debt, although there have been several 'conversions' used to reduce the associated interest payments.[5] Additionally *unanticipated* inflation did play a major role in reducing the burden of the UK's post-war debt, especially during the 1970s.

4.9 Investor concerns about outright default or future erosion of the real return on government debt may lead to a higher cost of borrowing.[6] In extremis, where investors lose confidence in the issuer's willingness or ability to service its debts, a government can face a total loss of access to finance (a 'sudden stop' or 'bond strike'). In these circumstances, more common to emerging markets and developing countries though not unknown in advanced economies, governments that cannot access sufficient emergency financing from bilateral or multilateral sources would need to cut spending and/or raise taxes sharply if they are to meet their debt obligations.

4.10 The higher a government's stock of debt, the more sensitive the public finances become to increases in interest rates. But the maturity structure of that debt is a crucial determinant of the speed at which higher interest rates feed through into higher interest costs, with shorter average maturities leading to faster pass-through. Debt levels and maturities can also interact, as heavily indebted governments may seek to shorten average maturities in order to take advantage of the typically upward sloping yield curve for government debt. In extreme circumstances, this can fuel a spiral of shortening maturities and growing sensitivity to further interest rate rises, eventually culminating in loss of market access or default.

4.11 Short of these cataclysmic events, higher government debt also appears to be associated with slower GDP growth over the long run. Most of the empirical evidence finds such an inverse relationship between government debt and GDP growth, although the quantitative magnitudes vary.[7] This could arise because the competition for funds drives up the cost of capital and reduces private investment ('financial crowding out') or because it leads to higher expected future taxes. The causality could also run in the other direction, with lower GDP growth leading countries to accumulate more debt.

[5] Ellison, M., and Scott, A., *Managing the UK National Debt 1694-2018*, American Economic Journal: Macroeconomics, 2020.
[6] See discussion of the impact of haircuts in sovereign restructurings on subsequent bond spreads in Cruces, J., and Trebesch, C., *Sovereign Defaults: The Price of Haircuts*, American Economic Journal: Macroeconomics, 2013.
[7] For example, see de Rugy, V., and Salmon, J., *Debt and Growth: A Decade of Studies*, Mercatus Center Policy Brief, April 2020.

4.12 So high debt is potentially a cause of concern, especially since the UK government debt-to-GDP has risen from the eighteenth highest amongst advanced economies in 2001 to the eighth highest in 2020.[8] Despite that, and as already noted, the cost of debt service has declined to historic lows as a result of the decline in the yields on government debt. To illustrate the dynamics involved, we start by noting that, in addition to the initial stock of debt, the identity describing the evolution of the debt-to-GDP ratio reflects three factors:[9]

- First, the size of the **primary balance** – the difference between government spending on everything except debt interest, and tax revenues and other receipts net of interest received by the Government.

- Second, the **'growth-corrected interest rate'** ('R-G') – the difference between the nominal interest rate paid on government debt (R), which pushes up the debt-to-GDP ratio, and the growth rate of nominal GDP (G), which reduces it. R is measured as net interest payments divided by the face value of the stock of government debt (i.e. the effective interest rate on that debt). R is thus the average interest rate that the Government pays on its stock of debt each period, rather than the interest rate prevailing in the market (which would represent the marginal cost of any new debt issued by the Government).

- Third, **stock-flow adjustments** – changes in debt unaccounted for by the primary balance or debt interest. These are usually the consequence of the net acquisition of financial assets, or of timing, classification and valuation effects.[10]

4.13 In this chapter, we focus on the UK's headline measure of public sector net debt (PSND) measured at face value – Box 4.1 discusses the measurement of government debt in more detail.

Box 4.1: Face and market value of debt securities in official statistics

The National Accounts framework recognises three possible ways of valuing government bonds:

- **market value**, which represents the amount the Government would have to pay to buy back the stock today;

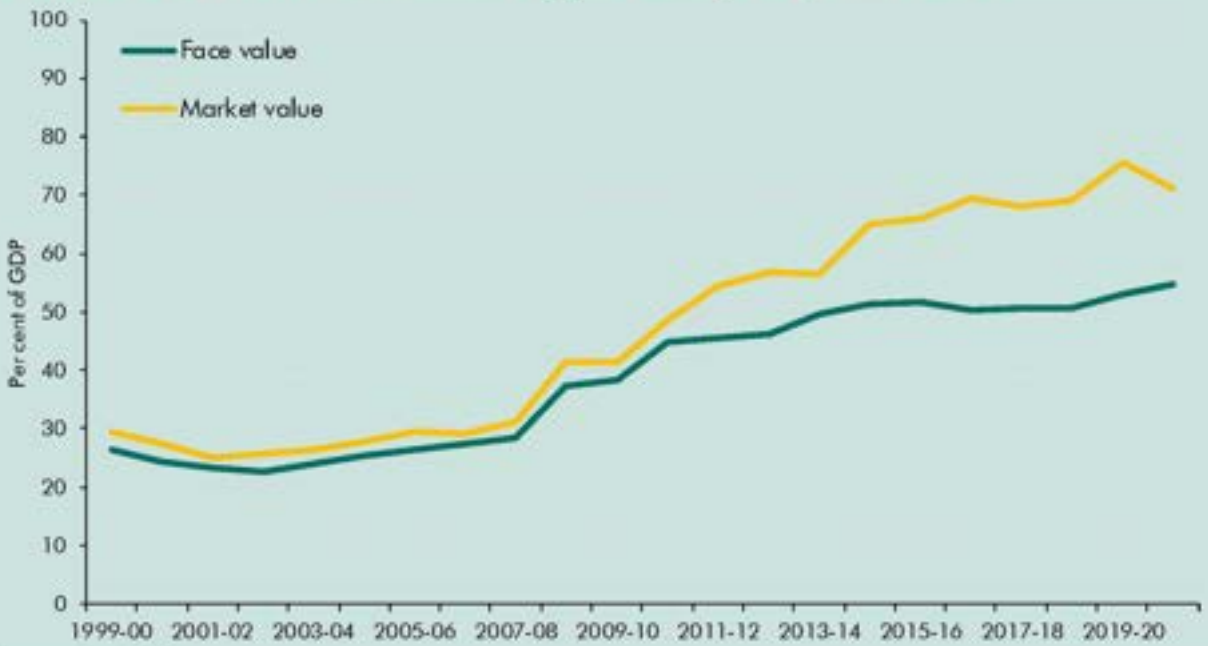
- **face (or redemption) value**, which is the amount that the Government has promised to pay to bond holders when the bonds mature; and

- **nominal value**, which is the original exchange value adjusted for any subsequent payments or accrued interest.

[8] Based on general government net debt to GDP ratios in 32 advanced economies for which the IMF provides data.
[9] This can be expressed as: $d_t - d_{t-1} = p_t + s_t + [(R_t - G_t)/(1 + G_t)]d_{t-1}$. The change in the debt-to-GDP ratio $(d_t - d_{t-1})$ is equal to the primary deficit (p_t), plus any stock-flow adjustments (s_t), plus the impact of any difference between the effective nominal interest rate (R_t) on the debt stock and nominal GDP growth (G_t).
[10] Examples of the former include loans issued to the private sector (the financing of which adds to debt but not the accrued deficit since they are matched by an asset). Examples of the latter include: the lag between tax liabilities being incurred and paid (which vary from tax to tax); changes to the public sector boundary that bring liabilities into or out of scope of measured public debt (as with reclassifications of housing associations in recent years); and currency movements that change the sterling value of the foreign exchange reserves.

Face or market value are most commonly used. In the past decade these two measures have diverged sharply, with the gap for gilts held by the private sector reaching about 15 per cent of GDP in 2020-21. Some of this has been caused by the increased stock of debt (since a given proportionate difference has increased when expressed as a share of GDP), but mainly it has been driven by declining yields and therefore increasing prices for government debt. This has increased the market value of the existing portfolio, while also affecting the price received for new debt issuance (particularly for index-linked gilts). The DMO prefers to issue new gilts with coupon payments close to market rates (that is close to 'par') and where this is possible the face value and market value at the time of issuance will be similar. However, as real interest rates are now negative, index-linked gilts would need to be issued with negative coupons to achieve a par price. This is not practicable and so prices for index-linked gilts are at a significant premium to par.

Chart A: Face versus market value of gilts held by the private sector



Source: ONS, OBR

The accounting identity that describes the evolution of the debt stock can be written in terms of either of these two debt valuations. The official measure of public sector net debt that we are charged with monitoring is measured at face value, so we use that definition in the analysis in this chapter. An alternative approach is to write the accounting identity in terms of market value, in which case the return on bonds includes not only coupon payments, but also capital gains or losses. This would be more suitable for some other purposes, such as evaluating the value for money of past debt issuance choices (which is beyond our remit). Papers by Hall and Sargent, and Scott and Ellison, provide a fuller discussion of the connection between the two approaches, as well as time series for US and UK government debt under the market value approach.[e]

Error! Reference source not found. Hall, G., and Sargent, T.J., *Interest rate risk and other determinants of post WWII U.S. government debt/GDP dynamics*, American Economic Journal: Macroeconomics, 2011, and Ellison, M. and Scott, A., *Managing the UK National Debt 1694-2018*, American Economic Journal: Macroeconomics, 2020.

4.14 The growth-corrected interest rate plays a particularly important role in debt dynamics and the analysis of debt sustainability. When the interest rate exceeds the rate of growth, extra debt incurred as a result of a temporary rise in the primary deficit must ultimately be paid for by higher taxes (or lower spending) in the future, otherwise the debt-to-GDP ratio will rise indefinitely. But, as recently pointed out by Blanchard, if the interest rate exceeds the rate of growth, the Government can pay for both the interest and principal by issuing more debt without triggering an upward spiral in the ratio of debt to GDP.[11] Blanchard also notes that the growth-corrected interest rate on US government debt has often been negative, including today and the recent past. Were that to continue to be the case, then the fiscal costs of extra debt would be negligible (though not necessarily the economic costs, as Blanchard explains).

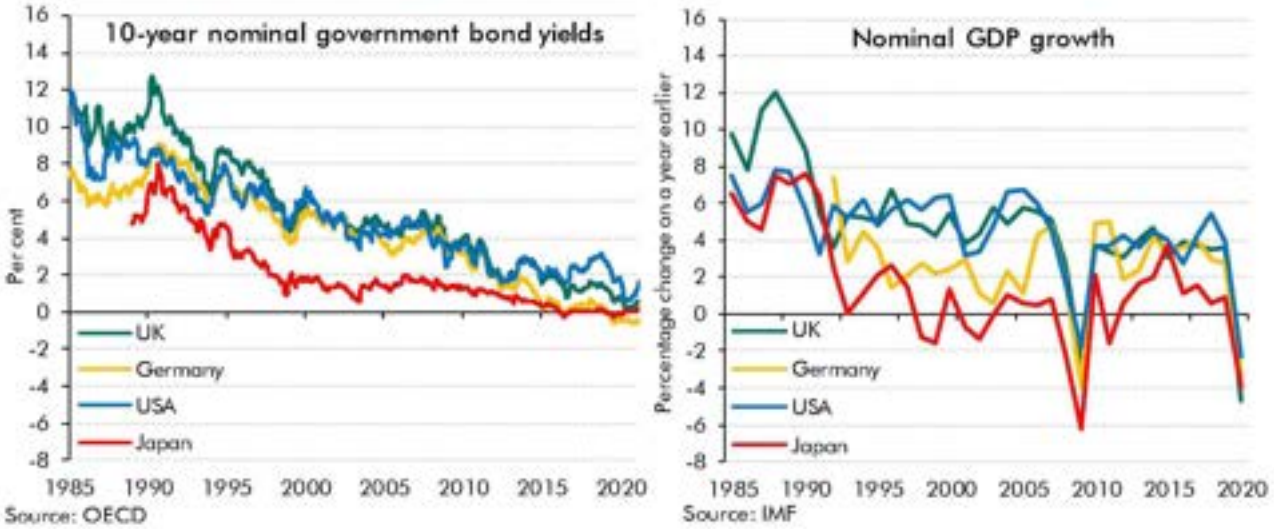
4.15 The growth-corrected interest rate paid on UK gilts has also been negative for much of the post-war period, including for most of the past decade, where the decline in yields since the 1990s has been greater than the fall in nominal GDP growth over that period (as shown in the middle panel of Chart 4.1 earlier in the chapter). This has led to historically low debt servicing costs for the Government, despite the debt-to-GDP ratio reaching its highest level since the early 1960s. Between 1997-98 and 2020-21, the effective interest rate on government debt has fallen from 7.2 per cent to 1.1 per cent.

Global interest rates

4.16 Whether the UK is likely to see continued low borrowing costs in future or a reversal depends in part on the factors driving down interest rates in the past. It is worth noting at the outset that the fall in interest rates on government debt is not just a UK but a global phenomenon, with long-term nominal government bond yields in all the major advanced economies drifting steadily downwards from an average of 9.0 per cent in 1990 to just 0.2 per cent in 2020 (Chart 4.2, left panel).[12] Other countries have also experienced falling nominal GDP growth, though not to the same extent as the fall in bond yields (right panel). The commonality in these movements strongly suggests that global factors, or domestic ones that are common across countries, have been at work.

[11] Blanchard, O., *Public debt and low interest rates*, American Economic Review, 2019.
[12] Unweighted average of nominal 10-year bond yields in Germany, USA, UK and Japan.

Chart 4.2: 10-year nominal government bond yields and nominal GDP growth



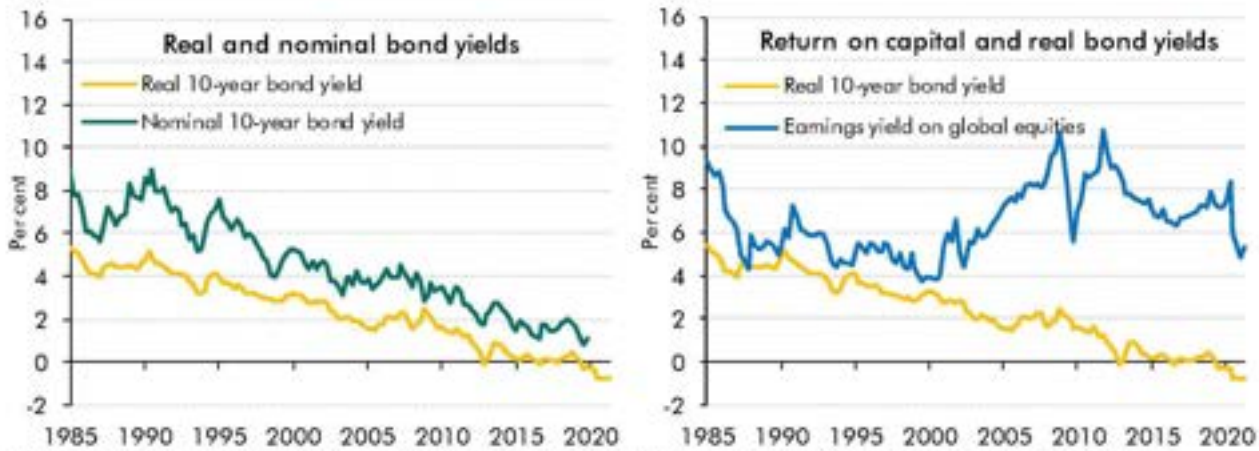
4.17 We can split nominal bond yields into the real bond yield plus inflation expectations. The left panel of Chart 4.3 shows nominal and real yields for high-quality government bonds (as represented by a weighted average across the US, eurozone, Japan and the UK), with the difference between them an indicator of expected inflation.[13] This suggests that although declining inflation expectations partly explain the fall in nominal rates from 1985 to the mid-1990s, the decline since then appears to have been primarily a *real*, rather than nominal, phenomenon.

4.18 At the same time, the return on capital (proxied by the yield on global equities in the right panel of Chart 4.3[14]) does not appear to have fallen in the same way as the real yields on high-quality government bonds. While they fell together during the 1980s and 1990s, the two have diverged since the turn of the century with equity yields rising (albeit with significant volatility around the financial crisis and the pandemic), whereas government bond yields have continued to fall.

[13] Where data are available, the nominal yield is on 10-year government bonds and the real yield is on 10-year inflation-linked government bonds for the US, Eurozone, Japan and UK. Where data on index-linked bonds are not available, the real yield is estimated using the relationship between variables that are available over a longer period (10-year nominal government bond yields and current and lagged inflation). To calculate the composite series, yields from each country are weighted by nominal GDP at current exchange rates. The difference between the two is not a perfect measure of expected inflation because illiquidity in the conventional and index-linked gilt markets could distort the measure, and in practice there will be an 'inflation risk premium' incorporated in the implied inflation rate.

[14] The earnings yield is calculated as π_{it}/V_{it}, where π_{it} is the earnings of all quoted companies gross of net interest payments and corporate tax in country i in the year to time t and V_{it} is the total market value of those companies including equity plus net debt.

Chart 4.3: Selected high-quality government bond yields and the return on capital



Note: The nominal and real 10-year bond yields are for the US, Eurozone, Japan and UK weighted by nominal GDP at current exchange rates. Countries are included in years where data is available.
Source: Daly, K., *A Secular Increase in the Equity Risk Premium*, International Finance, 2016 (Data extended to Q2 2021), OECD, OBR

4.19 So any explanation of the recent decline in government bond yields, and prospects for future reversal in this trend, needs to be compatible with three observations:

- First, that the fall in the nominal yields on government debt since the mid-1980s has been a persistent, global trend.
- Second, while falling inflation expectations following the stabilisation of inflation in part explains the fall in yields in the first part of the period, the declines since the mid-1990s appear to be largely a real phenomenon.
- And third, returns on riskier assets have not fallen in the same way, and indeed have on average risen, over the past two decades.

Box 4.2 describes a simple analytical framework to help understand this set of facts and how various factors are likely to affect the yields on high-quality bonds and on riskier assets such as capital.

Box 4.2: A simple analytical model of the capital market

To help explain the forces that have generated the movements in yields observed in recent decades, it is helpful first to construct a stylised model of the global capital market, shown in Figure A.[o] There are two assets: capital (K), whose real return is uncertain; and government bonds (B), whose real return is certain. In practice, of course, the return on government bonds will be uncertain too because of the possibility of default, either *de jure* or *de facto* through inflation, but for now it is helpful to put this to one side.

The overall supply of savings, or equivalently the demand for assets, (SS) that has to be held in one of these two forms derives from the need for households to provide for their retirement and to smooth consumption. It therefore depends on income, together with factors such as expected

longevity and retirement ages and whether there are unfunded pension schemes in place that affect the need for savings. It will also be affected by the expected real return on those savings, r_p, which is an appropriately weighted average of the expected real return on capital (r_K) and the real return on bonds (r_B). The supply of assets then derives from: the demand for capital by businesses for investment (II), which, in turn, depends on factors such as expected productivity and the required return on those funds, r_K; and the supply of bonds, which we take as exogenous. A possible equilibrium outcome is depicted in the left-hand panel of Figure A, which is shown assuming that savings increase as the rate of return on savings increases i.e. the SS curves slopes upwards (note that the analysis would be the same if SS sloped downwards so long as it is steeper than II).

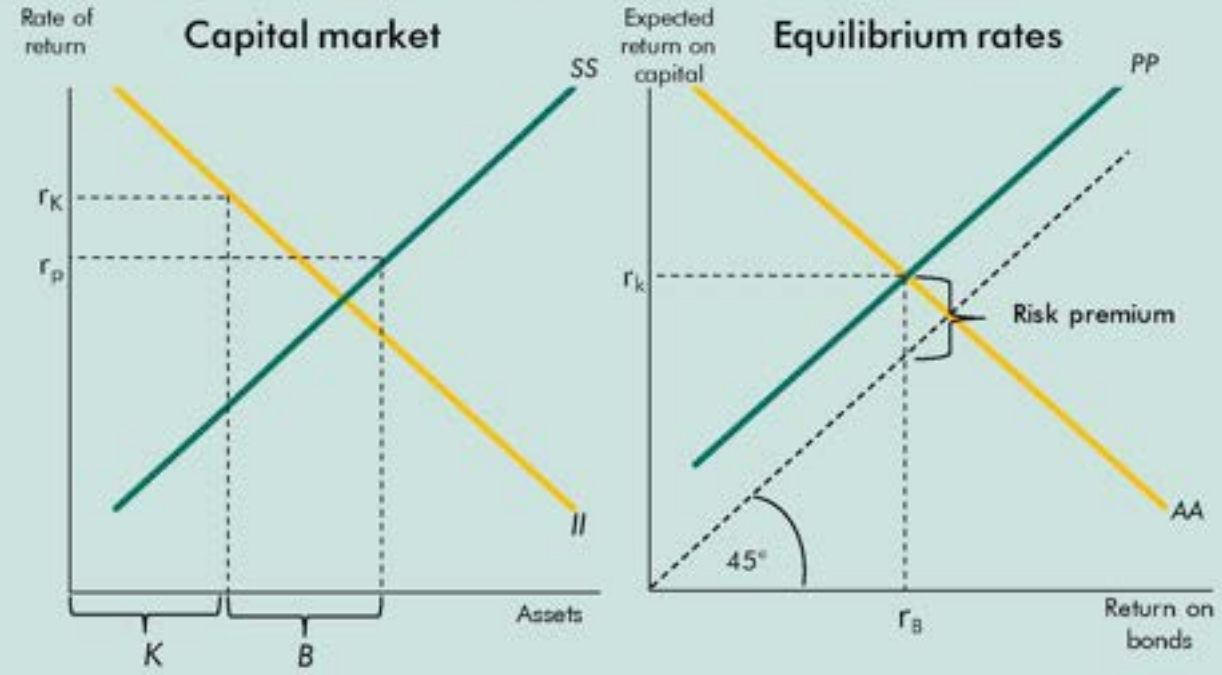
In order to see how the returns on risky and safe assets are related and move together, it is helpful to look at the right-hand panel of Figure A. The downward-sloping line AA shows the combinations of r_K and r_B that are consistent with *overall* asset market equilibrium (i.e. where the *total* supply of savings is equal to the *total* demand for them), other things equal. It slopes down because a lower required return on capital raises the demand for capital by businesses but also lowers the overall supply of savings. To bring forth the necessary extra savings, bonds would then need to offer a suitably higher return so that the overall expected return on the portfolio is sufficiently high to return the market to equilibrium.

We then need to supplement this with another, upward-sloping, relationship (PP) that shows the combinations of r_K and r_B that are consistent with portfolio equilibrium (i.e. that ensure the allocation of savings between risky and safe assets is consistent with investors' preferences and the respective supplies of each). In simple finance models, the spread of r_K over r_B, also known as the equity risk premium, depends just on the statistical properties of the returns on capital and the risk appetite of investors. But in arguably more realistic settings with incomplete markets and financial frictions, a greater range of factors may become relevant. In particular, government bonds may offer not only safety but also liquidity services – for instance, banks and other financial institutions can usually offer high-quality government debt as collateral for borrowing short-term funds from the central bank or other financial intermediaries. In such cases, the premium may also be affected by asset supplies; in particular, if bonds are already very plentiful the value of the extra liquidity services provided by additional issuance will be quite low.[b]

We can use this diagram to identify the sort of factors that are likely to have driven yields in recent years. In the 1990s, the yields on bonds and on capital fell together, roughly one-for-one. That is consistent with factors shifting the asset market equilibrium schedule AA inwards, so that r_K and r_B move along the portfolio equilibrium schedule PP in a south-westerly direction. Summers's 'secular stagnation' hypothesis, which focuses on a chronic tendency of savings to exceed investment, produces just such an outcome.[c]

Since the early 2000s, however, it appears that the return on capital has been edging up at the same time as bond yields have continued to decline, so that r_K and r_B have been moving in a north-westerly direction. To explain this, one needs to invoke upward shifts in the portfolio equilibrium schedule, PP, reflecting a shift in the demand and/or supply of assets in favour of safe assets and away from risky assets (it is possible, of course, that the AA schedule has at the same time continued to shift inwards).

Figure A: Determination of rates of return



[a] This is loosely based on the overlapping generations model discussed in Blanchard, O.J. *Public Debt and Low Interest Rates*, American Economic Review, 2019.
[b] For an analysis embodying these ideas, see Reis, R., *The constraint on public debt when r<g but g<m*, Centre for Economic Policy Research Discussion Paper, March 2021.
[c] Rachel, L. and Summers, L.H., *On falling neutral real rates, fiscal policy, and the risk of secular stagnation*, Brookings Papers on Economic Activity, 2019.

Explanations for the decline in real bond yields

4.20 Having established that the fall in interest rates on government debt over the past two decades is a global, real phenomenon distinct from returns on other assets, this section considers the potential explanations for the steady decline in real bond yields over time and, by implication, the potential for any reversals in these trends that could put the public finances under greater pressure. In particular, it considers the potential role of:

- **demographic trends** affecting both aggregate savings and preferences between safe and risky assets;
- **rising income inequality** concentrating wealth in the hands of those with higher propensities to save;
- **slower productivity growth**, which reduces businesses' desire to invest and raises household demand for savings;
- **falling prices for physical capital** reducing the funds necessary to purchase a given quantity of equipment;

- **increased risk awareness** raising the demand for safe assets; and
- **lower supply of safe assets**, in part reflecting changing investor perceptions of which assets offer a reliable store of value.

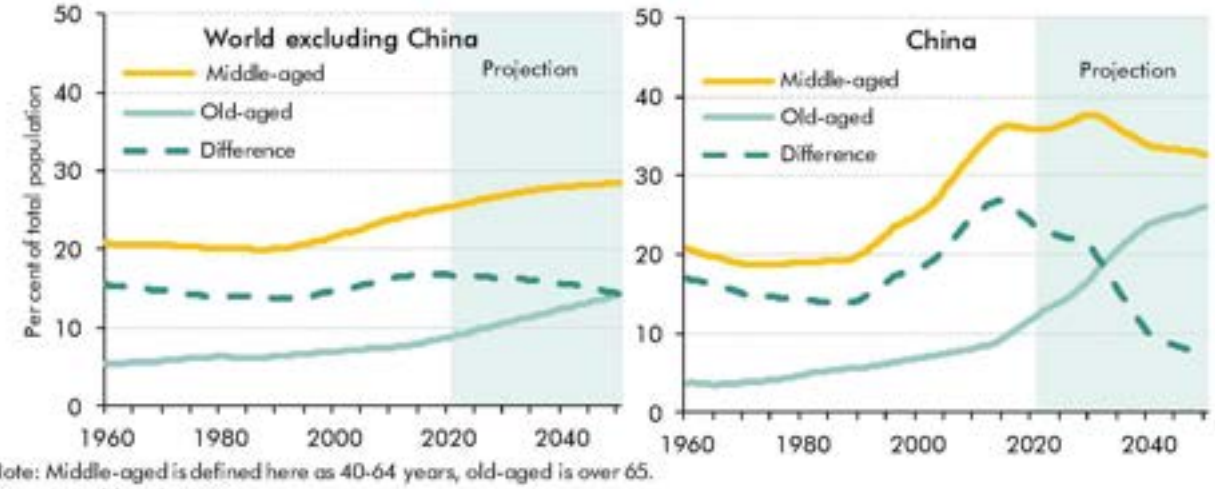
4.21 Throughout this section, we use the term 'safe' (or 'high-quality') to refer to assets where the risk of default is seen as negligible, such as high-quality government bonds. In practice, no asset can be completely safe and the real returns on nominal bonds will also be uncertain because of inflation. Moreover, safety is not an intrinsic feature of an asset but depends intimately on investors' beliefs about the creditworthiness of the debtor. Investors may collectively regard the bonds of a particular country as safe at one juncture, but later view them as distinctly risky (this was the case, for instance, for euro area periphery government debt during the financial crisis). We return to this issue in the final parts of the chapter.

Demographic trends

4.22 Rising life expectancy and declining fertility mean the world's population has been ageing and will continue to do so for many years. Assuming average retirement ages do not rise commensurately, that implies people will need to save more to fund more years spent in retirement. Typically, the bulk of such savings is made by those in the later part of their working lives, rather than by the young. Chart 4.4 shows the proportion of the global population aged 40 to 64 (who are likely to be doing the bulk of the saving) compared to the proportion of those aged 65 and over (who are more likely to be dissaving). The share of middle-aged people has been growing steadily since the late 1980s, reflecting in part the post-war 'baby boom', though those cohorts are now moving into retirement and will be starting to dissave. This trend has been particularly marked in China, which is shown separately,[15] but wider global demographic trends are likely to have played at least as important a role in boosting global savings over the past half-century. In addition, reduced fertility has lowered the growth of the working-age population which reduces the investment necessary to keep the labour force equipped. Taken together these demographic developments should have raised desired savings relative to desired investment (pushing 'AA' down in Figure A of Box 4.2), lowering the real yields on both bonds and capital.

[15] Bernanke, B. S. *The global saving glut and the U.S. current account deficit*, Sandridge Lecture, 2005.

Chart 4.4: Middle versus old-aged population globally and in China



Note: Middle-aged is defined here as 40-64 years, old-aged is over 65.
Source: World Bank, OBR

4.23 Demographic shifts could explain a general decline in yields and also appear to help explain the relative stability of the return on capital and its rising spread over bond yields. Many of those saving for retirement will be relatively risk-averse, while pension funds offering defined benefits will often be required to hold matching assets in the form of bonds. Moreover, those saving for retirement are frequently advised to steadily increase the proportion of their wealth held in bonds as they grow older. So demographic developments may have contributed to a shift in portfolio preferences towards bonds (an upward shift in PP in Figure A of Box 4.2), which reduces the yield on bonds and raises the yield on capital.

4.24 Looking to the future, the proportion of old-aged people is set to rise faster than middle-aged workers, reversing the trend since the 1990s (Chart 4.4). The implications of this for the real rate on bonds are, however, unclear. Goodhart and Pradhan argue that this demographic reversal will push up real interest rates as the dissaving of the elderly starts to dominate the saving of the middle-aged.[16] However, even if the overall rate of asset accumulation falls, retirees will only run down their assets over many years (and indeed rarely do so completely by the time they die), while also typically increasing the share held in safe forms. So the upward pressure on bond yields from this source is likely to take many years to materialise, though forward-looking investors may bring forward its effects.[17]

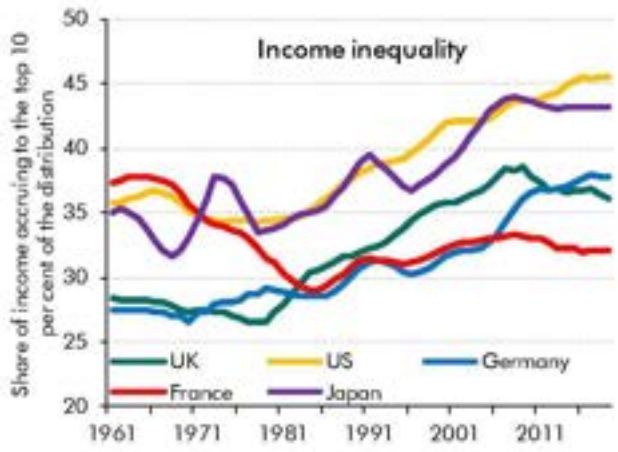
4.25 In summary, growing demand for safe assets from older workers may explain part of the fall in yields on government bonds in recent years. But it is not clear that rising numbers of retirees will lead to a rapid falling off in demand for government debt in the decades ahead. Indeed, as life expectancy increases and people spend longer in retirement, this could sustain demand for safer assets to fund their pensions. Therefore, the impact of continued ageing of the global population on government bond yields is, at best, uncertain and seems likely to take longer to materialise than some have suggested.

[16] Goodhart, C., and Pradhan, M., *The Great Demographic Reversal: Ageing Societies, Waning Inequality and an Inflation Revival*, 2020.
[17] See for example Auclert, A., Malmberg, H., Martenet, F., and Rognlie, M., *Demographics, Wealth, and Global Imbalances in the Twenty-First Century*, mimeo Stanford University, 2020.

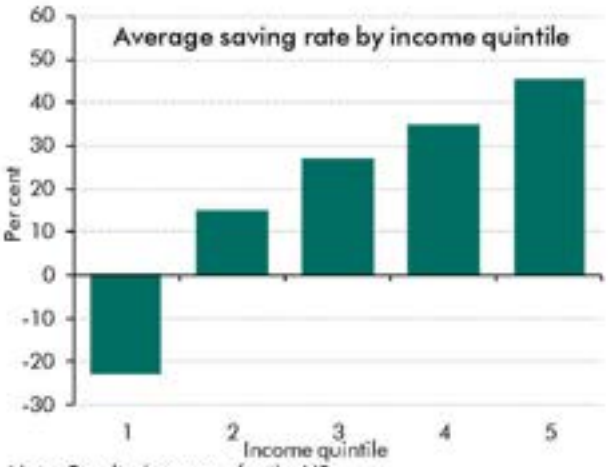
Rising income inequality

4.26 A second factor that may have contributed to higher savings and the decline in bond yields is increased inequality.[18] Since the early 1980s, many countries have seen an increase in the share of national income going to those with higher incomes. And since higher income households tend to save more of their income than the less well off, this raises demand for assets of all kinds (Chart 4.5). The reasons for the increase in income inequality are the subject of considerable debate, but possible explanations include technological change making it easier for 'superstar' individuals and firms to capture a market, the reduced influence of organised labour, the growing importance of higher education for future earnings, and changes in tax and benefit systems.[19] However, increased income inequality cannot easily account for the differential movement in the yields on bonds and capital since 2000, especially as one would expect wealthier households to have a greater appetite for holding higher risk assets. And trends toward greater inequality have moderated over the past decade at a time when government yields have continued to fall.

Chart 4.5: Income inequality and saving rates across the income distribution



Note: Chart shows rolling five year averages
Source: World Inequality Database



Note: Results shown are for the US
Source: Dynan et al (2004)

4.27 The outlook for inequality is uncertain. The benefits of technological change and automation may continue to accrue mainly to those on higher incomes. Against that, there is some evidence that the pandemic may have made people less tolerant of inequality,[20] which could manifest itself in more redistributive policy settings.

[18] See for example Auclert, A., and Rognlie, M., *Inequality and Aggregate Demand*, mimeo, 2020.
[19] See for example Dabla-Norris. E., Kochhar, K., Suphaphiphat, N., Ricka, F., and Tsounta, E., *Causes and Consequences of Income Inequality: A Global Perspective*, IMF Staff Discussion Note, 2015.
[20] Asaria, M., Costa-Font, J., and Cowell, F., *COVID-19 has made us more averse to both income and health inequalities*, 2021.

Slower productivity growth

4.28 Measured productivity growth has been weak in advanced economies since around the time of the financial crisis, with the slowdown being particularly marked in the UK.[21] Close examination of the data, particularly for the US, suggests that the slowdown predated the financial crisis, though it may have been aggravated by it.[22] A likely consequence of weaker productivity growth is a reduction in the propensity to invest by business. In addition, it will be associated with lower future incomes, raising households' incentive to save today. Together, these act to raise the supply of savings relative to the demand for funds to invest (so pushing AA down in Figure A of Box 4.2), lowering the yields on both bonds and capital. Indeed, in some simple theoretical settings, yields and the (expected) growth rate should move together one-for-one. This hypothesis fails, though, to provide an explanation for the disparate movements in the yields on bonds and capital since the early 2000s.

4.29 Looking ahead, views on the outlook for productivity growth differ. At the pessimistic end, Gordon argues that the past 250 years has been a period of unduly rapid growth based on three major general-purpose technologies (the steam engine; electricity and the internal combustion engine; and the digital revolution) that are now largely exhausted and that, together with a plateauing in educational attainment, the pace of innovation is likely to be permanently lower.[23] At the other end of the spectrum, Brynjolfsson and McAfee argue that the impact of the digital revolution is both underestimated in the official statistics and also still has a long way to run.[24] The central view embodied in our own *EFO*s and *FSR*s is for a gradual revival in UK productivity growth, although not to the historically high rates seen during the first part of the post-war period.[25] A gradual productivity revival would result in higher yields on bonds and capital (pushing AA up in Figure A of Box 4.2).

Falling relative price of capital goods

4.30 Another potential explanation for the decline in the demand for funds to invest is a falling relative price for capital goods, reflecting the faster productivity growth in manufacturing than in services and, more recently, in the information technology sector in particular.[26] This means any given investment project costs less, so the same investment volume can be achieved by absorbing a smaller share of nominal GDP. A lower cost of capital should also incentivise additional investments, so the net impact on desired investment depends on the elasticity of the demand for capital with respect to its price, but empirical estimates suggest the first effect dominates, so pushing down the net demand for funds to invest.[27]

4.31 Looking ahead, Eichengreen has argued that this downward trend in the relative price of capital goods may slacken as technological developments allow faster improvements in

[21] For a discussion on the reasons behind this fall see Goldin, I., Koutroumpis, P., Lafond, F., and Winkler, J., *Re-evaluating the sources of the recent productivity slowdown*, 2021.
[22] Antolin-Diaz, A., Drechsel, T., and Petrella, I., *Tracking the Slowdown in Long-run GDP Growth*, Review of Economics and Statistics, 2017.
[23] Gordon, R. J., *The Demise of US Economic Growth: Restatement, Rebuttal, and Reflections*, 2014.
[24] Brynjolfsson, E. and A. McAfee, *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*, Digital Frontier Press, 2011.
[25] See Annex B of our March 2020 *Economic and fiscal outlook* for a fuller discussion of this assumption.
[26] Karabarbounis, L., and Neiman, B., *The Global Decline of the Labour Share*, NBER working paper, 2014.
[27] See discussion in Thwaites, G., *Why are real interest rates so low? Secular stagnation and the relative price of investment goods*, Bank of England working paper, 2015.

consumption goods and services.[28] Consistent with this, the relative price of capital goods appears to have recently stabilised, although difficulties in capturing quality improvements in measures of the price of information technology goods remain.[29] But as with slower productivity growth, this hypothesis cannot explain the disparate movement in the yields on bonds and capital since the early 2000s.

Increased preference for safety

4.32 A more convincing explanation for the divergence in the yields on government bonds and capital since 2000 is a shift in investor preferences in favour of safer assets (i.e. an upward shift in the PP schedule in Figure A of Box 4.2). In particular, increased awareness of the risk of occasional large adverse shocks ('catastrophic risk') as a result of the financial crisis may have lowered investors' appetite for risk.[30] On top of that, tighter regulation since the financial crisis has required banks and other financial institutions to increase their holdings of safe assets. Coupled with changes in the relative supplies of risky and safe assets discussed below, this could explain falling yields on government bonds relative to riskier assets.

4.33 As far as the outlook goes, the coronavirus pandemic may have reinforced investor caution, though that may be mitigated somewhat by the very substantial insurance provided through the generous government support measures (see Chapter 2). One factor that may, however, disturb this is the capital losses that will crystallise if bond yields do start to rise. While high-quality government bonds such as US treasuries and UK gilts are most unlikely to default, their market value could still fall – and substantially so, given the current very low yields and correspondingly high market values. Once investors start to experience significant capital losses, there is a greater risk that they will take flight, pushing bond prices even lower and yields even higher. The 1994 bond market crash provides a salutary reminder of what can happen.[31] So one should not altogether discount the possibility of a sharp correction to bond yields (we return to this our final scenario – from paragraph 4.94).

Lower supply of high-quality assets

4.34 The outstanding stock of government debt in advanced economies has increased sharply over the past few decades, partly owing to the dual shocks of the financial crisis and the pandemic. This should have acted to counteract the increased demand for safe assets discussed above, limiting the downward pressure on bond yields.[32] However, two developments have offset that.

- First, the financial crisis led to a narrowing in the class of assets viewed as safe – in particular, both AAA-rated securitised mortgage debt and eurozone periphery government debt were shown to be far from safe.[33]

[28] Eichengreen, B., *Secular Stagnation: The Long View*, NBER working paper, 2015.
[29] See discussion in Rachel, L., and Smith, T., *Secular drivers of the global real interest rate*, Bank of England working paper, 2015.
[30] Barro, R., *Rare disasters and asset markets in the Twentieth Century*, Quarterly Journal of Economics, 2006, and Daly, K, *A secular increase in the risk premium*, International Finance, 2016.
[31] See short description in Mackenzie, M., *Markets: The ghosts of '94*, Financial Times, March 2013
[32] For example, see Rachel, L., and Summers, L., *On Falling Neutral Real Rates, Fiscal Policy, and the Risk of Secular Stagnation*, Brookings Papers on Economic Activity, 2019.
[33] Caballero, R. J., Farhi, E. and Gourinchas, P-O., *The Safe Assets Shortage Conundrum*, Journal of Economic Perspectives, 2017.

- Second, purchases of bonds by central banks have limited the quantity of safe assets available to the non-bank private sector. Prior to the financial crisis, these purchases largely consisted of reserve accumulation by emerging market central banks. But since the financial crisis, quantitative easing by advanced economy central banks has absorbed much of the new issuance of government bonds – as of the final quarter of 2020, domestic central banks owned 26 per cent of general government debt in the seven countries shown in Chart 4.6. Indeed, net of domestic central bank and foreign official sector holdings, the supply of high-quality government bonds in private sector hands has remained relatively constant as a share of global GDP, despite the large increase in issuance by advanced economy governments. Absent these purchases by the official sector, long-term interest rates would surely have been somewhat higher.

Chart 4.6: Holdings of selected high-quality government debt

Note: General government debt for Australia, Canada, France, Germany, Japan, UK and USA
Source: IMF

4.35 As far as the outlook goes, this depends on not only future fiscal policies but also the evolution of monetary policies. Fiscal policy across advanced economies has been dramatically loosened to protect households and firms from the effects of the pandemic. Governments in the US and elsewhere are contemplating further rounds of significant fiscal stimulus to fuel the post-pandemic recovery. As output recovers and inflation pressures start to build, central banks are likely to begin tightening monetary policy, including running down some of their asset holdings, which all else equal would put upward pressure on government bond yields. This could happen organically as bonds are not replaced when they mature or through active sales programmes. But either way, the unwinding seems likely to progress slowly.

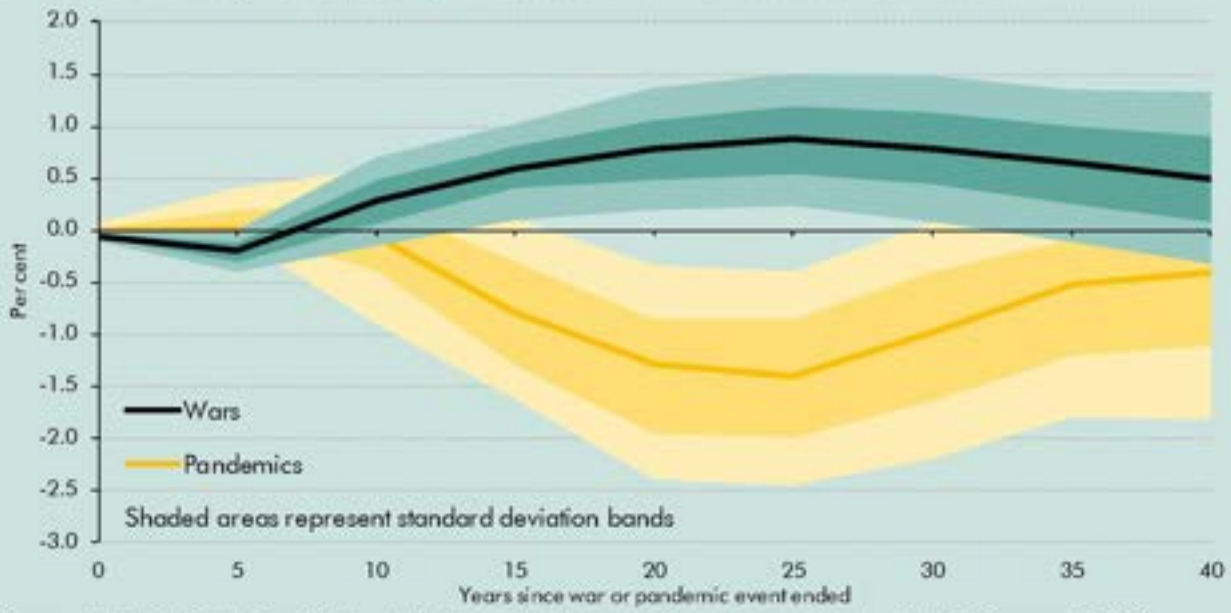
Box 4.3: The impact of the pandemic on real interest rates

Will the shock to the economy and public finances associated with the coronavirus pandemic have any long-run impact on real interest rates? Jordà, Singh and Taylor (2020)[a] find that past pandemics have indeed had long-lasting effects. Using European[b] data stretching back to the fourteenth century, they find that 20 years after a pandemic, the real interest rate was on average around 1.5 percentage points lower (Chart B) and took around four decades to return to pre-pandemic levels. However, the impact of pandemics on the real interest rate in the UK was rather less (a decline of just 0.25 percentage points after 20 years).

The likely source of this effect is the fall in the labour force as a result of a higher number of deaths, leaving a higher capital-labour ratio and a lower incentive to invest. That could be augmented by increased savings by survivors.

This contrasts with the impact of wars, after which real interest rates have typically risen. That most probably reflects the destruction of capital that typically occurs (especially in the wars of the twentieth century) generating a post-war need to rebuild. In addition, governments have often borrowed in order to fight wars, putting further upward pressure on interest rates.

Chart B: The impact of past pandemics and wars on interest rates



Source: Jordà, O., Singh, S. and Taylor, A. M., *Longer-Run Economic Consequences of Pandemics*, Covid Economics, 2020.

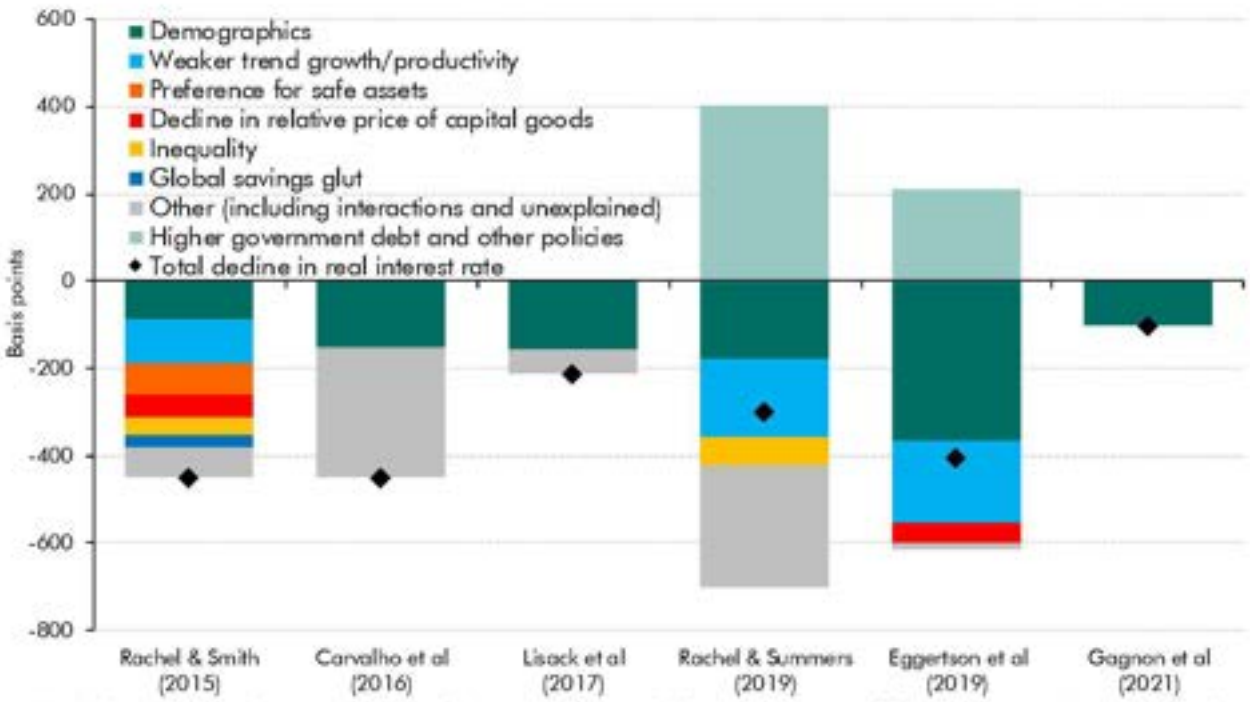
There are, however, reasons to think that the consequences of the coronavirus pandemic could be different to previous pandemics. First, this pandemic has had only a limited effect on the labour force, with total deaths being lower and more concentrated among the elderly. Second, the large rise in borrowing accompanying this pandemic has been more like past wartime episodes. That said, the response to the pandemic has largely filled the hole left by the contraction in private sector spending, which is different from a war when fiscal expansions for war spending and subsequent reconstruction place more pressure on available resources.[c]

[a] Jordà, O., Singh, S. and Taylor, A. M., *Longer-Run Economic Consequences of Pandemics*, Covid Economics, April 2020.
[b] Data for France, Germany, the Netherlands, Italy, Spain and the UK.
[c] Hatzius, J., Daly, K., Struyven, D., Bhushan, S., and Milo, D., *Inflation in the Aftermath of Wars and Pandemics*, Goldman Sachs Economics Research, March 2021.

Conclusions

4.36 The causes of the fall in global real interest rates have attracted much attention, but there is no clear consensus in the literature about their relative importance. Chart 4.7 shows results from several studies that have looked at the causes of falling global interest rates. Differing time periods and definitions of the real interest rate mean that the size of the fall to be explained varies across studies. But separate from that, it is clear that there is no consensus on the relative importance of the different potential causes. Demography and falling productivity figure most consistently in empirical studies. Since 2000, the shift in preferences towards safer assets is likely to have been a factor pushing government bond yields below returns on riskier assets, while purchases by central banks have helped to offset the upward pressure coming from higher bond issuance. Other factors are likely to have played a part too, though their precise contribution remains uncertain. This uncertainty is amplified by longer-run studies such as that by Borio, Disyatat, Juselius and Rungcharoenkitkul who find no robust relationship between real interest rates and any of the factors discussed above.[34]

Chart 4.7: Decomposition of the fall in global real interest rates



Note: The results of each paper are not directly comparable as not all cover the same set of factors. The exact time periods and geographical areas covered by each paper also vary.
Source: Rachel, L., and Smith, T., *Secular drivers of the global real interest rate*, Bank of England Working Paper, 2015; Carvalho, C., Ferrero, A., and Nechio, F., *Demographics and real interest rates: Inspecting the mechanism*, Federal Reserve Bank of San Francisco Working Paper, 2016; Lisack, N., Sajedi, R., and Thwaites, G., *Demographic trends and the real interest rate*, Bank of England Working Paper, 2017; Rachel, L., and Summers, L., *On falling neutral real rates, fiscal policy, and the risk of secular stagnation*, Brookings Papers on Economic Activity, 2019; Eggertsson, G., Mehrotra, N., and Robbins, J., *A model of secular stagnation: Theory and quantitative evaluation*, American Economic Journal: Macroeconomics, 2019; Gagnon, E., Johannsen, B., and Lopez-Salido, D., *Understanding the new normal: The role of demographics*, IMF Economic Review, 2021.

[34] Borio, C., Disyatat, P., Juselius, M., and Rungcharoenkitkul, P., *Why so low for so long? A long-term view of real interest rates*, BIS Working Paper 685, 2017.

4.37 Uncertainty about the factors driving real interest rates in the past necessarily carries over into the future. As already indicated, many of the potential drivers will continue to be in place over the foreseeable future, though some may at least partly reverse. The factors driving the balance between savings and investment (i.e. shifting the AA schedule in Figure A of Box 4.2) represent mostly slow moving forces, such as demographics, which would reverse and push real interest rates up only gradually. But there is perhaps scope for sharper changes to occur due to changes in portfolio preferences (i.e. the PP schedule) or monetary policy decisions.

4.38 Market expectations currently show a very gradual rise in real interest rates, with the level remaining low historically, and this would allow the Government to continue to finance its debt relatively cheaply. In our March 2021 *EFO*, we used market expectations for interest rates on 5 February and, since then, the yield curve has risen as the economic outlook has improved. Beyond 2025-26, the 'long-term economic determinants' used on our fiscal sustainability analysis assume that interest rates continue to rise to the point where they exceed GDP growth rates by a small margin, taking the average gilt rate and Bank Rate to steady-state levels of around 4 per cent.[35] Given the uncertainty over the future path of real interest rates, the remainder of the chapter explores how different scenarios for the evolution of real interest rates would impact the UK public finances. We do this relative to a baseline that is consistent with market expectations over the long term, since our long-term economic determinants already assume that real rates revert to somewhat higher levels than is priced into markets (and is in fact similar to our second scenario below).

The fiscal impact of higher global real interest rates

4.39 This section explores the fiscal implications of higher interest rates resulting from a rise in global *real* interest rates (higher rates associated with higher inflation are discussed later). Our focus is on the risk of higher, rather than lower, global interest rates, as this would be more challenging for the Government to deal with. But it is worth noting that a further fall in global real rates would present challenges of a different sort, particularly if it were accompanied by disappointing productivity growth that weighed on the outlook for tax receipts. In this world, the scope for monetary policy to support aggregate demand would remain constrained by the proximity of the effective lower bound on Bank Rate, while the efficacy of asset purchases in boosting demand is debatable when short- and long-term rates are already so low.[36] Fiscal policy would in this case need to be used even more actively, placing more value on having sufficient fiscal space in reserve. Fortunately, the continuation of low financing costs would also help preserve the fiscal space available.

The sensitivity of the public finances to interest rate changes

4.40 Before describing our scenarios, it is worth noting that the public finances are more sensitive to a rise in interest rates than in the past as a result of the increase in the debt-to-GDP ratio from the financial crisis and now the pandemic, which together have returned it to levels last

[35] Most recently updated on 5 May 2021 on our website.
[36] Vlieghe, G., *Monetary policy and the Bank of England's balance sheet*, Bank of England, 23 April 2020.

seen in the early 1960s. In addition, by replacing longer-dated gilts with reserves that pay Bank Rate, a by-product of quantitative easing has been to shorten the effective maturity of consolidated public sector liabilities (i.e. consolidating all government debt and the Bank of England's Asset Purchase Facility (APF)), so that the pass-through of changes in interest rates happens faster (see Box 4.5, and also Box 4.1 in our March 2021 *EFO*).[37]

4.41 This greater sensitivity is illustrated in the left-hand panel of Chart 4.8. The total impact as a share of GDP from a 1 percentage point rise in interest rates (that is the impact when all the debt stock has moved to the higher rate) increases sharply during the financial crisis and again in 2020 reflecting the increases in debt in those periods. The overall sensitivity in 2020 is three times that in 1998 (since the debt-to-GDP ratio has trebled from 33.9 to 100.2 per cent). The faster pace at which the increase passes through the debt stock is illustrated by the proportion that responds in less than one year (proxied here by the stock of Bank reserves used to buy gilts, Treasury bills, NS&I products and gilts with a residual maturity of less than one year). The one-year impact was less than 0.1 per cent of GDP in the decade up to 2008 but had risen nearly six-fold to over 0.5 per cent of GDP by the end of 2020. More than half of this rise in the short-run sensitivity has come about as a by-product of quantitative easing (since it has more than doubled the proportion of the much higher debt that responds to interest rate changes within a year).

4.42 Commentators often employ the simple average (or mean) maturity of gilts as a summary indicator of the speed of pass-through. This has risen from 10 to 15 years over this period (the green line in the right-hand panel of Chart 4.8). But this offers a misleading picture of the speed of pass-through of interest rate changes, and thus the immediacy of the fiscal risks they pose, for three reasons:

- First, it ignores **other forms of debt issued by central government** that have shorter maturities, including Treasury bills and NS&I products. Taking these into account shortens the mean maturity of this wider measure of debt to 13 years in 2020.

- Second, **one-third of the stock of gilts is now held in the Bank of England's APF**, financed by a corresponding issuance of central bank reserves that instead pay Bank Rate which can change overnight (as explained in Box 4.1 of our March 2021 *EFO*). This further reduces the mean maturity of the consolidated liabilities of the public sector in 2020 to nine years.

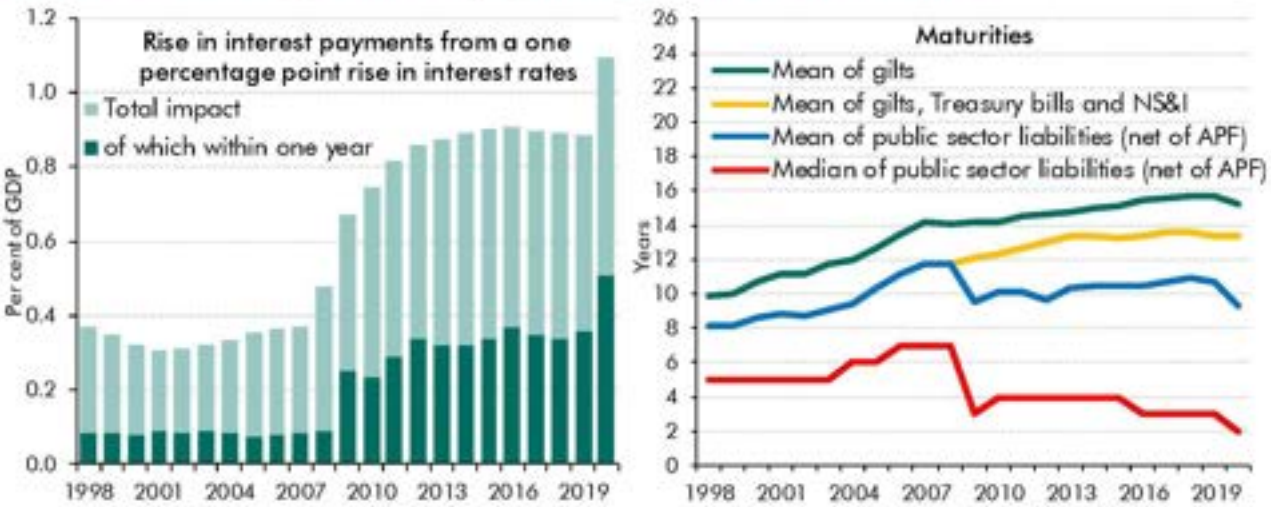
- Third, the mean maturity is itself a misleading guide to the speed of pass-through of interest rate changes into the public finances. That is because **the mean can be skewed by the presence of a relatively small volume of very long maturity bonds**. This is the case for the UK, where 27 per cent of outstanding gilts held by the private sector have a maturity of over 15 years. But the median maturity of the consolidated liabilities of the public sector is in fact only about two years at the end of 2020, while 45 per cent of the liabilities have an effective maturity of less than one year. As a result, much of

[37] It is also worth noting that because reserves do not have to be rolled over – they are effectively floating rate perpetuities – this shortening of effective maturity in terms of the speed of interest rate pass-through is accompanied by reduced, rather than increased, refinancing risk.

the impact of higher interest rates on the public finances now actually comes through quite rapidly.

4.43 The median maturity of these consolidated public sector liabilities is therefore a more suitable summary measure when considering the short-term fiscal risks posed by interest rate changes (the red line in Chart 4.8), as it represents a direct measure of the time it takes for half of the full effect of a rise in rates to be feed through to interest payments.

Chart 4.8: Sensitivity of interest payments to a rise in interest rates



Note: Consolidated public sector liabilities are proxied here by the stock of Bank reserves, Treasury bills, NS&I products and gilts net of those held in the APF. The total impact of a one percentage point rise in interest rates is on consolidated public sector liabilities. The impact within one year is on liabilities with a maturity of less than 1 year (gilts net of APF holdings with a remaining maturity of under one year, Bank reserves, Treasury bills and NS&I). The median shows the year in which half of the outstanding public sector liabilities would be impacted by a change in interest rates.
Source: Bank of England, Heriot-Watt/Faculty and Institute of Actuaries Gilt Database, ONS, OBR

Baseline assumptions

4.44 Turning to how this affects our scenarios for real interest rates, our baseline assumes a profile for interest rates similar to that anticipated by market participants at the time of our March 2021 *EFO*. Both the baseline and the scenarios extend to 2050-51 in order to allow us to evaluate the medium- and long-term implications of higher interest rates. The key assumptions in the baseline are as follows:[38]

- **Nominal GDP** follows our medium-term forecast from the March 2021 *EFO* and is constant at 3.9 per cent thereafter (in line with the average rate in steady state in our long-term economic assumptions).
- **CPI inflation** follows our March forecast up to 2025-26 and is constant at the 2 per cent target thereafter.[39]

[38] An additional assumption relates to stock-flow adjustments (changes in debt not accounted for by the primary balance or debt interest), which follow our March 2021 *EFO* forecast to 2025-26. Part of this adjustment comes from the rundown of the Bank of England's Term Funding Scheme. After 2025-26, we assume the scheme is run down over five years. We assume other stock-flow adjustments are 0.7 per cent of GDP in each year after 2025-26, in line with the later years of our March forecast.
[39] For simplicity, we assume that the GDP deflator, RPI, CPI all move together in the scenarios.

- The **primary balance** follows our medium-term forecast from the March 2021 *EFO* to 2025-26. After this, spending and receipts remain a constant share of GDP, which means the primary deficit remains at 1.8 per cent of GDP. (This abstracts from pressures due to ageing and other factors that are covered in the *FSR*s).

- **Bank Rate** rises in line with our March forecast, based on market expectations on 5 February. Beyond 2029-30, Bank Rate remains constant at 1.1 per cent, which is assumed to be consistent with the underlying equilibrium real interest rate in the baseline and with meeting the inflation target.

- The **average gilt rate**[40] increases in line with our March forecast and remains at 1.3 per cent from 2029-30 onwards. We assume that 7 per cent of gilts are refinanced each year (in line with the average between 2020-21 and 2025-26), which means any changes in average gilt rates feed through gradually to the Government's effective interest rate. For simplicity, we assume that all new government debt issued is in the form of gilts (88 per cent in conventional gilts and 12 per cent in index-linked gilts in line with the financing assumption in our March 2021 *EFO*)[41].

- The **APF** follows our March forecast and thereafter the stock of reserves is kept constant in nominal terms, paying the prevailing Bank Rate in interest costs.

- For **other interest payments and receipts**, such as Treasury bills and NS&I products, interest rates are assumed to move in line with either Bank Rate or the average gilt rate.

Alternative global real interest rate scenarios

4.45 We consider two alternative scenarios in which interest rates rise as a result of higher global real interest rates. Reflecting our earlier discussion of the outlook for global real rates, this rise is assumed to happen relatively slowly:

- In our **first scenario ('higher R and G')**, real interest rates and real GDP growth rise in tandem, for instance reflecting a recovery in productivity growth.

- In our **second scenario ('higher R')**, the interest rate rises without a corresponding rise in growth, for instance reflecting a shift in portfolio preferences away from bonds. This scenario is broadly in line with the assumptions in our 'long-term economic determinants' that underpin our fiscal sustainability analysis.

4.46 In both cases, the Bank of England is assumed to correctly diagnose what is happening and so raises Bank Rate in line, leaving inflation totally unaffected. Both scenarios also assume that there is no change in the size of the APF (Box 4.5 discusses the different pressures that could arise if the Bank opted to run it down). For the first two years of each scenario, we

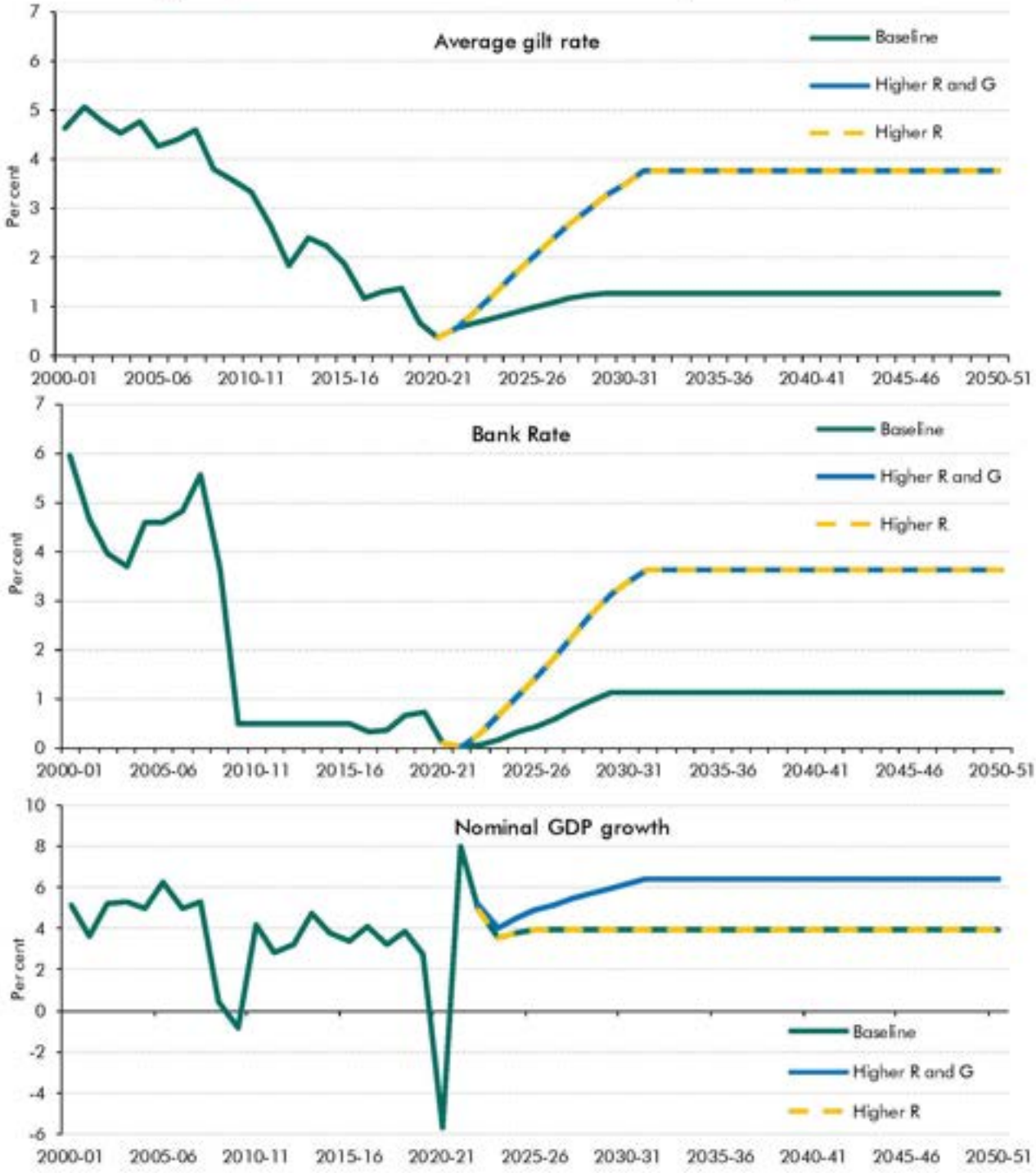
[40] This is the marginal cost of new gilt issuance. It is the weighted average of yields across all maturities.
[41] We assume that new gilts are issued with coupons such that they are sold at par.

also assume that non-welfare spending is fixed in cash terms and receipts move by more than any change in nominal GDP (due to fiscal drag), but beyond that public spending and receipts move one-for-one with nominal GDP. This allows us to highlight the mechanics through which higher interest rates affect the public finances. The specific assumptions for the path of R and G in the two scenarios are shown in Chart 4.9 and summarised below:

- In the **higher R and G** scenario, average gilt rates and Bank Rate gradually rise above the baseline over the next decade to settle 2.5 percentage points higher. This reverses approximately half of the fall in long-term bond yields over the past 20 years. But in historical terms, gilt rates and Bank Rate still finish at relatively low levels, at 3.8 and 3.6 per cent respectively. Real GDP growth rises in line with real interest rates, reaching 2.5 percentage points above our baseline by 2032-33. This would represent a large pick-up in real GDP growth to a rate last seen in the late 1980s. Inflation is unchanged, so nominal GDP growth rises in line with real GDP growth.

- In the **higher R** scenario, we assume the same increase in interest rates as in the first scenario but leave real and nominal GDP growth unchanged from the baseline.

Chart 4.9: Higher global real interest rate scenarios: key assumptions



Note: Average gilt rate is the average yield of gilt issuance before 2012-13
Source: Bank of England, DMO, ONS, OBR

4.47 Chart 4.10 shows the fiscal results from these two scenarios. In interpreting these it is important to note that in the **higher R and G** scenario, the growth-corrected interest rate falls somewhat rather than remaining unchanged. This is because, while the growth rate increases immediately, it takes time for higher market interest rates to feed through to the

average interest rate paid on all the Government's debt. Over time the growth-corrected interest rate then converges back to that in the baseline.

4.48 Borrowing rises compared to the baseline, reaching 5.1 per cent of GDP in 2050-51 compared to 2.9 per cent in the baseline. There is a small initial benefit to primary borrowing from the impact of fiscal drag on tax revenues and our assumption that non-welfare spending is fixed in cash terms for two years. But thereafter we assume the Government spends the proceeds of stronger nominal GDP growth so primary borrowing returns to the same level as in the baseline. Borrowing instead increases on the back of higher net interest payments, which by 2050-51 are more than three times the 1.0 per cent of GDP in the baseline, reaching 3.3 per cent of GDP – a level last seen in 1985-86. Interest costs as a proportion of revenue are more than three times higher, reaching 8.6 per cent in 2050-51 compared to 2.7 per cent in the baseline.

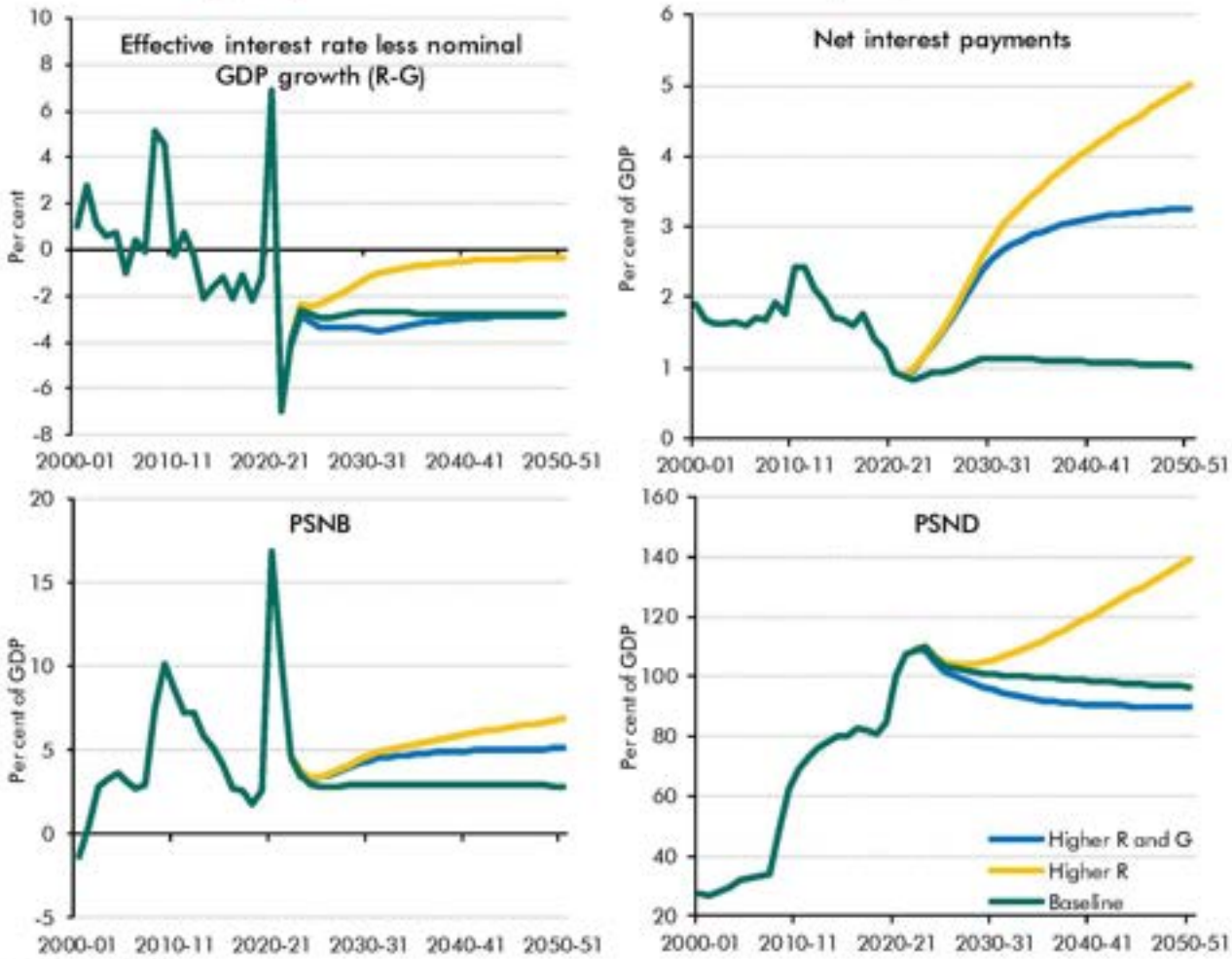
4.49 Throughout the scenario, and despite higher borrowing, the debt-to-GDP ratio is lower than in the baseline, primarily due to the more favourable growth-corrected interest rate. By 2050-51, PSND is 6.4 per cent of GDP below baseline. However, the debt-to-GDP ratio does not return to its pre-pandemic level by the end of the scenario.

4.50 In the **higher R** scenario, nominal GDP growth is unchanged but the higher Bank Rate and average gilt rate rapidly feed through to the effective interest rate the Government pays on its debt. The growth-corrected interest rate therefore rises compared to the baseline, although not quite enough to push it into positive territory (Chart 4.10).

4.51 Higher interest rates mean that net interest payments are five times higher than the baseline at 5.0 per cent of GDP in 2050-51. Net interest payments as a proportion of revenue rise from 2.7 in the baseline to 13.2 per cent by the end of the scenario, their highest since 1946-47. Higher spending on interest payments pushes borrowing above the baseline throughout the scenario, reaching 6.8 per cent of GDP in 2050-51 compared to 2.9 per cent in the baseline.

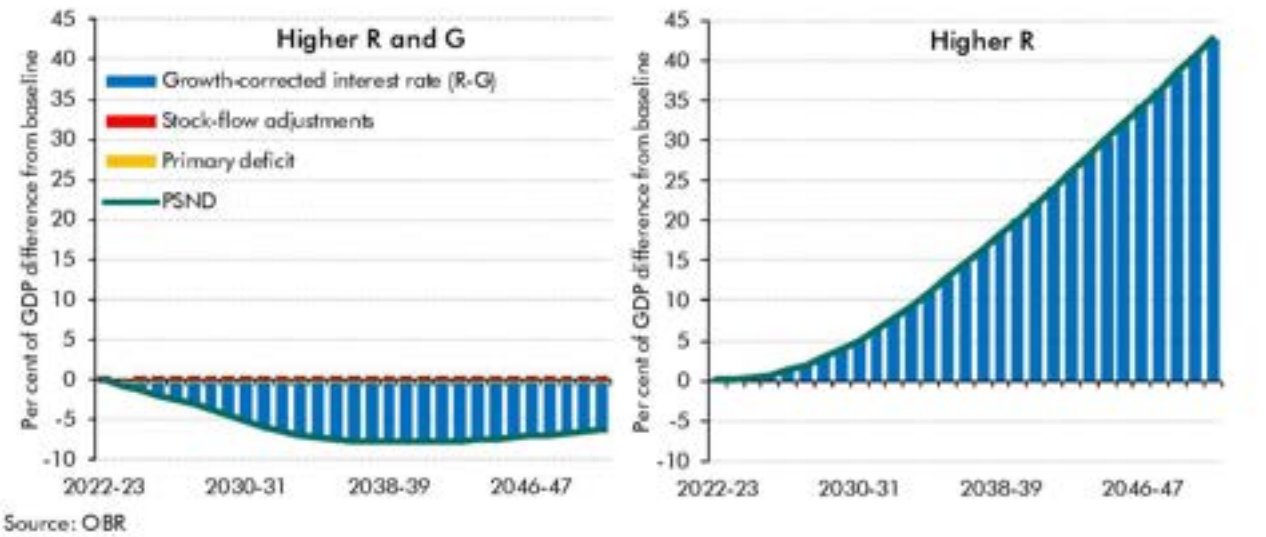
4.52 Debt is also significantly above the baseline due to the less favourable growth-corrected interest rate. Debt rises to 139 per cent of GDP by 2050-51 – almost 43 percentage points above the baseline. The higher growth-corrected interest rate in this scenario means that to stabilise debt, the Government would need to reduce the primary deficit – in 2029-30, lowering it by 0.9 per cent of GDP to 0.9 per cent would be sufficient; by 2050-51, the adjustment would need to be 2.0 per cent of GDP – approximately equivalent to the size of the defence budget in 2020-21.

Chart 4.10: Higher global real interest rate scenarios: key outputs



Source: ONS, OBR

Chart 4.11: Higher global real interest rate scenarios: contributions to differences in debt-to-GDP ratios from the baseline



Source: OBR

4.53 These scenarios envisage a gradual rise in interest rates relative to a baseline based on market expectations at the time we finalised our March 2021 *EFO*. Part of this rise has already crystallised because the yield curve has risen since our March forecast. The average gilt rate has risen by almost 50 basis points and market expectations for Bank Rate over the next five years have risen by 30 basis points. These changes would raise debt interest costs by around £7 billion in 2025-26, almost half of the increase in our higher R scenario.

Conclusions

4.54 The relatively benign scenario of a gradual increase in growth alongside interest rates gives a modest reduction in debt, although it does not return to its pre-pandemic level relative to GDP by the end of our scenario period in 2050-51. But even in this scenario, net interest payments reach more than three times the level in the baseline. Higher interest rates in the absence of higher GDP growth deliver a worse outcome for the public finances, with debt and borrowing climbing throughout the scenario. By 2050-51, the debt-to-GDP ratio reaches its highest level since 1954-55.

4.55 There are a several caveats to these scenarios worth mentioning. First, our simulations do not attempt to capture the full range of economic and fiscal effects from the changes in asset prices as bond yields rise. This could affect financial stability, for example, if they happened abruptly. Second, forward-looking financial markets could mean the fiscal benefits in the higher R and G scenario are more limited than shown above. We assume interest rates and growth gradually rise together, but investors could demand higher interest rates in anticipation of the pick-up in growth, thereby reducing the initial fiscal benefits.

The fiscal impact of higher inflation

4.56 Although interest rates could rise because of a partial reversal of the factors that have driven them down over the past three decades, it is also possible that real rates could remain unchanged but nominal rates rise as a consequence of higher inflation or inflation expectations. Prompted in part by continued expansionary US fiscal policies,[42] but also reflecting the continued accommodative monetary policies in many jurisdictions, there has been growing debate as to whether a resurgence of inflation is in prospect. There have also been suggestions that governments might welcome a period of higher inflation as a means of reducing the real value of their outstanding debt.[43] In this section, we therefore consider the impact on the public finances of a rise in yields that is associated with higher inflation. As inflation is ultimately a domestic phenomenon for a country with its own currency and a floating exchange rate, this should be thought of as reflecting UK policy choices or other UK-specific factors. But it is possible, of course, that there may a general tendency to higher inflation across multiple jurisdictions, reflecting the operation of the same factors in other countries.

4.57 Again, we consider two scenarios. In the first there is a burst of domestically-generated inflation that we assume requires a temporary rise in Bank Rate to bring inflation back to target. In the second there is a more persistent rise in inflation, which could be associated either with sustained failure to meet the inflation target or the adoption of a higher one. In both, we continue to assume that non-welfare spending is fixed in cash terms for just the first two years and beyond that rises in line with inflation, reflecting pressure for higher pay and to maintain the supply of government services. We also retain the assumption that receipts move with nominal GDP – initially more than one-for-one due to fiscal drag, and subsequently one-for-one in line with historical evidence on longer-term tax buoyancy.[44]

Temporary rise in inflation

4.58 A temporary rise in inflation could result from any number of shocks. In the current context it is perhaps easiest to think of it as resulting from an overestimation of the margin of spare capacity during the recovery from the pandemic that results in both higher inflation and higher inflation expectations. This necessitates a tightening of monetary policy to bring inflation durably back to the target, as this would not be the sort of inflation shock that the Bank could simply look through. Tighter monetary policy, in turn, acts as a temporary drag on GDP growth, bringing aggregate demand back into line with supply. In this scenario:

- **Inflation** rises sharply in 2022-23, hitting 5 per cent (3 percentage points above both our baseline and the target) the following year.

[42] For example, see Summers, L., *Comments to Federal Reserve Bank of Atlanta conference*, May 2021.
[43] For example, see discussion in Bank for International Settlements, *Annual Economic Report*, June 2020.
[44] See Table 1 in Belinga, V., Benedek, D., de Mooij, R. and Norregaard, J., *Tax buoyancy in OECD countries*, IMF Working Papers No 14/110, International Monetary Fund, June 2014.

- The Bank of England reacts by raising **Bank Rate** to 4 per cent in 2022-23 (3.9 percentage points above baseline).[45] **Average gilt rates** also rise to reflect the higher path for Bank Rate.

- Higher interest rates lead to weaker **GDP growth** over 2022-23 and 2023-24 (0.5 percentage points below the baseline in both years). There is no impact on potential output, so the output gap widens over these two years.

- **Beyond the near term**, inflation subsequently falls back, returning to target after four years, while GDP growth, Bank Rate, and average gilt rates all also return to their baseline paths over a similar timeframe.

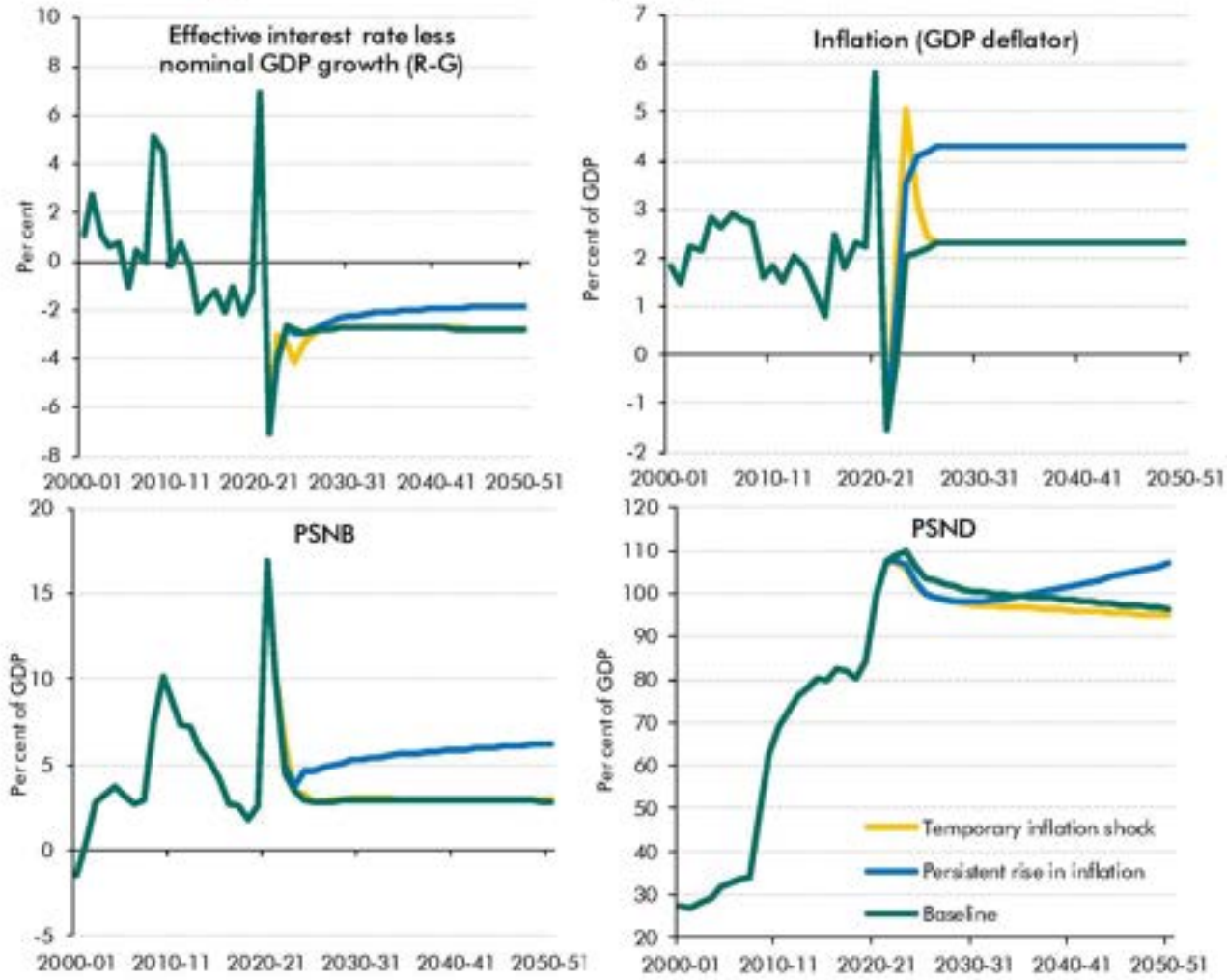
4.59 The burst of inflation initially improves the primary balance due to fiscal drag lifting receipts and departmental expenditure falling as a share of GDP due to being fixed in cash terms for two years. The primary balance subsequently returns to baseline as the Government increases cash spending and adjusts tax thresholds to account for the impact of inflation.

4.60 Debt interest payments rise immediately, underscoring the growing sensitivity of the debt stock to changes in both inflation and interest rates. Higher inflation has a direct impact on the interest payments on the stock of index-linked gilts, pushing interest costs up by £9 billion (0.4 per cent of GDP) in 2022-23. Similarly, the hike in Bank Rate leads to an immediate increase in the interest paid on reserves of £34 billion (1.4 per cent of GDP), reducing remittances from the APF to the Treasury by a corresponding amount (Box 4.5 has a fuller explanation). Finally, higher average gilt rates raise interest costs more gradually. This slower pace is because the Government only pays the interest rate prevailing in the market on new gilts, issued either to finance the deficit or refinance the 7 per cent of gilts assumed to mature each year (Chart 4.13 shows the breakdown).[46] In the long run, there is no change in annual net interest costs because this is a transitory shock and interest rates return to their baseline levels.

4.61 The effect of a temporary burst of inflation on the debt stock is quite modest in both the short and the long run. The debt-to-GDP ratio initially falls more quickly than in the baseline, due to a lower primary deficit and more favourable growth-corrected interest rate (Chart 4.13). But the fiscal benefit is quite small as interest costs rise quickly (particularly on index-linked gilts and on reserves as Bank Rate is increased) and, by assumption, starting in the third year of the scenario the Government increases cash spending to account for the impact of higher inflation. By 2050-51, debt is 2 per cent of GDP below the baseline at 95 per cent of GDP, but is still over 10 per cent of GDP above the pre-pandemic level.

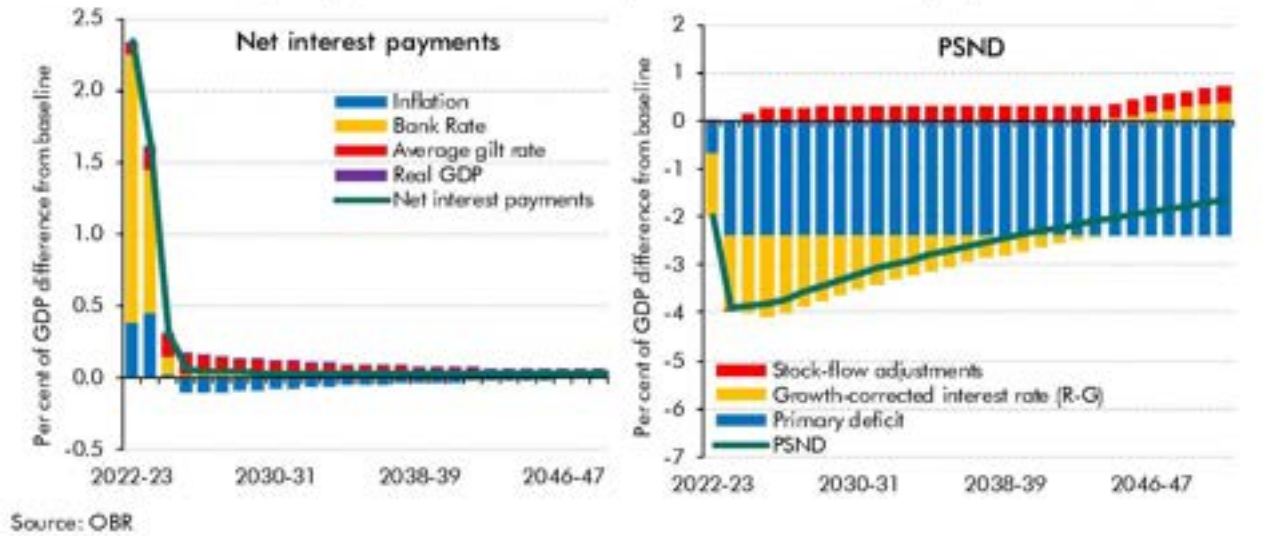
[45] Estimated using the model described in *Working paper No.4: A small model of the UK economy*, OBR, July 2012.
[46] We assume that gilts are issued at par, in line with general DMO practice.

Chart 4.12: Higher inflation scenarios: key outputs



Source: ONS, OBR

Chart 4.13: Temporary inflation shock impact on net interest payments and PSND



Source: OBR

Persistent rise in inflation

4.62 Our second inflation scenario examines the fiscal impact of a persistent increase in inflation and inflation expectations to 2 percentage points above the baseline. Within the confines of the existing monetary policy framework, that might result from a temporary inflation overshoot that became embedded in actual and expected inflation and was expressly accommodated through the open letter process.[47] But it would also be consistent with the suggestions from some quarters that the adoption of a higher inflation target would give more room for central banks to lower their policy rates before hitting their effective lower bound.[48]

4.63 In this scenario:

- **CPI inflation** rises to 4 per cent over three years and remains at that rate.[49] The process takes several years because of frictions in adjusting prices and wages.[50] **Bank Rate** rises in step with inflation, leaving the real short-term interest rate unchanged.

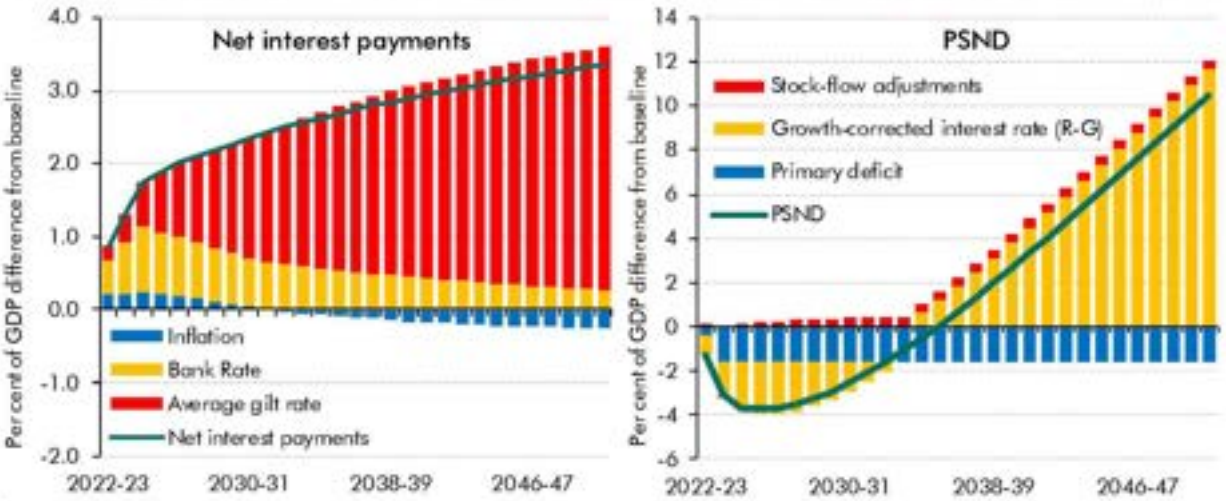
- **Gilt rates** react immediately to higher expected future paths of inflation and Bank Rate. But we assume that gilt rates rise by 3 percentage points rather than the 2 percentage point increase in the inflation expectations,[51] because investors fear there might be greater willingness to tolerate even higher rates of inflation in the future.

4.64 We assume that the economy adjusts smoothly to the persistently higher path for inflation so there is no impact on real GDP or the output gap. If that were not so, then there would be secondary impacts on borrowing and the debt-to-GDP ratio. A persistent inflation shock raises overall borrowing in every year of the forecast. The primary deficit initially falls as inflation rises, mostly due to nominal government spending being fixed for the first two years. However, overall PSNB still rises because higher net interest costs outweigh the impact of a lower primary deficit. The higher net interest costs come from three sources: the direct impact of higher inflation on the cost of index-linked gilts; the impact of higher Bank Rate on interest paid by the APF; and the impact of a higher average gilt rate on conventional gilts (Chart 4.14). The first two feed through immediately, but the third feeds through more slowly as existing gilts mature and new gilts are issued. Net interest costs rise to 4.4 per cent of GDP by 2050-51 compared to 1.0 in the baseline (this takes them from 2.7 per cent of revenue in the baseline to 11.6 per cent in the scenario in 2050-51). This raises borrowing to 6.2 per cent of GDP in 2050-51 compared to 2.9 per cent in the baseline.

[47] If CPI inflation deviates from the 2 per cent target by more than 1 percentage point, the Governor of the Bank of England is required to write to the Chancellor explaining why and what will be done about it. The Chancellor is required to respond and could in theory set out the Government's preferences for how quickly the Bank should aim to address the deviation given the trade-offs involved. See, for example, the discussion in Carney, M., *Lambda*, 16 January 2017.
[48] See, for instance, Blanchard, O., Dell'Ariccia, G., and Mauro, P., *Rethinking macroeconomic policy*, Journal of Money, Credit and Banking, 2010.
[49] This is consistent with the proposal in Blanchard, O., Dell'Ariccia, G., and Mauro, P., (op. cit.).
[50] In the charts in this chapter, we show the GDP deflator rather than CPI (which the Bank of England targets). The GDP deflator settles at slightly higher than 4 per cent but still 2 percentage points higher than the baseline, which is what is important for the scenario calculations.
[51] This is broadly consistent with the decline in inflation expectations around the Bank of England's independence in 1997.

4.65 In this scenario, persistently higher inflation does nothing to reduce the debt-to-GDP ratio over the long run. Debt initially falls marginally below the baseline due to the initial impact of lower primary borrowing, but it ends up above the baseline by the end of the scenario as higher interest rates work their way through the debt stock. In this scenario, the growth-corrected interest rate is slightly less favourable than in the baseline. Although nominal growth is lifted by higher inflation, the effective interest rate on government debt rises by more due to the assumed inflation risk premium on average gilt rates. This means debt rises back towards our baseline before exceeding it in the later years of the scenario. It reaches 107 per cent of GDP in 2050-51 (10 per cent of GDP above the baseline). This is more than explained by the assumed 1 percentage point inflation risk premium on gilt rates, which adds 12 per cent of GDP to debt in 2050-51.

Chart 4.14: Persistent rise in inflation impact on net interest payments and PSND



Source: OBR

4.66 The impact of rising yields on the market value of gilts is an additional factor not considered in this scenario. For conventional gilts currently in issue, a 100 basis point rise in yields would lower the average market value by 12 per cent, so the scenario would be consistent with them falling by around a third. This could adversely affect financial stability.[52]

Conclusions

4.67 Both scenarios suggest that inflation is not a very effective way to reduce the debt-to-GDP ratio in the current circumstances. A temporary burst of inflation has only a modest impact on the debt-to-GDP ratio, which is mostly achieved through a temporary squeeze on real spending. A persistent increase in inflation leads to a medium-term improvement in the debt position as inflation erodes the real value of the nominal debt in issue. But the impact is muted by the share of index-linked debt (23 per cent of gilts in 2020-21, up from 14 per cent in 1989-90) and the shortening of the effective maturity of debt due in part to quantitative easing. In the long run, there is actually a rise in the debt-to-GDP ratio due to the assumption of a higher inflation risk premium on gilts, which pushes interest payments from 1 to over 4 per cent of GDP, up to a level not seen since 1947-48.

[52] See discussion in Bank for International Settlements, *Financial Stability implications of a prolonged period of low interest rates*, July 2018.

Loss of investor confidence

4.68 Our scenarios so far have explored the fiscal implications of relatively modest, and often gradual, rises in the cost of government borrowing. However, history is replete with instances where governments experienced sudden and steep rises in the rates they had to pay to borrow, sometimes even ending in complete loss of investor confidence and market access. In such circumstances, access to an emergency loan from the International Monetary Fund (or similar official lender) may buy time, but a significant fiscal consolidation will usually be necessary to return the public finances onto a sustainable path and restore investor confidence and market access. The remainder of this chapter reviews some of the evidence regarding such government debt crises before exploring an extreme tail-risk scenario in which the UK is subjected to one.

Government borrowing costs in a debt crisis

4.69 Governments are likely to find it more expensive to borrow – that is the 'risk premium' rises – when investors lose confidence in their ability, or willingness, to honour their debt commitments. Factors that erode investor confidence include not only fears of outright default but also concerns that the government may take actions that have a similar effect, such as reducing the real value of those debt obligations through higher inflation. Governments rarely choose freely to repudiate their debt obligations, as that could result in them finding it much more expensive to borrow in the future – at least for a period.[53] Instead, they are usually forced into default – or to resort to the IMF or other multilateral or bilateral loans – by a combination of rising borrowing costs and difficulties in delivering the rapid adjustments to the primary balance needed to offset those rising interest payments. As a result, debt crises often feature adverse feedback loops, with higher borrowing costs worsening the fiscal position and the worsening fiscal position leading to higher borrowing costs.

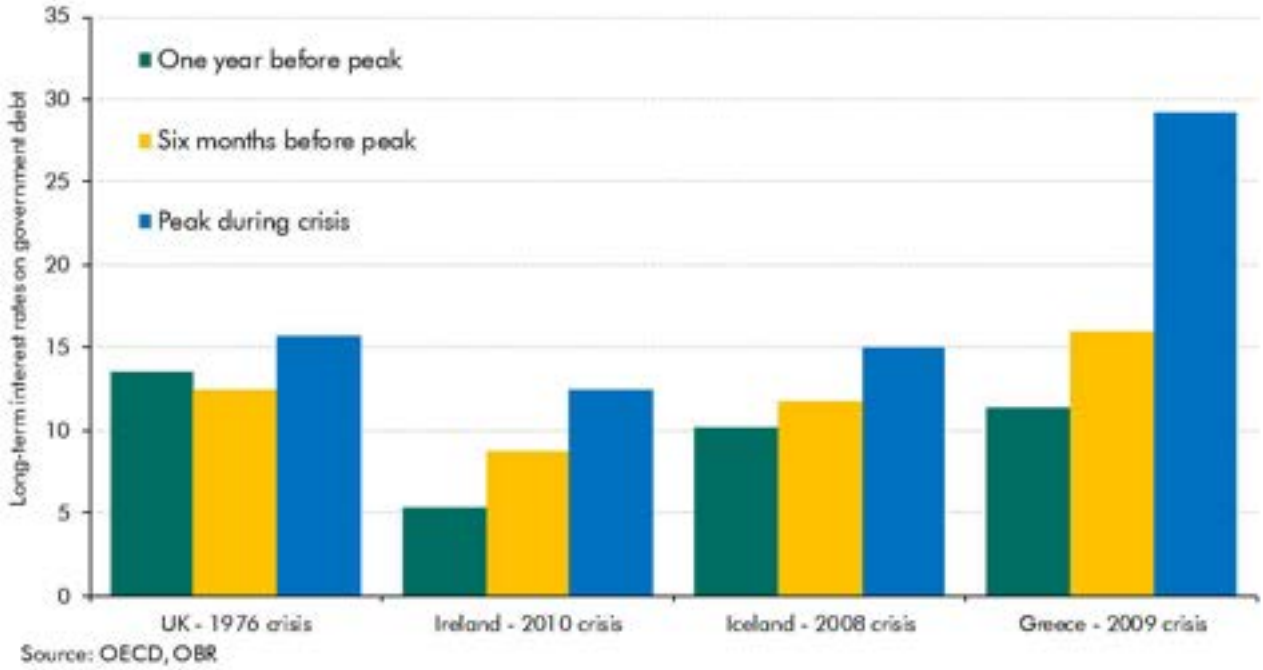
4.70 Chart 4.15 shows the behaviour of UK gilt yields around the time of its 1976 crisis, the last time the UK had to seek external assistance from the IMF. The chart also shows the yields on government bonds during some more recent government debt crises in other advanced economies. In each case, yields rose substantially in just a matter of months, illustrating how rapidly financing conditions can deteriorate.

4.71 The UK crisis in 1976 was on the surface a balance of payments crisis, though associated fundamentally with unsustainable fiscal and monetary policies – illustrating the range of factors that can combine to create a debt crisis. This combination of factors is reflected in the flatter profile of interest rate rises in Chart 4.15 – longer-term issues of high inflation, and the after-effects of a recession and the oil crisis left the deficit high, and gilt rates in 1975 already stood 7 percentage points higher than their 1960s average. Against this backdrop, from early 1976 market participants believed that sterling devaluation was

[53] See the discussion of the impact of a history of default on borrowing costs in Cruces, J., and Trebesch, C., *Sovereign Defaults: The Price of Haircuts*, American Economic Journal: Macroeconomics, 2013, and earlier work by Borensztein, E., and Panizza, U., *The Costs of Sovereign Default*, IMF Working Paper, October 2008.

inevitable in view of the UK's large current account deficit. Long-term rates rose by over 3 percentage points within seven months – but, more damagingly, investors came to regard existing yields as insufficient, and liquidity in the gilt market dried up in a 'buyers strike'. Eventually, an IMF loan of $3.9 billion (1.2 per cent of UK GDP in 1976) was necessary, the price of which was the implementation of politically unpalatable cuts in public spending.[54]

Chart 4.15: Long-term bond rates in selected government debt crises



Source: OECD, OBR

4.72 The other three episodes in Chart 4.15 all date from the financial crisis, when the cost of stabilising banking sectors against a backdrop of severe recessions sharply worsened fiscal positions in affected countries. Greece is perhaps the most notable, with large revisions to the pre-crisis fiscal accounts precipitating a crisis that led to the most significant bail-out in Europe. Revelations over the course of 2009 that the budget deficit was far higher than realised, and further deterioration in the fiscal position as a result of the financial crisis, led investors to think that both default and/or exit from the euro might be necessary. This caused interest rates to rise dramatically – eventually peaking at 29 per cent in February 2012. This was ultimately only resolved by a mixture of external support from the EU and IMF, and a commitment from the European Central Bank to maintain the integrity of the euro by purchasing Greek and other eurozone sovereign debt through its Outright Monetary Transactions programme. This was followed by a restructuring of private sector holdings of Greek debt in 2012, which reduced the face value of these private holdings by over €100 billion.[55]

4.73 The cases of Iceland and Ireland are notably different, insofar as neither entered their crises with weak fiscal positions. But in both, the banking system was so large relative to the economy that the costs of rescuing it implied a sudden and very large transfer of liabilities

[54] The National Archives, *Sterling devalued and the IMF loan*, accessed May 2021.
[55] For more discussion see: Zettelmeyer, J., Trebesch, C. and Gulati, M., *The Greek Debt Restructuring: An Autopsy*, August 2013.

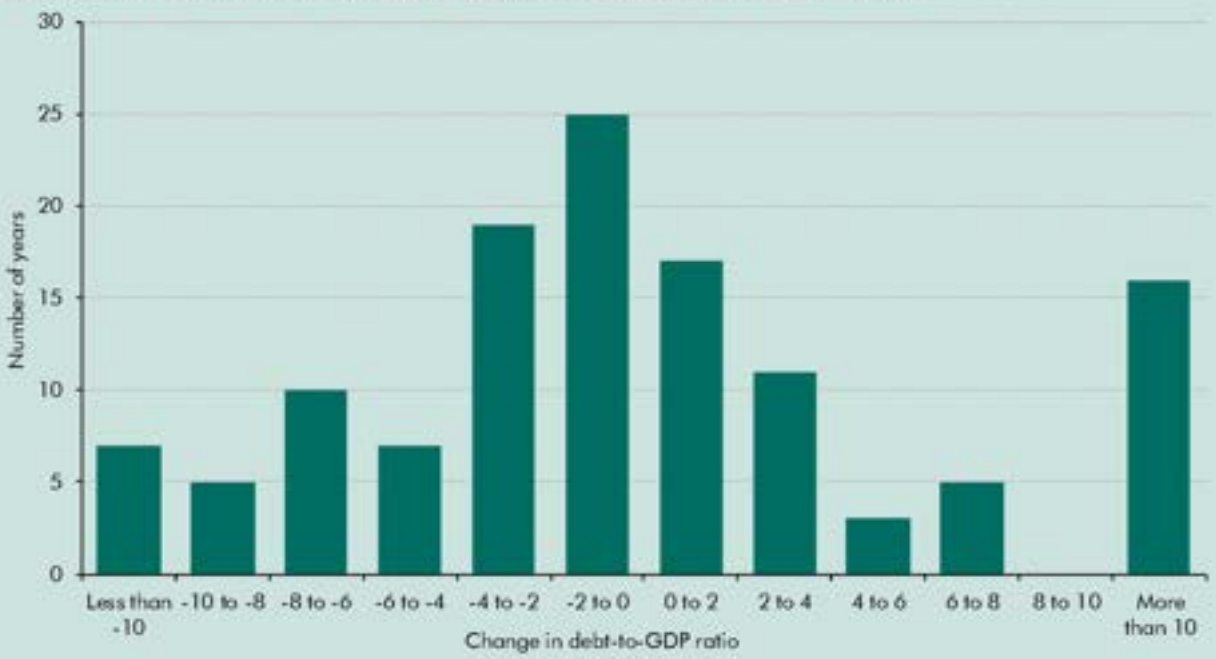
from private to public sector – increasing gross debt levels by 24.5 per cent of 2010 GDP in Ireland between 2007 and 2010, and by 42.8 per cent of GDP in Iceland over the same period.[56] In Ireland, the announcement of the renewal of the Irish Government's guarantee of the banking sector's debts in September 2010 was followed by a doubling in interest rates over the next ten months. In Iceland, the announcement of the nationalisation of the country's ailing banking sector in late 2008 sparked an even sharper rise in borrowing costs, with interest rates rising nearly 6 percentage points from September to October.

Box 4.4: Long run drivers of UK government debt

The history of UK government debt can be characterised as one of 'punctuated equilibria' in which long periods where the debt-to-GDP ratio is broadly stable or gradually falling are interspersed with occasional large increases in response to major shocks (Chart 4.1). Since 1900 (and including our March 2021 forecast), there have been 21 years in which debt rose by more than 6 per cent of GDP (Chart C); of these, 12 were associated with the world wars and the remaining nine came during the contractionary policy in the 1920s (two), the Great Depression (two), the financial crisis (three), and the coronavirus pandemic (two).

The two world wars were by far the most significant events. The first saw five years of debt-to-GDP increases averaging 23 percentage points a year, while the second saw seven consecutive years of rising debt at an average of 15 percentage points a year. While the total increase in debt during the world wars was far greater than during the pandemic, they are similar in being exogenous shocks that led to large, though temporary, increases in primary spending, partially offset by falling nominal interest rates.

Chart C: Distribution of changes in the UK debt-to-GDP ratio



Source: Bank of England, ONS, OBR

[56] IMF, *Fiscal Transparency, Accountability, and Risk*, August 2012.

After a crisis, governments usually seek to rebuild fiscal space in order to be able to respond to the next crisis. For crises driven by temporarily higher spending – such as wars and the pandemic – a rapid improvement in the primary balance should be possible simply by returning expenditure closer to pre-crisis levels once the need for the temporary rise has passed. But returning debt to pre-crisis levels can be the work of many decades.

The UK successfully brought debt down following the second world war. After 1946-47 the debt-to-GDP ratio fell for 27 consecutive years and by 206 per cent of GDP. Of this, 127 percentage points was achieved in the first decade. More than half the fall was achieved by a persistently negative growth-corrected interest rate. In part this was the result of interest rates being held down by a variety of institutional and policy factors ('financial repression'),[o] but the Government also ran relatively large primary surpluses, particularly in the early post-war period when the civilian workforce (and therefore tax revenues) was expanding rapidly. Later in the period, particularly from the late 1960s to the 1980s, persistently high (and sometimes unanticipated) inflation also helped to erode the real value of the Government debt stock at a time when nominal interest rates were still subject to administrative control.

Of the various strategies that contributed to the post-war debt reduction, the most desirable for society and bondholders alike would clearly be sustained higher real GDP growth (consistent with our 'higher R and G' scenario) but this has proved extremely difficult to achieve in the post-financial crisis period. Financial repression would be more difficult to achieve in an era of open capital markets and independent central banks and financial regulators. And our 'persistently higher inflation' scenario suggests that a period of higher inflation may no longer offer an effective way of reducing the debt-GDP ratio, especially if it results in a higher inflation risk premium.

[o] See for example Reinhart and Sbrancia, *The liquidation of government debt*, 2011.

What affects the risk premium on government debt during a crisis?

4.74 Of course, no two crises are alike and their fiscal consequences depend in part on how governments respond. So the historical and international experiences discussed above may not capture the sorts of risks the UK might face were it subject to one. However, empirical studies of interest rate differentials on government debt and sovereign debt crises point to several factors that drive the risk premium on government bonds.[57] When investors have full confidence in the creditworthiness of a government, the quantitative importance of these factors may not be that great. Indeed, such bonds may well benefit from acting as a 'safe haven' during general times of stress (see the discussion of fiscal space in Box 1.1). But these factors are likely to come to the fore when the creditworthiness of the Government is in doubt.

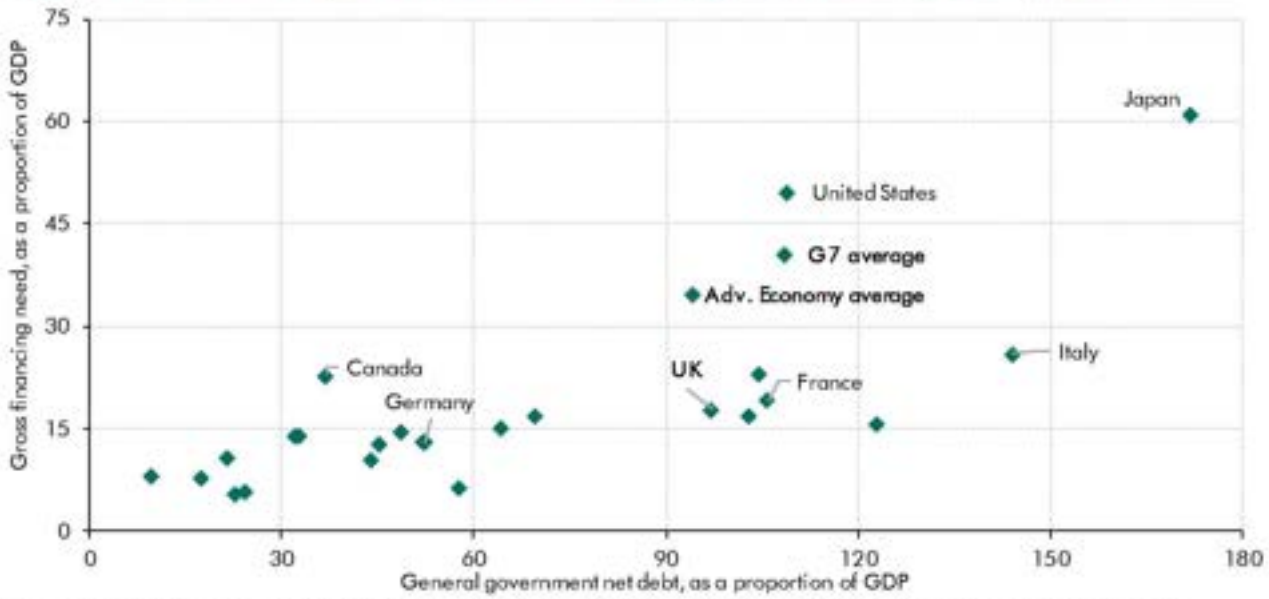
4.75 There are several potential drivers of risk premia on government bonds at such times. We begin with the **outlook for government deficits and debt**. Other things equal, higher debt paths could be expected to put upward pressure on yields because they increase the risk of

[57] For a fuller discussion of risk premia, see Gürkaynak, R. and Wright, T., *Macroeconomics and the Term Structure*, Journal of Economic Literature, June 2012.

future capital losses, either because yields continue to rise in the future or because of the heightened risk of some sort of default. While UK public borrowing has increased dramatically as a result of the pandemic and public debt has risen sharply as a result, the former should fall sharply as the pandemic recedes and the UK is in the middle of the pack of advanced economies as far as its debt-GDP ratio is concerned (see Chart 4.16).

4.76 Second, investor perceptions on the risk of default are also related to the **profile of the Government's financing needs**, which depend not only on the budget deficit but also on the quantity of maturing debt that needs to be rolled over. A high volume of short-term issuance makes a government more vulnerable to funding problems and shortens the time available to get the public finances in order. So, while funding at short maturities is typically cheaper, it also leaves the Government more at risk. Earlier in this chapter, we explored the effect of quantitative easing on interest rate sensitivities via the effective shortening of the maturity of the public debt. However, from a funding perspective, central bank reserves do not have to be refinanced; they are, in effect, a floating rate perpetuity. What matters instead is the total new debt that the Government needs to place with private buyers. Chart 4.16 shows projected financing requirements and debt burdens for advanced economies in 2021. Despite a high stock of debt, the UK has a lower financing requirement compared to other advanced economies with similar debt burdens. This reflects the relatively long average maturity of UK gilts – a factor that reduces the Government's exposure to financing risk.[58]

Chart 4.16: General government net debt and gross financing needs, 2021

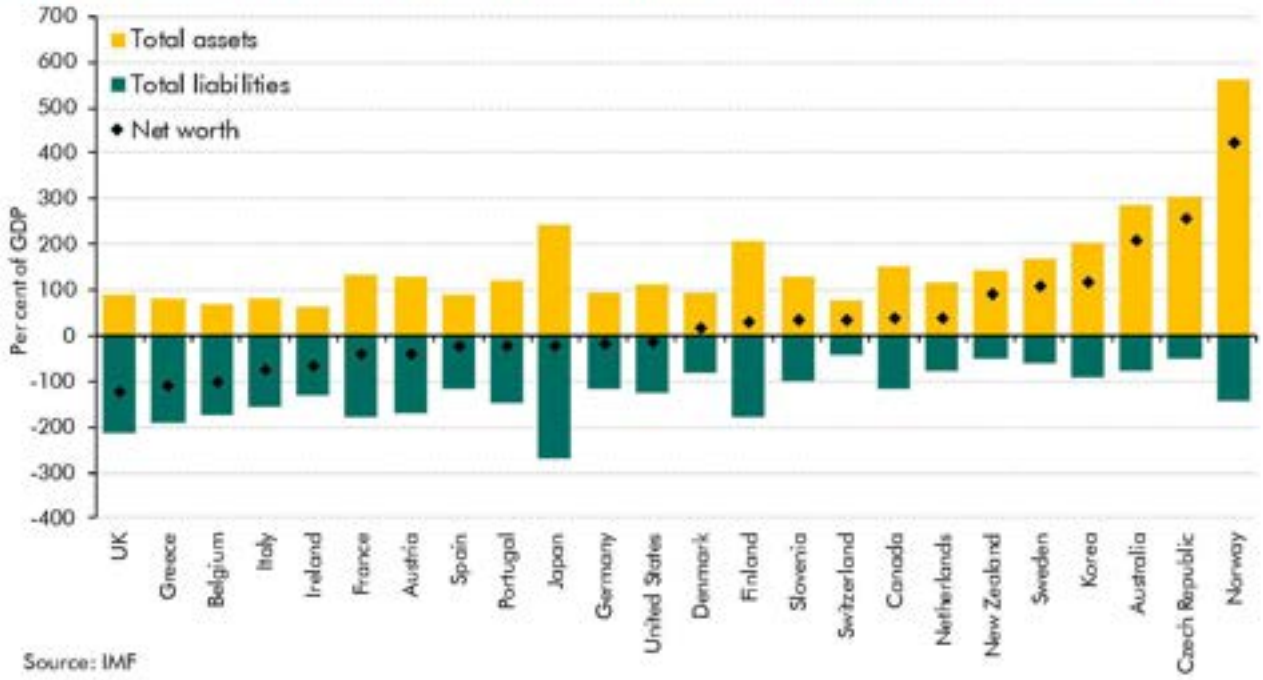


Note: Data shown for advanced economies, excluding Greece, Cyprus, Estonia, Hong Kong, Israel, Latvia, Luxembourg, Malta, Norway, Singapore and the Slovak Republic due to data availability.
Source: IMF

[58] Note that Bank reserves never mature and so do not need refinancing. For this reason, a maturity measure only including gilts is perhaps rather better as an indicator of financing risk.

4.77 Third, perceptions of government debt risk also depend on **wider pressures on the public sector balance sheet**, including the stock of debt-like obligations, such as public sector pensions, as well as the availability of assets that could be liquidated if required to meet government financing needs. IMF research suggests that an improvement in an advanced economy government's net worth of 10 per cent of GDP on average lowers its bond yields by just under 10 basis points.[59] Chart 4.17 shows the net worth position of selected advanced economies. Among these countries, the UK's relatively high debt stock, significant public sector pension liabilities, and paucity of financial and non-financial assets, place it at the bottom of the league table.

Chart 4.17: General government net worth for selected advanced economies



Source: IMF

4.78 Fourth, the **exposure of the public finances to wider economic risks** is a potential factor. The Icelandic and Irish governments were running fiscal surpluses and forecasts for gross debt in 2010 were below 30 per cent of GDP for both countries prior to the financial crisis. Yet both were forced by the high fiscal costs of dealing with it to seek support from the IMF and European Union.[60] This was because of their unusually large banking sectors whose liabilities were, in effect, a contingent liability of the Government. When the financial crisis hit, these liabilities were transferred to the Government, which was unable to service them without outside assistance. Governments whose revenues depend heavily on exports of volatile or finite resources such as fossil fuels can also find themselves quickly plunged into debt distress when either prices or volumes fall. The UK does, of course, have a relatively large financial sector, though it is considerably more resilient today than at the time of the financial crisis.[61]

[59] Youseli, S. R., *Public Sector Balance Sheet Strength and the Macro Economy*, IMF Working Paper, August 2019.
[60] IMF, *Fiscal Transparency, Accountability, and Risk*, August 2012.
[61] See Chapter 3 of our 2019 *Fiscal risks report*.

4.79 Fifth, government's institutional **capacity to deliver large and rapid fiscal adjustments** if such risks crystallise also shape investor confidence. The Government's perceived ability to adjust the state of the public finances to respond to fiscal shocks is important to reassure investors that it can deal with future fiscal pressures without resorting to default or inflationary measures. The degree of fiscal centralisation/decentralisation both within and across levels of government, starting levels and buoyancy of the tax burden, and the extent of structural rigidities in government expenditure all play roles in determining a country's capacity to deliver on large fiscal adjustments. Some historical evidence on the UK's relative capacity for doing so is discussed in the next section (from paragraph 4.82).

4.80 Sixth, on the demand side of the market, the **'stickiness' of investors' demand for government debt** may be a factor. Bonds offer a safer way of transferring purchasing power over time than risky assets, such as equities. They are therefore a natural asset for institutions with fixed future liabilities, such as defined-benefit pension funds, to hold. But in addition, many investors want to hold high-quality government bonds because they can be easily liquidated or employed as collateral. The value of this 'convenience yield' will decline as the stock of debt grows, providing another reason why yields may increase with the stock of debt. As we note below, domestic investors' demand is not necessarily 'stickier' in and of itself, but demand may be reinforced by regulatory requirements imposed on financial institutions. Central bank purchases of government bonds under quantitative easing programmes have also provided an important additional source of demand in recent years. Looking to international investors, the UK has the additional advantage of being a reserve currency (albeit a rather junior one) and UK gilts, like US Treasuries, have often benefitted from being seen as offering a safe haven at times of global stress. Of course, that might no longer be the case if the UK alone was subject to a shock with major fiscal consequences.

4.81 Last but certainly not least, a **credible institutional framework for macroeconomic policymaking** is central to maintaining investors' confidence that fiscal policy will be kept on a sustainable footing and that monetary policy will deliver low and stable inflation. Quantitative research has found that institutional strength and transparent fiscal frameworks are correlated with reduced borrowing costs, for both emerging and advanced economies.[62] The UK has historically been a leader in fiscal transparency, as noted by the IMF in their December 2020 assessment of fiscal space, which judged that the UK benefitted from the advantages of a *"strong macroeconomic and fiscal forecasting capacity"* and *"a long-standing and credible medium-term budget framework"*.[63]

Primary balance adjustment

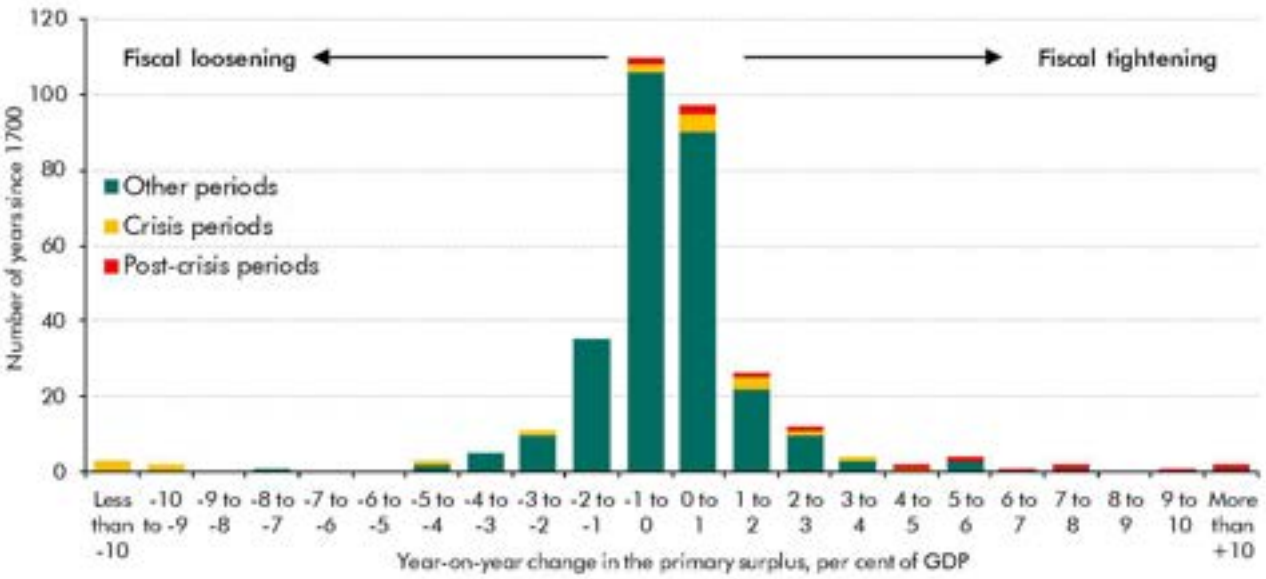
4.82 As noted above, one factor determining the risk premium is perceptions of a government's ability and willingness to make significant adjustments to the public finances when necessary. When the fiscal adjustment required to arrest a growing burden of debt exceeds what governments have demonstrated they can achieve, taking into account prevailing

[62] See Alfonso, A., and Tovar Jalles, J., *Fiscal Rules and Government Financing Costs*, Fiscal Studies, March 2019 on advanced economies, and Kemoe, L. and Zhan, Z., *Fiscal Transparency, Borrowing Costs, and Foreign Holdings of Sovereign Debt*, IMF Working Paper, August 2018 for a discussion of the effects of fiscal transparency in emerging economies.
[63] IMF, *United Kingdom: 2020 Article IV Consultation-Press Release; Staff Report; Staff Supplement; and Statement by the Executive Director for the United Kingdom*, December 2020.

political and institutional constraints, governments are likely to find it increasingly difficult to sell their debt to sceptical investors. This section reviews some of the evidence on the size and speed of past episodes of fiscal adjustment in the UK and other advanced economies.

4.83 Chart 4.18 shows the distribution of year-on-year changes in the UK's primary deficit since 1700. The vast majority (83 per cent) of these annual changes in the primary deficit are between minus 2 and plus 2 per cent of GDP, with larger adjustments almost always associated with wars and other major crises. For instance, the most significant annual fiscal consolidation of the past century was a fall of 9 per cent of GDP following World War II, which was the result of moving from the demands of total war to peacetime. Moreover, these changes in the primary balance represent just a single year of adjustment – sustaining a similar tightening in fiscal policy for several years would be increasingly difficult (as illustrated by the 'austerity fatigue' that built progressively over the past decade). So, for instance, even the significant fiscal consolidation following the financial crisis peaked at just over 2 per cent of GDP year-on-year.

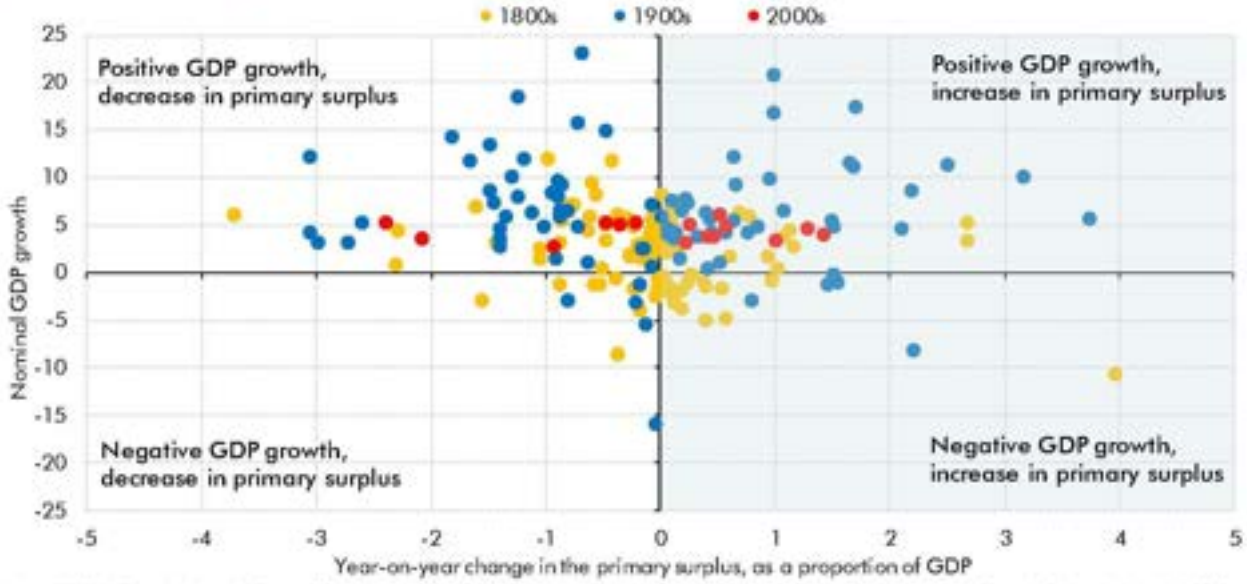
Chart 4.18: UK year-on-year change in the primary surplus



Note: Crisis periods include the post-Napoleonic depression, World War One, World War Two, the financial crisis and the coronavirus pandemic. Post-crisis periods are the three years following each crisis.
Source: Bank of England, ONS, OBR

4.84 A sharper reduction in the deficit is more likely when growth is strong because fiscal drag makes tax revenues rise faster than GDP, while spending typically falls, for example due to lower payments of unemployment benefits. Chart 4.19 therefore compares changes in the primary deficit and nominal GDP growth outside wars and other major crises (i.e. the 'other periods' shown in Chart 4.18). Predictably, this confirms that an improvement in the primary balance is much less common in the absence of strong growth (shown by more data points in the top right quadrant of the chart than in the bottom right). It also shows that, while the 2000s have already seen two instances of the primary surplus falling by more than 2 per cent of GDP, it has not yet seen any increases in the primary surplus on that scale. This underscores the asymmetric nature of fiscal shocks that the UK has faced in recent decades.

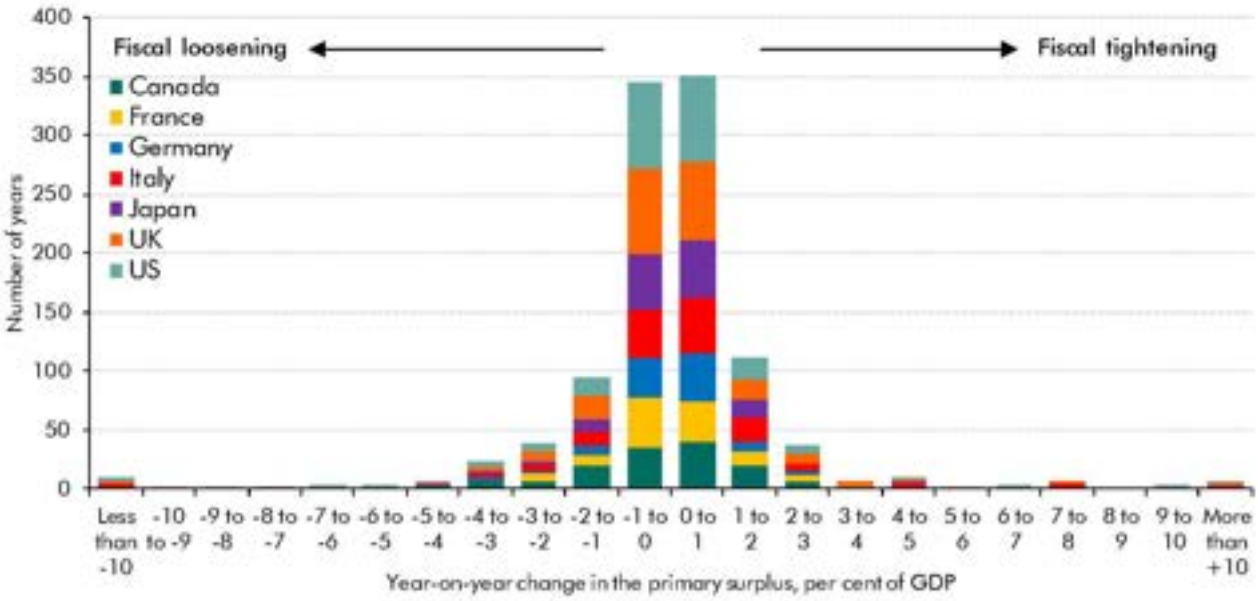
Chart 4.19: UK – year-on-year change in the primary surplus and nominal GDP growth excluding crisis periods



Note: Excluding crisis periods and the three years following each crisis. Crises excluded are the post-Napoleonic depression, World War One, World War Two, the financial crisis and the coronavirus pandemic.
Source: Bank of England, ONS, OBR

4.85 The UK's experience is similar to that of other G7 economies over the past two centuries, where the year-on-year changes in the primary deficit have also been highly concentrated between 2 and -2 per cent of GDP (Chart 4.20). Again, the transition from the needs of a wartime economy to peacetime accounts for the most significant episodes of fiscal tightening in the data, with the United States and Canada seeing improvements in the primary balance of 15 and 21 per cent of GDP respectively in 1946.

Chart 4.20: G7 year-on-year change in primary deficit



Note: Data since 1800 or earliest available date
Source: IMF, OBR

4.86 Institutional arrangements for fiscal policymaking also affect the achievability of a significant and rapid improvement in the primary balance. In a 2014 paper, the IMF found that *"G-20 countries with stronger budget institutions overall have tended to plan and deliver more fiscal adjustment in the wake of the [financial] crisis"*, finding that countries with 'strong' institutions delivered, on average, a 2¼ per cent of GDP reduction in the cyclically adjusted primary balance from 2010 to 2012, compared to the ¼ per cent of GDP reduction delivered by countries with 'weaker' institutions.[64] The UK's long-standing commitment to fiscal transparency and medium-term budgetary planning is likely to be an advantage here – and an IMF analysis of the UK's overall fiscal transparency suggested that the UK has experienced *"a strong record of delivering on its medium-term commitments on the expenditure side"* (while also noting that revenue forecasts had tended to be overly optimistic).[65] However, no consolidation is painless and, ultimately, how quickly and how far the Government can adjust is also determined not only by institutional arrangements but also by political factors.

Demand for UK government debt

4.87 As also noted above, another factor that may be important during a sovereign debt crisis is the 'stickiness' of investor demand, which is, in part, a function of the nature of the investor base. This section provides further analysis of the buyers of UK gilts and how the composition of holders has changed over the past 35 years (Chart 4.21). It also considers the likely stickiness of that demand in the face of a UK-specific crisis.

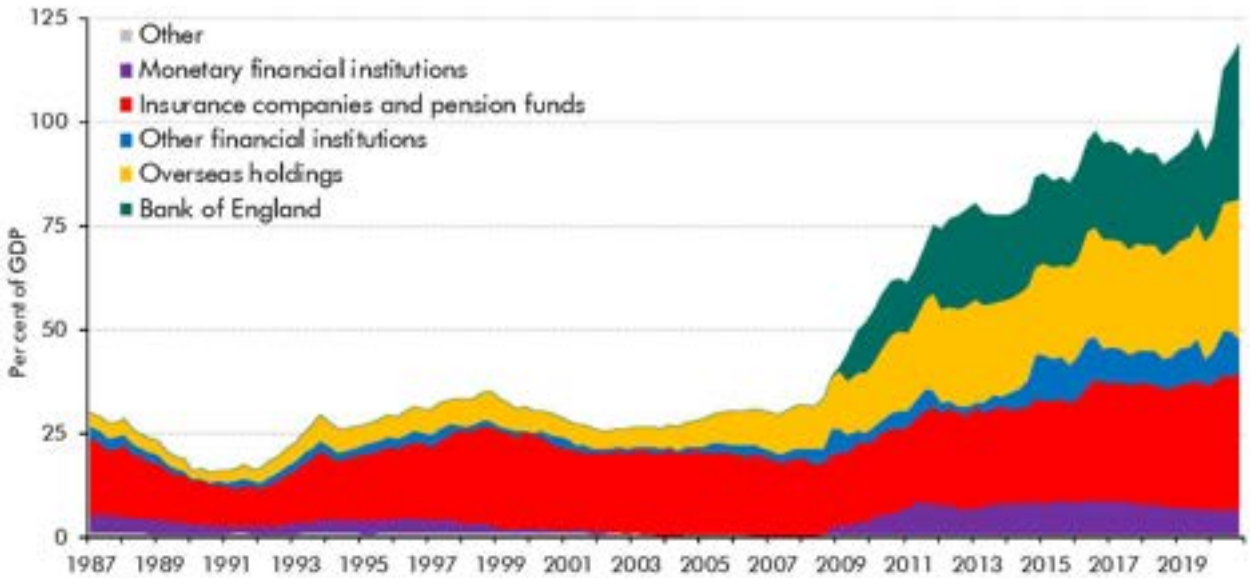
4.88 The expansion of the Bank of England's holdings of gilts has been the most notable change since the financial crisis – as of the final quarter of 2020 the Bank held 32 per cent of the stock of gilts in issue, with a market value of 38 per cent of GDP. Since the start of the pandemic, the Bank has in effect absorbed 83 per cent of net gilt issuance (the second largest purchasers have been overseas investors, who have purchased 14 per cent).[66] The Bank's purchases have helped to hold down the Government's debt interest costs, even as debt has risen rapidly (see Box 4.5). The Bank estimated that the initial £200 billion tranche of quantitative easing in 2009 lowered 10-year gilt yields by around 1 percentage point.[67] Subsequent tranches appear to have had a somewhat smaller impact, though the Bank estimates that gilt purchases during the pandemic have had the largest impact on gilt yields since the financial crisis, lowering them by almost 0.4 percentage points.[68]

4.89 If and when the Bank decides to run down the APF – either by active sales or by allowing it to run off organically as the gilts mature – it can be expected to put upward pressure on yields (though this may be partially offset by banks wanting to replace the reduced stock of central bank reserves with other liquid assets such as gilts). There is a risk that the

[64] See IMF Policy Paper, *Budget Institutions in G-20 Countries – An Update*, April 2014 for more detail on assessments of institutional strength.
[65] IMF, *United Kingdom: Fiscal Transparency Evaluation*, November 2016.
[66] Calculated as the Bank's net purchases of gilts through the APF as a share of total net transactions in gilts over this period (as published by the ONS).
[67] Joyce, M. Lasaosa, A., Stevens, I and Tong, M., *The Financial Market Impact of Quantitative Easing in the United Kingdom*, International Journal of Central Banking, September 2011.
[68] Bailey, A., Bridges, J., Harrison, R., Jones, J., and Mankodi, A., *The central bank balance sheet as a policy tool: past, present and future*, Staff Working Paper No. 899, December 2020.

movement in yields when such a policy is announced could be quite sharp, as market participants price in further sales (as was the case with the 2013 US 'taper tantrum', triggered by speculation that the Federal Reserve was about to reduce the pace of its asset purchases).

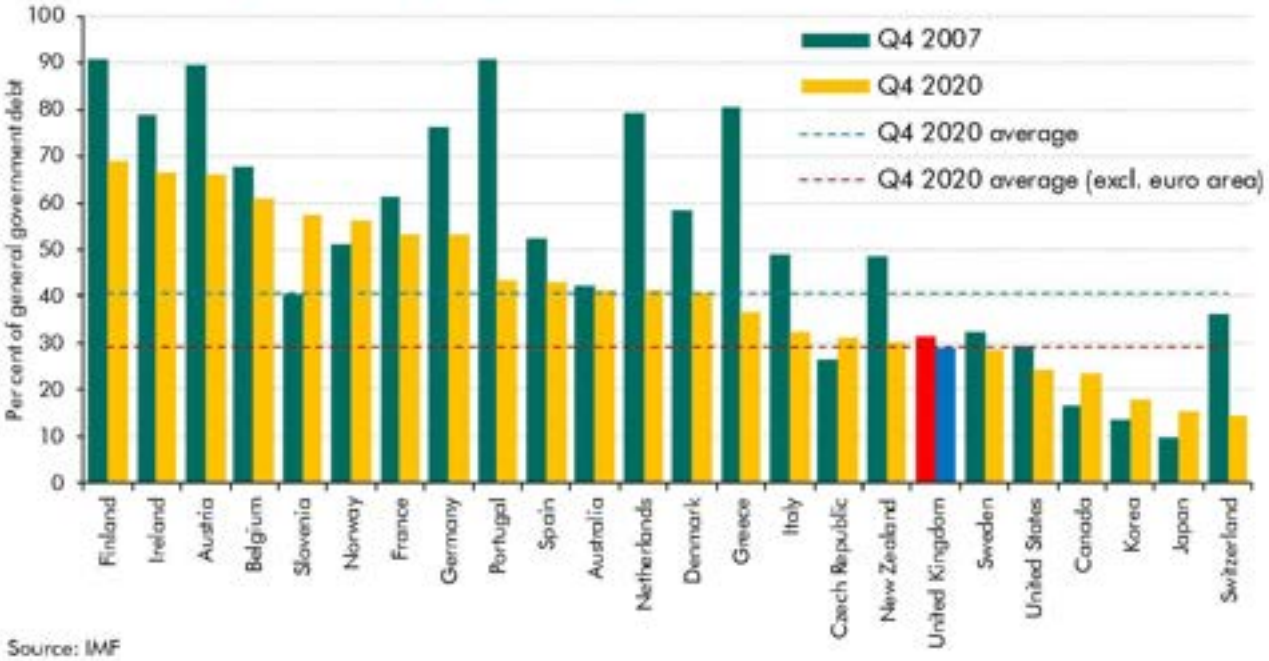
Chart 4.21: UK gilt holders



Note: Chart shows holders of gilts at market value. Other includes local government, non-financial corporations, households and non-profit institutions serving households.
Source: DMO, ONS

4.90 The second biggest development has been the increase in the proportion of debt held by overseas investors, from 11 per cent in the first quarter of 1987 to 28 per cent by the final quarter of 2020. While this is a substantial increase, the proportion of UK debt held by overseas investors is still below the average for advanced economies (Chart 4.22). It is, though, much closer to the average of advanced economies excluding the euro area (where cross-holdings are more likely), which is 29 per cent.

Chart 4.22: Foreign holdings of general government debt securities



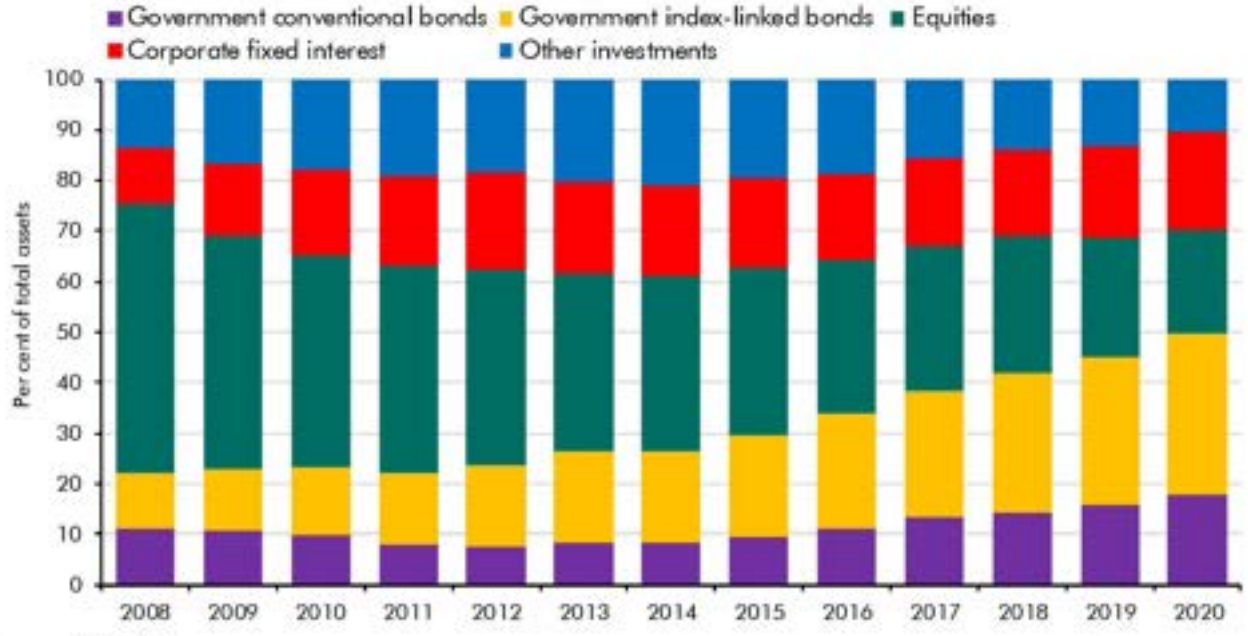
Source: IMF

4.91 A third notable change has been the rise in domestic bank holdings of gilts from 2 per cent in 2007, pre-financial crisis, to an average of 6 per cent in 2020. In part that reflects the requirements on banks' liquidity introduced under the Basel 3 banking regulations. Higher holdings of government debt by domestic banks increase the risk of a government-bank 'doom loop' (the adverse feedback that arises because falls in the value of government bonds weaken banks' balance sheets, increasing the potential cost of official support, and in turn worsening the expected fiscal position). The proportion of UK debt held by domestic banks is, however, still low compared to countries where such adverse feedback effects were experienced in the past. For example, during the euro area debt crisis, domestic bank holdings of government bonds in Portugal, Italy, Ireland and Spain peaked between a quarter and a third of total debt, and a fifth for Greece.

4.92 Fourth and finally, pensions funds have been, and continue to be, reliable holders of gilts, in part for regulatory reasons. Their holdings have stayed relatively constant at around 25 per cent of GDP over the past 35 years, although that means their share of the total stock in issue has fallen as the debt-to-GDP ratio has risen. The pensions landscape has been changing for many years, with defined benefit (DB) schemes in decline and defined contribution (DC) schemes growing. DC schemes currently invest more in equities and less in government bonds compared to DB schemes.[69] Given the difference in maturity of the two different types of schemes and regulatory needs for DB schemes to hold gilts, it is likely that pension funds will remain a stable source of demand for gilts in the future.

[69] Pension Policy Institute, *DC scheme investment in illiquid and alternative assets*, March 2019.

Chart 4.23: Defined benefit pension schemes asset allocations



Source: PPF, OBR

4.93 The changing sectoral structure of gilt holders in recent decades has increased some risks and reduced others. Greater exposure to foreign holdings may have made the UK somewhat more vulnerable to sudden changes in investor sentiment in a crisis. By contrast, greater holdings by the Bank of England have reduced risks (by reducing yields and directly reduced rollover risk and by helping to preserve a deep and liquid market for gilts in times of crisis). And pension funds and insurance companies remain large and dependable sources of private domestic demand for gilts. However, the large Bank of England holdings mean that the fiscal position is more sensitive to variations in Bank Rate. Consequently, were a loss of investor confidence to necessitate a tightening in monetary policy (for instance to prevent a sharp fall in the pound), then it would have immediate implications for the fiscal position (as illustrated in our final scenario).

Simulating a loss of investor confidence in the UK

4.94 Public borrowing and indebtedness have risen substantially as a result of the pandemic. But the former is likely to drop sharply as the economy rebounds and pandemic support measures come to an end. And the latter, while markedly higher than before the financial crisis, has not limited the UK's fiscal space to respond to the pandemic (see Box 1.1 in Chapter 1). And while there are certainly fiscal challenges facing the Government, including dealing with the rising costs of an ageing population (see our past *FSR*s) and legacy of the pandemic (see Chapter 2 of this *FRR*), addressing them does not look unmanageable, as can be inferred from the continued robust demand from investors to hold UK gilts. So there seems to be very little immediate danger of the UK being subject to a sovereign debt crisis.

4.95 Nevertheless, in the spirit of considering even quite remote tail risks, our final scenario looks at what might happen if, for some reason, there were a loss of investor confidence in the UK

Government's creditworthiness and its macroeconomic policy framework. In this scenario, rising public debt leads to growing concerns amongst bond investors about the risk of losses. This in turn pushes borrowing costs up further, generating a vicious circle of rising debt and rising borrowing costs. In such a scenario, the Government would need to undertake significant fiscal tightening to stabilise its debt-to-GDP ratio. As discussed earlier, adjustments greater than 2 per cent of GDP are rare outside of the automatic fiscal correction that occurs after wars end (and as will happen as pandemic support rolls off).

4.96 As in our other scenarios, our aim is to highlight how the fiscal consequences of a loss of confidence could unfold rather than take a view of the potential cause of the crisis. That said, such a crisis would be more likely to be triggered by a UK-specific shock rather than a global one, such as the pandemic. Global shocks typically lead investors to shift from risky assets into high-quality government debt, benefitting countries perceived as safe havens. In the case of an idiosyncratic shock affecting just the UK, there is more likely to be a flight of investors from UK gilts into overseas assets instead.

4.97 In this scenario, we assume:

- There is an adverse supply shock that pushes **real GDP growth** 4 percentage points below our baseline for two years – a similar output loss to the financial crisis and less than half that precipitated by the pandemic. This results in real GDP growth of 1.0 per cent in 2022-23 and -2.5 per cent in 2023-24. Rising borrowing costs and an escalating crisis mean that growth fails to rebound and the economy continues to shrink for a further two years. We assume growth then returns to our baseline rate but there is no catch-up growth so long as the crisis continues. Output consequently lies persistently beneath the baseline, with the shortfall peaking at 8.5 per cent.

- **Inflation** rises to 4 percentage points above baseline in 2022-23, reflecting both the shock and a depreciation in sterling as investors sell UK assets. Inflation subsequently falls back to target over three years.[70]

- The Bank of England reacts to the rise in inflation by raising **Bank Rate** to 4.1 per cent in 2022-23 (4 percentage points higher than the baseline). It gradually falls back to baseline by 2027-28 as inflation returns to target.[71]

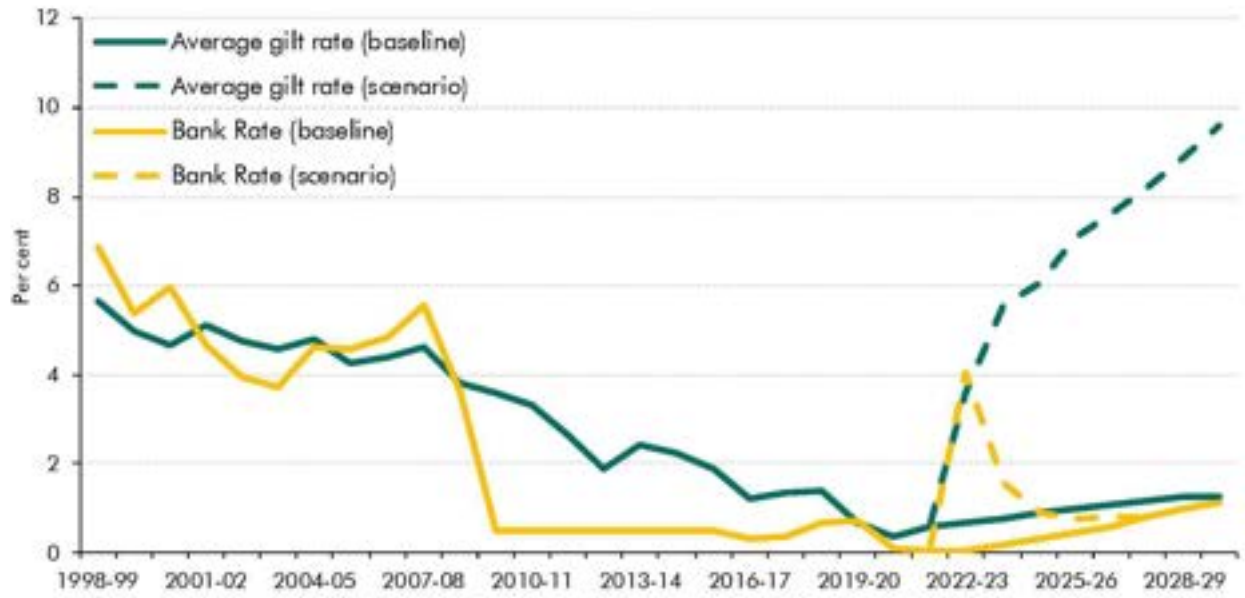
- In line with the assumptions in our previous scenarios, the **primary balance** worsens in the first two years due to falling tax receipts as GDP growth weakens, welfare spending rises though non-welfare spending is fixed in nominal terms. After 2024-25, we assume tax receipts remain constant as a share of GDP. We assume primary spending remains the same as our baseline and so does not fall with GDP. This allows us to calculate the reduction in primary spending or increase in taxes that would be necessary to compensate for rising interest costs and stabilise the debt ratio, rather than the scenario delivering this adjustment by assumption.

[70] As modelled, higher inflation delivers a fiscal benefit for the first two years as tax receipts increase with nominal GDP and non-welfare spending is fixed in nominal terms. Since inflation is due to the depreciation in sterling, the receipts benefit would probably be much smaller because it would lead to reverse fiscal drag. But such effects would small relative to the overall scenario.
[71] Estimated using the model described in *Working paper No.4: A small model of the UK economy*, OBR, July 2012.

- We assume that **private sector bailouts** in the first year of the crisis add 10 per cent of GDP to debt (a 'stock-flow adjustment'). This is comparable to the global financial crisis where financial sector interventions totalled 9 per cent of GDP.[72]

- The **average gilt rate** increases as the debt-to-GDP ratio rises because investors demand an escalating premium to hold UK government debt. We use the results of a study by Bayer, Born and Luetticke to calibrate the link between debt and the cost of borrowing, with a 10 per cent increase in government debt leading to a 250 basis point increase in the yield on government debt in the short run, fading to a 25 basis point increase in the long run.[73] As a greater reliance on short-dated debt is often necessary in severe crises such as we model here, we also assume that one third of the new debt issued by the Government during the crisis has a maturity of one year.[74] Issuing short-dated debt means that subsequent increases in interest rates feed through faster into public spending. Chart 4.24 shows the profile for average gilt rates in the scenario.

Chart 4.24: Interest rates in the loss of investor confidence scenario



Note: Average gilt rate is the average yield of gilt issuance before 2012-13
Source: Bank of England, DMO, OBR

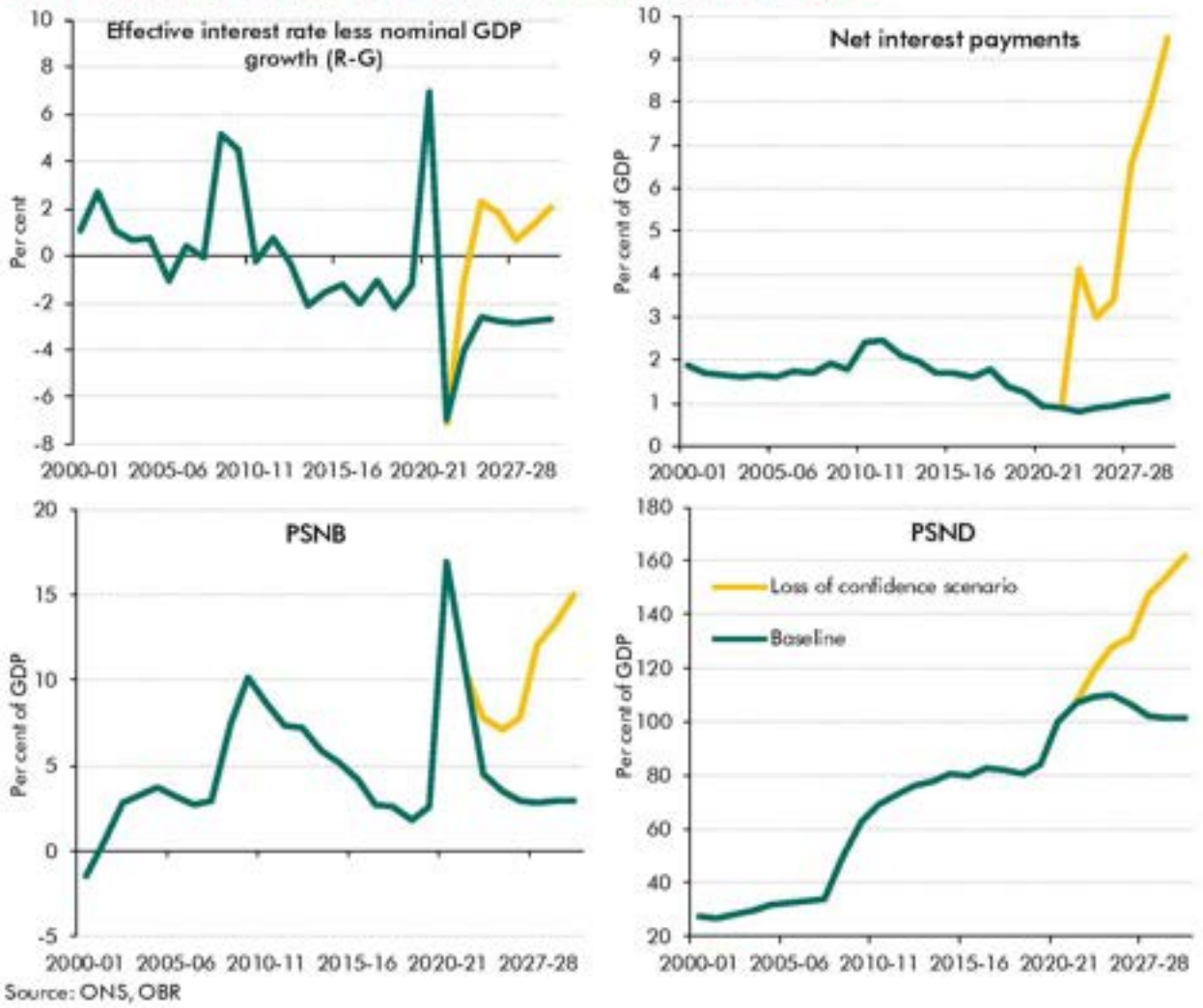
4.98 Net interest payments rise rapidly in this scenario, reaching 9.5 per cent of GDP by 2029-30 – higher than in any year in at least three centuries (the previous peak was 8.4 per cent of GDP in 1926-27). Borrowing therefore increases throughout the scenario due to higher primary borrowing as the economy shrinks and interest costs escalate (Chart 4.25), reaching 15 per cent of GDP in 2029-30. The debt-to-GDP ratio also rises in every year of the scenario and reaches 162 per cent of GDP by 2029-30 (Chart 4.25). While higher debt burdens were witnessed in 24 years of the twentieth century, the cost of servicing debt is

[72] See Annex B of our March 2021 *Economic and fiscal outlook*, calculated as a percentage of 2009-10 GDP.
[73] Bayer, C., Born, B., and Luetticke, R, *The Liquidity Channel of Fiscal Policy*, CEPR Discussion Paper 14883, 2021.
[74] This simple assumption is designed to produce an effect similar to the shortening of maturity that happens when governments need to issue large amounts of debt.

higher than at any point during that period. This demonstrates that it is the cost of servicing debt, not the debt-to-GDP ratio alone, that is central to generating financing pressures. We only show the scenario until 2029-30, as the Government would most likely need to undertake major fiscal retrenchment to stabilise the debt (discussed below) or seek support from multilateral or bilateral creditors (such as the IMF) long before this point is reached.

4.99 Rising interest costs are primarily the result of the adverse feedback loop between higher debt and higher gilt rates. The initial shock causes debt to rise 12 per cent of GDP in 2022-23, mainly due to the private sector bailouts (Chart 4.26).[75] This rise in debt pushes up the average gilt rate, which causes the Government's effective interest rate to rise and debt to increase further. By 2029-30, the average gilt rate reaches 9.6 per cent (10-year gilt rates were last at this level in 1991). The shortening of the maturity of gilts means higher market rates feed through into higher public spending more quickly. In the first few years of the scenario, higher inflation and the rise in Bank Rate also contribute to the sharp increase in interest costs.

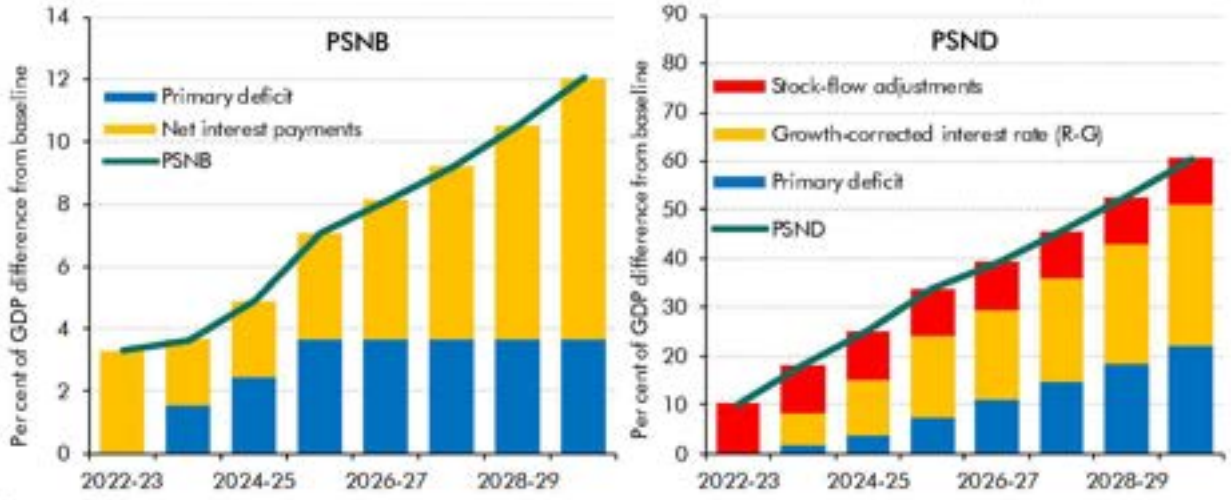
Chart 4.25: Loss of investor confidence scenario: key outputs



Source: ONS, OBR

[75] In 2022-23, real GDP falls 4 per cent below baseline and inflation rises to 4 per cent above baseline, meaning nominal GDP is unchanged. We use changes in nominal GDP to calculate changes in the primary deficit, which means the primary deficit is the same as the baseline in this year.

Chart 4.26: Loss of investor confidence scenario: differences from baseline



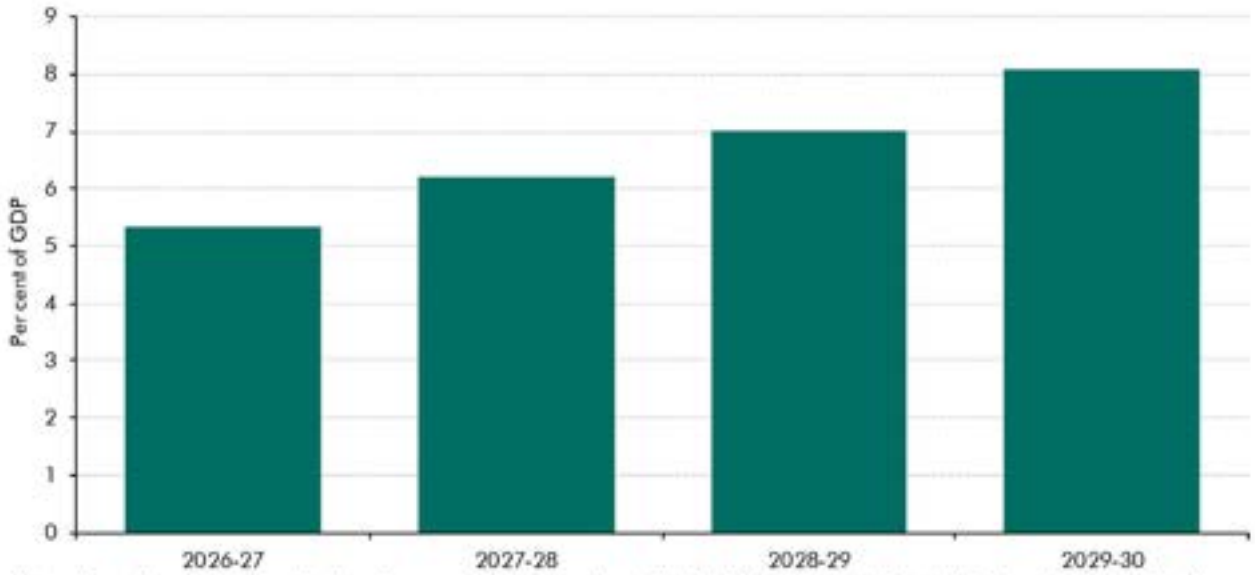
Source: OBR

4.100 In this scenario, it is possible that liquidity in the gilt market could dry up as investors struggle to price gilts accurately. March 2020 saw such incipient illiquidity, leading the Bank of England to step in as a 'market maker of last resort'.[76] Our scenario ignores such illiquidity problems, implicitly assuming that the Bank would again step in if needed. But were that not to happen, it could lead to a 'sudden stop' as buyers leave the market altogether.

4.101 As noted at the start of this section, the Government would need to make large primary deficit adjustments to stabilise debt in this scenario. Assuming this would only happen after the economy stops shrinking in 2026-27, Chart 4.27 shows that the necessary adjustments would have to be very large by historical standards. The 5 per cent of GDP reduction in the primary deficit needed to stabilise debt in 2026-27 has only occurred in 3 per cent of the years since 1700 and all of these were after wars. The required adjustment increases to 8 per cent in 2029-20 as higher interest costs have to be offset by an even larger primary surplus to stabilise debt. So acting earlier both reduces the eventual adjustment needed and stabilises debt at a lower level. It may not in practice be necessary to make a full adjustment in any individual year to break the feedback loop between rising debt and rising rates. Instead, credible plans spread over several years may be sufficient to restore lost investor confidence, allowing interest rates to fall back and making the required adjustment smaller.

[76] For an account of events see Hauser, A., *Seven Moments in Spring: Covid-19, financial markets and the Bank of England's balance sheet operations*, Bank of England Speech, 4 June 2020.

Chart 4.27: Primary surplus adjustment required to stabilise the debt-to-GDP ratio



Note: Chart shows the change in the primary surplus required to stabilise PSND excluding the Bank of England to avoid distortions from the rundown of the Term Funding Scheme.
Source: OBR

Box 4.5: The fiscal impact of the Asset Purchase Facility

The Asset Purchase Facility (APF) houses the assets (predominantly gilts) purchased by the Bank of England as part of its programme of quantitative easing initiated in 2009. QE has had a variety of impacts on the public finances, for example: indirectly through its impact on the wider economy; through lowering yields on government debt; and through shortening the effective maturity of the consolidated public sector's liabilities. This shortening of maturity arises as Bank reserves (floating rate debt) have been used to purchase gilts (long-term fixed-rated debt). This has increased the short-run sensitivity of debt interest payments to rate rises. To date, the APF has benefitted the Treasury (which receives the cash surplus) as the higher rates on longer-dated debt have meant that the payments on the additional reserves have fallen far short of the payments on the associated gilts. Our March forecast shows the APF paying £0.6 billion in 2022-23 on the £875 billion reserves issued by then to finance gilt purchases (a rate of under 0.1 per cent), but receiving £17.2 billion on the purchased gilts (a yield of 2.0 per cent). This reduces overall public sector interest payments to the private sector (and therefore the deficit) by £16.6 billion. To date, positive cash flows from the APF to the Treasury have totalled £113 billion.

It should be noted, though, that despite the large direct reduction in debt interest costs associated with the APF (reducing the effective interest rate by about 0.8 percentage points), the total fall in debt interest costs over the past decade is much larger (4.1 percentage points). The overall fall reflects lower Bank Rate and a flatter yield curve, in part a consequence of quantitative easing.

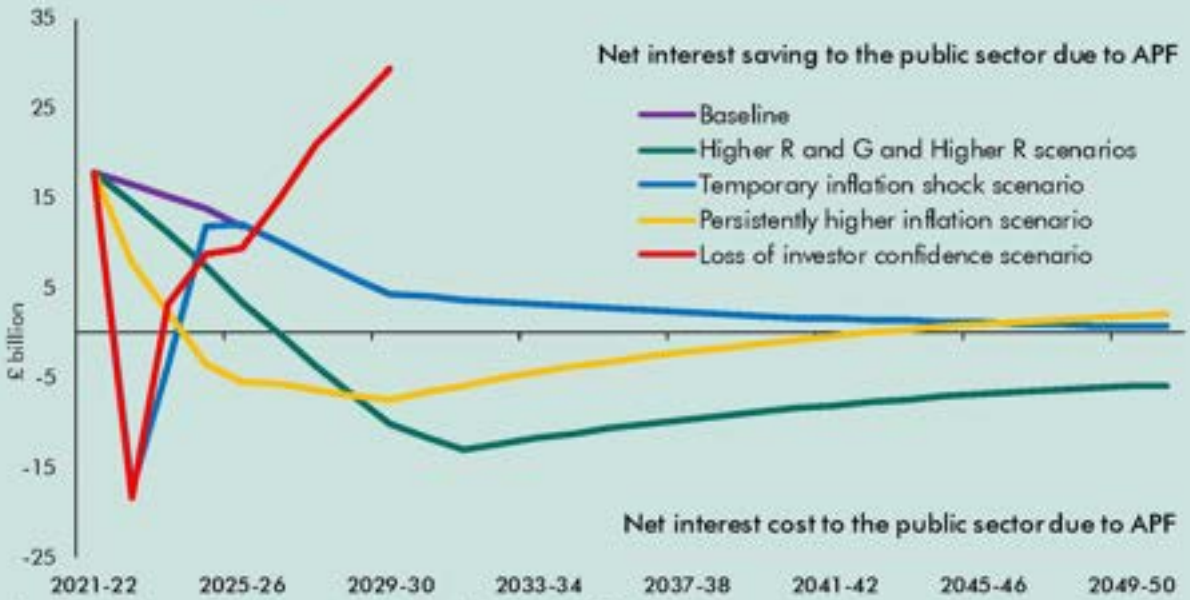
In the scenarios used in this chapter, we hold the size of the APF constant. Changes to Bank Rate (quickly) and the rate paid on gilts (more slowly) alter the 'wedge' between the APF's interest

receipts and payments. In the baseline, net interest savings gradually decline, at first largely because Bank Rate rises and then as gilts mature and are rolled over at lower rates (Chart D).

In the 'higher R' and 'higher R and G' scenarios, a rising Bank Rate sharply increases payments on reserves reducing the cash surplus of the APF and by 2026-27 these payments exceed the coupon income earned and so the APF shows a deficit. Gradually, as gilts are rolled over at higher rates, these losses diminish. The 'persistently higher inflation' scenario shows a similar pattern, though here, gilt rates rise far enough that eventually the APF returns to surplus.

Under the 'temporary inflation shock' scenario, sharp increases in Bank Rate quickly send the APF into deficit. But as the rise in Bank Rate is only temporary, after a few years the APF returns to surplus. At the start, the 'loss of investor confidence' scenario is similar, but here the surplus keeps rising as the soaring gilt rate rapidly increases earnings on rolled over gilts.

Chart D: Net savings to the public sector of the APF in our scenarios



Note: Loss of investor confidence scenario only shown to 2029-30

Source: OBR

In practice, were inflation pressures to pick up markedly, the MPC might choose to reduce the size of the APF rather than relying solely on Bank Rate to tighten monetary policy. This would be consistent with the MPC's current guidance that it *"intended not to reduce the stock of purchased assets until Bank Rate reached around 1.5%"*,[9] though the Governor has noted that this guidance is currently under review. This would have several effects on the APF:

- **Bank Rate** would need to rise less in order to meet the inflation target, resulting in a larger surplus/smaller deficit.
- The **smaller size of the APF** would correspondingly reduce the size of future surpluses or deficits.
- **Gilt sales** would be likely to take place at a lower price than was originally paid, leading to a cash loss (on the assumption that sales only take place once Bank Rate has exceeded

1.5 per cent), which, under the Government's indemnity on the APF, would be made good by the Treasury. Such trading losses could potentially be large: as of April 2021, selling all gilts in the APF portfolio at par would crystallise a trading loss of £114 billion.

The extent to which APF sales could substitute for increases in Bank Rate will depend on how fast sales could take place. In practice a run-down is likely to take several years, as the MPC has indicated that any reduction in the stock of assets will be at a *"gradual and predictable pace"*.[b]

In principle, the Government could cover any reduction in the cash flow from the APF by raising taxes, reducing spending, or increasing borrowing. Commentators have also advanced several alternative suggestions for mitigating the reduction in cash flow itself:

- **Lowering (possibly to zero) the interest paid on reserves.**[c] This is economically equivalent to maintaining the existing arrangements and introducing a new tax on banks related to their reserve holdings. Also, because it would increase the opportunity cost of holding reserves relative to other assets, it would change the nature of the monetary transmission mechanism and force the Bank of England to change its technique of managing short-term interest rates. It would also divert financial flows from banks to other less transparent channels.
- **Require banks to hold some minimum level of reserves but pay a low or zero interest rate on them, paying Bank Rate on only the excess**.[d] This would maintain the effectiveness of Bank Rate as a monetary policy tool, but would not avoid the consequences for banks' profitability of acting like a tax on reserve holdings.
- **Delaying the fiscal consequences of higher interest rates**, for example by exchanging some of the reserves for short-maturity gilts.[e] This would reduce the speed with which interest rate changes fed through to spending, but would come with increased funding risk, since reserves do not need to be rolled over whereas the new securities would.

In conclusion, a tightening in monetary policy is likely to result, one way or the other, in a smaller contribution of the APF to the public finances. And though there are ways this could be mitigated, they each involve drawbacks of their own.

[a] *Monetary policy summary and minutes of the monetary policy committee meeting ending on 20 June 2018*, Bank of England.
[b] *Monetary policy summary and minutes of the monetary policy committee meeting ending on 20 June 2018*, Bank of England.
[c] Goodhart, C., Evidence to House of Lords Select Committee on Economic Affairs, 16th March 2021.
[d] Turner, A., Evidence to House of Lords Select Committee on Economic Affairs, 16th March 2021 and Holtham, G. "Monetary Policy and the Value of Public Debt" in *Designing a New Fiscal Framework: Understanding and Confronting Uncertainty*, (edited by J. Chadha, H. Küçük and A. Pabst), 2021.
[e] Allen, W., *Managing the fiscal risk of higher interest rates*, NIESR policy paper 25, 2021.

Conclusion

4.102 Interest rates on advanced economy government bonds have declined for several decades. Since the mid-1990s, this has been almost entirely attributable to a fall in real interest rates rather than lower inflation. As interest rates have declined faster than economic growth, this has also moved the growth-corrected interest rate well into negative territory. This has been

true in the UK too, where the decline in interest rates has resulted in a fall in debt interest costs despite the rise in debt from the financial crisis and the pandemic.

4.103 Several explanations have been put forward for this fall in bond rates, including demographics, the productivity slowdown and shifts in portfolio preferences, but there is still disagreement about their relative importance. This uncertainty carries over into uncertainty about the future path of rates. Some factors that affect the savings-investment balance, particularly demographics, may be starting to reverse though the impact on rates is likely to be felt only gradually at best. But other forces, especially those affecting portfolio preferences, could reverse more rapidly.

4.104 Our first two scenarios explored the fiscal consequences of a gradual rebound in real interest rates. Higher interest rates on their own (say because of a shift in portfolio preferences) would add to the fiscal headwinds facing the Government. But a rise in interest rates that is associated with faster growth (perhaps driven by a revival in productivity growth) would produce a more benign outcome; although debt interest costs rise, that is offset by the faster expansion in the size of the economy, so that the path of the debt-to-GDP ratio is a little lower, although still above its pre-pandemic level after 30 years.

4.105 Our third and fourth scenarios explored the fiscal consequences of a rise in interest rates that is instead associated with higher inflation. Temporarily higher inflation produces a small reduction in the debt burden, though a good part of that arises from the short-run cash limits on government spending. Persistently higher inflation produces a similar outcome in the short to medium run, but is actually counterproductive in the long run because of an assumed rise in the inflation risk premium on nominally-denominated bonds. In both scenarios the share of revenues consumed by interest payments rises. The relative ineffectiveness of inflation in reducing the debt burden reflects several factors, including the shortening of the effective maturity of the consolidated public sector's liabilities as a result of quantitative easing and the relatively high share of indexed-linked bonds.

4.106 Finally, we explored the consequences of a loss of investor confidence leading to a debt crisis. Currently the demand for UK gilts is fairly robust and the risk of a debt crisis in the UK in the near future seems remote. But debt crises do happen from time to time, even in advanced economies, so in line with the emphasis of this *Fiscal risks report* on catastrophic risks, we also modelled a scenario in which investor confidence is lost, leaving debt interest costs and the debt-to-GDP ratio spiralling higher. In these conditions an unsustainable position can develop quickly, and early action to halt the spiral is desirable. But, in our admittedly extreme scenario, the size of fiscal adjustment necessary exceeds that which has been achieved in the past century (outside of the large automatic corrections that occur after the end of major wars and also expected to be the case as the pandemic subsides and support measures such as the CJRS are wound down). That speaks to the importance of avoiding triggering such a spiral in the first place, by maintaining investors' confidence in the Government's commitment to monetary and fiscal responsibility and the institutions that support them.

5 Update on other fiscal risks

Introduction and summary

5.1 The preceding chapters of this report have focused on three large and looming threats to the public finances, but the array of other fiscal risks highlighted in previous reports have not evaporated. Indeed, as this chapter shows and as history warns, the pandemic has triggered the crystallisation of several of these risks, aggravated many others, and even diminished a few. This final chapter details how these other risks have evolved since our previous *Fiscal risks report* (*FRR*) in July 2019 and how our full risk assessment has changed after factoring in both those changes, and the risks discussed in the preceding chapters.

5.2 Our 2019 report was accompanied by our first risk register, which identified 106 risks from the 57 issues we raised in our 2017 *FRR* plus additional ones from the 2019 report. The *Charter for Budget Responsibility* requires the Treasury to respond formally to the *FRR* within a year of its publication. The Treasury's 2018 *Managing fiscal risks* report was a substantive 140-page response to our initial report. The Government's response to our 2019 *FRR* was understandably overtaken by the pandemic and the Treasury's focus on developing and delivering the economic policy response to the crystallisation of what has proved to be the largest fiscal risk in peacetime. Its official response to the 2019 *FRR* therefore constituted a brief Written Ministerial Statement by the Chancellor on 14 July 2020, which discussed only four issues that in one way or another related to 12 of the 106 risks we had identified.[1]

Changes in fiscal risks since 2019

5.3 For this report, we have first recast and consolidated some of the risks that were identified on our 2019 register, bringing the total down to 97. Of these:

- **14 have crystallised** including weaker productivity growth, lower net migration, and the declining proportion of spending subject to firm DEL controls. Of these, **13 remain active** risks in future (including normal cyclical downturns, the deterioration in public sector net worth, and cost overruns for major projects) and **1 has been removed** (the balance sheet risk relating to the classification of housing associations).

- **19 have increased**, including those related to higher future health and social care spending as a result of the pandemic, the longer-term sustainability of the fuel duty tax base in light of the bringing forward of the ban on petrol-driven cars, and the pandemic-driven increase in the non-payment of taxes due.

[1] The issues that were referenced were weak productivity (which accounted for two of the 90 risks), climate change (six risks), shadow banking (three risks) and tax reliefs (one risk).

- **11 have decreased**, including the tendency for fiscal policy to respond asymmetrically to movements in our underlying forecasts following the tax rises announced in the March Budget, the risks associated with persistent household financial deficits in light of the savings accumulated by some during the pandemic, and the loss of revenue from people moving to more lightly taxed forms of employment status.

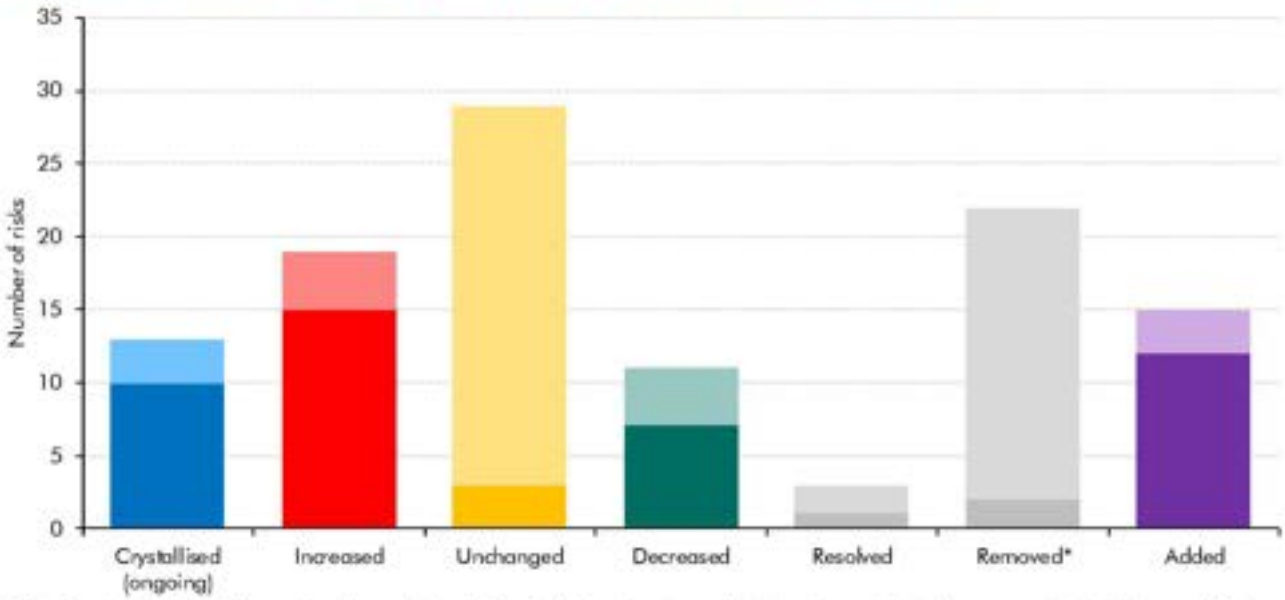
- **29 remain unchanged**, including our broad assessment around risks associated with the financial sector, which has so far weathered the coronavirus storm, clean-up costs for nuclear plants, and those around stated policy aspirations.

- **3 have been resolved and removed** from the register, including those around the possibility of a 'no deal' Brexit and the rise in local authorities' prudential borrowing for commercial property purchases.

- **21 have been removed for other reasons** including their being unquantifiable, superseded by analysis presented in this report, or consolidated with other risks (taking the total number of risks removed from the register to 25).

5.4 Finally, **15 risks have been added** in this report including nine arising from the coronavirus pandemic, three associated with climate change, two relating to the cost of public debt and a final one on the threat posed by potential cyberattack. This takes the total number of risks in our register to 87. Chart 5.1 depicts these changes as well as the number of risks that have been affected to some extent by the pandemic.[2]

Chart 5.1: OBR fiscal risk register: changes since our 2019 report



Note: Darker shaded portions show the number of risks within each category that have been affected to some extent by the pandemic.
* The one risk that has crystallised and is no longer on the register is included in 'Removed'.
Source: OBR

[2] Chart 5.1 classifies all those risks with a coronavirus impact labelled as 'Maybe' in Tables 5.1 to 5.10 as having had an impact.

Impact of coronavirus on other fiscal risks

5.5 Reflecting the correlated nature of fiscal risks, of the 97 risks from 2019, 38 have been affected to some extent by the coronavirus pandemic. This includes around half of the economy risks, two-thirds of the public spending risks, half of the risks relating to the Government's balance sheet and one-third of revenue risks. Of those 38, in 15 cases the risk has increased and in ten cases it has crystallised (with the remaining 13 being either unchanged, decreased resolved or removed).

5.6 Examples of those affected, each of which is discussed in more detail below, include:

- **Pandemic-related pressures on health spending** that are described in Chapter 2. These could amount to £7 billion a year on average over the next three years, with pressures likely to be greatest in the near term. The larger sources of potential pressure include: maintaining a standing capacity for test and trace and vaccinations; addressing the backlog of elective treatments built up during the pandemic; and the implications for NHS productivity of building in greater resilience and a greater capacity for infection control than was allowed for in pre-pandemic plans

- **The state pension triple lock**, where unusual pandemic-related fluctuations in earnings growth have seen it rise to 5.6 per cent in the three months to April 2021, from where it is almost certain to rise further in the three months before the uprating is calculated. The triple lock raises spending by £0.9 billion for every 1 percentage point, and our March forecast assumed uprating of 4.6 per cent next year. So, if earnings growth in the three months to July period that determines triple lock uprating for next April was 8 per cent, as some expect, that would add around £3 billion a year to spending.

- **The risk of lower net migration**, which has crystallised as the pandemic and associated lockdown has led to significantly fewer net arrivals into the UK than we previously expected, with initial modelling suggesting that there was a net outflow of around 67,000 between March and June 2020 alone.

- **Non-payment of taxes due and the tax gap**, where the lockdowns led to sharp rises in unauthorised tax debt, which were then overlaid by Government support measures allowing taxpayers to defer self-assessed income tax and VAT payments. To give a sense of scale, around £34 billion of VAT was deferred between March and June 2020, and just under half had already been repaid by the end of April 2021.

- **Risks associated with statistical reclassifications**, such as the bringing of some train operating companies into the public sector during the pandemic. The scale of the impact of this on the government balance sheet has not yet been quantified.[3]

[3] As noted in ONS, *Recent and upcoming changes to public sector finance statistics*, May 2021, the ONS has so far partially implemented the reclassification of train operating companies and the full balance sheet impact is not yet known.

Structure of the chapter

5.7 The remainder of this chapter summarises our updated assessments for each of the 97 risks from the 2019 risk register and describes the reasons for material changes.[4] Risks are grouped into those deriving from the economy, financial sector, government revenue, government spending, the government balance sheet, and the fiscal policymaking process. We also discuss the 21 risks that have been removed and the 15 that have been added in this report (some that are genuinely new and some that we have assessed for the first time).

Economy risks

5.8 Since our 2019 *FRR*, of the 13 economy risks that we identified: five have crystallised (of which four reflect the same risk crystallising over both the medium and long term), two have increased, one has decreased, one has been resolved, one has been consolidated into another, and the remaining three are unchanged. Only weak productivity growth was referenced in the Treasury's 2020 response to our report.

[4] The tables in this chapter present each of the risks from the 2019 risk register and our latest assessment of those risks in terms of the probability of the risk crystallising and its impact on public sector net debt. The risks are grouped into those that affect the medium term, within our typical 5-year forecast horizon, and longer-term risks that lie beyond that horizon. Some risks span both the medium and long term. The note beneath each table briefly explains the methodology, and more information is available in our online fiscal risk register.

Table 5.1: Latest assessment of the economy risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Weak productivity growth*	Medium	Medium	Maybe	●	◆
Low migration *	Medium	Medium	Yes		◆
Recession*	Medium	High	No		◆
Composition of GDP	Medium	Low	No		—
Housing sector exposure	Medium	Not quantified	Yes		⬆
Household financial deficits	Medium	Not quantified	Yes		⬇
Current account deficits	Medium	Not quantified	No		—
Output gap mismeasurement	High	Medium	Yes		⬆
Risks from 'no deal' Brexit	N/A	N/A	No		×
Long term					
Weak productivity growth*	Medium	Medium	Maybe	●	◆
Low migration	Medium	Medium	No	●	—
Recession*	High	Medium	No		◆

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ⬆ Increased — Unchanged ⬇ Decreased × Removed

5.9 The main changes are:

- The fiscal risks associated with **weak productivity growth** have crystallised in both the medium and long term. In our March 2020 *Economic and fiscal outlook* (*EFO*), we lowered our long-run productivity growth assumption from 2.0 per cent to 1.5 per cent a year, having reviewed historical and international evidence.[5] We also revised down our central forecast for the level of productivity due to the scarring effects of the pandemic (while leaving our long-run productivity growth assumption unchanged). But while the productivity risk has crystallised since 2019, it remains possible that it could deteriorate further, for example if the pandemic weighs on productivity growth, the impact of Brexit is greater than we have assumed, or the post-financial crisis period of sluggish growth continues, so we consider this to remain a live risk.

- The one-in-two chance of a **recession** in any five-year period has also crystallised, though the pandemic can hardly be described as a 'typical recession', with the largest annual fall in output since 1709. This is another risk that remains active despite crystallising, as the likelihood of future shocks has not diminished. Indeed, as we

[5] See Annex B, Long-term economic determinants, in our March 2020 *Economic and fiscal outlook*.

discuss in Chapter 1, the world may in fact be becoming riskier than the historical experience that underpins the probability and impact reported in Table 5.1.

- The risk of **lower net migration** has crystallised as the pandemic and associated lockdown has led to significantly fewer net arrivals into the UK than we previously expected (with both outflows likely to have been higher and inflows lower). Experimental estimates from the ONS suggest that net migration was negative at 67,000 during the second quarter of 2020[6] compared with positive net inflows of 271,000 in 2019 as a whole.[7] Medium-term risks have increased due to uncertainties around the economic outlook in the UK and source countries for inward migrants, including the possibility of continuing travel restrictions, as well as the fact that any post-pandemic catch-up migration will need to take place under the new, post-Brexit migration regime, which is more restrictive on average than the previous regime.[8]

- The conclusion of the UK-EU Trade and Cooperation Agreement on 24 December 2020 **resolved the risks that were associated with a 'no deal' Brexit**. We previously estimated that were the UK to default to trading with the EU under World Trade Organization rules when the transition period ended on 31 December 2020, then real GDP would have been 2 per cent lower in 2021 (mainly due to temporary short-term disruptions). The weakening of productivity over the medium and long term would have reduced output by around 1½ per cent after five years, rising to 2 per cent in steady state. The fiscal implications of this would have been to raise borrowing by an average of 0.5 per cent of GDP between 2020-21 to 2025-26.[9]

5.10 The other changes to our assessments are:

- The **Government's direct fiscal exposure to the housing sector has increased** following the announcement of a new mortgage guarantee scheme that was introduced in the March Budget and is due to run until December 2022.

- The **uncertainty around real-time output gap estimates and its policy implications has increased**. Public health restrictions to control the pandemic have acted to restrict both supply and demand, while government support measures have made it harder to disentangle one from the other. The risk has been amplified by large swings in the data and the wider difficulty in measuring the economy at present.

- The **risks associated with persistent household financial deficits have improved**. Households reduced consumption during the pandemic, lowering their outlays, while some have benefited from generous fiscal support measures protecting their incomes. The net effect has been to boost household financial wealth. For example, deposits increased by 14 per cent (£210 billion) between February 2020 and April 2021, while consumer credit fell 18 per cent (£24 billion) over the same period.

[6] ONS, *Using statistical modelling to estimate UK international migration*, April 2021.
[7] ONS, *Provisional long-term international migration estimates*, August 2020.
[8] See Box 2.4 of our March 2020 *Economic and fiscal outlook*.
[9] See Annex B, Brexit scenarios, in our November 2020 *Economic and fiscal outlook*.

Financial sector risks

5.11 Our assessment of the fiscal risks associated with the financial sector is unchanged.

Table 5.2: Latest assessment of the financial sector risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Financial crises impact	Low	High	No		—
Long term					
Financial crises impact	Very high	Medium	No		—
Post-crisis regulation loosened over time	Low	Not quantified	No		—
Large and concentrated banking system	Low	Not quantified	No		—
Shadow banking	Very low	Low	No	●	—
Regulation risks	Very low	Low	No		—

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ⬆ Increased — Unchanged ⬇ Decreased ✕ Removed

5.12 The lack of pandemic-related deterioration reflects two factors:

- first, reforms that took place during the post-financial crisis decade meant that **the banking system entered the pandemic much better capitalised**, and therefore more resilient to shocks, than in the 2000s; and

- second, **the authorities stepped in aggressively** to ensure markets continued to function smoothly (thanks in particular to the Bank's additional gilt purchases) and to support households and businesses, thereby reducing credit risks around banks' loan assets (thanks in particular to the £75 billion of government guaranteed loan schemes).

5.13 This accords with the assessment in the Bank of England's most recent *Financial Stability Report* from December 2020, which argues that the performance of the financial system through the pandemic reflects *"the resilience that has been built up since the global financial crisis, and the extraordinary policy responses of the UK authorities"*.[10]

5.14 Of course, reducing fiscal risks that might crystallise via the financial sector by taking on direct exposure to borrowers via loan guarantee schemes does not reduce the *overall* fiscal risks associated with bankruptcies and loan defaults, which will rise to the extent that the associated losses are no longer borne by lenders and are instead transferred to the state.

[10] Bank of England, *Financial Stability Report*, December 2020.

Revenue risks

5.15 Of the 17 revenue risks from our previous report, none have crystallised and few have been affected by the pandemic. Three risks have increased, five have decreased, and nine are unchanged. Only one was referenced in the Treasury's 2020 response to our 2019 report.

Table 5.3: Latest assessment of the revenue risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Income tax reliance on high earners	Low	Low	Maybe		—
Stamp duty reliance on top end	Low	Low	Maybe		—
Self-employment and incorporations	Low	Low	Maybe		↓
Excise duties: behaviour or technology change	Medium	Low	No		↑
Policy non-implementation	Very high	Low	No		—
Policy aspirations not yet costed	High	Medium	No		—
Reliance on anti-avoidance measures	High	Low	No		↓
Complexity of tax legislation	Low	Low	No		—
Non-payment of taxes due and the tax gap	Medium	Low	Yes		↑
Tax reliefs: costs continue to rise	Medium	Medium	No	●	↓
Digitalisation: tax policy challenges	Medium	Low	No		—
Digitalisation: administration gains	Medium	Low	No		—
Financial services: Brexit impact on tax receipts	Very high	Low	No		↓
Long term					
Self-employment and incorporations	Medium	Low	Maybe		↓
Tobacco: downard consumption continues	High	Low	No		—
Fuel duty: further efficiency improvements	High	Low	No		↑
Oil and gas decommissioning costs	Very high	Low	No		—

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ↑ Increased — Unchanged ↓ Decreased × Removed

5.16 The five improvements relate to:

- **The loss of revenue as people move to more lightly taxed forms of employment status.** Policy decisions have reduced the medium- and long-term incentive for individuals to incorporate and benefit from paying the lower rate of tax on corporate profits (and dividends) compared to the higher rates of income tax and National Insurance contributions paid on employment income. The most significant change is the reversal in the decade-long reduction in the main rate of corporation tax – first by maintaining

the 19 per cent rate at Budget 2020 (rather than implementing the planned cut to 17 per cent) and then by announcing an increase to 25 per cent from April 2023 in the March 2021 Budget, the latter raising £17.2 billion a year by 2025-26. Reforms to off-payroll working (announced at Budget 2018 but implemented this April) also reduce the incentive. Another factor that might reduce the future attractiveness of incorporating is that owner-managers have been less generously supported than either employees or the self-employed by the Government's coronavirus support measures. The reintroduction of a small profits rate tempers the effect of these reforms for those with profits of up to £250,000 (particularly those at £50,000 and lower that will still pay a 19 per cent rate).[11]

- **Reliance on anti-avoidance and compliance measures with relatively uncertain costings.** While the Government has sought to continue to raise revenue from HMRC anti-avoidance and compliance measures, it has reduced its reliance on these types of measures. Anti-avoidance and compliance measures announced in the past two Budgets are estimated to raise less than £2 billion a year by 2025-26. This is dwarfed by the close-to £33 billion that is expected to be raised in the same year from the increases to the corporation tax rate and the freezing of income tax thresholds, the costings for which are considerably less uncertain than those for typical anti-avoidance and compliance measures.[12] By comparison, in the five fiscal events between Budget 2016 and Budget 2018 the expected yield from anti-avoidance and compliance measures accounted for around 40 per cent of the total from all revenue-raising measures across the same period – a far higher proportion.[13]

- **The high and rising cost of tax reliefs and expenditures, and the poor understanding of changes over time.** At Budget 2020 the Government announced two significant policy changes: the removal of entitlement to use red diesel and rebated biofuels from most sectors from April 2022; and a reduction in the lifetime allowance for the business asset disposal relief (formerly entrepreneurs' relief) from capital gains tax from March 2020. The combined savings from these two measures rises to £3.5 billion a year by 2024-25. HMRC has also expanded the number of reliefs for which it publishes costs. That said, the cost of R&D tax credits continues to rise quickly, and there remains an ongoing challenge around new reliefs, including those to be introduced as part of the 'freeports' package discussed below.

- **Potential effects of Brexit on the financial sector and the tax receipts it generates.** The fiscal risks from a no-deal Brexit have been averted, so while there remains uncertainty over the future relationship between the UK and the EU, particularly with regard to financial services, our assessment is that Brexit-related revenue risks have decreased.

[11] For a fuller discussion, see paragraphs A.10 to A.14 in Annex A, Policy measures, of our March 2021 *Economic and fiscal outlook*.
[12] This includes the March 2020 Budget decision to maintain the corporation tax rate at 19 per cent, rather than the planned reduction to 17 per cent.
[13] Based on the aggregated costings across all years of the forecast at the time.

5.17 The three revenue risks to have worsened since 2019 are:

- **The pressure on excise duty tax bases from behavioural and technological change**, in particular the long-term downward trends in fuel and tobacco consumption. The main change relates to the former, where the Government has announced that it will bring forward the ban on sales of new petrol and diesel cars and vans to 2030, ten years earlier than was mooted in 2019, which affects both the medium and long term. The pace at which electric car sales have been rising has repeatedly exceeded our forecasts (as discussed in Box 3.2). Fuel and vehicle excise duties are forecast to raise just under £39 billion in 2025-26, so the risk is fiscally material – particularly over the long term.

- **Non-payment of taxes due and the tax gap**. The lockdown in spring 2020 led to a sharp rise in tax debt, particularly for PAYE income tax. This was then overlaid by Government support measures allowing taxpayers to defer self-assessed income tax and VAT payments. As we reported in our November and March *EFOs*, much of the deferred and unpaid tax was swiftly repaid – no doubt aided by the Government's suite of financial support measures – but our forecast does assume that some will ultimately go unpaid.[14] To give a sense of scale, around £34 billion of VAT was deferred between March and June 2020, and just under half had already been repaid by the end of April 2021. We also assume a relatively modest medium-term impact on business rates, but there remains the risk that some businesses may be unable to pay once the payment holiday ends in March 2022, for example due to the pandemic-induced jump in online retailing. A second factor contributing to the worsening of this tax gap risk since 2019 is the continuing uncertainty around elements of the post-Brexit trading regime. In our November 2020 *EFO* we included a non-compliance loss of £0.7 billion in VAT and excise duties in 2021-22 to account for risks around the operation of the UK border, including the decisions to phase in customs controls and introduce postponed accounting for most import VAT.[15] The eventual outcome of negotiations around the operation of the Northern Ireland protocol is another unknown, and one that we do not yet have sufficient information about to quantify for our forecasts.

5.18 The risk around **policy aspirations** is ever-present, with new ambitions continuously replacing or augmenting existing ones. Many of the risks that we outlined in 2019 have now crystallised – the 2 per cent stamp duty land tax surcharge for residential property purchases by non-UK residents will raise £0.1 billion in 2025-26 and the plastic packaging tax a further £0.2 billion in the same year. Several Brexit-related policies have also now been confirmed. In their place are manifesto commitments to raise the National Insurance threshold, aspirations related to reducing emissions to net zero by 2050, and more.[16] Until these are confirmed government policy we are prevented by legislation from costing them, though in most cases there is simply insufficient policy detail to arrive at a reasonable and central estimate. Some of the potentially larger new policy risks include:

[14] Proportions vary by tax, with the most fiscally significant being the 7 per cent non-payment rate assumed for PAYE tax debt.
[15] This is described in detail in Annex A, Policy measures, in our November 2020 *Economic and fiscal outlook*.
[16] See the *Policy risks database* on our website for the complete current list.

- **The G7 Finance Ministers' agreement around the taxation of multinational company profits**. Pillar One of the agreement grants taxation rights to market countries and applies to multinationals with global profit margins in excess of 10 per cent. At least 20 per cent of profits beyond the 10 per cent margin will be subject to tax in the market jurisdiction. Pillar Two is a commitment to a global minimum tax rate of at least 15 per cent, on a country-by-country basis. The G7 agreement is not legally binding on non-member countries and the next stage in the process takes place in the forthcoming G20 meeting. The Chancellor has committed to removing the digital services tax (DST, forecast to raise £0.4 billion this year, rising to £0.7 billion by 2025-26) once a Pillar One solution is in place. The Government expects the agreement to raise revenue, but there remain too many uncertainties to determine a reasonable and central estimate at this stage, with initial external estimates varying considerably.[17]

- **Bank surcharge**. If the Government's ongoing review confirms its initial view that levying the existing bank surcharge rate on top of the planned 6 percentage point rise in the corporation tax rate would result in a *"combined level of bank taxation [that] would be too high"*, ensuing policy changes would reduce revenue. We forecast the bank surcharge will raise £1.4 billion in 2025-26 at a rate of 8 per cent, so roughly £0.2 billion per percentage point of the existing tax rate.

- **The Chancellor's March Budget announcement on the eight English locations that are due to become 'freeports' later this year**. Freeports are designated areas within a country that usually lie outside its customs territory. The freeports will benefit from simplified customs arrangements and duty suspension in approved customs sites, plus several tax concessions that are yet to be costed. These could include enhanced capital allowances, and reliefs for stamp duty land tax, employer NICs, and business rates. Once sufficient detail on these concessions is available, we will be able to factor their cost into our forecasts.

- **Uncertainty over the implementation and operation of the Northern Ireland protocol**. The UK-EU Joint Committee that is tasked with overseeing the implementation of the protocol published operational decisions last December, including several temporary 'grace periods' for the collection of customs duties as requested by the UK Government. Since then, the UK Government has unilaterally extended some grace periods, leading the European Commission to express *"the EU's strong concerns"* over the action. Current statements from both parties suggest it may be a while before final implementation, and the ensuing fiscal consequences, are determined.

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[17] Law firm Clifford Chance estimated that *"the likely additional government revenue from topping up large UK company profits to a global minimum tax rate of 15 per cent would depend on the exact rules but were likely to fall in a range of £900m to £5bn a year based on 2019 figures,"* but also that the upper estimate was *"almost certainly too high"*. But the think tank Taxwatch has suggested that *"for every company that is subject to the DST, the Pillar One proposals would lead to substantially less money being raised in taxation in the UK"*.

Spending risks

5.19 Reflecting the dramatic impact of the pandemic on public spending, of the 27 spending risks identified in our register (after consolidating three from the original 30 into other risks), 17 have been affected by the coronavirus pandemic in either the medium or long term. Of these 27 risks, five have crystallised (all remain active), nine have increased, three have decreased, two have been resolved, and only eight remain unchanged since 2019. None were referenced in the Treasury's 2020 response to our 2019 report.

Table 5.4: Latest assessment of the spending risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Less spending subject to DEL controls*	Very high	Not quantified	Yes		◆
Major project cost overrun*	Medium	Low	Yes		◆
Spending announced outside SRs*	Very high	Medium	Yes		◆
State pension triple lock	High	Medium	Yes		↑
Implementation of welfare reform	Very low	Low	Yes		↓
Welfare system legal challenges	Low	Low	No		↓
Precedent from reversing welfare cuts	High	Low	Yes		↑
Additional health spending	Very high	Low	Yes		↑
Topping-up health spending settlements	Very high	Medium	Yes		↑
Health costs from NLW and migration	High	Low	No		↑
Adult social care	Very high	Medium	Yes		↑
Higher tax litigation costs	Low	Low	No		—
Higher clinical negligence payments	Very low	Low	Yes		↑
Clinical negligence: legal fees costs	Medium	Low	No		—
LAs running down reserves	Low	Low	Yes		↓
LAs borrowing for commercial property	Very low	Low	Yes		×
Devolved administration borrowing*	Medium	Low	Yes		◆
Devolved administration top-ups*	Medium	Low	Yes		◆
Brexit-related exchange rate volatility	Very high	Low	No		×
Long term					
State pension triple lock	Low	Medium	No		—
Additional health spending: demographic	Very high	Medium	Yes		↑
Additional health spending: other pressures	High	High	Yes		↑
Adult social care: ageing	Very high	Low	No		—
Adult social care: other pressures	Very high	Medium	Yes		—
Sellafield clean-up	Low	Low	No		—
Clean-up costs for new nuclear plants	Low	Low	No		—
Nuclear decommissioning	Low	Low	No		—

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ↑ Increased — Unchanged ↓ Decreased × Removed

5.20 Of the five risks that have crystallised:

- Two relate to the control of spending within departmental limits. The risk around **the declining proportion of total spending subject to relatively firm DEL controls** has clearly

escalated during the pandemic, due to both the unprecedented size of the Government's discretionary policy response, as described in Chapter 2, and the suspension of multi-year planning that it has prompted. This has also led to the crystallisation of **the tendency for major spending policies to be announced outside Spending Reviews**, with a succession of (often large) spending announcements taking place during 2020.[18] Chapter 2 also considers the significant potential unfunded legacy costs of the pandemic for public services, focusing on those relating to health, education and transport. Both issues clearly remain potential fiscal risks for the future.

- Two relate to spending by the devolved administrations (DAs). The larger of the two is the **pressure to top-up devolved administrations' budgets outside the funding mechanisms set out in the 'fiscal frameworks'** between the UK Government and the Scottish and Welsh Governments respectively. This was significantly affected by the pandemic and the large associated increase in UK Government spending, which had similarly large 'Barnett consequentials' for DAs' budgets. In light of the speed and scale of in-year spending announcements, the Treasury guaranteed additional funding to the DAs, which by December had reached £16.8 billion that the DAs could spend in 2020-21. By February's Supplementary Estimates for 2020-21, the Barnett consequential on additional UK Government spending had reached £18.9 billion, and the DAs were allowed to choose whether to receive their portion of the additional £2.1 billion in 2020-21 or 2021-22, with all choosing the latter. The guarantees provided a firmer base from which each DA could plan their spending but, since the amounts were fixed, they reduced the extent to which it remained directly linked to UK Government decisions and Treasury spending controls. The second devolved risk that has crystallised relates to the **increased borrowing powers for the devolved administrations**. The Scottish Fiscal Commission's January 2021 economy forecast triggered a 'Scotland-specific economic shock' that, under the terms of the fiscal framework, doubles the Scottish Government's annual borrowing limit for forecast error from £300 million to £600 million, and will apply from 2021-22 to 2023-24. Both risks remain ongoing despite crystallising.

- One relates to **the possibility of cost overruns for major projects**, which has crystallised in several areas that we looked at in our 2019 report. Two large transport projects – High Speed 2 and Crossrail – have been affected by the pandemic, with delays and social distancing requirements lowering productivity and raising construction costs.[19] A third, non-construction, item is the Ministry of Defence Equipment Plan, where the NAO recently stated that, *"for the fourth successive year, the Equipment Plan remains unaffordable"*.[20] Cost overruns for major projects remains a live risk, with the pandemic requiring new major projects to be set up and their often-large costs to be managed, notably the very large initial and continuing cost of NHS Test and Trace that is also discussed in Chapter 2.

[18] In 2020-21 there were in effect 14 mini-Budgets in the run-up to the full Budget on 3 March (see Box 3.1 of our March 2021 *EFO*).
[19] Even before the pandemic the NAO reported that there were risks that HS2 costs, already far beyond initial estimates, could rise further. NAO, *High Speed Two: A progress update*, January 2020.
[20] NAO, *The Equipment Plan 2020-2030*, January 2021.

5.21 Nine risks have worsened since our previous assessment. These are:

- Four risks related to **higher health spending**, both in the medium and long term. These relate to the consequences of the pandemic for NHS productivity, backlogs of elective procedures, and the mental health consequences of the pandemic and lockdowns, among other factors (as we describe in detail in Chapter 2).

- The **state pension triple lock**, in the medium and long term, where earnings growth is currently particularly uncertain due to 'base effects' (stemming from year-on-year comparisons being made relative to the initial lockdown-related hit to earnings in 2020), and to compositional effects owing to net job losses being concentrated among the lower paid, raising the average earnings of those still in work. These factors have lifted earnings growth to 5.6 per cent in the three months to April 2021, with the Bank of England noting that earnings growth could rise to 8 per cent over the next two months due to base effects alone (i.e. even if earnings remained flat at their April level, due to the weakness in the same months last year).[21] The triple lock raises spending by £0.9 billion a year for every 1 percentage point, and our March forecast assumed uprating of 4.6 per cent next April. So, if earnings growth in the three months to July period that determines triple lock uprating for next April were 8 per cent, that would add around £3 billion a year to spending relative to our forecast. The ratchet effect of the triple lock means the higher starting point would raise state pensions costs relative to GDP in all future years too. Over the long term, the downward revision to productivity growth we made in March 2020 would imply the 2.5 per cent minimum uprating being triggered more frequently, which would again raise state pensions spending progressively as a share of GDP each time it happened.

- Risks related to the **uncertain medium-term costs of adult social care**, including around its general funding, how much to limit individuals' exposure to costs, and the potential pressure to bail out a private social care provider in financial difficulty. The policy uncertainty around medium- and long-term funding and individuals' liability for social care costs has barely moved in the ten years since the Dilnot Review, but costs for social care providers have risen during the pandemic, reflecting factors like purchasing PPE and implementing social distancing. At the same time, the tens of thousands of excess deaths in care homes over the past year will have reduced providers' incomes. Overall this has increased the fiscal risk associated with spending on social care.

- The **precedent set by yielding to pressure to reverse planned cuts to welfare spending**. This risk tends to be more acute where there are clear and identifiable cash losers.[22] A recent example is the extension of the £20-a-week increase to the universal credit standard allowance in the March Budget, which was initially due to expire in April 2021 and is now slated to end this September. The uplift is now due to be withdrawn around the same time that the furlough scheme ends, which could be associated with rises in unemployment, so pressure to extend the policy could build again. The six-

[21] Bank of England, *Monetary Policy Summary and minutes of the Monetary Policy Committee meeting ending on 22 June 2021*, June 2021.
[22] As discussed in our December 2019 *Welfare trends report*.

month extension that was announced in the March Budget cost £2.2 billion (with an equivalent payment for working tax credit recipients costing a further £0.8 billion).

- The **likelihood of higher clinical negligence pay-outs than currently provisioned for**, where the Government extended litigation cover to more providers in the pandemic.

5.22 Three risks have improved in the past two years:

- Risks surrounding the **implementation of the new state pension and universal credit**, where DWP systems coped well with the surge of 3 million new claims that were started between 16 March and 31 May last year during the first lockdown.[23]

- The risk around **limited formal reporting of the cost of potential legal challenges to the welfare system**, with a provision of £0.9 billion now included in DWP's *Annual Report & Accounts*. The disclosed amount does, however, seem narrowly defined.

- The **possibility that local authorities will resume running down their reserves** has also decreased, despite the severe pressures on their finances due to the pandemic, as more unexpected costs having been borne centrally. In terms of risks to the public finances as a whole, this means the risks associated with such costs crystallise via central rather than local government. It does not reduce fiscal risk overall.

5.23 Finally, there are two risks that have been resolved:

- The **rise in local authorities' prudential borrowing for commercial property purchases**, where the pandemic has reduced the attractiveness of these investments while the Government also tightened the rules in November 2020, making it harder for local authorities to use the Public Works Loan Board in this way. The combined effect of these developments led us to revise down local authority capital spending from these sources by £2.6 billion a year on average from 2021-22 onwards.

- The **exposure to potentially greater exchange rate volatility as a result of Brexit**, where there was little exchange rate volatility around the actual departure date, particularly relative to the large and sustained fall at the time of the referendum in June 2016.

Balance sheet risks

5.24 Of the eleven balance sheet risks we identified two years ago, four have crystallised (though three remain active), one has increased, one has decreased, two are unchanged, and three have been consolidated into others. None were referenced in the Treasury's 2020 response to our 2019 report.

[23] See our March 2021 *Welfare trends report* for further detail.

Table 5.5: Latest assessment of the balance sheet risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Public sector net worth*	Medium	Not quantified	Yes		◆
Asset sales*	Low	Low	Yes		◆
Guarantees in infrastructure and housing*	Very low	Medium	No		◆
Housing associations	N/A	N/A	No		◆
Reclassifications and balance sheets	Medium	Medium	Yes		↑
PSND and fiscal illusions	Very high	Medium	No		—
Long term					
Contingent liabilities	N/A	N/A	Yes		↓
Balance sheet management	N/A	N/A	No		—

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ↑ Increased — Unchanged ↓ Decreased × Removed

5.25 The crystallised risks are:

- **Public sector net worth** has deteriorated significantly due to the costs associated with the pandemic, which remains an ongoing risk. One aspect of the deterioration over the past two years, unrelated to the pandemic, is the **Government's response to the 'McCloud-Sargeant' public sector pension ruling** where Government estimates suggest a total balance sheet cost of £17 billion, with the associated spending spread over the next 60 to 70 years.[24] This has yet to be reflected in official estimates or our forecasts.

- **Asset sales expected to yield £2.6 billion in 2024-25 have been delayed**, as we highlighted in our March *EFO*, and there remains the risk of further delays or the sales raising less than expected. Future risks are now focused on the Government's plans to sell its remaining stake in NatWest Group (formerly RBS), which our March forecast assumes will raise £13 billion over the next five years. Since then it has completed two sales, on 19 March and 11 May, raising £1.1 billion from each.

- The **growing size of guarantees in infrastructure and housing**, with the introduction of the UK Investment Bank (UKIB) in the March Budget and the new 95 per cent mortgage guarantee scheme that was introduced in April. The UKIB can issue £10 billion of guarantees so this is another risk that remains ongoing.

[24] See Box 3.5 of our March 2021 *Economic and fiscal outlook*. The original £17 billion estimate is from: *Public service pension schemes: changes to the transitional arrangements to the 2015 schemes, Consultation*, HM Treasury, July 2020. The Public Accounts Committee recently noted further challenges and potential risks associated with the Treasury's response to the McCloud judgement – see *"Treasury's '£17bn mistake' that will take "generations to resolve" only part of "perfect storm" brewing in public pension costs"*, 11 June 2021.

- The risk relating to the **statistical classification driving regulatory policy in respect of housing associations**. Following the ONS decision in 2020 to reclassify housing associations from the public to the private sector, which in turn followed Government changes to regulations that were expressly designed to relinquish sufficient control over housing associations to change their statistical classification,[25] we have removed the risk from the register. That said, the broader fiscal risk associated with housing associations as the vehicle to deliver the Government's social housing policies remains.

5.26 The risk that has increased is that associated with **statistical reclassifications**, due to Government interventions to support different activities during the pandemic, as well as the creation of the UKIB. These could crystallise into the reclassification of currently private sector entities to the public sector. Indeed, one already has, with some train operating companies brought into the public sector during the pandemic. The Government has also converted loans into equity stakes in several start-up businesses, which could eventually be considered controlling interests for statistical purposes. The recent announcement of the creation of the new public body, Great British Railways, could also expand the public sector's balance sheet in the rail transport sector.

5.27 The risk that has decreased relates to the **management of contingent liabilities**. In April the Government launched its Contingent Liability Central Capability in UK Government Investments to strengthen contingent liability expertise and risk management across government. Its remit includes analysing and reviewing both new and existing contingent liabilities – the latter being the key information gap that we identified two years ago.

5.28 The risk associated with the use of **PSND as a fiscal sustainability metric and fiscal illusions** remain unchanged overall, though this is due to offsetting factors. Fiscal illusions relating to student loans have now been removed thanks to changes in accounting treatment in the official statistics that better match economic reality. The ONS also began publishing more data on public sector net worth capturing a broader range of assets and liabilities. But these improvements are offset by the risks that might arise from the UK no longer being part of the European Statistical System and so losing the external oversight and audit function previously provided by Eurostat. This might encourage greater exploitation of statistical boundaries.

Fiscal policy risks

5.29 Understanding the way governments make fiscal policy and react to events is important when assessing the future sustainability of the public finances. Of the three risks we identified in our 2019 *FRR*, two have increased and one decreased:

- **The tendency to revise fiscal rules in line with movements in the forecast**. The fiscal rules in the existing *Charter for Budget Responsibility* have now expired, with the current Chancellor's Budgets and Spending Review to date being guided first by rules

[25] As discussed in our November 2017 *Economic and fiscal outlook*.

set out in the Conservative Party's 2019 manifesto, then most recently by three 'principles' described in his March 2021 Budget speech. These rules and principles allow for higher borrowing than the legislated rules. The Chancellor stated his intention to set out new fiscal rules later this year, conditional on the economic circumstances. This risk has therefore increased.

- **The tendency to respond asymmetrically to movements in our underlying forecasts.** This risk has decreased. Presented with a structural deterioration in our medium-term fiscal forecast due to the pandemic, the Chancellor chose to tighten medium-term fiscal policy rather than absorbing it in higher borrowing, through reductions in spending and increases in corporate and personal taxes over the medium term.

- **Assuming cuts outside Spending Review periods, but then revising totals up when plans are set.** The first element of this risk has been aggravated by the £14½ billion a year cuts to pre-pandemic departmental spending totals from 2022-23 onwards. Given the pandemic-related pressures documented in Chapter 2, this year's Spending Review looks particularly challenging, increasing the risk that totals are raised when detailed departmental spending allocations are set later this year.

Table 5.6: Latest assessment of the fiscal policy risks identified in our 2019 report

	Probability of crystallising	Impact on PSND	Coronavirus impact	Treasury response	Change in risk
Medium term					
Fiscal rules moved in line with forecast	High	Low	Maybe		⬆
Respond asymmetrically to forecast changes	Medium	Low	Maybe		⬇
Post-SR spending assumptions do not hold	High	Medium	Yes		⬆

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.
Treasury response refers to the Chancellor's written statement of 14 July 2020. A blank implies it was not discussed.
Coronavirus impact asks whether the pandemic has materially changed our future assessment of the risk.
*Risk remains active despite crystallising.

◆ Crystallised ⬆ Increased — Unchanged ⬇ Decreased × Removed

Risks we have removed or replaced for other reasons

5.30 Alongside the updated risk assessments described above, we have consolidated the presentation of several risks in the register. In the process, we have removed or replaced the remaining 21 risks that were included in our 2019 risk register (Table 5.7):

- Five of those relate to the **cost of public debt**, where the 2019 list has been replaced with a new list of risks that reflects the analysis and scenarios presented in Chapter 4.

- The six **climate change** risks we included in 2019 were conceptual issues around how to consider climate-related fiscal risks. These have been replaced with three risks focused on different paths for climate change and for the transition to net zero emissions in the UK, underpinned by three of the scenarios presented in Chapter 3.

- Nine risks relate to **questions for the Government about wider risk management**. These were first raised in our 2017 report and were addressed in the Government's 2018 response. They are pertinent to the management of many risks across the register and remain important, but they cannot be quantified in their own right. We have therefore removed them from the register so that it focuses on the underlying risks themselves.

- The final risk we have removed is the **stress test** that we carried out in the 2017 *FRR*, which provides an illustration of several specific risks occurring at once (in this case a 'severe recession' with additional balance sheet risks) rather than being a risk in itself.

Table 5.7: Risks removed or replaced since 2019

Cost of public debt
Increase in the debt stock and the issuance of index-linked gilts in recent years
Balance between inflation risk exposure and other goals in ILG issuance choices
Potential fiscal impacts of material changes to the Retail Prices Index
Temporary impact of the APF in lowering the Government's borrowing cost
Balance of risks around the future path of the growth-corrected interest rate
Climate change
Integration of climate-related risks into the broader management of fiscal risks
Appropriateness of the Bank/NGFS scenario framework for assessing fiscal risks
Analysis of the sources and transmission channels relevant to the public finances
Trade off between climate and other policy objectives – e.g. around fuel duty
Way to manage potential shocks to the public finances from climate change
Trade-off between longer-term climate-related fiscal pressures and other priorities
Risk management
The need to review risks governments choose to expose themselves to
The need to prepare for near-inevitable future shocks
The need to deal with many slow-building pressures
Challenges of dealing with those needs while negotiating Brexit
Challenges of doing so in an environment of apparent 'austerity fatigue'
More vulnerable starting position from which all of this is faced
Sources of fiscal risk that we have not analysed - major wars and climate change
How to embed risk management changes in departments' decision-making?
How to ensure that the impacts of these changes can be meaningfully assessed?
Other
Fiscal risks report 2017 stress test: severe recession

Additions to the risk register as a result of this report

5.31 The analysis in Chapters 2 to 4 has led us to add a further 15 risks to our risk register, nine relating to the coronavirus pandemic, three from climate change, two from the cost of public debt, and a final one on the fiscal risks posed by cyberattacks. Some of these are genuinely new risks that have emerged over the past two years, while others are longer-standing risks that we have assessed for the first time.

Coronavirus pandemic risks

5.32 As discussed in Chapter 2, the coronavirus pandemic has had immediate and wide-ranging impacts on the UK's public finances, creating a legacy of potential medium- and long-term risks. We have added the following 9 risks to our register:

- **The risk of future pandemics.** The number of infectious disease outbreaks around the world has risen significantly in recent decades (as discussed in Chapter 1), culminating in the coronavirus pandemic. The economic and fiscal risks that have crystallised in the UK as a result of this pandemic are discussed from paragraph 2.3.

- **The post-pandemic pressures on public services.** This generates three new risks, one each for spending on health and social care, transport and education. These are discussed from paragraph 2.40.

- **Risks relating to the fiscal cost of guarantees extended by the Government for the different loan-support schemes.** These are discussed from paragraph 2.32.

- **Risks relating to scarring of potential output**. We added four risks under this heading, one that is overarching, underpinned by individual risks associated with population, employment rate and productivity. These are discussed from paragraph 2.51.

Table 5.8: Coronavirus pandemic risks

	Timescale	Probability of crystallising	Impact on PSND
Coronavirus			
Future pandemics	Long term	Medium	Medium
Post-pandemic pressures on public services *of which:*			
Health and social care	Medium term	High	Medium
Transport	Medium term	High	Low
Education	Medium term	High	Low
Government guaranteed loans	Medium term	Medium	Low
Scarring of potential output			
Pandemic scarring of potential output *of which:*			
Population	Medium term	Medium	Medium
Employment rate	Medium term	Medium	Medium
Productivity	Medium term	Medium	Medium
Fiscal legacy of the pandemic			
Structural shift in receipts accelerated by pandemic	Medium term	Low	Low

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.

Climate change risks

5.33 Chapter 3 considers the fiscal risks posed by climate change, and the economic and fiscal implications (both positive and negative) of alternative paths to meeting the Government's legislated target to reduce net greenhouse gas emissions to zero by 2050. To construct paths for these effects, we draw on scenarios produced by the Climate Change Committee (CCC) for whole economy costs and savings from decarbonisation, and by the Bank of England for the price of carbon necessary to achieve net zero and its economic implications.

5.34 Based on this analysis, we have added the following three risks to our register:

- **Unmitigated climate change**. If the world fails to bring global warming under control, physical risks from higher temperatures in the UK, and the consequences of spillovers from greater impacts in hotter countries, could be very fiscally damaging. Our illustrative scenario sees debt rising to 289 per cent of GDP by the end of the century. This high impact risk is considered low probability thanks to the progress being made under the Paris Agreement, with 131 countries now committed to achieving net zero.

- **Early and smooth action to achieve net zero, with policy measures to offset predictable receipts losses**. If the measures necessary to achieve net zero are put in place promptly and smoothly – both globally and in the UK – the economic and fiscal cost of the

transition could be modest. If, in addition, the Government maintains the tax burden on motoring as fuel duty receipts fall away with the switch to electric vehicles, the largest fiscal cost of the transition would be ameliorated. Our early action scenario with motoring taxes maintained actually sees debt reaching 3 per cent of GDP *below* the baseline in 2050-51, thanks to the carbon tax revenues that both incentivise decarbonisation in the private sector and also fund public spending on the transition.

- **Late and disruptive action to achieve net zero**. If action globally and in the UK to achieve net zero by 2050 were delayed another decade, but then imposed abruptly so that households, businesses, and financial markets could not adjust smoothly, the economic and fiscal consequences of the transition would be more costly. Our late action scenario sees debt reaching levels in 2050-51 that are 47 per cent of GDP higher than the early action scenario with motoring taxes maintained.

Table 5.9: Climate change risks

	Timescale	Probability of crystallising	Impact on PSND
Scenario analysis			
Unmitigated climate change	Long term	Low	High
Early and smooth transition to net zero	Long term	Medium	Low
Late and disruptive transition to net zero	Long term	Medium	Medium

Note: Refer to the risk register on our website for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.

Cost of public debt risks

5.35 Chapter 4 presents scenarios for the fiscal consequences of possible future paths for interest rates. We have used these, plus the latest balance sheet data, to refresh our presentation of debt interest risks and to look at the consequences of tail risks around investor confidence. Three risks have been retained from the 2019 register and two have been added:

- **Higher stock of public debt increases sensitivity to rate changes**. Chart 4.8 shows that the higher stock of debt means that a 1 percentage point rise in interest rates will ultimately increase debt interest spending by 1.1 per cent of GDP, three times as much as it would have in 2007-08, just prior to the financial crisis.

- **Reduced median maturity of consolidated public sector liabilities increases the speed of pass-through of interest rate rises**. Chart 4.8 also shows that the increase in debt interest spending within the first year of an increase in interest rates has risen six-fold over the same period, including a sharp increase in 2020, reflecting a by-product of quantitative easing that raises the proportion pass-through that happens immediately.

- **The impact of higher inflation on government debt**. The fiscal impacts of higher inflation are explored from paragraph 4.56. Our scenarios show that a temporary shock may benefit debt as a share of GDP, but a permanent rise would not.

- **The impact of higher real interest rates on government debt** are explored from paragraph 4.39. Our scenarios show how the impact on debt depends on the extent to which rate rises are accompanied by higher economic growth. If they are, the growth-corrected interest rate is little changed and fiscal implications are modest; if they are not, and the growth-corrected interest rate rises, higher debt interest spending is not offset by higher revenue growth, with adverse fiscal implications.

- **A loss of investor confidence in UK sovereign debt**. This tail risk scenario results in a risk premium on government borrowing costs and a recession that together generate a debt spiral and loss of fiscal sustainability. It is discussed from paragraph 4.68.

Table 5.10: Cost of public debt risks

	Probability of crystallising	Impact on PSND	Change in risk
Size and composition of debt (Medium term)			
Higher stock of debt increases sensitivity to rate changes	Crystallised	Medium	Added
Reduced median maturity increases sensitivity to rate rises	Crystallised	Medium	Added
Sensitivity to inflation and interest rate risk (Long term)			
The impact of higher real interest rates on government debt	Medium	Medium	⬆
The impact of higher inflation on government debt	Medium	Medium	—
A loss of investor confidence in UK sovereign debt	Very low	High	⬆

Note: None were referenced in the Chancellor's written statement of 14 July 2020. Refer to the online risk register for more details.
Medium term is within 5 years and long term beyond that.
Probability: Very Low = <10%; Low = 10%-40%; Medium = 40%-60%; High = 60%-90%; Very High = > 90%.
Medium-term impact (using 2025-26 GDP): Low = <1% of GDP; Medium = 1%-10% of GDP; High = 10%-100% of GDP.
Long-term impact (using 2070-71 GDP): Low = 1%-10% of GDP; Medium = 10%-100% of GDP; High = >100% of GDP.

◆ Crystallised ⬆ Increased — Unchanged ⬇ Decreased ✕ Removed

Cyberattacks

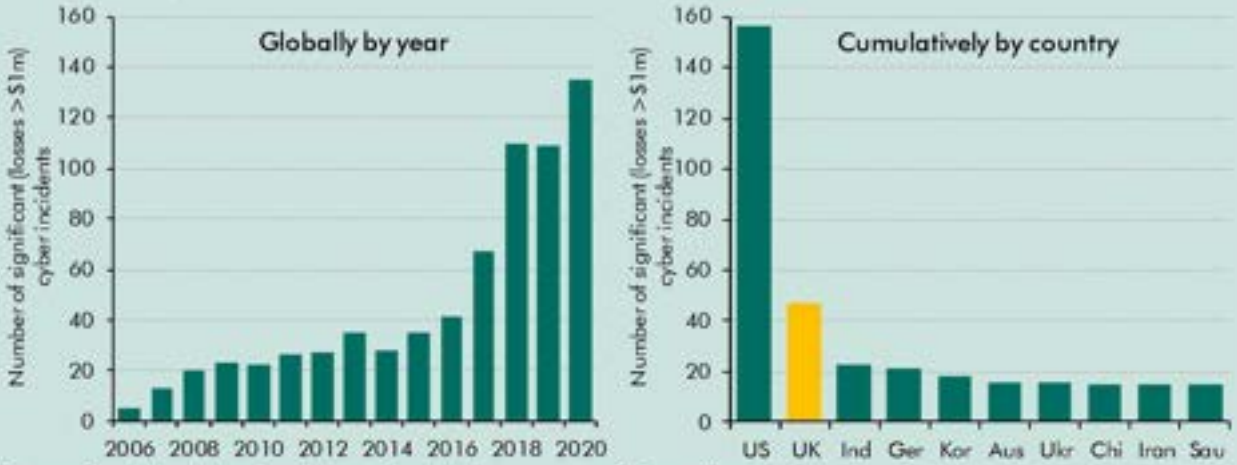
5.36 The final addition to our 2021 fiscal risks register is the risk posed by a cyberattack with systemic consequences that causes sufficient disruption to have macroeconomic and fiscal implications. At this stage we have not quantified the potential impact of such an event, which we will attempt to do in our next *FRR*.

Box 5.1: The fiscal risks posed by cyberattacks

One fiscal risk that we have yet to assess relates to cyber security and the UK's resilience to cyberattack. Cyberattacks are a growing threat, but to date none have caused sufficient disruption to critical national infrastructures to have caused material economic and fiscal harm.[a]

But the relatively small scale of the damage of cyberattacks to date may not be a good guide to the risk of more significant harm being done in the future. They have been on a sharply rising trend (left panel of Chart A). On one measure, the UK is ranked in the top ten countries in the world in terms of global connectedness, so is arguably more vulnerable to cyberattacks by virtue of its role as a major global financial centre and the international reach of many of its companies.[b] Indeed, according to one study the UK suffered the world's second highest number of significant cyberattacks between 2006 and 2020, behind only the US (right panel).[c]

Chart A: Significant cyberattacks since 2006



Source: Centre for strategic and international studies

Source: Specops

The UK Government's *National Risk Register* places cyberattacks in its second highest 'likelihood' category, but in its second lowest 'economic impact' category, with attacks typically costing millions rather than billions of pounds. It warns that cyberattacks *"can impact critical national services, and could cause a variety of real-world harm if services like the NHS are impacted"*. The latter crystallised albeit modestly in 2017 with the global 'WannaCry' attack, which resulted in seven days of disruption across one-third of hospital trusts at a cost of £92 million.[d]

Cyberattacks come from a variety of sources including criminal and terrorist organisations, 'hacktivists', industrial spies and state-sponsored activities. The Chief Executive of the National Cyber Security Centre (NCSC) has warned that state actors have been a constant presence in recent years, but that *"for the vast majority of UK citizens and businesses, and indeed for the vast majority of critical national infrastructure providers and government service providers, the primary threat is not state actors but cyber criminals, and in particular the threat of ransomware"*.[e]

The number of ransomware attacks has increased in recent years. On one estimate, over $400 million of payments were made by ransomware victims in 2020, with growth in recent years having been exponential.[f] In the UK, the NCSC reports that it handled three times more ransomware incidents in 2019-20 than in the previous year.[g]

Some recent attacks illustrate the potential for wider economic and fiscal consequences, though they were resolved before such effects crystallised. These include disruption to fuel supplies across parts of the US that could have resulted from the attack on the largest fuel pipeline in the US by the group DarkSide, and the hack on the US company SolarWinds, where malicious code inserted into the company's network monitoring software affected 18,000 organisations across the world, the consequences of which may not be fully understood for many years.

Future cyberattacks could pose a major threat to the functioning of the global financial system, with an attack on one institution potentially spreading rapidly to others. To that end, the Bank of England is undertaking a cyber stress test for UK financial institutions in 2022.[h] Such attacks could pose material macroeconomic and fiscal risks. An IMF study estimates that average annual losses from cyberattacks on the financial system could be in the region of $100 billion globally, and in more severe scenarios might reach as high as $350 billion.[i]

The pandemic has also emphasised our reliance on digital technologies, which facilitated the rapid switch to working from home for large parts of the workforce, the accelerated shift to purchasing goods and services online, the Government's design and delivery of unprecedented degrees of fiscal support to households and businesses, and rapid processing of welfare claims.

So while cyberattacks to date have had modest economic and fiscal implications, it is clear that they could pose a more material risk in the future. These could manifest themselves via some combination of: (i) disrupting public services; (ii) disrupting the collection of revenue or payment of benefits; (iii) disrupting payment systems or threatening financial stability, forcing government to step in and insure against or meet associated costs; and/or (iv) disrupting the critical national infrastructure on which the economy depends, like the power grid and transport network. These could result in various direct and indirect fiscal costs pushing debt higher.

As with our assessment of the fiscal risks from climate change in this report, it may be possible to build on the Bank of England's 2022 cyber stress test to explore the fiscal risks from cyberattacks more fully in our next *Fiscal risks report*.

[a] Four in ten businesses, including two-thirds of large businesses, reported a cyber security breach in the 12 months to 24 March, with an estimated average cost of £8,460 each (£13,400 for large businesses). Among these, 27 per cent reported cyberattacks at least once a week. See, Department for Digital, Culture, Media & Sport, Cyber Security Breaches Survey 2021, March 2021.
[b] Global Connectivity Index, *Country rankings*, January 2021.
[c] World Economic Forum, *The Global Risks Report 2021*, January 2021, originally in Specops, *The countries experiencing the most 'significant' cyber-attacks*, July 2020, and based on Center for Strategic and International Studies, *Significant cyber incidents since 2006*, June 2021.
[d] Department of Health and Social Care, *Securing cyber resilience in health and care*, October 2018.
[e] Lindy Cameron, *Speech to the Royal United Services Institute*, June 2021.
[f] Chainalysis, *Ransomware 2021: Critical Mid-year Update*, May 2021.
[g] National Cyber Security Centre, *Annual Review*, August 2020.
[h] Bank of England, *Financial Policy Summary and Record of the Financial Policy Committee Meeting on 11 March 2021*, March 2021. This supplements the Bank's 'CBEST' security assessment framework that is designed to test the cyber resilience of individual firms.
[i] Christine Lagarde, *Estimating cyber risk for the financial sector*, June 2018.

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