Office for
Budget Responsibility

Briefing paper No.8

Forecasting potential output – the supply side of the economy

November 2022

Contents

1 Introduction

1.1 The evolution of potential output, or potential GDP, is the most important determinant of long-term economic prospects, a key driver of our medium- and long-term economic and fiscal forecasts, and a major focus of economic policy under successive governments. To shed more light on this important concept, this *Briefing Paper* considers:

- **What potential output is**, how it differs from other measures of output, and why it matters.
- **What determines potential output**, namely two factors of production (the labour supply and capital stock) and the efficiency with which they are combined in the production process (total factor productivity).
- **How we forecast potential output** and how that has changed over time in response to methodological improvements, new data, and unforeseen events.
- **How potential output has evolved** since the financial crisis and how this compares with our forecasts.
- **How government policy can affect potential output** and how our forecasts have reflected this.

What is potential output?

1.2 Potential output is the value of goods and services that an economy can generate when its productive resources are being utilised at their maximum sustainable rates. Box 1.1 discusses how potential output relates to other measures of the output of the economy. Unlike actual output, potential output is not something that can be directly observed or measured, so it needs to be estimated or inferred from other measures. It can therefore be subject to significant revisions even long after the fact – particularly in and around turning points in the economy that prompt a reassessment of underlying trends.[1]

[1] See Chapter 2 of our 2019 *Fiscal risks report* for a fuller discussion of these issues.

Box 1.1: Potential output and other measures of output

Potential output is one of several output measures we use in putting together our forecasts. The differences between these measures and the relationship between them is set out below. Unless otherwise stated these variables are in real terms, to strip out the impact of price movements:

- **Potential output** (or 'potential GDP' or 'productive potential' or 'supply potential' or sometimes simply 'supply'[a] or 'trend GDP'[b]) is the value of goods and services that an economy can generate when its productive resources are being utilised at their maximum sustainable rates. We often find it useful to consider potential output as determined by three influences: (i) the available supply of labour; (ii) the available stock of capital; and (iii) the efficiency with which those two 'factors of production' can be combined to generate a unit of output, known as 'total factor productivity' (TFP).
- **Output** (or GDP or 'actual output') is the total value of all goods and services that are actually produced in the economy over a given period (typically a month, a quarter, or a year). The ONS measures GDP using three approaches: (i) the 'output approach' which sums the value added (total sales less the cost of intermediate inputs used in production) at each stage of the production process; (ii) the 'expenditure approach' which sums the final value of all goods and services purchased domestically plus exports less imports; and (iii) the 'income approach' which sums the total value of incomes generated by domestic production and paid in compensation to workers and in profits. In theory, these three approaches should result in the same figure, although in practice measurement error typically results in some relatively small differences between them.
- **The output gap** is the difference between potential and actual GDP at any point in time. A negative output gap (actual GDP below potential) implies that there is some 'excess supply' or 'slack' in the economy, with levels of domestic resource utilisation below what can be sustainably deployed. Negative output gaps have historically been associated with low or falling rates of inflation due to high levels of unemployment or underemployment (people working fewer hours than they would like) and low levels of capacity utilisation by firms. A positive output gap, or 'excess demand' or 'overheating' in the economy, implies that levels of domestic production exceed what can be sustainably produced from resources held domestically. Positive output gaps have tended to be associated with high or rising inflation, as 'excess' demand pushes up the prices of domestically produced goods and services thanks to low unemployment and pressures on capacity utilisation.

[a] As the term 'supply' can also be used in relation to the macroeconomic position at a given point (i.e. the actual goods and services produced by firms or hours worked in a given year), we use the term 'potential output' in this briefing paper to focus on the *capacity* of the economy to provide these things.

[b] Trends in GDP can be extrapolated using the average actual GDP growth experienced by an economy over a period of time or via more complex statistical filters that extract cycles from trends. Indeed, this is one way of estimating potential output, although we use the term 'potential output' in this paper because an average rate of growth over a historical period can reflect extended periods of above or below potential growth. And because future levels of labour supply, capital stock, and TFP can differ from those implied by past trends as the labour force grows or shrinks, investment levels rise or fall, or technological change accelerates or decelerates.

Why does potential output matter?

1.3 Potential output is often thought of as placing a limit on the amount of output that can be produced by an economy over the long term, and therefore a 'speed limit' on the sustainable rate of actual GDP growth. This is because actual output cannot exceed potential output for long periods without stoking inflationary pressures which, under existing institutional arrangements, would require the Bank of England to tighten monetary policy to reduce demand and bring actual output back in line with potential to meet its inflation target. As such, the growth rate of potential GDP can be thought of as the 'sustainable' rate at which the economy can grow without either under- or over-utilising available resources.

1.4 While potential output is subject to some absolute limits (like the total population and stock of equipment at any point in time) it is not a fixed constraint on the level of economic activity. Like actual GDP, potential GDP is subject to both positive and negative shocks, and can also be influenced by government policy, though this can take time. Short-term, adverse shocks to supply can happen as a result of catastrophic events such as natural disasters or armed conflicts that render some amount of the stock of labour or capital temporarily or permanently unavailable. A recent example of this was the Covid pandemic, during which a significant proportion of business premises were forced to close temporarily and workers were furloughed to protect public health. Longer-lasting changes in supply can come as a result of, for example, changes in the number of people able and willing to work, rates at which businesses and governments invest, and the pace at which new technologies are developed and diffused across the economy.

2 What determines potential output?

How potential output is determined

Potential inputs to production

2.1 The economy's potential output is determined by the extent to which different 'factors' of production can be utilised sustainably as well as the efficiency with which they can be combined. In our recent medium-term forecasts, we have decomposed changes in potential output into three main determinants:

- **Labour supply**. This is a function of the size of the population, the proportion of the population willing and able to work (the participation rate), the sustainable share of participants in the labour market that are able to find work (one minus the equilibrium unemployment rate), and the average number of hours those in employment can sustainably work.

- **The capital stock**. This is a function of past levels of investment in tangible and intangible productive assets, the rate at which investment depreciates or is retired, plus the flow of new investment that adds to the stock.

- **Total factor productivity (TFP)**. This is a measure of the efficiency with which labour and capital can be combined in the production process. It is a function of the state of global technology and knowledge, and the degree to which that technology and knowledge is effectively utilised domestically, which depends, to a significant extent, on the skill levels of the working population.

2.2 These inputs into the production process are measured at their *potential* levels – the sustainable utilisation rates that are consistent with stable inflation – rather than their *actual* levels. For instance, potential output is a function of the *structural* rate of unemployment (sometimes known as the non-accelerating inflation rate of unemployment or 'NAIRU') rather than the *observed* rate of unemployment measured by the ONS. This distinguishes between *cyclical* fluctuations in economic activity – such as a temporary increase in unemployment during a recession – that affect output via changes in the rate at which resources are utilised, and *structural* ones that affect the amount of resources available to be utilised.

How potential inputs determine potential output

2.3 Exactly how these potential inputs combine to determine the level or growth of potential output is an important modelling judgement. One common simplifying assumption is to

model potential output via a two-factor Cobb-Douglas production function. Under stylised assumptions, this then implies that growth in potential output is equal to growth in total factor productivity plus the weighted sum of growth in the two factors: potential labour supply and the capital stock, with weights determined by these two factors' respective shares of income. An alternative, simpler decomposition looks at just a single factor – labour supply – so that growth in potential output is the sum of labour supply growth and labour productivity growth (with this latter term implicitly combining growth in capital and TFP).

2.4 Although we have typically relied upon these one- or two-factor breakdowns, it can be useful to consider the influence of other factors. For example, estimates of *quality-adjusted* labour inputs can capture differences in productivity amongst workers using identifiable characteristics related to skills, such as education levels and earnings.[1] And some approaches explicitly incorporate human capital or broader sets of intangible assets into the production function.[2] In our July 2022 *Fiscal risks and sustainability report* (*FRS*), we incorporated fossil fuels into a production function, alongside labour, capital and TFP, to illustrate the potential output consequences of higher energy prices. Also, some approaches use direct measures of 'capital services', rather than proxying them via the capital stock.[3]

Inferring the level of potential output via estimates of the output gap

2.5 The ONS does not record the *potential* levels of inputs to production, but rather the values actually observed. As a result, determining the level of potential output typically requires the modeller to infer it by using ONS and other data to make judgements about the size of the output gap (see Box 1.1 above) or the level of over- or under-utilisation of resources in the economy. Typically, this might involve combining 'top-down' judgements (for instance, regarding the overall size of the output gap) with 'bottom-up' ones (regarding the sustainable rates of particular indicators of employment or capacity utilisation).

2.6 For instance, when considering actual output, we use, among other sources, Labour Force Survey (LFS) data for the actual levels of participation, unemployment, and average hours worked to determine the degree of 'tightness' or 'slack' relative to our view of their sustainable rates. Given our view of the overall level of the output gap, this would then determine the gap in output per hour from its sustainable rate. So, looking at labour supply and productivity per hour, it is possible to produce a bottom-up estimate of the extent to which the output gap reflects productivity or labour supply being above or below their sustainable levels. In practice, when producing our forecasts, we might iterate between such bottom-up estimates and top-down judgements until we reach an overall picture that we believe to be the most plausible estimate of potential output and the size of the starting output gap. Judgements about individual component gaps then determine the scope for

[1] The ONS splits out quality-adjusted labour in its experimental productivity datasets.
[2] See for instance, Haskell, J., *Will the pandemic "scar" the economy?*, 2021.
[3] Capital services measure the flow of services that different types of assets provide to the production process. As they are challenging to measure, the capital stock, a related but distinct concept, is used as a proxy. Our current practice is to use National-Accounts-consistent measures of capital stocks as a proxy for capital services. The ONS has recently started producing estimates for capital services as part of its experimental productivity datasets and we will be investigating incorporating these into our framework.

growth in *actual* productivity and employment across our forecast as we typically assume that these gaps close over the medium term.[4]

Drivers of potential output growth

2.7 The rate of growth in potential output is a function of the evolution of the two large 'stocks' and the efficiency with which they are combined that are described above (the labour force, the capital stock, and TFP). These typically change slowly, including in response to any incentives created by government policy. To give a sense of scale:

- The adult population in the UK is just under 54 million and, with around 63 per cent of them active in the labour force, the total UK **labour supply** is around 34 million people. Against this, the average inflow of those from secondary, further, and higher education into the labour force is around 1 million (around 3 per cent) a year, while the outflow of older workers retiring from the labour force is also around 1 million (around 3 per cent) a year, and the net inflow of migrants into the UK has been running at about 250,000 a year since 2004 (around ¾ per cent of the labour force).[5] This means that things like changes in the proportion of people undertaking further or higher education, increases in retirement ages, or changes in migration can take several years to have a have significant impact on the effective supply of labour.

- The total economy-wide **capital stock** (excluding assets held by the household sector and dwellings) is £4.6 trillion (equivalent to around 200 per cent of GDP), of which about a quarter belongs to the public sector and three-quarters belongs to the private sector. Against this, the total annual gross flow of investment (gross fixed capital formation excluding dwellings)[6] is about £250 billion (12 per cent of GDP or 5.5 per cent of the capital stock), of which the public and private sectors also make up about a quarter and three-quarters respectively. This means that even large changes in the flow of private and public investment can take a number of years to have a material impact on the size of the capital stock.

- **Technological and organisational knowledge** (which influences TFP) is the product of centuries of research and innovation around the world. Any one country's ability to contribute to that stock of accumulated human knowledge is limited. For example, the UK ranked seventh in global patent applications in 2021 (with China, the US, and Japan being the top three), accounting for just over 2 per cent of total applications.[7] For most countries, the greater potential source of growth opportunities is not by contributing to extending the global frontier of knowledge but in adopting and

[4] Our forecasts are typically conditioned on monetary policy bringing output back to its potential level and thus inflation back to the 2 per cent target over the medium term, with the overall output gap and its component parts therefore closed by the forecast horizon.
[5] The average level of total net inward migration is 216,000 in our November 2022 forecast, with the ONS National Population Projections assuming around 70 per cent of those are adults.
[6] Gross fixed capital formation (GFCF) is the measure of investment used in the National Accounts that adds to the gross capital stock. Excluding dwellings means we have calculated this by summing the ONS's measures of business and general government investment.
[7] WIPO, *PCT newsletter No. 02/2022*, February 2022.

diffusing existing knowledge more extensively across the economy or by allocating existing resources more efficiently across the economy.

3 How do we forecast potential output?

3.1 Since the OBR was established in 2010, our forecasts have traditionally started with an updated assessment of prospects for growth in the supply potential of the economy based on existing government policies. This, coupled with an updated assessment of the starting output gap, determines the scope for growth in actual GDP over the forecast period (though its profile across the forecast reflects many other factors). Changes in government policy can also influence the evolution of actual and potential GDP (as discussed in Chapter 5).

Determining the starting level of potential output

3.2 In our five-year forecasts we infer the starting *level* of potential output from the most recent data on actual GDP and our estimate of the starting level of the output gap. As described above, this latter judgement is informed by a range of indicators of economy-wide capacity utilisation including unemployment, vacancies and recruitment difficulties, supply-chain constraints, and price and wage increases.[8]

Forecasting the growth of potential output

3.3 By looking at the latest data, economic research, and our own analysis we produce an updated five-year forecast for potential output that depends upon growth in:

- **Potential labour supply**, broken down into the size and demographic structure of the population (including any net migration flows), different age-groups' trend rates of participation in the labour force, the sustainable rate of unemployment (or NAIRU), and the trend level of average hours worked.

- **Potential labour productivity**, which we have more recently been able to disaggregate into the respective contributions of **capital stock per worker** and **total factor productivity** thanks to the improvements in ONS data discussed below.

3.4 The ways in which the supply of labour and the stock of capital evolve in large part reflect the incentives that individuals and companies have to work, invest, and innovate. These

[8] The output gap models that we use were described in Murray, J., *OBR Working paper No.5: Output gap measurement: judgement and uncertainty*, July 2014. The size of the output gap at the start of the forecast also determines the scope for above- or below-potential GDP growth over the forecast period, since we usually expect any output gap to close over the medium term, bringing actual and potential GDP into line. In our long-term (50-year) fiscal projections, we assume that the output gap remains closed beyond the five-year point, which means real GDP growth is dictated entirely by potential GDP over most of the projection period. This is not to suggest that output will not deviate from potential over the long term, but rather that it is as likely to deviate in one direction as another, so by assuming an output gap of zero, the risks around that central projection should be balanced.

supply decisions depend on the economic and policy environment and the opportunities and constraints they create. On investment, the crucial factor is the rate of return that suppliers of funding for capital spending require relative to the expected, after-tax return from more capital being deployed. For labour supply, a key factor is the after-tax real wage that a potential worker receives and the amount of labour income they need to finance consumption given the satisfaction (or lack of it) from work and other demands on time. Taxes, benefits, investments, and regulations determined by governments affect these supply decisions in multiple ways that are often complex and can push in different directions.

Developments in data, methodology, and approach

Developments in methodology

3.5 Over the past 12 years, we have adapted our approach to estimating potential output to take account of significant improvements in our forecasting models and in data produced by the ONS:

- Given its importance in understanding the state of the economy in the aftermath of the 2008 financial crisis, we made several improvements to our **output gap models** in the first half of the 2010s. An April 2011 OBR *briefing paper* explained how we estimated the output gap at the time and outlined a series of improvements to variables and methods.[9] Our first OBR *working paper* in November 2011 produced estimates of the historical output gap using a longer time series, which suggested output had been slightly above its sustainable level in the run up to the financial crisis, as well as making other improvements to variables and methods.[10] A later working paper, published in 2014, highlighted the degree of uncertainty around estimates of the output gap (and therefore potential output) due to different estimation approaches, the arrival of new and revised data, and model choice.[11] It noted how it was impossible to remove judgement from the estimation process and recommended using several models to inform our judgements, which we have utilised since then.

- We have also made improvements to incorporate relevant **labour supply data**. For instance, in 2015, we brought our medium-term labour market participation modelling in line with a 'cohort modelling' approach that we had hitherto only used in our long-term projections. Doing so allowed us to better model the labour supply consequences of increases in the State Pension age to 65 for women and then to 66 for all, the second of which had by that point entered our five-year forecast horizon. This entailed selecting an ONS population projection, taking the latest outturns for participation by age, and taking account of the influence of the Government's policy for State Pension age rises to estimate the future path of participation. And in the wake of the pandemic, we produced our own population projections to overcome lags in the production of the ONS's own variants.

[9] OBR, *Briefing paper No.2: Estimating the output gap*, April 2011.
[10] Pybus, T., *OBR Working paper No.1: Estimating the UK's historical output gap*, November 2011.
[11] Murray, J., *OBR Working paper No.5: Output gap measurement: judgement and uncertainty*, July 2014.

- More recently, we have moved from a one- to a **two-factor decomposition** of potential output. In our November 2022 forecast, we have taken advantage of improvements in ONS **capital stocks data** to separately model the effects of capital deepening and TFP on labour productivity. This enables us to better decompose the underlying drivers of growth, and in doing so achieve greater consistency between our business investment and potential output forecasts. In addition, we have stopped stripping out North Sea output from our potential output figures, given the waning influence of North Sea production on output levels in recent decades.

Responses to previous events

3.6 We have also adapted our forecasting approach over time to take account of **significant events** that we expected would alter the evolution of potential output relative to past trends. Three events in particular were expected – both by us and by other forecasters – to have a lasting impact on the productive potential of the UK economy: the financial crisis; Brexit; and the Covid pandemic.

The financial crisis

3.7 The decade following the **financial crisis** saw successive reductions in our assumptions for growth in potential labour productivity. As outturns disappointed across the 2010s, we both pushed back the date at which we assumed that labour productivity growth would return to pre-crisis rates and later assumed that potential productivity growth would not return to those pre-crisis rates. The three most significant changes were:

- in our **March 2016** *Economic and fiscal outlook* (*EFO*) we downgraded our estimate of steady-state potential productivity growth from 2.2 to 2.0 per cent a year, assuming that it would be reached at the forecast horizon;

- in our **November 2017** *EFO* we lowered our potential productivity growth forecast from 1.7 to 0.9 per cent on average for the first four years of that forecast to reach only 1.2 per cent at the horizon. At this point we still assumed that it would eventually recover to a steady-state rate of 2.0 per cent a year, but that this would not be reached until well beyond the 5-year forecast period; and then

- in our **March 2020** *EFO*, we downgraded the long-run rate of productivity growth from 2.0 to 1.5 per cent a year (with little effect within the forecast period, which assumed productivity growth averaging around 1.1 per cent a year).

3.8 Initially, we thought the impaired operation of the financial sector had been the main factor weighing on productivity over this period, although recent data now suggest that more of the slowdown may have been caused by global factors (such as a slowdown in manufacturing productivity) than we had originally assumed.

Brexit

3.9 **Brexit** also led us to revise our estimate of the future evolution of potential output. Initially, we assumed that the uncertainty created by the EU referendum would lower business investment and thus capital deepening, thereby weighing on labour productivity growth. Over the longer run we expected higher tariff and particularly non-tariff barriers to reduce the trade intensity of output. This lowers productivity by reducing the scope for the UK to realise its comparative advantages and to exploit economies of scale, thereby diverting resources away from their most productive uses. In line with the average estimate derived from 13 studies deploying a variety of different modelling approaches, we expected this to result in potential productivity settling around 4 per cent lower than would otherwise have been the case had we remained in the EU.[12]

3.10 The introduction of a new, post-Brexit migration regime led us to lower our net migration forecast in March 2020 to the 2018-based 'zero net EU variant' of the ONS's population projections, which assumed net inward migration would fall to 129,000 a year by 2025.[13] The combined effect of the post-Brexit migration regime adopted by the Government in 2021 and other developments appear to have restricted net migration by less than we had assumed, such that in our November 2022 forecast we have shifted back to using the ONS principal migration projection, which assumes net migration remains above 200,000 a year – settling at 205,000 from 2026 onwards (see Chapter 4).

The Covid pandemic

3.11 The **Covid pandemic** required a more significant change to our usual approach as it represented a sudden, significant, exogenous constraint on both aggregate supply and demand, which would also have lingering effects on potential output:

- In **the near term**, the nature, severity, and duration of these constraints depended on the course of the pandemic (and the public's behavioural response), the strictness of public health restrictions, and the rollout and effectiveness of vaccines. We therefore relied upon discussions with SPI-M[14] and other public health experts to understand these key epidemiological parameters and model their implications for the level of economic activity that was possible in different sectors of the economy.

- For **the longer term**, we estimated a scarring effect of the pandemic on potential output as a result of foregone investment, increases in unemployment, business failures, loss of skills, and increases in labour market inactivity. We currently assume that this reduces the level of potential output over the horizons relevant to our medium-term fiscal forecast by around 2 per cent relative to a rebased March 2020 pre-pandemic forecast (down from our initial July 2020 estimate of 3 per cent).

[12] See Box 2.1 from our March 2020 *EFO*.
[13] See Box 2.4 from our March 2020 *EFO*.
[14] SPI-M is the Scientific Pandemic Influenza Group on Modelling, which supports the SAGE committee (Scientific Advisory Group for Emergencies) that advises the Government in emergencies.

Responses to current events

3.12 Persistently higher **energy prices** would also weigh on potential output. We explored such a scenario in Chapter 3 of our 2022 *FRS*: modelling the hit to potential output via a three-factor production function, that – alongside labour and capital – incorporated fossil fuels. In this framework, rises in the price of gas and oil have a direct effect on the economy's supply potential by, all else equal, lowering the level of output firms are willing to produce for a given price, with the size of this impact depending on the relative importance of gas and oil in the economy, among other factors. In a scenario in which oil and gas prices rose and then remained at around £3 a therm and $147 a barrel respectively, potential output fell to around 2 per cent below our baseline after five years.

3.13 Like the Covid scarring assumption and the long-run hit to productivity from Brexit, the energy price shock in our 2022 *FRS* was modelled as a levels shift to potential output that was overlaid on the underlying path for potential output growth. As time passes, it becomes progressively less feasible to disentangle whether surprises relative to our forecasts in the economic data stem from differences in the impact of these successive shocks to the level of potential or from the underlying growth rate being stronger or weaker than we had assumed before the shocks struck. As a result, even though we continue to believe that there is little evidence to suggest either that our 4 per cent Brexit scarring assumption or the 2 per cent Covid scarring assumption are unreasonable, in our latest forecast we have reverted to our previous approach of producing forecasts for growth in each of the components of potential output starting from now. So rather than selecting counterfactual forecasts from a world where Brexit, Covid, and now the energy crisis, had not happened and then separately factoring in adjustments for each of them, we make our best forecast reflecting the current state of the world.

3.14 While this series of shocks to the UK economy over the past few years has triggered downgrades in our estimate of the evolution of potential output, changes can also increase potential output. Improvements in production, transport, and communication technology can, for example, lead to sustained higher growth in productivity. And there is potential for policy to improve the long-run level of labour supply, capital stock, productivity, output and incomes. We consider this in more detail in Chapter 5.

How do we forecast potential output?

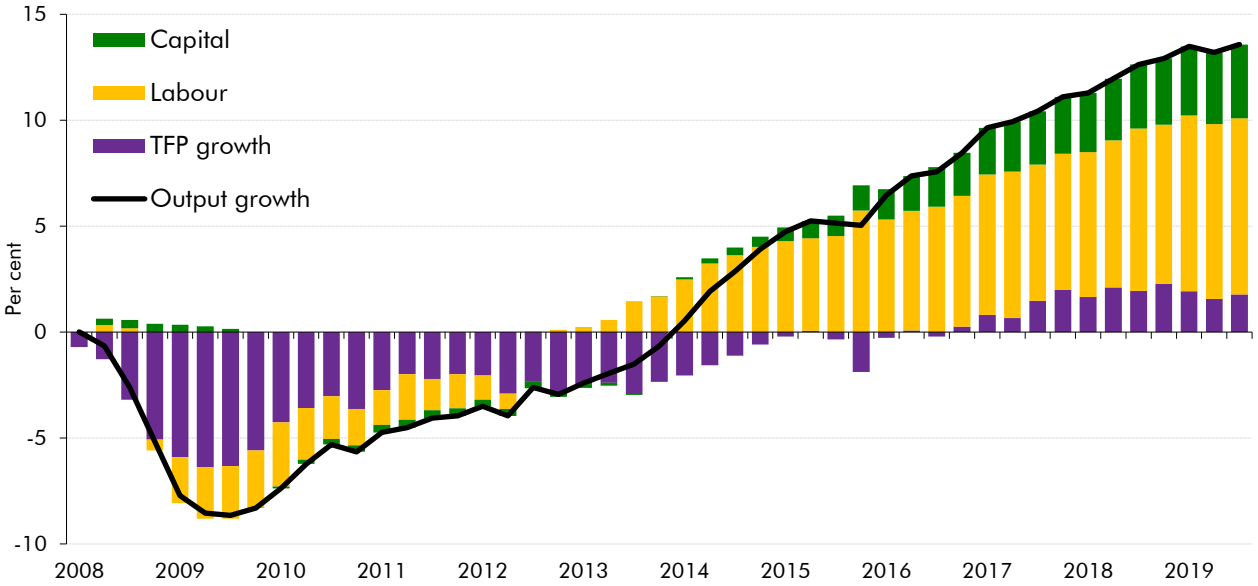
4 How has potential output evolved relative to our forecasts?

4.1 Potential output cannot be observed, so it is not possible to evaluate our past forecasts relative to outturn data (as we do each year for the rest of our economy and fiscal forecasts). Therefore in this chapter we consider how actual output and its key drivers have evolved relative to our forecasts, and how our assumptions about potential output have evolved as a consequence of those developments, including in our latest forecast.

How actual output has evolved

4.2 Output growth has slowed significantly since the financial crisis of the late 2000s. This was driven primarily by a slowdown in investment and in measured TFP, which reduced labour productivity growth and resulted in stagnating real earnings and living standards over the past decade. As shown in Chart 4.1, the majority of post-financial-crisis growth in actual output came from an increase in labour supply (total hours worked) due to a combination of continued relatively high levels of net migration, rising labour market participation rates (particularly among older workers) and falls in the unemployment rate.

Chart 4.1: Determinants of cumulative output growth since the financial crisis

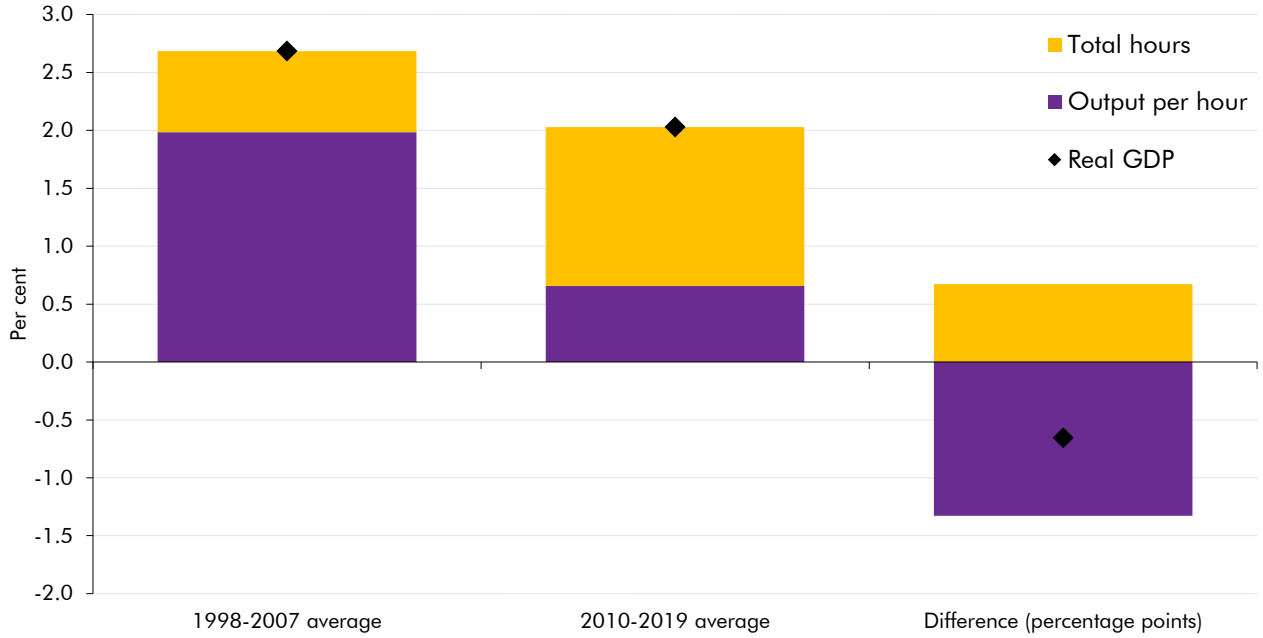


Note: Contributions are to actual output so reflect changes to potential output and capacity utilisation. TFP growth is measured as the residual after taking account of labour and capital inputs.
Source: ONS

How has potential output evolved relative to our forecasts?

4.3 This stands in stark contrast to the decade prior to the financial crisis, during which output growth was both higher and was dominated by growth in the productivity of labour (output per hour) rather than the supply of labour (hours worked). As Chart 4.2 shows, GDP growth has slowed since the financial crisis from an average rate of just under 2¾ per cent in the run up to it, to 2 per cent in the post-crisis decade. This slowdown is more than explained by a just over 1¼ percentage point slowdown in growth in output per hour, partly offset by a just over ½ a percentage point increase in the growth of hours worked.

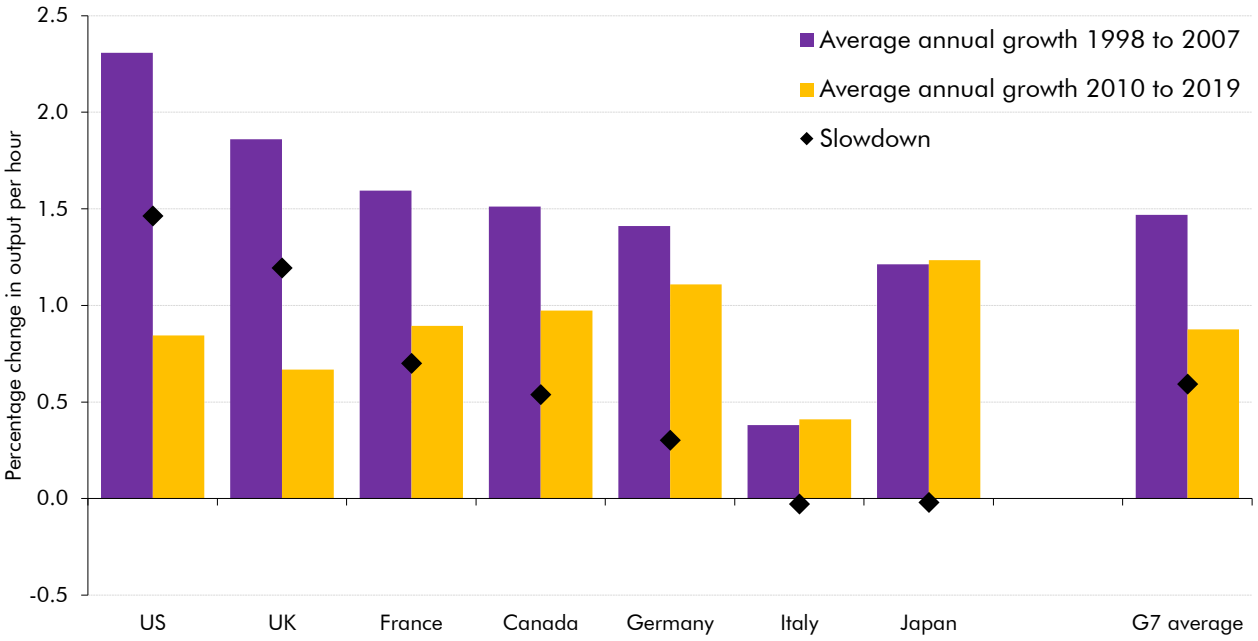
Chart 4.2: Supply-side decomposition of GDP growth



Source: ONS, OBR

4.4 As shown in Chart 4.3, all G7 countries have experienced a slowdown in productivity growth, though output per hour in the UK has slowed by more than it has in most. Before the financial crisis, growth in the UK was second-fastest in the G7 after the US, while post-crisis it has been second slowest in the G7 after Italy. And at 1.2 percentage points, the slowdown in average annual growth in output per hour in the UK is the second largest in the G7 after the US – and is 0.6 percentage points larger than the average. Compounded over a decade, this small difference in growth rates has therefore reduced the level of output per head by around 2 per cent relative to the average across the G7 economies.

Chart 4.3: International comparison of the post-financial crisis productivity slowdown



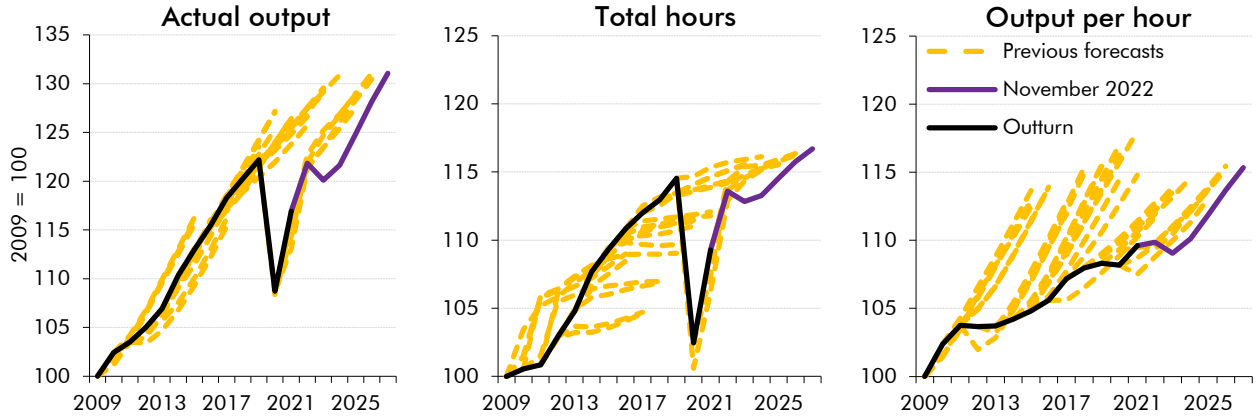
Source: ONS

How our potential output forecasts have performed

Comparing our output, hours, and productivity forecasts with outturns

4.5 Over the past 12 years, our forecasts for growth in actual output have proven relatively unbiased outside of major shocks, though within that we have systematically underestimated growth in the number of hours worked and overestimated growth in hourly productivity (Chart 4.4). As the left panel shows, our forecasts for output growth have been relatively close to unbiased except for the immediate aftermath of the financial crisis and the large, and mostly temporary, hit to output caused by the Covid pandemic.

Chart 4.4: Actual output, total hours, and productivity: Autumn forecasts vs. outturn



Note: Output per hour for the November 2022 forecast line has been done on a non-North Sea GVA basis to be consistent with previous forecasts.
Source: ONS, OBR

How has potential output evolved relative to our forecasts?

4.6 The degree of bias in our output forecasts is small relative to that in the labour supply and labour productivity components of output growth and relative to cumulative growth over our standard five-year forecast horizons. But it also differs to a degree from the broad conclusions of our successive forecast evaluations over the past decade, which have pointed to overestimates of GDP growth being more common than underestimates. This reflects subsequent ONS data revisions, with successive ONS 'Blue Book' releases resulting in estimates of quarterly growth rates being revised up on average, bringing final outturns closer to our initial forecasts over time.[15] For instance, we initially thought that growth over the first two calendar years of our November 2010 forecast would average 1.9 per cent a year. By our December 2013 forecast, outturn data suggested growth had fallen short of that forecast at 1.4 per cent a year, whereas the latest data report growth of 1.7 per cent a year. More recently, we initially thought growth over the first two calendar years of our November 2015 forecast would average 2.4 per cent. Three years on, initial outturn data put growth at 2.1 per cent a year, whereas the most recent ONS Blue Book outturn was for 2.3 per cent a year growth in these years. So, viewed with sufficient hindsight, our real GDP forecasts have been less optimistic than they initially appeared.

4.7 The middle and right-hand panels of Chart 4.4 show that the composition of output has been quite different from what we predicted. Total hours worked have mostly exceeded our forecasts while output per hour has mostly disappointed. From 2012 onwards, this has consistently reflected lower-than-expected unemployment. But it has also reflected other factors at different points, including higher-than-expected migration (particularly in the middle of the decade), stronger-than-expected (until recently) participation rates among older workers, and unexpected strength in average hours. Our initial overoptimism regarding productivity growth was the result of assuming that the post financial-crisis slowdown in productivity growth would be temporary and that pre-crisis rates of growth would ultimately return (albeit with no recovery of the shortfall in productivity relative to a continuation of pre-crisis trends). In the event, weaker-than-expected business investment (especially since the Brexit referendum) together with the failure of TFP growth to pick up has meant that growth in output per hour has remained sluggish for over a decade.

How we have changed our potential output forecasts in response

4.8 Our forecasts for actual output, hours, and hourly productivity contain cyclical and structural elements, with cumulative growth being the sum of growth in potential and the closure of any initial output gap. We never observe the 'true' level of potential output or the output gap, so cannot easily perform the exercise described above for these variables. But we have changed our *judgements* surrounding potential output in response to the differences between our forecasts and outturns for observed variables.

[15] For instance, the ONS estimated in May 2022 that, the mean average revision to the first estimate of quarterly GDP growth from the first quarter of 2010 to the final quarter of 2018 had been +0.06 percentage points three years after it was first made. See, ONS, *GDP revisions in Blue Book: 2021*, May 2022.

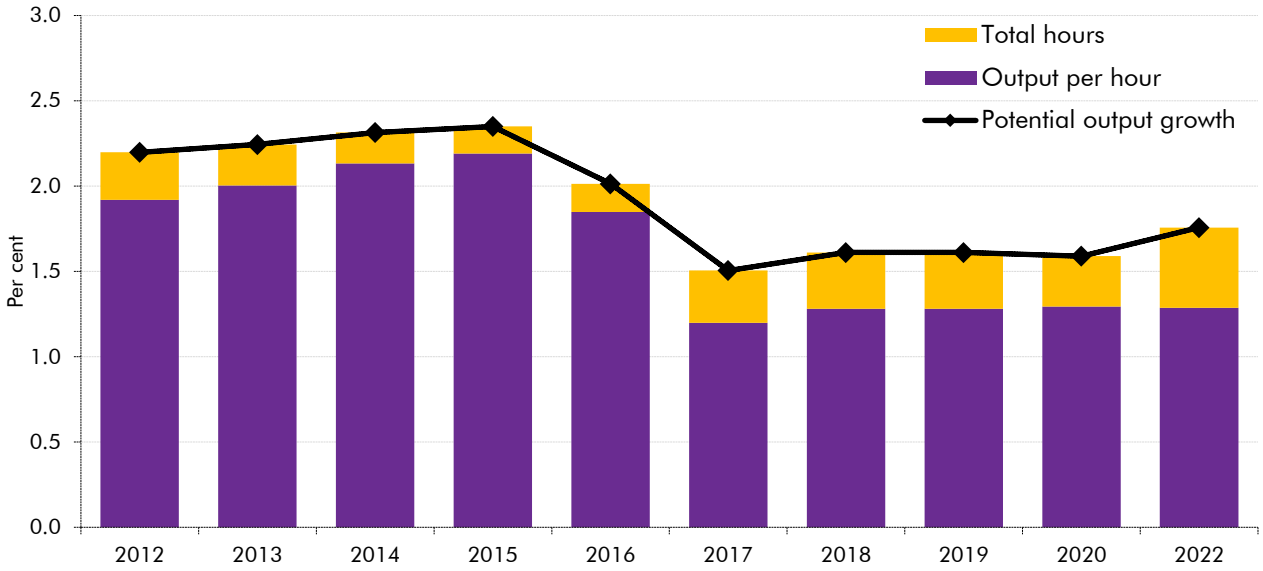
4.9 Chart 4.5 shows how we have revised our expectations for potential output growth in the final year of our forecasts made in each of the last 10 years.[16] This is split into expected growth in total hours and growth in productivity (output per hour). It reflects our evolving judgements about trend total hours and trend labour productivity in light of emerging data on actual hours and productivity. It shows that our early forecasts assumed a full recovery in productivity growth to its pre-financial crisis rates, but not necessarily by the end of each forecast period. This approach ended when the accumulated evidence of persistent post-financial crisis weakness led us to make two downward revisions in 2016 and 2017. The 2016 revision slightly lowered the steady-state growth rate and included a downward revision to reflect the effect of the decision to leave the EU. The 2017 revision significantly pushed back the date at which the steady-state rate was attained to beyond our medium-term forecast horizon.

4.10 In contrast, small revisions to forecast-horizon potential total hours growth have generally reflected changes in migration (resulting from different data vintages of the ONS principal population projections that have typically been used in our forecasts) or the changing influences of policy, demographics, and other factors on participation. In 2017, while dropping the assumption that labour productivity growth would eventually recover its pre-crisis rates, we also dropped the assumption that the pre-crisis fall in average hours would reassert itself (instead assuming average hours would remain flat over the medium term). And in 2020, despite an upward revision to the principal migration projection (due to stronger-than-expected initial outturns), we revised *down* migration, by switching to the ONS's zero net EU migration variant to take what we expected to be a stricter migration regime into account. But net migration has remained high since, so we have returned to the principal projection in our latest forecast, as discussed both above and below.

[16] We did not produce an autumn forecast in 2019, so that year is represented by our March 2019 forecast. The disruption caused by the pandemic means that our autumn 2020 and 2021 forecasts are not representative of broader trends – we have therefore included our March 2020 forecast for that year and have not shown any forecasts from 2021.

How has potential output evolved relative to our forecasts?

Chart 4.5: Final-year potential output growth in Autumn forecasts



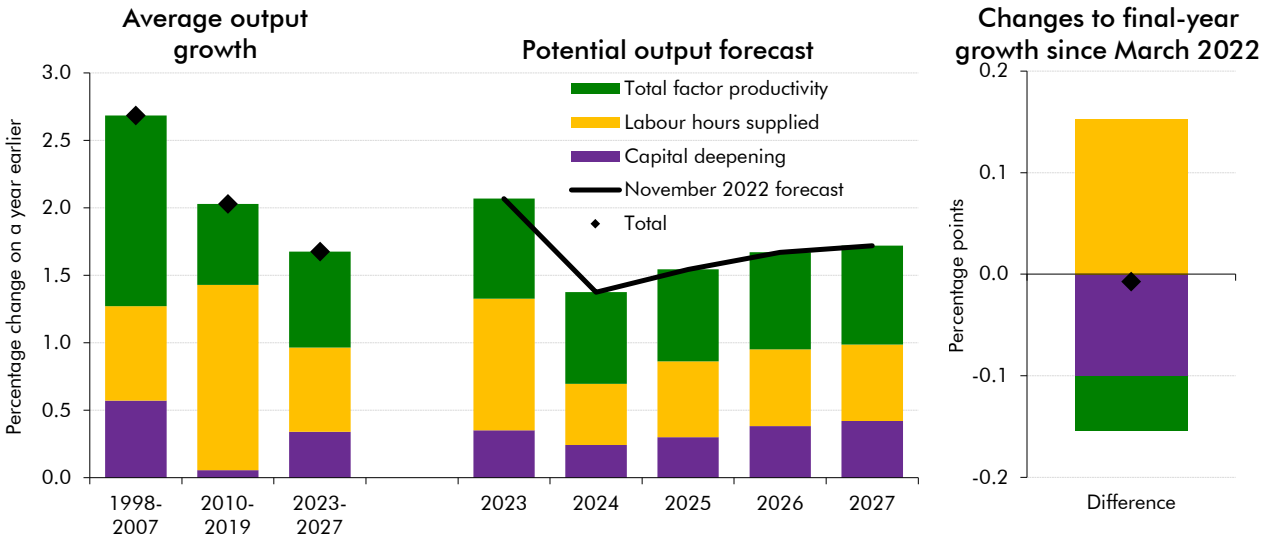
Note: The March forecast is used for 2019, because no autumn forecast exists for that year. To exclude the pandemic, the March forecast is also used for 2020 (and 2021 is excluded altogether). Potential output prior to 2022 is on a non-North Sea GVA basis.
Source: OBR

Our latest forecast

4.11 In our November 2022 forecast, cumulative growth in potential output over the forecast period is 1.7 percentage points lower than in March, largely reflecting the impact of higher energy prices. In comparison to historical trends, our forecast for annual average growth is around a third of a percentage point lower than the decade following the financial crisis and 1 percentage point slower than in the decade that preceded it. As Chart 4.6 (left panel) shows, our forecast assumes:

- **hours** supplied (yellow bars) grow more slowly in our forecast than during the 2010s reflecting the ageing of the population, modestly lower net migration, and less scope for the unemployment rate to fall;
- **capital deepening** (purple bars) grows more strongly than over the past decade, but still below rates seen prior to the financial crisis; and
- **TFP** (green bars) also grows a little faster than witnessed since the financial crisis, but still below rates seen pre-crisis.

Chart 4.6: Potential output growth: latest vs. pre and post financial crisis averages



Note: Historical average growth rates calculated using actual GDP and labour hours outturns. The 2010 to 2019 actual labour hours supplied involved a large fall in the unemployment gap, not just growth in potential labour hours supplied.
Source: ONS, OBR

4.12 The near-term path of potential productivity in our latest forecast is affected by its rebound from the restrictions imposed during the pandemic and by the easing of supply bottlenecks that came in the pandemic's aftermath. Therefore, in order to gauge the underlying rate of potential output growth, it is more meaningful to focus on prospects from 2024 onwards. The average rate over this period is 0.2 percentage points lower than implied by our March forecast. By component (Chart 4.6 central panel):

- **Labour supply growth** contributes 0.5 percentage points a year from 2024 onwards. This is 0.1 percentage points higher than in our March forecast due to higher net migration (in light of recent migration and visa outturns). We have revised down our forecast for the labour market participation rate (due in large part to higher levels of long-term sickness in the wake of the pandemic and in the context of further rises in the number of people awaiting NHS treatments)[17] although this has little effect on medium-term *growth*.

- **Capital deepening** contributes 0.3 percentage points a year from 2024 onwards.[18] This is around 0.1 percentage points lower than the implied rate in March, reflecting a weaker outlook for business investment following successive disappointing outturns and several factors that are expected to weigh on the financial performance of companies, including the weaker demand outlook, higher input costs, and higher borrowing costs driving up the cost of capital.

[17] The latest data from NHS England show that the waiting list for NHS consultant-led elective care has reached over 7 million as of September 2022.
[18] This decomposition focuses on the contribution of capital deepening (growth in the capital-to-labour ratio) rather than just growth in the capital stock.

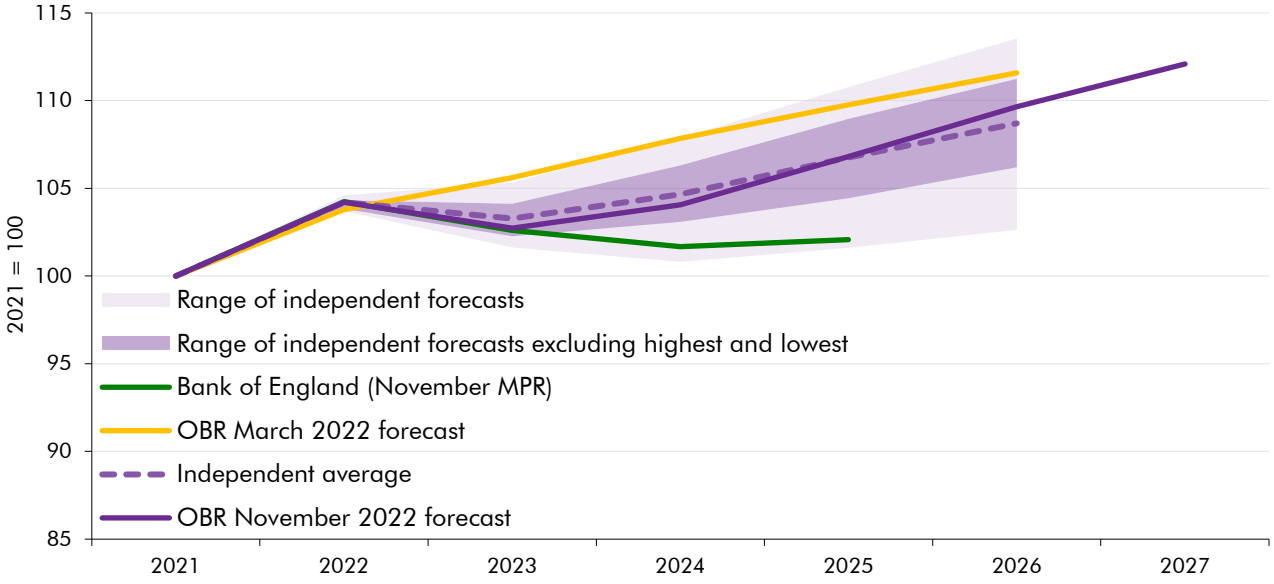
How has potential output evolved relative to our forecasts?

- **Total factor productivity** contributes 0.7 percentage points a year, which is 0.2 percentage points a year lower than the implied contribution in March. It is still 0.1 percentage points higher than outturn TFP growth over the 2010 to 2019 decade. Higher energy prices help to explain why our forecast for TFP growth is closer to the historically weak post-financial crisis rates rather than the materially stronger growth rates achieved in the decade before the financial crisis. Real energy prices in the medium term are around four times higher than pre-pandemic norms, which weighs on TFP growth for several years as the economy adjusts.[19]

4.13 By the forecast horizon, potential output growth reaches 1¾ per cent, the same as our March 2022 forecast's horizon (chart 4.6 right panel). By this point, the reduction in the level of potential output from higher inactivity (that temporarily depresses the potential growth rate) has largely passed through. Similarly, a significant part of the economy's adjustment to higher energy prices has occurred, such that the contribution of TFP to potential output growth is only 0.1 percentage points lower than expected in March.

4.14 Despite this downgrade in average potential output growth over the forecast period, our forecast for average yearly actual GDP growth over the next four years remains 0.2 percentage points above the average of other independent forecasts (Chart 4.7).

Chart 4.7: Real GDP forecast comparison



Note: Independent average uses the most recent average of independent forecasters' medium-term projections, published by the Treasury in November. Bank of England forecast excludes the backcast.
Source: Bank of England, HM Treasury, ONS, OBR

[19] Between January 2010 and December 2019, 1-month ahead forward prices for gas averaged 50 pence a therm.

5 How can government policy affect potential output?

Accounting for the economic impact of policy measures

5.1 Our economic and fiscal forecasts always take account of not only the direct financial cost or yield to government of any policy changes but also their indirect effects (also known as 'second round' effects) on the public finances via their impact on the economy. Changes in tax, spending, or regulatory policies can affect the macroeconomy both through their impact on aggregate demand and on the level of potential output.[20] In the longer run, the effect on potential output is the more significant.

5.2 The impact of fiscal policy changes on our forecasts for aggregate demand is determined by 'fiscal multipliers' drawn from empirical studies and periodically reviewed against the latest evidence. The scale and timing of these demand multipliers varies by policy instrument, though in all cases the impact tapers to zero by the fifth year of our forecasts as monetary policy is assumed to tighten or loosen to bring actual GDP back in line with potential. So fiscal policy only has a long-run impact on GDP if it affects supply potential. The fiscal multipliers used in our forecasts are published on our website, with successive reviews of the evidence having been provided in Box 2.4 of our October 2012 *Forecast evaluation report* (*FER*), Box 2.3 of our October 2013 *FER*, Box 3.2 of our July 2015 *EFO*, and Box 2.2 of our December 2019 *FER*.

Accounting for the impact of policies on potential output

5.3 Our forecasts for potential output itself also take account of policy measures that could have a meaningful impact on the effective supply of labour, the capital stock, or TFP within the relevant forecast horizon. Specifically, we take explicit account of those policy interventions that we judge to meet four criteria – they must be:

- **Significant** in magnitude, such that they could make a material difference to the very large stocks of labour and capital, and the efficiency with which they are combined that determine the supply potential of the economy. For instance, most studies find that changes in average post-tax wages have a relatively small effect on whole-economy

[20] In governmental systems such as that in the US, where the legislature proposes new policies individually and the cost or yield of these is assessed by a body such as the US Congressional Budget Office, this is known as 'dynamic scoring' – where the macroeconomic impact of an individual measure and the indirect fiscal consequences of those macroeconomic effects are captured in the costing of the individual measure (see Elmendorf, D., *"Dynamic Scoring": Why and How to Include Macroeconomic Effects in Budget Estimates for Legislative Proposals*, 2015). In a system like ours in the UK, where policy measures are typically announced in packages at a Budget or other fiscal statement to Parliament, these effects are typically captured by the OBR at the level of the package as a whole and represent the net effect of positives and negatives across individual measures.

labour supply.[21] And recent changes in personal tax settings introduced in the UK have been relatively small, with income tax changes focused on increases to the personal allowance, while the basic rate and higher rate have been unchanged since 2010, and the additional rate unchanged since 2013, when it was lowered from 50 to 45 per cent. But larger changes took place in the past, with the 1980s in the UK seeing sharp reductions in the higher rate of income tax (from 83 per cent in 1973-74 to 40 per cent in 1988-89), which did have more material effects on overall labour supply.[22]

- **Durable** in timescale, such that they are likely to have a lasting impact on the longer-run productive capacity of the economy. Temporary tax reliefs or time-limited grant programmes are unlikely to make a substantial difference to how many hours individuals choose to work or how much firms invest in the long run. In contrast, and as we have observed, permanent increases in the State Pension age have had lasting effects on the number of years people work, and therefore increased the long-run labour supply.

- **Additional** in nature, such that the policies being introduced represent something more than a continuation of previous government efforts to support the supply-side of the economy (albeit in a slightly different form). In that sense, our historically informed baseline potential output forecast implicitly captures an ongoing level of government effort to, for example, promote skills, encourage investment, and support research and development. To increase the level of potential output materially, there needs to be a substantial increase in either the level or effectiveness of such activity.

- **Evidence-based**, such that there is clear empirical support for the effectiveness of a policy in raising or reducing potential output in the UK or similar countries. Because potential output is subject to a broad range of influences and responds only relatively slowly to policy interventions, and because many such interventions prove short-lived or are subject to frequent modification and revision, it is often difficult to quantify the impact of individual policy measures with any precision.

5.4 In most cases, a policy that improves the supply-side of the economy will ultimately affect the *level* of output, with only a transitory impact on potential output *growth* as it moves to that new level. For example, raising the State Pension age from 65 to 66 will bring more 65-year-olds into the labour market, raising the whole economy participation rate and labour supply. That raises *growth* in labour supply during the transition to the higher participation rate but will not place the participation rate on a permanently rising path (without further increases beyond 66 years of age).

[21] See for instance, Keane, P., *Labor Supply and Taxes: A Survey*, 2011. In addition, Appendix E of Adam, S., and Phillips, D., *An ex-ante analysis of the effects of the UK Government's welfare reforms on labour supply in Wales,* 2013, provides a discussion of labour supply elasticities in a UK context.

[22] For instance, one study finds the elasticities of labour supply to after-tax wages for married women over the 1980s were *"positive and moderately sized"*, implying a meaningful increase in this group's labour supply due to this policy (although the in-practice tax policy changes occurred alongside a general restructuring of the tax system and shift from direct to indirect taxation, complicating interpretation). Blundell, R., et al., *Estimating labor supply responses using tax reforms*, 1998.

5.5 Since 2010, our forecasts for potential output have taken account of spending, tax, regulatory, or other policies that satisfy the above criteria. For example:

- The introduction of the **National Living Wage (NLW)** in April 2016 and subsequent increases in it relative to median earnings were initially assumed in our July 2015 *EFO* to reduce potential output by 0.1 per cent. This reflected 0.4 percentage points lower labour supply, 0.2 percentage points of which stemmed from an increase in the sustainable rate of unemployment and 0.2 percentage points from a reduction in trend average hours, which were largely offset by a 0.3 percentage point increase due to average productivity (as a result of the lost labour supply being concentrated among lower-paid employees). We revised our assumptions about the impacts of the NLW in March 2020, following the Treasury-commissioned *Dube review* of the international evidence on the impacts of minimum wages,[23] by lowering the effects of changes in the sustainable rate of unemployment and trend average hours from around 0.2 to around 0.15 percentage points each (with the offsetting impact through productivity also tempered proportionately).

- The decisions to equalise the female and male **State Pension ages** at 65 by November 2018 and then increase them both to 66 by October 2020 has raised our estimate of the participation rate among older workers and thereby boosted labour supply. A recent IFS study into the impact of the State Pension age increase from 65 to 66 found that it had boosted the employment rates of 65-year-old men by 7.4 percentage points, and of 65-year-old women by 8.5 percentage points (25,000 and 30,000 people respectively).[24]

- The Government's plans to increase **departmental capital spending** permanently by more than 30 per cent in real terms in the March 2020 Budget were assumed to gradually but significantly increase the public sector capital stock – by around a quarter over the long term. Our projections assumed that the higher public capital stock would add less than 0.1 percentage points a year to potential output growth over the long term. This was based on the average elasticity of output to the public capital stock of 0.1 found in international studies.[25] Given the lead time on public investment projects, we assumed that this boost would only be felt beyond our five-year medium-term forecast horizon but within the longer time horizon of our *Fiscal risk and sustainability report*.[26] As the November 2022 Autumn Statement reduces departmental capital spending, lowering public investment by 8 per cent in the medium term, this will, all else equal, remove around half the boost to long-term productivity growth assumed in our most recent long-term economic projections.

[23] A. Dube, *Impacts of Minimum Wages: Review of the International Evidence*, 2019 and Low Pay Commission, *National Minimum Wage: Low Pay Commission Report*, 2019. Key to our revised assessment was Chart 4.B of the Dube review, which summarised the results of 55 studies of the impact of minimum wages on employment, finding a mean 'own-wage employment elasticity' of 0.17.
[24] Cribb, J., C. Emmerson, and L. O'Brien, *Labour market effects of the increase in the state pension age from 65 to 66*, January 2022.
[25] Bom, P., and J. Ligthart, *What have we learned from three decades of research on the productivity of public capital?*, 2014.
[26] We incorporated this change at the same time as incorporating a similarly sized downward influence from the transition to net zero, which implies a steadily rising 'shadow' carbon price that weighs on productivity growth over the coming decades. For simplicity, these two effects were assumed to offset, leaving our long-term productivity growth assumption at 1.5 per cent a year. (See Chapter 4 in our July 2022 *Fiscal risks and sustainability report*.)

How can government policy affect potential output?

- Following the announcement of the **post-Brexit migration regime** in February 2020, in our March 2020 *EFO* we moved from using the ONS principal migration projection (in which net migration settled at 190,000 a year in 2025) to using the net zero EU variant (in which net migration settled at 129,000 a year). This lowered both our population and labour participation forecasts as migrants have a higher average participation rate than the overall population because a larger fraction of them are of working age when they arrive. This left the labour force 0.4 per cent smaller at the forecast horizon. But we assumed there would be a partial offset (worth 0.1 per cent) via higher potential output per worker because the reduction in migration due to the new regime was likely to be concentrated among lower-wage workers. In total this lowered potential output at the forecast horizon by around 0.3 per cent.[27] The latest data on net migration, which has recovered strongly since the pandemic to reach 239,000 in the year to June 2021, and continued high numbers of non-EU, non-visitor visas issued by the Home Office (which reached 1.1 million in the year to June 2022) have prompted us to revise this judgement. Our November 2022 forecast returns to using the ONS principal projections, which now settle at net migration of 205,000 a year in the medium term. This adds 0.6 per cent to the level of potential output in 2027 relative to using our previous lower migration assumption.

5.6 As highlighted in the previous chapter, our latest forecast takes account of several policies that are expected to have a material impact on potential output – both positive and negative. But more significantly, the net effect of these policies on potential output has been more than offset by a set of wider, and mostly adverse, macroeconomic developments, in particular higher energy prices, interest rates, and inactivity levels, which may or may not ultimately prove lasting – and whose impact could prove larger or smaller than we have assumed. Only the higher-than-expected numbers of migrants coming to the UK under the post-Brexit migration regime adds materially to prospects for potential output growth over the coming five years relative to the assumptions that we made in March. This underscores the importance of looking at the impact of any individual policy on potential output in the round and periodically reviewing past forecast judgements in the light of the latest data.

[27] Home Office Technical Paper to accompany *The UK's future skills-based immigration system economic appraisal: Annex B,* 2018 and HM Government, *EU Exit: Long-Term Analysis Technical Reference Paper,* 2018.