Recent experience with macroeconomic forecasting for UK monetary policy

By Huw Pill[1]

Abstract

Macroeconomic forecasting has proved challenging of late. Inflation has been subject to large external shocks, and uncertainty surrounds the persistence of inflation as those shocks work their way through the economic system. Forecasters face potential non-linearities and asymmetries in the Phillips curve relationship between labour market tightness and wage inflation. Bank of England staff have developed an eclectic and broad set of approaches to address the resulting challenges. While no individual framework provides a comprehensive solution to the difficulties recently faced in modelling and forecasting inflation, using this suite of models and approaches gives important input to the development of the necessary judgement underpinning the MPC's published inflation forecasts and monetary policy decisions.

1   Introduction

In these short remarks, I seek to make three points: first, to acknowledge the difficulties faced by macroeconomic forecasters of late, in the face of very significant and unanticipated economic disturbances such as the Covid-19 pandemic and the war in Ukraine; second, to distinguish between the challenges arising from the incidence of these shocks and the propagation of these shocks, which have different implications for forecasting and interpretation; and third, to outline some of the responses made by Bank of England staff to the challenges raised in this context, such as making greater use of longer runs of historical data, of 'big data' with richer cross-sectional variation or of non-linear modelling techniques. I conclude with a few observations on the role of macroeconomic forecasting in the formulation of monetary policy.

2   Recent performance of macroeconomic forecasts

John Kenneth Galbraith famously stated that: *"the only function of economic forecasting is to make astrology look respectable"*. That is a little harsh. Economic forecasts can and do serve useful purposes, even if they inevitably fail to reliably

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predict macroeconomic outcomes in the face of considerable uncertainty. If well-constructed, macro forecasts represent a coherent and internally consistent framework that respects basic accounting and theoretical principles within which to conduct policy discussions and communication.

That said, macroeconomic forecasting has proved especially challenging in recent times, as reflected in the magnitude of recent forecast errors. To illustrate, consider the Bank of England's Monetary Policy Committee (MPC) forecast of UK inflation published in the MPC's Monetary Policy Report of February 2021 shown in **Chart 1**.

Chart 1

CPI inflation projection in the February 2021 MPR

(consumer price index, annual change, percent)
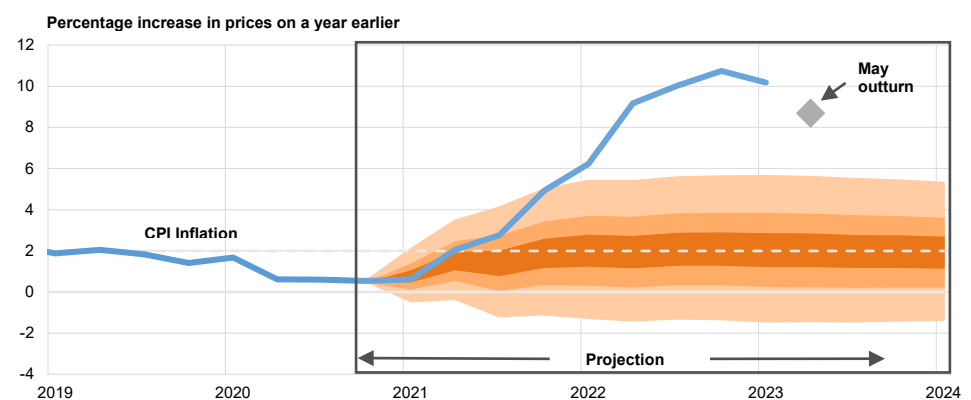
Sources: Office for National Statistics and Bank of England calculations.
Notes: For the conditioning assumptions on which the February 2021 projections were based, see the footnotes to Table 1.A of the MPC February 2021 *Monetary Policy Report*.

Given the MPC's mandate to maintain price stability, as defined by its remit to return UK CPI inflation to the 2% target, it is natural to focus here on forecasts of inflation rather than other macro variables. And, given the well-known long and variable lags in monetary policy transmission and the empirical evidence suggesting that monetary policy actions have their largest impact on inflation after 18-24 months,[2] arguably it is forecasts made in the spring of 2021 that make the relevant benchmark for assessing inflation outcomes over the past six months from a monetary policy perspective.[3]

Going back to its adoption of inflation targeting in the mid-1990s, the Bank of England has a long history of recognising uncertainty in the presentation of its inflation forecasts. The MPC has tended to downplay central inflation projections in its narrative, favouring instead fan charts capturing the probability distribution of inflation outcomes at various horizons. Such an approach has supported communication of several central tenets the MPC's approach to monetary policy: its focus on inflation control as the primary objective of monetary policy; the need for a forward-looking and medium-term oriented approach to monetary policy decisions given the lags in transmission; and the futility of attempting to fine tune short-term or

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[2]   Andre et al. (2022).

[3]   Choosing that vintage has the added advantage that the current author was not involved in producing the MPC forecast shown, which pre-dates him (re-)joining the Bank of England staff.

high frequency inflation developments owing to the shocks and uncertainty facing the economy.

The methodology used to construct these fan charts has varied over time and – like other aspects of macroeconomic forecasting – has always embodied a degree (sometimes a large degree) of judgement. In practice, the fan charts are wide. In **Chart 1**, the breadth of the 95% confidence interval for inflation at the two-year horizon is greater than six percentage points. And yet, headline inflation outturns in recent months have fallen well outside these wide fan charts. Forecast misses have not only been large, but they have also proved persistent. Unfortunately, inflation remains unacceptably high today.

The causes of this substantial and lasting overshoot of the inflation target are well-trodden ground, to which I will return to shortly. But, in the spirit of viewing macroeconomic forecasts as vehicles for constructing an economic narrative, it is helpful to recall the discussion that surrounded the MPC's February 2021 forecast.

Chart 2

Household consumption since the Covid-19 pandemic

(index, 2019Q4=100)
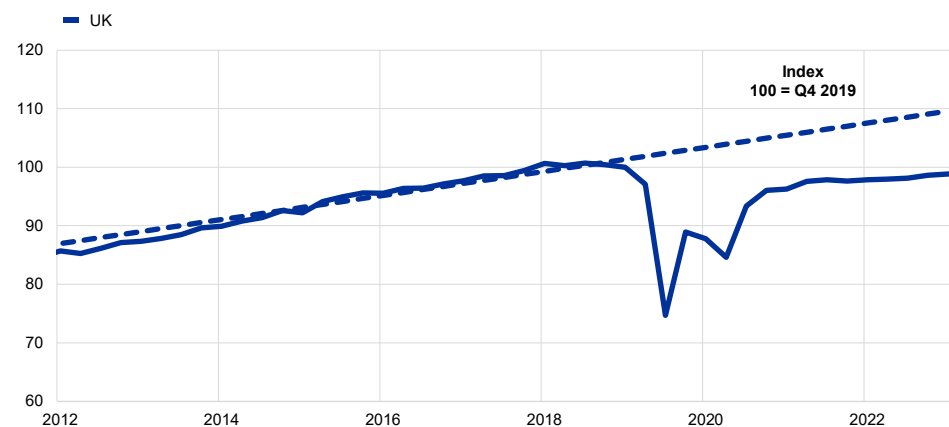
Sources: Office for National Statistics and Bank of England calculations.
Notes: This chart shows a chained-volume measure defined as households' final consumption expenditure and final consumption expenditure of non-profit institutions serving households. Trend line estimated using 2012-2019 data.

That discussion centred on how households would respond to their accumulation of excess saving as a result of pandemic-induced lockdowns. In aggregate, lockdowns had hindered consumer spending on services at a time when household income was being supported by fiscal measures, notably the UK government's furlough scheme supporting jobs. Much of the resulting excess saving took the form of a build-up of bank deposits and thus represented a (broad) 'monetary overhang'. In the spring of 2021, risks around the inflation forecast shown in **Chart 1** were believed to centre around the possible threat of an inflationary consumption boom, as excess savings were rundown rapidly once the lockdown restrictions were removed.

As illustrated in **Chart 2**, in real terms household consumption in the UK still has to recover to the level seen at end-2019, and remains roughly 10% below what would be implied by an extension of pre-pandemic spending trends. The UK did not enjoy a consumption boom during the recovery from Covid-19. The substantial inflation that

has emerged (and shown in **Chart 1**) is unlikely to reflect the strength of demand but rather a weakness of supply that was not sufficiently anticipated in the spring of 2021: first, stemming from the supply bottlenecks associated with disruption to global value chains and shipping owing to the pandemic; and latterly, to the impact of the invasion of Ukraine on European energy and food prices.

Indeed, the exceptional increase and volatility introduced into the pricing of European wholesale natural gas as a result of the Russian invasion of Ukraine (shown in **Chart 3**) has had a profound impact on inflation outturns. Given its reliance on natural gas to both heat homes and generate electricity, the UK is particularly exposed to this energy shock. This has made forecasting UK inflation more difficult.

Chart 3

Wholesale natural gas prices and conditioning assumptions

(pence per therm)

Sources: Bloomberg Finance L.P. and Bank of England calculations.
Notes: Spot price is the one-day forward price of UK natural gas, as of 21 June 2023. The projections in May 2023, February 2023 and November 2022 are conditioned on wholesale gas prices following futures curves. These futures curves were the 15 working day averages to 28 April 2023 and 24 January respectively for May and February 2023 and the seven working day average to 25 October 2022 for November 2022. The projections in August 2022 were conditioned on wholesale gas prices following the futures curve in the 15 working days to 26 July for the first six months and then remaining constant.

For the UK and the euro area – both of which are net importers of energy, particularly of natural gas – the rise in European wholesale gas prices imply a significant deterioration in the terms of trade. In turn, that worsening of the terms of trade has led to a squeeze on national income: simply put, the price of what the UK and euro area are buying from the rest of the world has risen significantly relative to the price of what they sell, squeezing the real spending power of domestic residents. This squeeze helps to explain the substantially weaker recovery in household consumption after the pandemic in Europe relative to the US.

Higher wholesale natural gas prices also represent a substantial cost-push shock in the UK, with significant direct and indirect effects on headline inflation. Even as the initial impulse to inflation from these channels dissipates, UK inflation remains vulnerable to second-round effects that render inflationary pressures more persistent, as actors in the economy understandably attempt to regain lost purchasing power by pressing for domestic incomes to catch up with higher imported prices. The embedding of any such second-round effects can generate persistence

in the inflation process, which demands a monetary policy response. Assessing the risk of such persistence is the current pre-occupation of the MPC.

On this basis, the substantial inflation forecast error illustrated in **Chart 1** can largely be explained by the incidence of an energy price shock stemming from the invasion of Ukraine.

From a monetary policy perspective, that shock had three key characteristics: it was unanticipated; it was large; and the bulk of its direct and indirect impact on headline inflation take place within a shorter horizon than it would take for the lags in monetary policy transmission to unwind. By implication, monetary policy could not fully offset the rise in headline inflation resulting from the energy price shock – some deviation of inflation from target was inevitable, reflecting an irreducible volatility in inflation. And because the energy price shock was exceptionally large, that deviation of inflation from target and heightened volatility were both large as well.

From a narrower forecasting perspective, it is the first two characteristics of the energy price shock that are most relevant. Crucially, just because a shock was – by nature – *unanticipated*, that does not necessarily mean that it was *unanticipat-able*. Any shock is identified relative to some model (or at least 'view-of-the-world'). In principle, a better model could have anticipated that shock – and thus improved the any subsequent forecasts made.

Can we expect central banks' economic forecasters to be able to anticipate geo-political events such as the Russian invasion of Ukraine (or for that matter other recent phenomena, like the Covid-19 pandemic or the outcome of the Brexit referendum)? For sure, forecasters should listen to the experts in such matters and be open-minded enough to consider their assessment rather than remaining narrowly focused on economic time series. But retaining a focus on where their expertise lies rather than widening the scope of their models and framework even wider remains in our mind the sensible approach.

3   Incidence and propagation

One implication of this approach is that economic forecasters can expect to be confronted by significant shocks in a world of geo-political and supply side uncertainty. If those shocks cannot be anticipated, forecasters should focus more on deepening their understanding how these shocks will propagate through the economic system, and assess whether existing forecasting frameworks are robust to challenges on this dimension.

3.1   Conditioning assumptions

In that context, it is important to recognise that the MPC's macroeconomic forecasts are formulated conditionally on assumptions about a variety of policy and other variables. Rather than being attempts to predict the future as accurately as possible,

these conditional forecasts should be understood as projections of the economic outlook that assume paths for some key economic drivers.

More specifically, the MPC's inflation forecasts are based on: (a) a path for the short-term policy interest rate (the Bank of England's Bank Rate) that follows the path implied by market pricing of the risk-free yield curve; (b) on fiscal policy that has already been announced by the UK government; and (c) on an assumed path for energy prices (currently the path of energy prices implied by futures contracts, in the past a 'random walk' path, where prices are held at their current level).

To the extent that these conditioning assumptions are wrong and/or misleading, the resulting forecasts are likely to prove poor predictors of the economic outlook, even if they nevertheless provide a useful basis for discussion about the policy decision within the MPC. In particular, recent experience has demonstrated the difficulty of forecasting energy prices and the shortcomings of both futures prices and random walk assumptions in making such forecasts (as shown in **Chart 3**). From a forecasting perspective, the Bank of England can draw some solace – but little comfort – from the failure of others to improve upon such approaches.

Because of the magnitude of recent shocks to energy prices, fiscal policy and the yield curve (as well as technical changes to the implementation of the conditioning assumptions we have chosen to make in recent rounds), the impact of changes in conditioning assumptions on the MPC forecast have been very substantial over the past 18 months.

Some of those shifts were anticipatable and – to the extent that they were anticipated by the MPC – may have been incorporated into policy decisions, even though they were not part of the MPC's modal forecast. As a result, a gap has opened up between the MPC's forecast and its monetary policy decision. Even though that gap has been explicitly acknowledged and discussed in the MPC's public statements, it represents a departure from the long experience of the Bank of England with an inflation forecast based form of inflation targeting, which established a close relationship between the MPC's inflation forecast and its choices over Bank Rate. That has posed challenges to monetary policy communication.

The magnitude of recent economic shocks – notably to natural gas prices – has shifted the UK away from the 'resting point' or steady-state of the economy consistent with the 2% inflation target. As a result, the belief that changes in one forecast conditioning assumption can be treated separately from changes in others – in other words, the belief that you can draw meaningful inferences about the economic outlook on a 'holding other things equal' basis – is breaking down.

In this environment, it is the co-movement across conditioning assumptions as much as changes in any individual assumption that may be driving economic behaviour and challenging the performance of conditional forecasts.

This can be illustrated with the example of the August 2022 MPC forecast. Consistent with standard practice at that time, this forecast was constructed on the basis that energy prices followed the path implied by futures prices for the first six

months and then followed a random walk (i.e. were kept constant, as shown in **Chart 3**). In parallel, the August 2022 forecast was based on announced government fiscal policies, again in line with standard practice.

The random walk assumption locked-in natural gas prices at close to their historical all-time highs. Given the leadership change in the Conservative Party underway in the summer of 2022, UK fiscal policy decisions were postponed under the selection process was complete. At a time when most other European countries were announcing significant fiscal support for households and businesses confronted by the substantial rise in wholesale natural gas prices, the UK government did not act.

Taken in isolation, each of these two conditioning assumptions was subject to challenge. Arguably, neither represented the most likely forward path for the variables in question. But what was even more implausible was the combination of assumptions: if natural gas prices were to remain at such historically high levels indefinitely, the absence of any fiscal support for firms and households to ease and facilitate the inevitable transition away from dependence on natural gas was especially implausible.

As a result, a forecast conditioned on this combination of conditioning assumptions was unlikely to be a good predictor of future outcomes. The MPC therefore distanced itself somewhat from its forecast in the presentation of the rationale for its policy decision, which complicated its communication with financial markets, the media and the public.[4]

Rather than simply being *additive*, the implications of departures from the conditioning assumptions interact with one another, and thus have a *multiplicative* effect on the final forecast.

3.2   The Phillips curve: Non-linearities and asymmetries

This has important implications for the assessment of the economic outlook at present. The vulnerability of the UK economy to second round effects in price and wage setting following the sharp rise in inflation driven by the external energy prices shocks is heightened by the tightness of the labour market and unexpected resilience of aggregate demand relative to weakened aggregate supply. In this context, the emergence of persistence in inflation is more likely than would be the case if resource pressures in labour and goods markets were weaker.

Such 'state-dependence' in price- and wage-setting behaviour (and indeed in other relevant aspects of economic behaviour, such as the transmission mechanism of monetary policy) pose challenges for macroeconomic forecasting.

Generalising from this specific example, one way of thinking about these challenges is to recognise that the UK economy has moved outside the locality around the

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[4]   While the MPC could – and did – show alternative scenarios in its *Monetary Policy Report*, it limited itself to alternative paths for energy price, which were based on the assumption that natural gas prices would follow the path implied by futures prices rather than the random walk. However, in those scenarios, the other conditioning assumptions (for Bank Rate and fiscal policy) were kept unchanged.

steady-state defined by the 2% inflation target where linear approximations of the standard macroeconomic models on which the forecast framework can provide reliable guidance about the inflation outlook.

Recent experience points to important non-linearities in economic behaviour: for example, of convexity in the Phillips curve. Given the MPC's current assessment of modest excess demand in the economy, recent high core inflation is indicative of a steepening of the Phillips curve. Phillips curves estimated over the past 25 years of inflation targeting – which tend to be flat – cannot explain current elevated rates of core price or wage inflation.[5]

But evidence of convexity alone would not justify concerns that the inflation process is becoming more 'persistent' – and thereby posing risks to the MPC's price stability mandate at the longer horizons where monetary policy can exert an influence, as policy transmission lags unwind. A convex Phillips curve would simply imply that, just as inflation has risen more rapidly for given excess demand in the past eighteen months, it will also tend to fall more rapidly as excess demand eases following monetary tightening. Inflation would follow broadly the same 'fast-by-historical-standards' path on the way back down as has been observed as inflation went up.

For inflation persistence to emerge, we need an asymmetric Phillips curve – one where price and wage inflation remain stubbornly high as excess demand recedes and slack emerges.

4 Forecasting in the face of non-linearity and asymmetry

Economic forecasting in support of monetary policy decisions therefore needs to face the challenge of dealing with potential non-linearities and asymmetries in key macroeconomic relationships, such as the Phillips curve. Importantly, these challenges need to be met in real time. Policy makers cannot afford to wait until definitive evidence has been established using long historical time series: acting only at that point is inevitably acting too late. Rather policy makers and the forecasters supporting them need to make an informed judgement based on available data.

Crucially, empirical evidence for asymmetry can only be established when we have seen both sides of the story – experience of wage and price setting behaviour during the run-up in headline inflation, but also experience as inflation falls back due to base effects. At the moment, we have the former but not the latter. But in judging the likely persistence of inflation, both policy makers and forecasters need to make a judgement about how asymmetric the Phillips curve will prove in the future. By nature, that judgement has to rely on data from the present and the past.

In the remainder of this section, we list some of the approaches adopted by Bank of England staff to address this challenge.

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[5]   Speigner (2014); Esady et al (2023).

Historical analysis

The MPC's latest macroeconomic forecast (as published in May 2023 *Monetary Policy Report*) relies mainly on empirical tools developed using the last three decades of UK economic data, which cover the period since the introduction of inflation targeting. There are good reasons to focus on this span of data. The time series are sufficiently long to allow estimation of the models. And the sample is sufficiently recent to make it relevant for conjunctural analysis. Moreover, using an empirical framework that draws on data from the prevailing monetary policy regime has the advantage – at least in principle – that key features of that regime, which remain relevant today, are captured in the empirical framework. By nature, models estimated using data from other, earlier regimes (such as those involving exchange rate or monetary targets) may not capture those features so well.

More specifically, to the extent that economic decisions are driven by expectations and the way households, firms and financial market participants form their expectations is influenced by the monetary policy regime, economic behaviour can vary from one monetary policy regime to another, creating an instability in estimated empirical models as the relationships between macro variables change.

This is a restatement of the so-called 'Lucas critique' of macroeconomic models: while structural behavioural relationships should in principle be stable through policy regime changes, in practice macroeconomic models are based largely on 'reduced-form' estimated relationships which are vulnerable to instability as the policy regime – and the expectation formation process – change. Relying on an empirical framework estimated within the same monetary policy regime offers the best hope of estimating stable (and thus more reliable) empirical models. Restricting estimation samples to specific monetary policy regimes is standard practice in the research literature.

Of course, this argument assumes that the expectation formation process has remained stable throughout the entire inflation targeting regime to date. But it is possible that expectations formation has changed in recent times, owing to the exceptionally high rates of headline inflation seen over the past two years. This eventuality cannot be dismissed out of hand since, as recognised above, inflation developments have proved more persistent in the aftermath of the invasion of Ukraine than they were during the earlier part of the inflation targeting era, even as longer-term inflation expectations have remained anchored close to target.

To shed light on recent developments, models and analysis from a different monetary policy regime where inflation was both more elevated and more persistent could be explored. This is one approach Bank staff have adopted. In particular, the staff have revisited models of wage and price determination published in the academic literature in the 1980s, which explored the surge in inflation in the UK from the mid-1970s (in particular following the oil price shocks of 1973 and 1979) and incorporate a greater degree of 'real income resistance' in price and wage setting behaviour. In doing so, Bank of England staff have both re-estimated those models using recent data and taken model estimates from that period to develop frameworks that can explore and evaluate recent wage and price developments. The MPC have

used these frameworks to discuss how the deterioration in the UK's terms of trade associated with the rise in imported natural gas prices led to a squeeze on UK national income and, in concert with efforts by UK residents to sustain their real spending power, prompted greater inflation persistence.[6] This mechanism draws directly from the experience and modelling of the 1970s and '80s.

Such exercises can therefore shed helpful light on the current situation. They represent one element underpinning concerns that inflation may prove more persistent in the aftermath of the recent, exceptionally large inflationary impulse generated by the invasion of Ukraine.

Yet there are a number of reasons for caution in relying on evidence from or models developed in the 1970s and '80s. The structure of the UK economy has changed dramatically over the past half century: the manufacturing sector has declined; the economy is more open to international trade and finance; labour markets and the wage bargaining process have been transformed by a decline in unionisation and deregulation; debt burdens and their distribution across and within sectors have evolved. And the change of monetary policy regime has influenced expectations and thus behaviour: based on developments in long-term nominal interest rates, UK inflation appears much better anchored to low levels today than was the case in the 1970s.

Theoretical advances in labour market modelling

Another approach to address uncertainties surrounding the Phillips curve is to draw on developments in the theoretical literature that underpin matching models in the labour market.[7]

The starting point for the Bank of England's modelling of the labour market tightness remains the 'unemployment gap' – the difference between unemployment rate and the 'NAIRU' (the non-accelerating inflation rate of unemployment).[8] But the matching literature (and recent empirical studies) emphasise alternative metrics, such as the ratio of vacancies to unemployment (the V/U ratio) or measures of churn (such as the magnitude of job-to-job flows).[9]

While these three measures of labour market slack moved largely in lock-step in the more benign inflationary environment associated with the bulk of the inflation targeting regime, in more recent times that correlation has weakened. Using alternative measures of tightness such as the V/U ratio – which rose to unprecedented levels in the aftermath of the pandemic – can help to account for the recent strength of inflation in statistical models.

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[6]   This is discussed in greater detail in the author's recent speech to the International Centre for Monetary and Banking Studies (Pill, 2023.

[7]   Kanngiesser et al. (2023).

[8]   Layard et al. (2005).

[9]   Pissarides (2000).

But some caution is still required in interpreting this favourable empirical performance. The relative success of the V/U ratio compared with the unemployment gap relies heavily on developments in recent quarters. Using these models in preference to the conventional wage suite relies on the theoretical underpinnings to the matching models being robust to recent challenges, since we do not have long enough time series to distinguish model performance definitively.

Using matching models of the labour market also offers a helpful perspective on recent inflation outcomes and can inform the judgement required of forecasters and policy makers about the likely persistence of inflation from here. But these models face the mirror image of the critique made of relying on historical experience in the 1970s and '80s: while these matching models capture significant theoretical advances made during past 30 years, in empirical form they may also capture the experience of the past 30 years – and it remains an open question as to whether that experience is the most relevant for the more challenging inflationary environment faced of late.

Non-linear empirical models using machine learning

If the essence of the challenge facing forecasters is to explain recent, possibly non-linear developments in the Phillips curve, a natural response is to employ modern non-linear modelling techniques that embrace machine learning in order to capture that behaviour. This approach has been adopted by Bank of England staff in their estimation of a so-called 'neural Phillips curve' using neural network methods to account for the empirical relationship between inflation and economic slack.[10]

Unsurprisingly, these methods fit the data well. This is precisely what they are designed to do: by focusing on the more recent period, they are essentially seeking to fit one set of observations, and the non-linear approach offers a high degree of flexibility in the estimated model to do so.

But the open question is whether this good fit to recent data constitutes 'over-fitting', given that these machine learning approaches are vulnerable to the well-known weaknesses of data mining. In particular, the non-linear character of these models may create a good fit over one domain of the estimated function (say the period over which headline inflation is rising) but could have a very poor fit over a different domain of the function (say the period where headline inflation is falling back towards target).

Somewhat ironically, it is precisely the non-linear character of these models that magnifies the risk associated with using an 'over-fitted model' estimated in one phase of the inflation cycle to forecast inflation in another phase of that cycle. This dictates a need for caution in using these techniques both for forecasting inflation and for drawing conclusions for monetary policy.

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10   Buckmann et al. (2023).

Exploiting cross-sectional heterogeneity and 'big data'

A related empirical approach exploits the potential for cross-sectional variation across households, firms, financial institutions or transactions – often available at higher-than-previous frequency and more timely fashion – to shed light on the recent behaviour of the economy. This line of attack has been facilitated by the emergence of both large data sets (often associated with administrative tasks, such as data on payrolls, loan-by-loan data on mortgages or transactions data from financial markets), and the computer power and empirical techniques needed to explore them. Bank of England staff have been in the forefront of analysing such datasets for analytical and policy purposes.

In parallel with these empirical innovations, Bank staff have also invested in theoretical models that capture heterogeneous behaviour across firms and households. Foremost among these tools are HANK (heterogeneous agent new Keynesian) models. At least in principle, these models offer a structural framework within which cross-sectional variation in the data can be understood, which has the potential to deepen our understanding of monetary policy transmission.

While these avenues are promising, from a monetary policy perspective it needs to be kept in mind that inflation itself and – even more so – the persistence of inflationary dynamics are, by nature, time series concepts. Moreover, given the uncertainty surrounding the length and magnitude of lags in monetary policy transmission, the ability of the MPC to fine-tune higher frequency developments in inflation is very limited.

As a result, the value of 'big data' approaches to macroeconomic forecasting is questionable – at least in so far as such forecasts are used to support monetary policy making. The extra dimensionality offered by 'big data' relates to cross-sectional and / or high frequency aspects of the data, which may not offer much insight into the lower frequency time series component of behaviour and price dynamics that necessarily should be the focus of a monetary policy appropriately oriented to achieving the inflation target on a lasting basis over the medium term.

To make 'big data' approaches useful in this context, empirical and theoretical models need to be combined in a manner that allows inference to be drawn about those lower frequency price developments from the richness of the data set on cross sectional and high frequency dimensions. Our ability to do so remains uncertain at this stage.

Exploiting information in firm and household surveys

Another way of coming to an understanding of whether price and wage setting behaviour has changed is to simply ask those concerned. In that light, Bank of England staff also make use of information derived from surveys of market participants, households and firms to develop an assessment of inflation persistence, and non-linearities and asymmetries in the Phillips curve.

An important aspect of this work is to look at inflation expectations, which can also be compared with market pricing of inflation indexed bonds and inflation swaps (i.e. so-called breakeven inflation rates). New Keynesian macroeconomic models assign importance to inflation expectations in pricing decisions and thus to the evolution of inflation itself. Since this is a well-rehearsed topic, I will not dwell on it further here, other than to flag that some caution needs to be taken in treating market-based indicators of inflation expectations as central to price and wage setting behaviour, since market participants are not immediately active in goods and labour markets where prices and wages are set, but rather assess prospects there one-step removed.

Chart 4

Survey evidence on frequency of firm pricing decisions

(Decision Maker Panel, percentage of firms reporting)
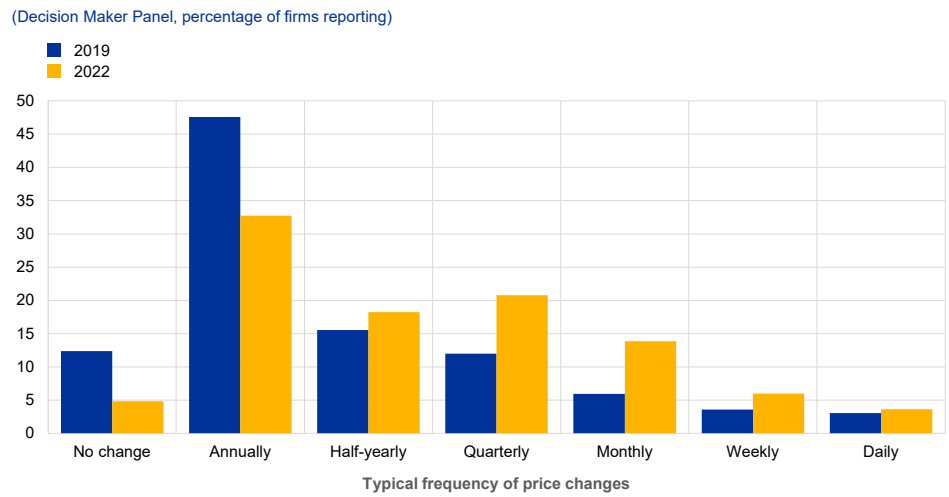
Sources: Decision Maker Panel survey and Bank of England calculations.
Notes: The latest data are from the May 2023 Survey. The results on frequency of price changes are based on the question: Approximately how often did your prices change in each of the following years?' Respondents were then asked to choose one of the following options for both year 2019 and 2022: daily, weekly, monthly, quarterly, half-yearly, annually, and prices did not change.

Rather I will focus on surveys of firms' choices when setting prices, derived from the Bank of England's Decision Maker Panel survey. Using responses from that survey, **Chart 4** illustrates how firms have shifted towards more frequent resetting of their own prices in recent years, as inflation has risen in the economy as a whole following the external shocks discussed above. This is consistent with the view that firm pricing is *state-dependent*: rather than setting prices according to a fixed exogenous schedule (i.e. acting in a *time-dependent* manner), firms change how often they reset prices in the face of external events.

Chart 5 shows that firms that price in a state-dependent manner have raised their own prices faster than firms that act in a time-dependent manner since the middle of 2021. Taken together with the observation firms have shifted towards more state-dependence, this can help to explain the observed greater convexity in the Phillips curve on the basis of a non-linearity in aggregate corporate pricing dynamics.

However, as I have already discussed, that non-linearity does not of itself rationalise the asymmetry in pricing behaviour that is needed to validate concerns about greater inflation persistence emerging in recent years. On the contrary (and as reflected in

the two dots shown in **Chart 5**), firms that report pricing on a state-dependent basis expect own price inflation to fall more significantly in the coming year than firms that continue to price in a time-dependent manner. If borne out by behaviour of the coming year, this survey evidence suggests that firm pricing behaviour may prove more symmetric than those who fear a rise in inflation persistence assume.

Chart 5

Survey evidence on changes in firm pricing behaviour and expectations

(Decision Maker Panel, own price changes, %, three-month moving averages)
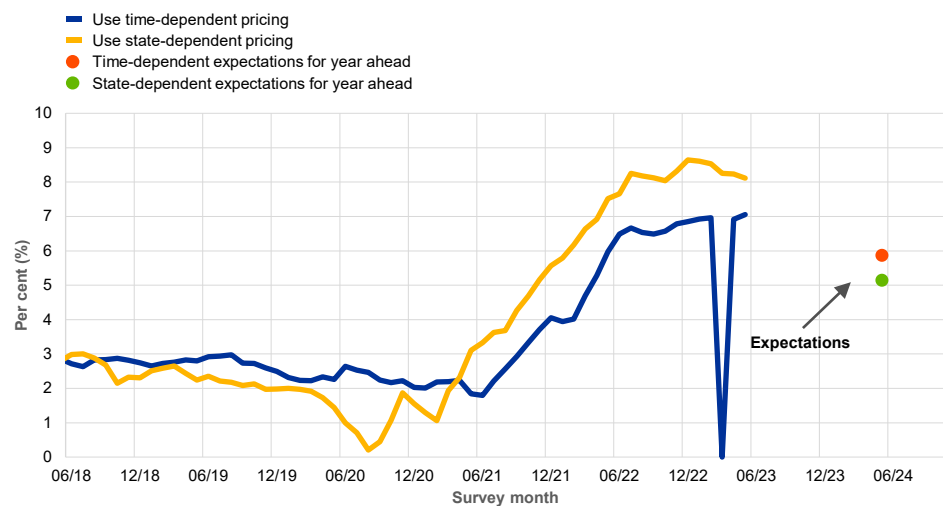
Sources: Decision Maker Panel survey and Bank of England calculations.
Notes: Realised price growth (lines) are responses to the question: 'Looking back, from 12 months ago to now, what was the approximate % change in the average price you charge, considering all products and services?'. The latest data are from the May 2023 Survey. Expected price growth (diamonds) are responses to the question: 'Looking ahead, from now to 12 months from now, what approximate % change in your average price would you expect in each of the following scenarios: lowest, low, middle, high and highest?', and respondents are asked to assign a probability to each scenario which is used to create a weighted average expectation of price growth.

While there is no room for complacency about the risk of greater inflation persistence in the UK economy given recent developments in services prices and wage growth, nonetheless this survey of firms' pricing behaviour offers some evidence in the other, more benign direction.

5   Concluding remarks

Recent years have proved challenging for macroeconomic forecasters seeking to support monetary policy decisions. A variety of models and framework have been revisited and explored to assess the potential emergence of greater inflation persistence. Non-linearities and asymmetries in the Phillips curve relationship between economic slack and the price and wage inflation have been in focus.

In this context, I conclude by paraphrasing the famous British statistician Prof. George E.P. Box: *"All (economic) models are wrong, but some are useful".* In addressing the significant challenges facing monetary policy at present, the Bank of England's forecast team seek to consider a broad set of useful – even if imperfect – models and forecasts to shed light on these potential non-linearities and asymmetries. Such analysis supports the development of a robust MPC response to

the substantial underlying economic challenges at present, and ensures inflation will return to the 2% target assigned to the MPC in a lasting manner.

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