A Snapshot of Central Bank (two year) Forecasting: A Mixed Picture

Abstract

Central Banks normally adjust monetary policy so that inflation hits the Inflation Target (IT) within two years. Since a central bank must believe its policy stance is appropriate to achieve this goal, its inflation forecast at the two-year horizon should generally be close to target. We examine whether this has held for three main Central Banks, Bank of England, ECB and Fed. During the IT period, there have been two crisis periods, The Great Financial Crisis (GFC), and then Covid/Ukraine. We examine how the two-year forecasts differed depending on whether we were in a crisis, or more normal, period. Although over the *whole* IT period, up until 2022, both forecasts and outcomes were commendably close to target, we found that this was due to a sizeable forecast *underestimate* of the effects of policy and inherent resilience to revive inflation after each crisis hit, largely offset by an *overestimate* of the effect of monetary policy to restore inflation to target during more normal times. We attribute such latter overestimation to an unwarranted belief in forward looking, 'well anchored', expectations amongst households and firms, and to a failure to recognise the underlying disinflationary trends, especially in 2010-2019. We outline a novel means for assessing whether these latter trends were primarily demand driven, e.g. secular stagnation, or supply shocks, a labour supply surge. Finally, we examine how forecasts for the uncertainty of outcomes and relative risk (skew) to the central forecast have developed by examining the Bank of England's fan chart, again at the two-year horizon.

JEL categories: D10, D21, D80, D89, E17, E31, E37, E47, E59

Keywords: Inflation Targeting; Forecasting; Crisis Periods; Expectations; Fan Chart

Charles A.E. Goodhart – caegoodhart@aol.com
London School of Economics

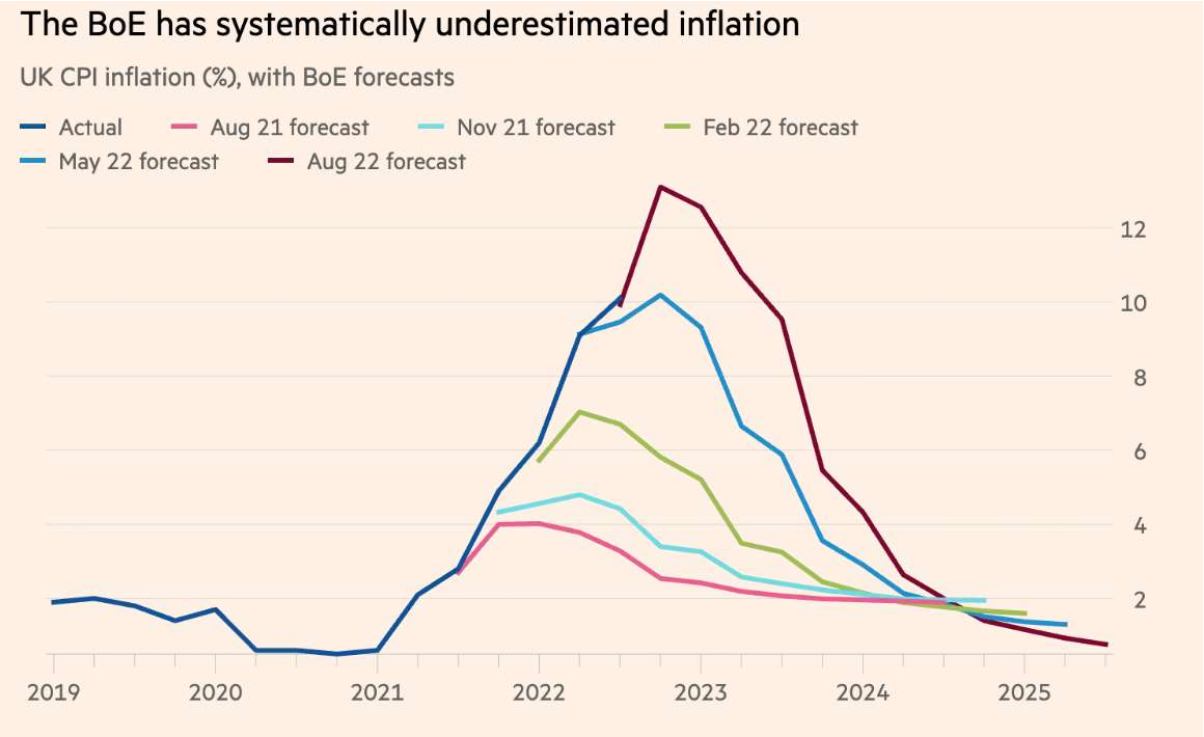
Manoj Pradhan - manoj@talkingheadsmacro.com

Talking Heads Macroeconomics

Introduction

In so far as the major Central Banks, the Fed, ECB and Bank of England, have made policy mistakes in 2021 and 2022, this has been due largely, if not primarily, to forecasting errors. A set of BoE forecasts are show below, and similar ones for the Fed and ECB could be provided.

Figure 1



Source: BoE and FT

So it seems an appropriate moment for a study of the longer-term forecasting record of these Central Banks. This is, however, quite a daunting task, in part because of the masses of data involved, with each forecast generating loads of data points. So we have not felt able to do anything like a full-scale study of Central Bank forecasting. Instead, when one of the authors was appointed as an external member to the Bank of England's initial Monetary Policy Committee (MPC) in 1997, he soon came to the view that the basic responsibility that he, and the MPC, had was to set the (path of the) official short rate so that inflation would (be expected to) return to the mandated target by the

end of the forecast period, generally two years hence. This, we thought, was the essence of flexible inflation targeting, where prices/wages were sticky in the short run, so changes in interest rates impinged mainly on output in the short run, and only with a considerable lag on inflation.

So, the first hypothesis for this study is whether this approach, i.e. setting short-term official interest rates so that inflation could be forecast to revert to target by the end of a two year period, was common to the Central Banks whose forecasts we study in this exercise, Fed, Bank of England and ECB. The starting point for targeting inflation was different for our three Central Banks; BoE in 1997 Q2; the ECB in 1999; we put the date for the Fed as 2003 Q2. There are inevitably data difficulties, e.g. the target was not specifically quantified and/or changed over time; the inflation rate on which the Committee focussed was not specifically identified, and/or changed over time. We outline how we dealt with these difficulties and the sources and derivation of our data set in Section 2. We provide our database in the Appendix at the end of this paper.

We reveal the outcome of the tests of this hypothesis, (i.e. that monetary policy will be set so as to drive inflation back to target in two years time), in Section 3.

As is generally recognised, the period of the combination of Inflation Targetry, (IT), plus Central Bank Independence (CBI), has been separated into four, uneven, quarters. We give (in some cases approximate) dates of these four quarters, and a brief description of their key features, as follows:-

- Start of IT until GFC, Q3 2008, the Great Moderation.
- Q4, 2008 until Q4, 2010, the Great Financial Crisis (GFC).
- Q1, 2011 until Covid Q4, 2019, Testing the Effective Lower Bound to interest rates (ELB).
- Q1, 2020 until the present (Q2 2022), Covid and Ukraine.

The dating of the start of IT is clear and certain for the Bank of England and ECB, but there is a degree of uncertainty about the dating for the Fed, as discussed below. The timing of the onset of the two crisis periods, GFC and Covid, is again clear and certain: what is uncertain is the dating of the end of the GFC and the beginning of the third more normal period. We have put the timing of the end of the GFC at 2010 Q4, but we accept that further research might shift that date by a few quarters in either direction.

We start by examining how far, if at all, our three Central Banks adjusted their forecast for inflation at the two-year horizon to take account of the rather different conjunctures in our four periods; two crises, one good period and one disinflationary period. We provide bar charts for each Central Bank for each period. These reveal that the two-year horizon forecasts are, most of the time, extremely close to target, and increasingly so as we move from Period 1 to Period 3, with a partial exception, especially for the Bank of England, during the GFC second period. As a result, the two-year ahead forecast is in most cases almost a constant, equal to the inflation target. In any regression of the relationship between outcome and forecast, the forecast and a constant term become highly multicollinear, and so the constant has to be dropped.

What observers are generally most interested in discovering is how closely actual outcomes matched the prior forecasts, 'How good have the forecasts been?' Before turning to that, however, in Section 4, a number of caveats are in order. First, whatever the relatively slight, (but persistent), structure of divergences of actual outcome from forecast, over the whole period, at least until end 2021, the cumulative rate of change of inflation for each Central Bank has been remarkably and gratifyingly close to target. This must count as a great success. It is only now, with the present inflation surge, that the present monetary regime has come under its greatest challenge.

Second, major divergences between forecast and subsequent outcome must be expected, even if the forecast made at time zero was the very best possible, given the information set at that time. Even if viral epidemics, unprovoked aggression leading to war, sudden major bankruptcies or other sharp political reversals, etc., etc., are to be expected to occur from time to time, they are so rare, and the date of their onset so unpredictable, that they surely count as unforecastable events, otherwise more commonly described as 'shocks'.

The two year gap between forecast and outcome, on which we focus here, leaves plenty of time for 'shocks' to occur, and many have. Moreover, these shocks are not for one quarter alone, but the shock and the recovery from it can take many calendar quarters, even years. Hence the divergences between actual and forecast outcome will, almost by definition, be long lasting and strongly auto-correlated, as we document in practice. Note that we do not describe the divergence between forecast and outcome as an 'error'. This would be invalid terminology since the time zero forecast may be the very best possible, given the initial information set.

So, our focus is on the determination of each Central Bank's forecast, on the information set at that time. But conditions will inevitably have changed, often markedly, by the time the actual outcome takes place two years hence. Thus a forecast made in the last two yeas of Period T, say 2007 Q1, will relate to outcomes in Period T+2, say 2009 Q1. Consequently all forecasts in Period 2 of 8 quarters relate to outcomes in Period 3.

The division of our data sets into four periods is, thus, made somewhat more complicated by the, quite lengthy, two year gap in our chosen data series between the date that the forecast was *made in* and the date, two years hence, for which the forecast was *made for*. When looking at forecast accuracy, we focus on the period that the focus was *made in*. This implies that the forecasts for the last two years of Periods 1 and 3 will relate to outcomes in the first two years of Periods 2 and 4, thereby making the estimated forecasting accuracy in Periods 1 and 3 appear worse. Of course, the onset of the GFC and the Covid crisis were basically unforecastable, but so were all the other minor shocks that hit throughout.

In contrast, when we compare the divergences between forecast and outcome for inflation compared to growth forecasts (see Section 5), we look at the dates which the forecasts were *made for,* that is the actual date of the outcomes. In this latter case, the divergences/errors within Period 1 stop in 2008 Q3, before the GFC crisis takes hold.

Some may feel that this may give a bias against (towards) finding forecasting success in Periods 1 and 3 (and for success in Period 2). We give several reasons for sticking with this timing. Inflation is a lagging indicator with much initial momentum, and our data are mainly for the rate of change in the year up until the relevant quarter. There were many minor shocks along the way besides GFC, Covid and Ukraine. Above all, our empirical data, shown below, are the exact reverse of the suggested biases above.

Anyhow, does this all mean that we can make no inferences whatsoever about forecasting skills by examining the divergences between forecast and outcome, since any divergences between forecast and outcome could be due to an unpredictable shock? We are not so nihilistic. We suggest three

criteria for assessing the forecasting skills of our three central banks. First, if the outcome for inflation diverges by more than 2%, plus or minus, from target, the success of the inflation targeting policy comes under question. Similarly, if the outcome diverges from the forecast by more than 2%, plus or minus, we think that the forecasting skill of the Central Bank can be questioned. Second, the purpose of policy is to return deviations of inflation back to target. If the deviation becomes greater than 1% and does not start to return to target within three quarters, the efficacy of policy may be questioned. Of course, as demonstrated in Section 3, the forecast for inflation two years hence is often exactly equal to the target, so the criteria for both policy and forecasting thus become identical; but this is not always the case, as we show in Section 4, and there can be cases where there is relative success in policy, while failing in forecasting, or vice versa.

Our third criterion is whether a regression of actual inflation on forecast inflation has a coefficient significantly different from unity over a relatively long period. If that should occur, it would show that the forecasters had significantly and habitually failed to predict the effect of their policies on inflation, either underestimating, or overestimating, the effect of policies on future inflation.

We show that the results of such tests are very different for crisis periods, periods 2 and 4, and as compared with more normal periods, periods 1 and 3. In the two crisis periods, our Central Banks tended to *underestimate* significantly the effect of expansionary policies, and the resilience of our economies, in bringing about a strong recovery in output and then on inflation. In contrast, in the normal periods, periods 1 and 3, our Central Banks tended to *overestimate* their power of monetary policy to return inflation to target.

We do think that there may be lessons to be learnt from the more persistent tendency during 'normal' times for CBs to over-estimate the effect of monetary policy on future outcomes. Why did this exaggeration happen? In Section 5 we discuss a number of potential reasons. We start with two possible reasons, but ones that we dismiss, out of hand. The first is that Central Bank forecasts were 'fake news', knowingly (by the forecasters) biased, and simply presented to encourage outsiders to believe that inflation remained under tight control, (whereas the true 'inside' forecast was somewhat less reassuring). There are several strong reasons for denying this. The first is that such forecasting involved hundreds of experts from many countries over several decades. With these countries being liberal democracies with a free press, any such chicanery would have been

bound to leak, and would have destroyed the reputation of the Central Bank involved. No Central Bank could take that risk. A second reason is that one of the authors was himself a Central Bank insider for a time, though not then a forecaster, and knows from personal experience that the forecasting process did *not* involve conscious deception.

A second, slightly more plausible, reason is that the forecasters may have systematically overestimated the effect of changes in their monetary policy instruments, notably of the official short-term interest rate, on demand, and hence on output and thereafter on inflation. Thus there was an active debate about the potency of interest rate changes on the economy in the UK in the 1950s and 1960s, e.g. the Radcliffe Report of 1959; and there was a strong body of opinion that such rate changes were influential in affecting the exchange rate and other financial variables, but not demand directly, except via the housing market. That said, the impact of changes in interest rates, both nominal and real, on demand is one of the most carefully and empirically studied subjects in macro-economics. We are reluctant to believe that, after all these studies over so many years, the direct role of interest rates on demand was systematically overestimated, [The full story on the effect of Quantitative Easing on demand has yet to be completed however].

A much more likely candidate for this bias is an over-emphasis on (longer-term, 'well-anchored'), expectations of future inflation as a means for, quasi-automatically, returning inflation to target. Expectations of inflation by financial market participants and professional (economist) forecasters have clearly been influenced by the forward guidance that Central Banks provide, but they are something of an 'echo chamber'. As the saying has it, 'Don't fight the Fed'. On the other hand, the expectations of households and firms appear to be more closely related to their own past, personal experiences, especially of more salient prices, such as food and energy, which are exactly those items dropped from 'core' measures of inflation. Our guess is that, in the 'normal' periods, 1 and 3, among our four quarters, two-year forecasts would have been more accurate had zero weight been placed on supportive expectations, but we do not have access to internal data to test this hypothesis.

Of course, as earlier noted, *any* divergences between outcome and forecast could be due to unforeseen shocks. So the tendency for forecasts to exaggerate the impact of monetary policy, especially in our third period, could have been due to the power of unforeseen disinflationary

pressures, less so in our first period. Here there are two candidates, one from the demand side, (secular stagnation; savings glut), one from the supply side, (our Great Demographic Reversal; excess supply of labour); though both are related to the dramatic rise of China as an economic power in recent decades.

While both factors would tend to have lowered inflation, notably in period 3, their effect, if unforeseen or underestimated, on forecasts of output would be opposite. A negative demand shock lowers both, relative to forecasts, whereas a positive supply shock would lower inflation, but raise output, relative to forecast. In Section 5 we also compare the divergences of outcome from forecast for both inflation *and* output in all our periods to try to ascertain whether the main underlying shocks took the form of demand, or supply, shocks.

Again as noted earlier, our main focus has been on the central point forecast for inflation two years hence. But the Bank of England has also provided, in its four quarterly Monetary Policy Reports, a density forecast, more commonly called a Fan Chart, giving forecast expectations of the potential volatility of outcomes, and whether the risks of divergence from the central tendency are skewed to the upside, more inflation, or downside. As before, we focus solely on their estimates of volatility (spread) and relative riskiness (skew) at the two-year horizon in our study of their forecasting procedures in Section 6.

The final Section 7 contains our Conclusions, suggested lessons and suggestions for future forecasting.

Our paper differs in several respects from the previous sizeable literature on central bank forecasting. Perhaps the most obvious difference is that we focus solely on the forecast eight-quarters hence, and the accompanying actual outcomes. Most other prior papers have either looked at the complete set of the forecasts, or have focussed as much, or more, on the forecast and relevant outcomes for earlier periods. Many of these forecasts have concentrated as much, or more, on the forecast for one quarter and four quarters hence, and relevant outcomes, as on the eight quarters hence forecast and outcomes.

But, perhaps, the most important difference with most earlier papers has been that we have divided up the whole period from the start of IT until the latest crisis into four separate periods, as earlier noted, whereas most of the other papers have tended to focus on the longest available set of such data, or perhaps the most recent set of data. In many ways the paper closest to our work is by Kontogeorgos and Lambrias (2022). In their main study of ECB's forecasts they look at the whole period and test for unbiasedness, etc., but they do note, e.g. in Section 5.1.1 that there has been time-varying bias with underestimating HICP inflation over the earlier years, 2000-2012, and overestimating inflation in the later years, 2013-2016. Also, see the final paragraph in their Conclusions. They do not distinguish, as we do, between crisis and normal periods. Partly because there now has been a second crisis, it seems interesting to examine how our central banks' forecasting capacities differed between crisis and normal periods. The one paper that makes an attempt to look at the crisis forecast is by Alessi, et al. (2014), which also compares the responses of the ECB and FRBNY. But rather than comparing how the forecasting changed once the crisis struck, their focus was mainly on whether the onset of the crisis and its subsequent development might have been better forecast in advance.

This paper is again about the only one to compare the forecasts between central banks, and then only ECB and FRBNY. In the vast majority of papers the comparison is made between the forecast of the central bank and of other private sector forecasts made within the same country. In that respect our focus of comparison is between these three major central banks. We have also taken the opportunity to assess the accuracy of the Bank of England's forecast for the width and skewness of its fan charts in Section 6, which again is not common. So we are attempting to assess central bank forecasting capacity from a rather different angle than most of the prior literature.

Whereas many of these papers on central bank forecasting capacity, also look at their ability to forecast growth, as well as inflation, we are, we believe, the first to look at the correlation between the divergencies in the two sets of forecasts as a way of trying to assess whether the underlying shocks were from the demand or supply side.

As already noted, in many ways the most important difference is that we focus on four differing periods within the years of CBI and IT. We think that the results reported in the body of this paper

show that there have been sufficient differences in central bank forecasting capacity between these four periods to justify fully that decision.

Section 2

Data

Nearly every dimension of the data for each of the central banks differs when it comes to inflation forecasts. Unlike inflation forecasts, growth forecasts are relatively straightforward but real-time and revised data can differ markedly.

Inflation forecasts

For starters, inflation targeting as a regime began at different points for each of the central banks. The Bank of England started in 1997, while the ECB started in 1999. For the Fed, we 'set' the date as 2003 based on Fed ex-Chair Bernanke's statement in his latest book (Bernanke 2022, page 97).

For comparability, we evaluated the forecasting performance for headline CPI, even though that is not the official mandate of the ECB nor the implicit measure of focus for the Federal Reserve (though CPI has recently become a point of focus for the Federal Reserve).

We thank Huw Pill and Jack Meaning for providing us with quarterly 1-year, 2-year and 3-year ahead inflation and growth forecasts since 1997. Quarterly growth forecasts for RPIX are available until the end of 2003. Since 2004, these have been replaced by forecasts for the annual change in CPI. In order to create a longer time series, we spliced the RPIX and CPIX series together by noting that the RPIX target was always approximately 0.5% above that for CPIX.

For the Federal Reserve, 'Green Book' forecasts (available online) provide a long time series of CPI and growth (and other) forecasts. Since the Fed holds eight meetings every year, we used the forecasts for the last meeting in each quarter to maximise the information embedded in the quarterly forecast series. An added complication particular to the Fed is that the Green Book is published with a five-year lag. The post-1986 database thus runs only until 2017. Forecasts for the post-2017 period are extracted from the Fed's SEP projections. The period after 2017 had the potential to be a bit tricky because of the way the Federal Reserve's SEP forecasts are presented. In every SEP projection, inflation and growth forecasts are presented for a calendar year. Because of that reporting format, the information set in successive meetings in a calendar year is a superset of

the previous one. As an example, the point 2-year ahead inflation forecast in both March 2017 and June 2017 would be for the calendar year 2019, which means the information set in the June meeting is superior to the one available in the March meeting. Fortunately, the inflation forecast at the 2-year horizon is so stable, moving one- or two-tenths of a percentage point at most, that the issue of information sets does not become a serious problem.

Data on CPI inflation (and growth) forecasts for the ECB were relatively straightforward and readily available on the ECB's website from 1999 to the latest meeting at a quarterly frequency.

Growth forecasts

Unlike CPI, growth is revised very frequently. Comparing real-time forecasts with heavily revised data would put the central bank at a disadvantage that is outside the scope of our interest. In order to evaluate forecasting performance on a level playing field, we compare growth forecasts to real-time growth estimates available in the forecast databases described above.

The only other complication regarding growth forecasts pertains to information sets for the Fed's SEP forecasts described above for inflation. However, since the growth forecasts are more variable than inflation forecasts, some caution about accumulating information in successive meetings is warranted.

Section 3

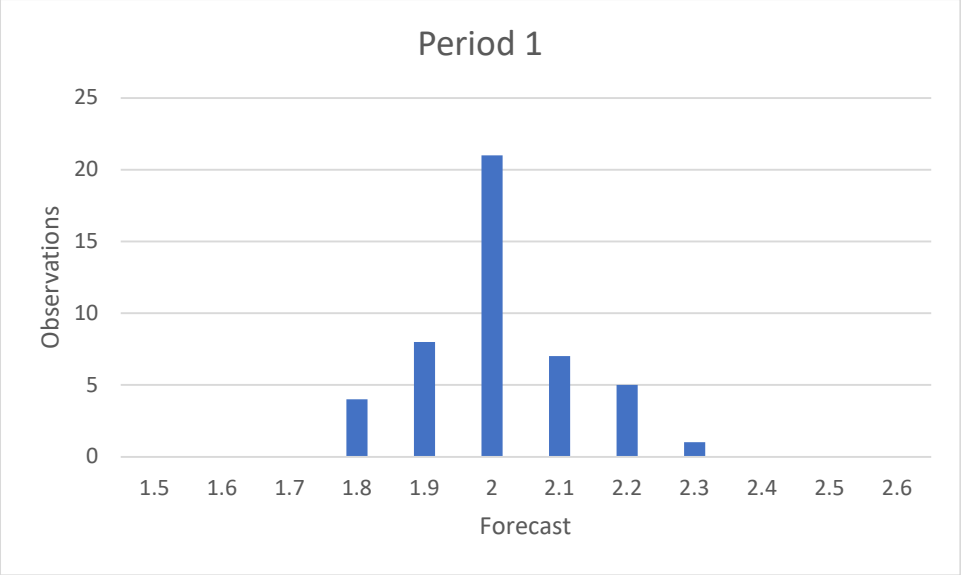
Aiming to Hit the Inflation Target – Two Years down the Road

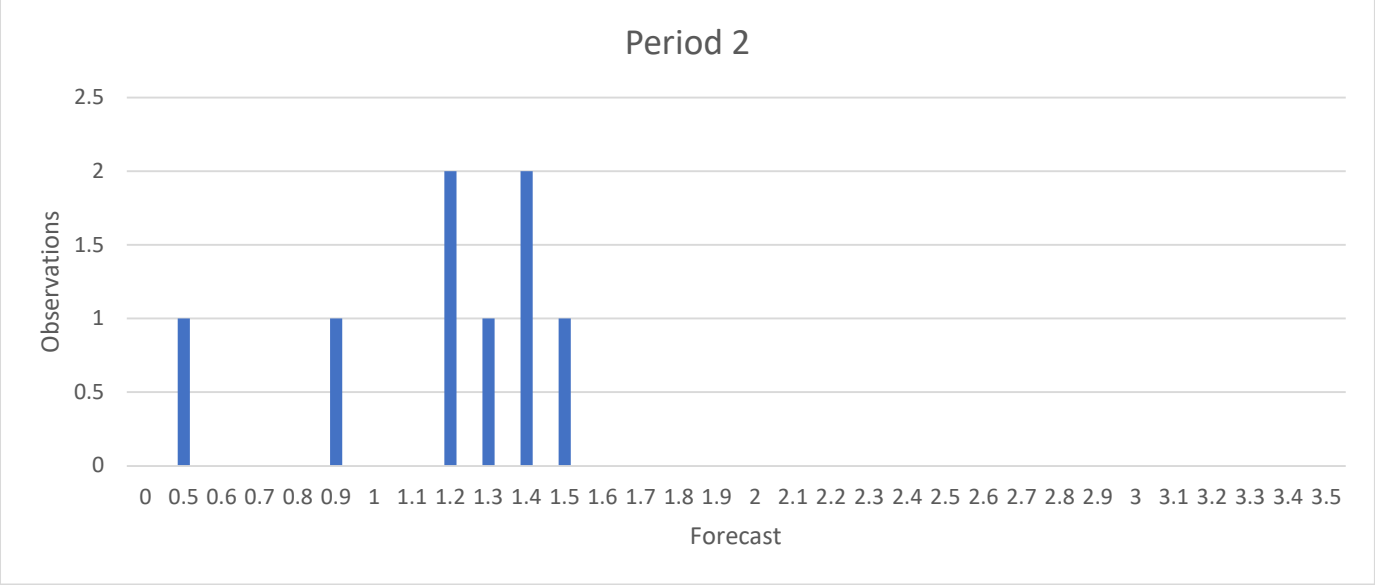
In the Introduction to this paper we expressed the hypothesis that the normal procedure for independent Central Banks would be to set policy so as to return inflation to target at the two year horizon. As will be seen in the remainder of this Section, this hypothesis is valid for our three Central Banks whose (two year) forecasts are reviewed here. This is so much so that it is easiest to discuss deviations from this behavour. We shall take our three Central Banks in turn, first the Bank of England, then the ECB, and finally the Fed. Once more as mentioned in the Introduction, we find it helpful to divide our three lengthy overall data sets into four sub-periods, first from the start of IT in the Great Moderation up until 2008 Q3, then the GFC from 2008 Q4 until 2010 Q4, third the disinflationary lower bound period, 2011 Q1 until 2019 Q4, and finally the Covid/Ukraine crises, 2020 Q1 until the data run out on us.

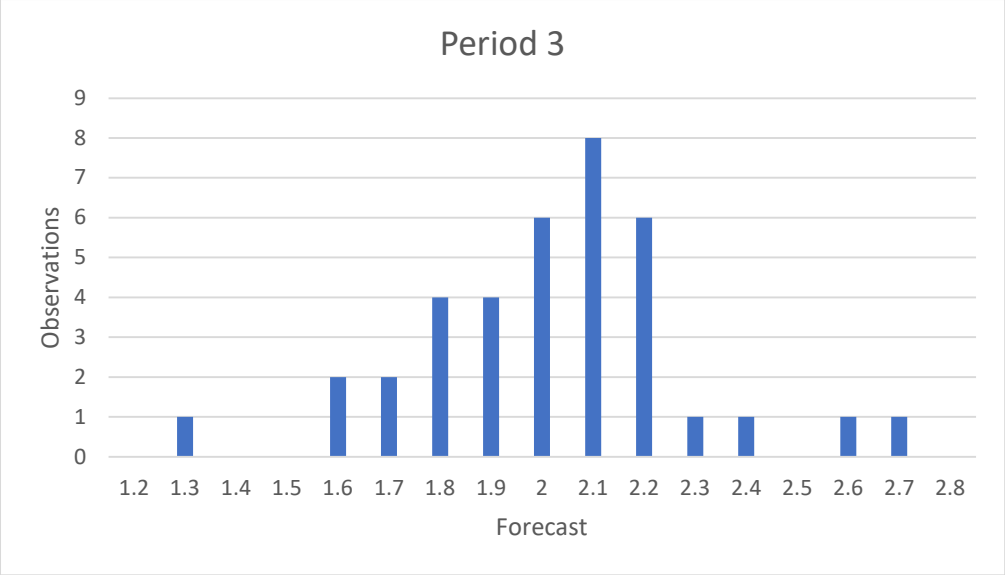
Bank of England

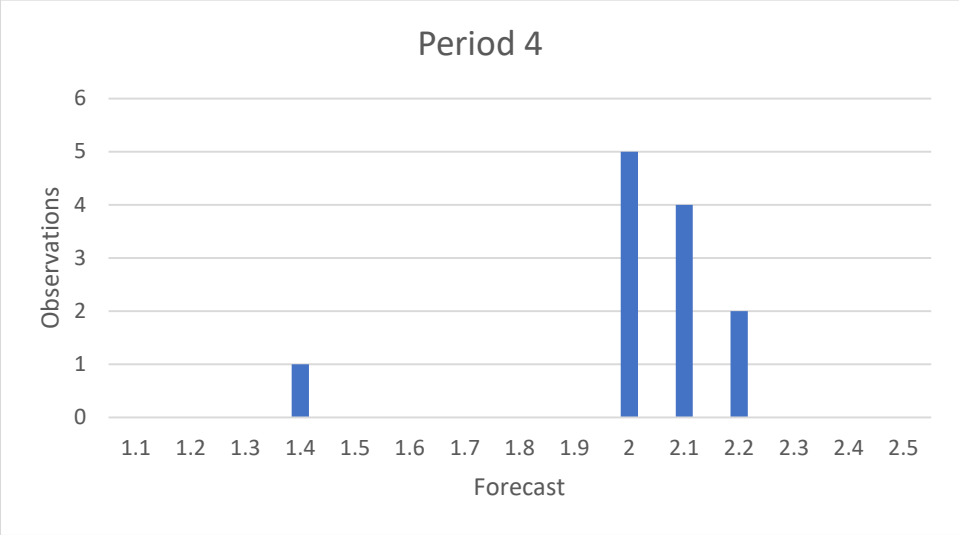
We start with the Bank of England. As noted in Section 2, the IT switched from RPIX at 2.5% to CPIX at 2.0% at the end of 2003; we simply adjust the earlier RPIX two year forecasts by subtracting 0.5% to make them consistent with the subsequent CPIX forecasts.

The bar charts for the forecasts made in each period are as follows:-









Period 1 has 46 observations, (1997 Q2 – 2008 Q3), with an average of 2.01; period 2, 8 observations with an average of 1.18; period 3, 38 observations with an average of 2.00; and period 4, 12 observations, averaging 2.15. In both periods 2 and 3, the start of these two periods saw the lowest forecast values, which then climbed rather slowly, but steadily as time progressed. Over the whole period, for which we have both forecasts and actual data (94 observations), the average two-year forecast was 1.94, held down by the low forecast in period 2, compared with an average actual up until 2022 Q3 of almost exactly 2.0.

The period 2 BoE two-year hence forecasts, made during the GFC, are unusual and particular, since these show the most extreme deviation from target in all our first three data sets. The financial crisis so unnerved the Monetary Policy Committee then, that they saw that there was a good chance of inflation remaining well below target, even up to the end of 2012. Thus the highest modal (two

year) forecast in the GFC period, (1.4%), was below the lowest modal forecast in the preceding Great Moderation period (1.8%). As we shall show in Section 4, they were excessively pessimistic, and the deviations of actual from forecast were larger than in any period until the latest crisis.

Whereas this was in practice a quite large forecasting divergence, it nevertheless showed a realisation of the potential limits to the efficacy of monetary policy, and a serious attempt to forecast the future rather than rely on (dubious) models which assume a quasi-automatic reversion to the target equilibrium.

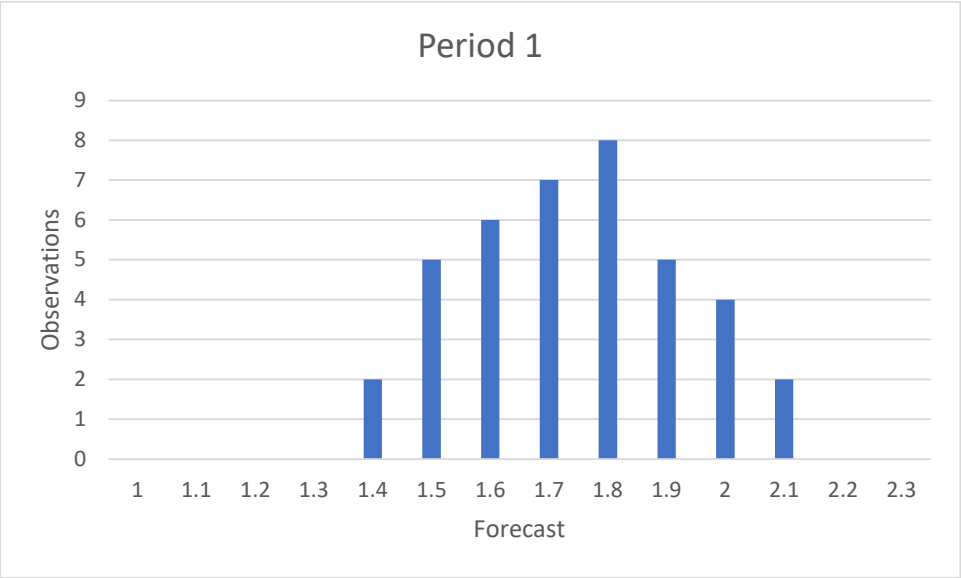
In Period 3, 2010 Q4 to 2019 Q4, with disinflation and a lower bound to interest rates, forecasts for inflation two-years hence remained below 2.0% from Q1 2011 until Q1 2013, and then, following Q1 2015, never fell below 2.0% for the rest of the period. As shown in Section 4, this slow but steady rise in forecast inflation was not matched by a similar pattern in actual inflation. Subsequently the extreme fluctuations in actual inflation in our final period have had no counterpart in the two-year forecast which has, (so far, as of 2022 Q3), remained firmly fixed to the target value.

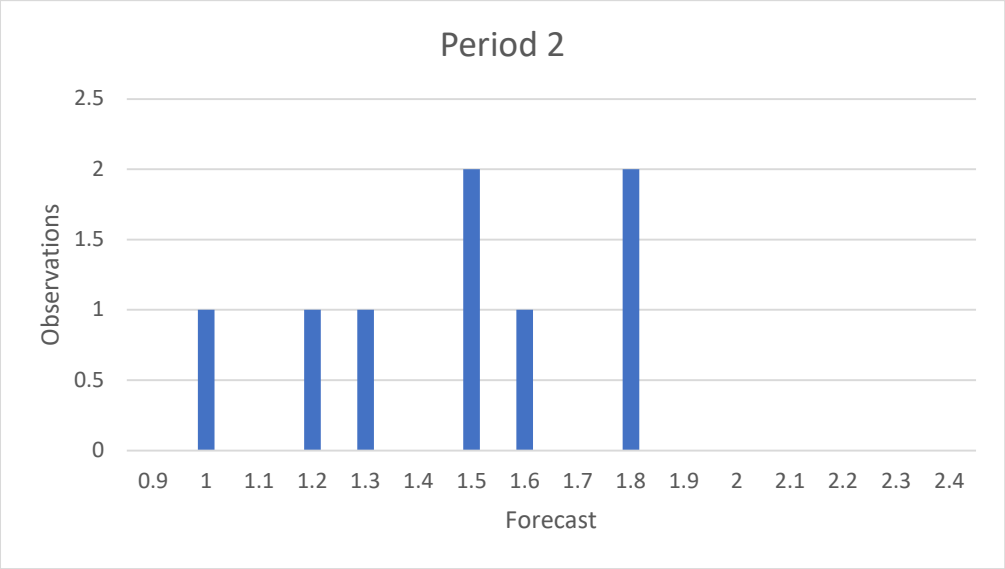
In fact, the modal forecast for CPI inflation two year hence (at market interest rates) remained extremely close to the target value, or marginally above, from the start of the Covid crisis, 2020 Q1, until the latest observation, for 2024 Q4, when it fell below target to 1.4. But this latter was offset, in part, by a positive projected skew, with the mean forecast notably higher at 1.9.

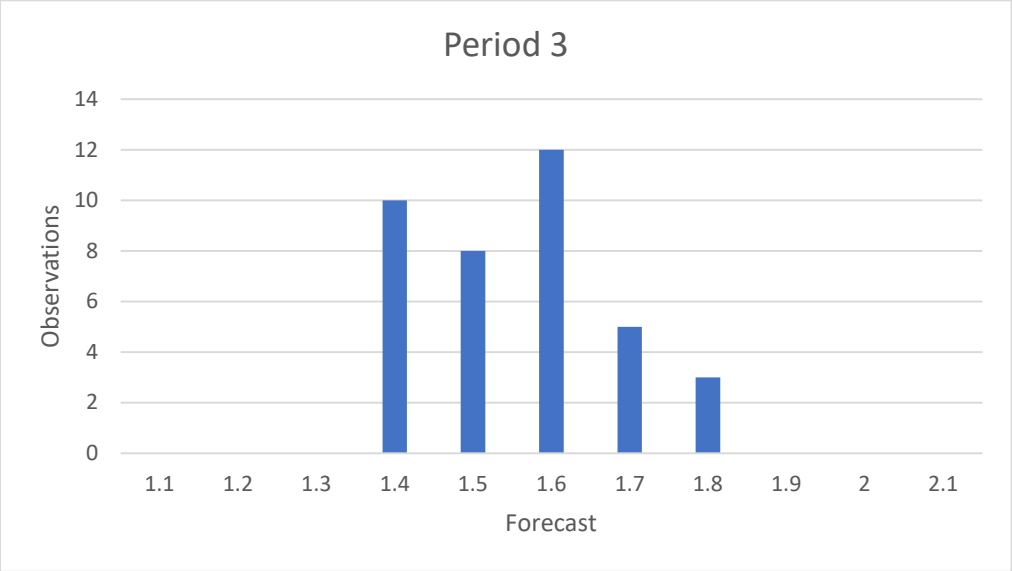
As discussed at greater length in Section 6, both the uncertainty (i.e. the range of the fan chart) was by this time (2020) assumed to be constant and the skew to be zero at our two year horizon. The forecast level of uncertainty was then, however, raised quite sharply in 2020 Q3, before being reduced slightly again in 2021 Q2 and then held constant once more. Meanwhile, the skew was also *assumed* to be constant and zero, until 2022 Q1. Since then the skew was forecast as marginally positive in Qs 1 and 2, marginally negative in Q3, but quite strongly positive in Q4. The earlier (2020 Q3) increase in width and latter introduction of a forecast skew was the first attempted real use of the fan chart approach (as contrasted with a simple single central forecast) for a number of years (see further in Section 6).

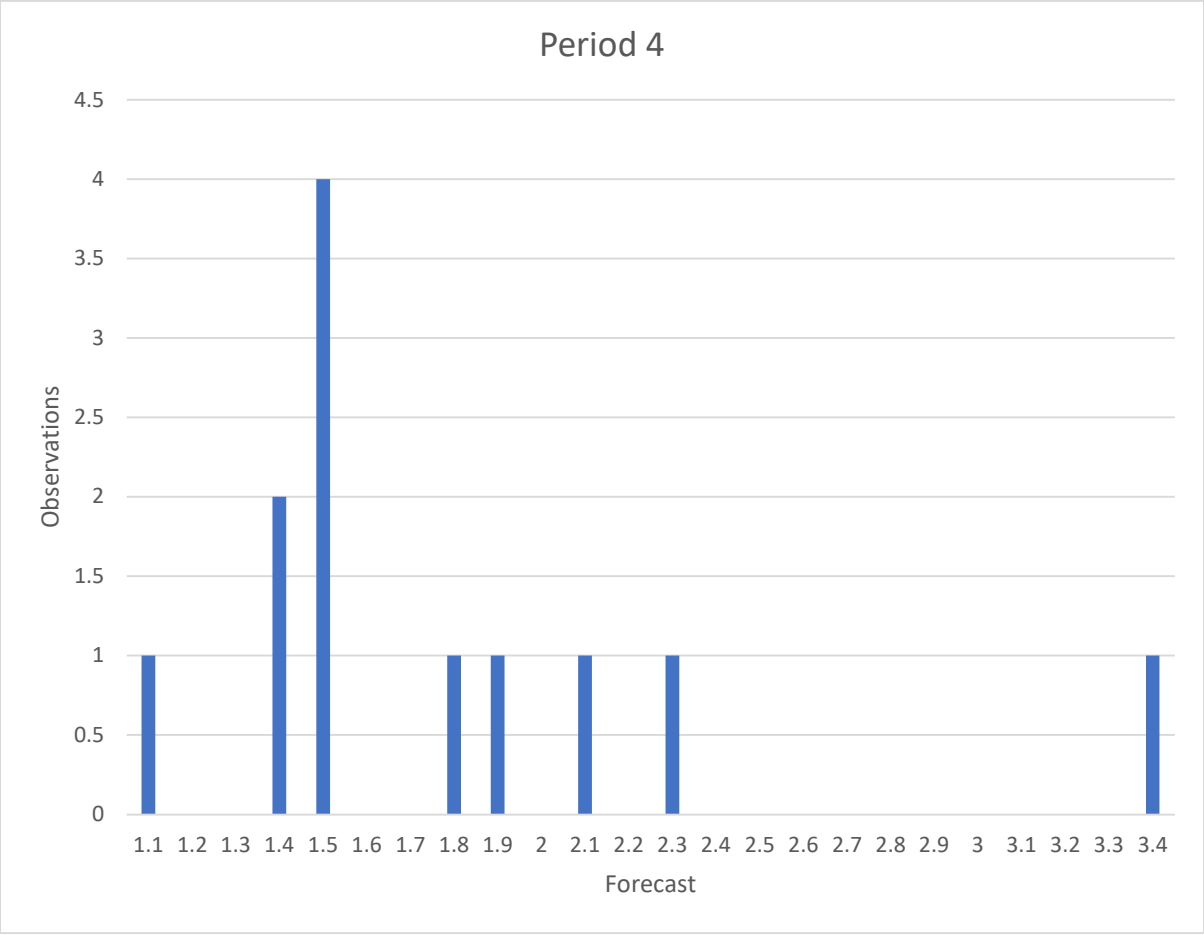
European Central Bank

Let us turn next to the ECB. The bar charts for our four periods are as follows:-






Period 3
Observations
14
12
10
8
6
4
2
0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
Forecast


Period 4
Observations
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3 3.1 3.2 3.3 3.4
Forecast

Period 1 has 38 observations with an average of 1.74; period 2, 8 observations with an average of 1.46; period 3, 38 observations with an average of 1.56; and period 4, 12 observations with an average of 1.8. Over the 87 observations for which we have both forecasts and actuals, the average two year inflation forecast was 1.58%, compared to 1.79% in actual HICP inflation.

Unlike the Bank of England where the distribution of forecasts widened from period 1 to period 3, those of the ECB narrowed slightly. Like the BoE, the ECB foresaw somewhat lower inflation during the GFC, but the reduction was far less (a decline of 28 bps compared with 83 bps for the BoE).

The ECB has been remarkable in that, until 2021, it did not quantify its target precisely, instead stating that it was 'close to, but below, 2%' for the HICP. The average value of 1.74 in period 1 fits this rubric; but the average values of forecast two-year hence inflation, at about 1.6% since then (up to 2022 Q1) hardly seem to do so. Perhaps the constraints on expansionary monetary policy, e.g. the effective lower bound to nominal interest rates, made the forecasters doubtful that their target value could be obtained within the two year horizon. In this judgement they were, of course, largely correct, since during the years 2013-2020 HICP remained stubbornly below forecast, and even further below (the presumed) target. So of all our three Central Banks, the ECB had its two-year forecast apparently diverging the most from its presumed target value. Perhaps the absence of a specific number for its target gave it more flexibility.

That relative flexibility continued into the final Covid crisis years. Unlike the BoE and Fed, who basically assumed a continuous return to target inflation at the two-year horizon, the ECB staff projections swung around quite markedly as the crisis developed, first falling below the earlier levels of 1.5 to 1.7 in 2021, and then rising steadily, especially after the Ukraine war took place, to end 2022 at over 3.

The Federal Reserve System

For the Fed we have five, rather than four, periods, since we have a long period, starting in 1984 Q1 for which we have quarterly forecasts of CPI, which can be compared with outcomes two years hence. But for many years the aim was to steadily lower inflation, rather than to keep it at a

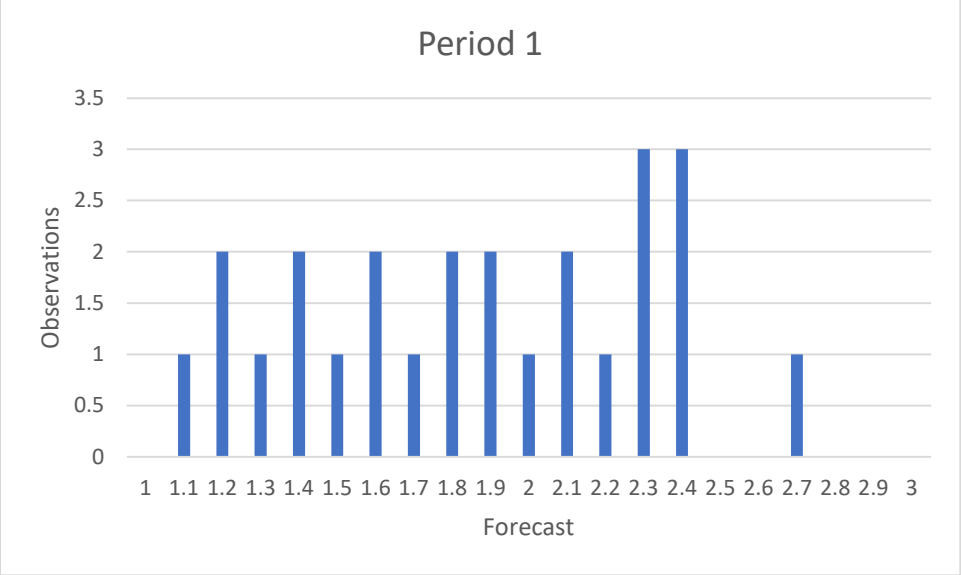
constant, target, level; Inflation Targeting (IT) was not in operation, so there was no question of hypothesis 1 holding.

It is, however, difficult to date exactly the time when the Fed switched from wanting to lower inflation to keeping it at a constant level, since there was no formal adoption of a target. The latter was implicit, rather than explicit, and the choice of variable for measuring inflation could be, and was, adjusted from time to time, (e.g. CPI or PCE, headline or core). We rely on Bernanke (2022, page 97) to take as our starting date for effective IT, 2003 Q2.[1] Thus we treat all the prior years, 1984 Q1 until 2003 Q1 as Period 0; 2003 Q2 until 2008 Q3 becomes Period 1, and Periods 2, 3 and 4, are the same as for our two other Central Banks.

Although the Fed had been shifting its attention more towards PCE, rather than CPI, from 2003 onwards (Bernanke, ibid, page 88), published quarterly projections for PCE are only available from 2007 Q3 onwards (Bernanke, ibid, page 180). Since this occurs rather late in Period 1, we felt it easiest to look at the CPI forecasts (and compared to CPI outcomes) throughout Period 1, rather than try to splice the two series together.

Be that as it may the bar chart for Period 1 for two year-ahead CPI is shown below:

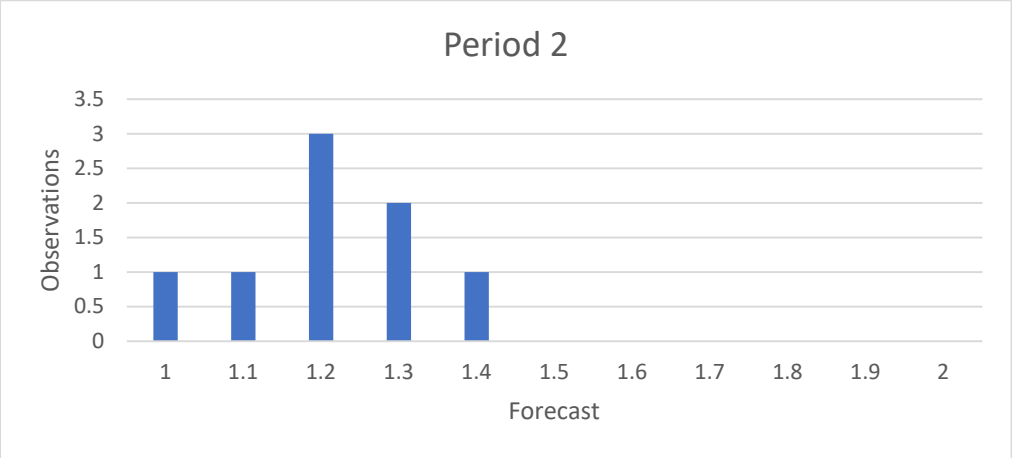
[1] "The changes in language in May and August 2003 were important in several respects. The reference, beginning in May, to an "unwelcome" fall in inflation contrasted starkly with Fed policy of previous decades, in which low or declining inflation had always been treated as desirable. Effectively, the Fed had publicly acknowledged that it had an inflation target, and that the target was greater than zero, even if it was not yet willing to give a precise number. Moreover, according to the May statement, low inflation would likely be the Committee's "predominant concern for the foreseeable future."" Page 97.



Although the mean of the distribution, at 1.9, is very close to an informal target of 2, the distribution is notably flat. From 2001 Q3 until 2004 Q4 CPI inflation forecasts remained below 2.0, dropping to a low point of 1.1 in 2003 Q2, whereas actual outcomes, per contra, remained generally well above 2.0, rising to a peak of 3.9 in 2006 Q2. Perhaps as a consequence of underestimating inflation in these earlier years, the CPI forecasts made from 2005 Q1 until 2006 Q4, (for the span 2007 Q4 until 2008 Q4), remained above 2.0. Even so, they continue to underestimate actual inflation which rose to a temporary peak in 2008 Q3.

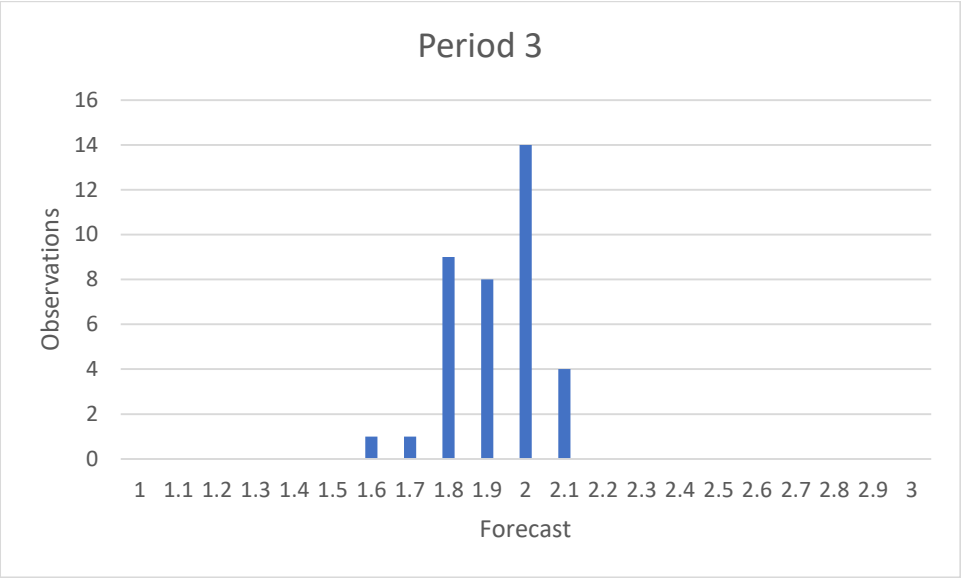
The low figures for inflation forecasts at the start of Period 1, and the persistent underestimate of actual inflation (rather like the ECB) suggests either that the FOMC was not unduly concerned with the need to hit its inflation target then, or habitually overestimated the effect of its policies in returning inflation to target.

In Period 2, 2008 Q4 to 2010 Q4, the bar chart for inflation forecasts two years hence is shown below:-



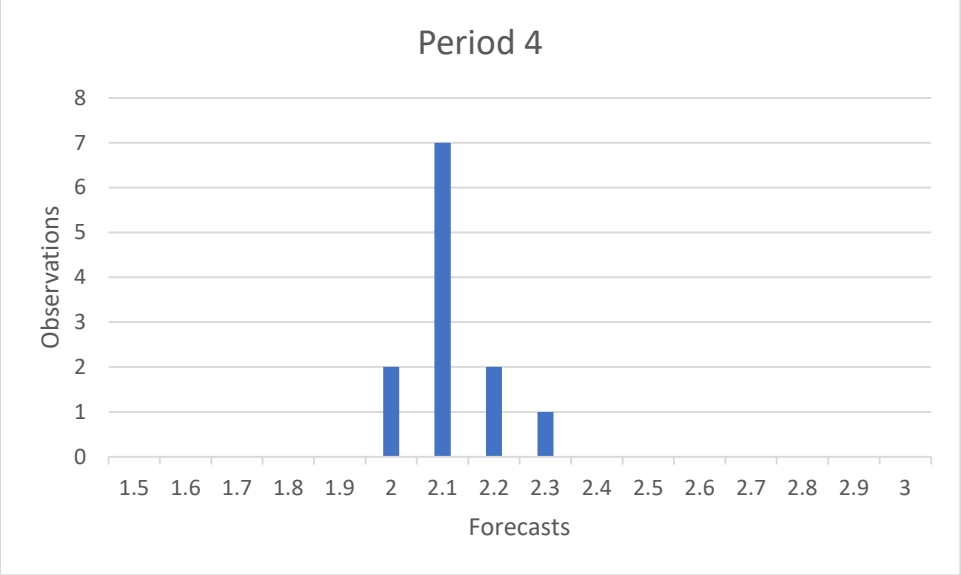
Like the other two Central Banks, the Fed dropped its two year ahead forecast, by about 70 bps, from 1.9 to 1.2 during the GFC, more than the ECB but about the same as BoE. Again, in common with the BoE and ECB, it underestimated the recovery in inflation that then occurred.

In Period 3, the distribution of forecasts becomes much tighter, and nearer a 2% target, than earlier as shown below:-



The mean value has reverted to 1.9, but the distribution of forecasts is now much tighter than in Period 1. All the forecasts below 2.0 were made in the earlier years of this Period 3, and all the forecasts marginally above 2.0 in the latter years, especially in 2018. The tightness of the forecasts indicates that, by this time, the FOMC was keen to adjust policies so that forecast inflation two-years hence was expected to be close to target, (i.e. hypothesis 1 is met), whereas this is less clear in Periods 1 and 2, (and not relevant for Period 0).

This confidence that the inflation target would be obtained at the two-year horizon was steadfastly maintained during the Covid crisis. Despite the fact that actual economic conditions were fluctuating greatly, with inflation first falling sharply in 2020 and then spiking upwards in 2021/22, the distribution of the two-year forecasts became even more narrowly concentrated, around 2.1, than in Period 3.



Section 4

Measuring Forecasting Success?

When a forecaster cannot influence the outcome that is the subject of the forecast, such as the weather, the measure of success is simply how close is that outcome to the prior forecast, e.g. was it sunny; did the temperature rise to 21 Celsius; and was the wind 15 mph from the North? The measure of success becomes much more difficult if the forecaster can, or hopes to, affect the outcomes. Thus, forecasts emanating from financial institutions may be somewhat, even unconsciously, swayed by their hopes to persuade others to make future trades in a way that would benefit their own current portfolios, i.e. 'talking their book'.

The problem of measuring forecasting success becomes yet even harder when the (partial) control is not aimed at the immediate present, but at a more distant future. As stated earlier, the main objective of Central Banks has been to return inflation to target two years hence. But by the time the two-year gap arrives, other, inevitably unforeseen, disturbances will have occurred, which the Central Bank neither can, nor wants to, offset immediately. Assume that a Central Bank is *completely* successful in always driving disturbing shocks to inflation back to target; then its two-year ahead forecast will be a constant, equal to the target. But disturbances will cause outcomes to fluctuate around that constant. Thus in any regression of outcomes as a function of the inflation forecast, there will be massive multicollinearity between a constant term and the forecast, as we demonstrate below, and the ability of the forecast to predict the fluctuations (around target) of outcomes (the R^2) will be zero (as we again demonstrate below).

So, how can we assess whether the forecasts were good, or bad, (since the fit of a regression will tell us nothing)? We offer three criteria. First, since any divergence of inflation from target of more than plus, or minus, 2% will usually call policies into question, we can similarly argue that any divergence from *forecast* that is greater than plus, or minus, 2% represents a failure. Second, the aim of policy is to correct persistent deviations from target. So, any divergence of greater than 1% should be corrected (i.e. on a clear reverse track) within, say, two or three quarters; otherwise there is a correction failure. Again, we can apply this test to the *forecast*. Of course, since the forecast is mostly very close to target, we usually can expect exactly the same result of success or failure for both policy and forecast, but not always, as shown below.

Third, if policy corrects disturbances, and such disturbances/shocks are anywhere near random, then the relationship between forecast and outcome should be linear, i.e. that the coefficient on the forecast in a regression relating outcome to prior forecast should be one, unity. If the coefficient is significantly greater (lower) than one, it means that policy was unable to correct inflation above (below) target, and that the forecast failed to reflect such errors. Of course, it takes time for policies to respond, and disturbing trends may continue for some time. But we think it reasonable to make the above tests in our two longer 'normal' periods, Period 1 from start of inflation targeting until GFC and Period 3, 2011 Q1 until 2019 Q4; though much less so in our shorter (about 8 quarters) crisis periods (GFC and Covid/Ukraine).

So, armed with these three criteria, what do the data tell us? We start, once again, with the Bank of England.

Bank of England

We shall begin by examining each period, starting with Period 1, 1999 Q2 – 2008 Q3. In this period the divergences of outcome from forecast were small, and varying in sign, until 2006. Then the forecasts made in 2006, for the equivalent quarter in 2008, failed to see the minor surge of inflation during the last three quarters of 2008. The divergences then were as follows:-

Forecast			**Actual**	**Divergence**
Made in	**For**	**Was**		
2006 Q2	2008 Q2	2.0	3.4	1.4
2006 Q3	2008 Q3	2.1	4.5	2.4
2006 Q4	2008 Q4	2.0	3.7	1.7
2007 Q1	2009 Q1	2.0	3.0	1.0

By our Criteria 1 and 2 this counts as a failure, though not a particular serious one, especially since the inflation spike in early 2008 was largely caused by an unpredictable, and temporary, rise in the cost of oil. Moreover, it was soon overtaken by the GFC, beginning in 2008 Q4. By Criterion 3, however, forecasting was successful. In a simple regression of forecasts determining outcomes, we get the following results:-

Coefficient on Forecast	**S.E.**	**T**
1.04	0.06	17.7

While the R^2 is -0.008 and the D.W. 0.43, this is irrelevant, since unpredictable disturbances led to fluctuations around a nearly constant forecast, and to strongly auto-correlated divergences from that forecast.

We turn next to the forecasts made during the GFC, 2008 Q4 – 2010 Q4. These were particularly bad initially, as shown below:-

Forecast			**Actual**	**Divergence**
Made in	**For**	**Was**		
2008 Q4	2010 Q4	0.9	2.7	1.9
2009 Q1	2011 Q1	0.5	3.6	3.1
2009 Q2	2011 Q2	1.2	3.7	2.5
2009 Q3	2011 Q3	1.4	4.1	2.7
2009 Q4	2011 Q4	1.6	4.0	2.4
2010 Q1	2012 Q1	1.2	3.1	1.9
2010 Q2	2012 Q2	1.4	2.5	1.2
2010 Q3	2012 Q3	1.3	2.2	0.8

The forecasters failed to realise that a combination of expansionary policy measures, and the innate resilience of the economy, would drive inflation not only back to target, but, for a time, quite well above it at the two-year horizon.

As might be expected, Criterion 3 was also badly failed.

Coefficient on Forecast	S.E.	T
1.61	0.13	12.1

R^2 = -0.16 D.W. = 1.21

But while the forecasts failed, the policy outcome, with a reasonably strong recovery from the GFC, was generally regarded as successful, so the Bank of England's forecasters came in for little criticism.

In Period 3, 2011 Q1 to 2019 Q4, there were two lengthy spells of below target inflation, from 2014 Q1 until 2017 Q1, and then again in 2019, which were not picked up by the forecasters two years before. But the only occasion when the divergences were nearly 2% and persisted for a few quarters occurred as follows:-

Forecast			Actual	Divergence
Made in	For	Was		
2013 Q1	2015 Q1	2.3	0.4	-1.9
2013 Q2	2015 Q2	2.0	0.4	-1.7
2013 Q3	2015 Q3	2.1	0.3	-1.8
2013 Q4	2015 Q4	1.9	0.4	-1.6
2014 Q1	2016 Q1	1.9	0.7	-1.2

So for a brief spell the forecasters failed both Criteria 1 and 2. They also failed Criterion 3 since the forecasts on average overestimated inflation,[2] as the regression results show:-

[2] Though one could argue that the coefficient is not quite significantly different from zero.

Coefficient on Forecast	S.E.	T
0.885	0.09	10.3

R^2 = -0.17 D.W. = 0.32

So, as a result, Criterion 3 over the whole period, 1999 Q1 – 2020 Q1, is quite comfortably successfully met, as shown below:-

Coefficient on Forecast	S.E.	T
1.06	0.06	18.9

R^2 = -0.04 D.W. = 0.31

But these failings, in Periods 1 to 3, are quite mild in retrospect, given the difficulties in forecasting, in comparison with the errors that have been made since then in the present period. Once again, in Period 4, the current crisis period, as in Period 2, the forecasters failed to appreciate the strength and speed of the recovery from Covid, nor the scale of the further upwards pressure on prices from supply shocks, notably from the Ukraine war, but who could have predicted that? Moreover, the scale and persistence of recent divergences from forecast are much greater than during the GFC.

We only now have three two-year forecasts and accompanying actuals for the current crisis period, as follows:-

Forecast			Actual	Divergence
Made in	For	Was		
2020 Q1	2022 Q1	2.0	5.5	3.5
2020 Q2	2022 Q2	2.1	7.4	5.3
2020 Q3	2022 Q3	2.0	8.8	6.8

The outlook for the next few quarters, moreover, is that the divergences will remain at historically high, indeed unprecedented, levels. But Central Banks, including the BoE, remain confident that they will return inflation to target by the end of 2024.

Forecasting during crisis periods has been particularly difficult, and poor. But, outside of crisis times, during our longer normal periods, divergences never rose to 3%, and those few instances when they rose above 2% were quite quickly brought back to target.

European Central Bank

We turn next to a similar exercise for the ECB. In Period 1, 1989 Q1 – 2008 Q3, there were no divergences of forecast from outcome greater than 2%, except a single instance in Q3 2008 when the forecast for HICP was 1.8 and the actual 3.9; so Criterion 1 is just about met. Similarly, at the start of the period, in the forecast for 2001 Q2, and at the end, in the forecasts for Q1 – Q3 2008, the outcome for HICP was for three consecutive quarters above the forecast by 1% or more, so Criterion 2 is marginally failed. But on those two criteria, the forecasts in this period were rather good.

On the other hand, the ECB fails Criterion 3 rather badly, as shown below:-

Coefficient on Forecast	**S.E.**	**t**
1.30	0.03	50.5

$R^2 = 0.23$ D.W. = 1.65

The reason is that the outcome for HICP during this period was systemically and continuously above forecast. The ECB steadily forecast that an (HICP) inflation rate averaging marginally above 2 (and quite steady) would come back to a forecast level averaging about 1.7 (less earlier, more later), and it never did. Thus, they continuously overestimated their powers to bring inflation back to target.

In Period 2, Q4 2008 – Q4 2010, the forecasts made for the years Q4 2010 until Q4 2012 uniformly underestimated the recovery from GFC, and the return of inflation to, and beyond, target. But, unlike the BoE, they did not slash their (two year) forecasts during the GFC, dropping it by only 28 bps, and inflation immediately post GFC did not rebound quite as much in the ECB as in the UK. So Criterion 1 was satisfied, no divergence greater than 2, though Criterion 2 was failed with a sequence of four consecutive divergences more than 1% above target. With inflation consistently above target, Criterion 3 was again failed, as shown below:-

Coefficient on Forecast	**S.E.**	**t**
1.38	0015	9.5

$R^2 = 0.03$ D.W. = 0.70

More, or less, immediately as we move into Period 3, Q4 2010 – Q1 2020, we shift from a context in which the ECB consistently and habitually underestimated future inflation two years hence, into a period in which it habitually and consistently overestimated future HICP inflation, with a very brief exception in 2018. Although the ECB brought down its average forecast (from its level in Period 1) by about 20 bps, the average actual inflation rate fell by much more, from slightly over 2% in Period 1 to just under 1% in Period 3.

Nevertheless, there were no divergences greater than 2%, so Criterion 1 was fully satisfied. Criterion 2 was failed, since this was a continuous divergence (forecast greater than outcome) of 1% or more from Q3 2014 until Q3 2016. As will have been expected, Criterion 3 was, once again, failed.

Coefficient on Forecast	**S.E.**	**t**
0.79	0.11	7.5

$R^2 = 0.02$ D.W. = 0.17

As is obvious, the forecasting failures in Period 4 outshadow what had gone before. All the Criteria are failed, with persistent divergences greater than 3%, and a forecast coefficient diverging markedly from unity, as shown below:-

Forecast			Actual	Divergence
Made in	For	Was		
2020 Q1	2022 Q1	1.5	6.1	-4.6
2020 Q2	2022 Q2	1.5	8.0	-6.5
2020 Q3	2022 Q3	1.5	9.3	-7.8

Over the whole data set, 2001 Q4 – 2019 Q4, (once again excluding the current crisis period), the forecast coefficient is close to 1.

Coefficient on Forecast	**S.E.**	**T**
1.08	0.06	19.3

$R^2 = 0.17$ D.W. = 0.25

But this disguises long periods when the coefficient was significantly greater than unity (Periods 1 and 2) offset by Period 3, when it was well below unity.

Along one dimension, the size of extreme divergences from forecast (or target), the ECB did rather well, until very recently, with few such divergences above 2%, and hardly any above 3%. But along another dimension (Criterion 3) the ECB forecasts were continuously poor, in that there was virtually no sign of steady, almost continuous, divergences being brought back to forecast levels. One might argue that in Period 3 this was because policy was constrained by the effective lower bound. But if policy was so constrained, an accurate forecast should have reflected that fact.

The Federal Reserve System

Let us now finally turn to the Fed. The Fed staff have been making forecasts of CPI inflation from 1984 onwards, available in the Greenbook, with a lag before publication (for the time being) of five years. As earlier noted, Bernanke has suggested that the Fed were moving towards an implicit inflation target (of 2%) from 2003 Q2 onwards. Prior to that, both inflation and the inflation forecast were on a (welcome) downwards trend, though with fluctuations around that trend, which the forecasters only partially captured. Thus, CPI was on a rising trend from 1986 to 1990, peaking at about 5%, while forecasts rose from above actuals to slightly below them in 1990. Then inflation fell steadily to below 2% in 1998, whereas forecasts remained around 3%. Similarly the forecasters failed to see the rebound in inflation, to around 3%, in 2000 with the forecast only rising to just over 2%.

Nevertheless the divergences in Period 0 were small. Out of the 75 forecasts (for two years ahead), only three (actually the very first two, made in 1984 Q4 and 1985 Q1 for 1986 Q4 and 1987 Q2 and one towards the end), deviated from the outcome by more than 2%, so criterion 1 is mostly met. There were only two periods, in forecasts made in 1998 and early 1999, for 2000 and early 2001, and then again in 2003 and early 2004, for 2005 and early 2006, when there were periods of underestimating inflation by over 1% for several consecutive quarters. Consequently Criterion 2 is mostly, but not entirely, met. The simple correlation between forecasts and outcome shows, however, that, on average, the Fed significantly and persistently underestimated the decline in CPI inflation:-

Coefficient on Forecast	**S.E.**	**t**
0.88	0.03	26

$R^2 = 0.30$ D.W. = 0.25

So Criterion 3 is failed. But while the forecasting could have been better, from a policy viewpoint, no one minded.

Since both outcomes and forecasts were on a falling trend, from around 4% to about 2%, during these years, we also ran the regression between outcomes and forecasts with a constant. The results are:=

	Coefficient	**S.E.**	**t**
Constant	0.69	0.43	1.6
Forecast	0.69	0.12	5.5

$R^2 = 0.31$ D.W. = 0.25

We believe that the reason why the constant is (almost) significant, and why the coefficient for the forecast falls in value, is due to the largely accidental fact that the fluctuations were such that inflation was on balance overestimated in the earlier years and underestimated at the end of the period.

Overall we would characterize the forecasting during Period 0 as successful, though whether that success should be seen as moderate or exemplary is, perhaps, a matter of judgement. That success, however did not persist into Period 1. During the period, with forecasts made from 2003 Q1 to 2008 Q3, for outcomes from 2005 Q1 to 2010 Q3, there were 8 divergences greater than 2%, with two over 3%. So Criterion 1 is (badly) failed. From 2003 Q3 until 2004 Q3, for 2005/2006, there was a continuous and sizeable underestimate of inflation, followed in 2007 by a major overestimate of inflation taking place in 2009. The latter is not surprising as the 2007 forecasters were unaware of the subsequent GFC. Nevertheless Criterion 2 was also failed, though excuses can be made.

The simple correlation between forecast and outcome is:-

Coefficient on Forecast	**S.E.**	**t**
1.22	0.23	5.3

R^2 = -0.41 D.W. = 0.41

While the coefficient is not significantly different from unity, so Crtierion 3 is just met, perhaps an indication of the extent of forecasting failure during this period is demonstrated by the finding that the best regression with a constant included would have a massive positive constant and a *negative* value for the forecast coefficient:-

	Coefficient	**S.E.**	t
Constant	6.09	1.44	4.2
Forecast	-2.00	0.78	-2.6

Surely, this is quite largely due to multicollinearity, but even so.

Fortunately Period 1 marked a low point (until now) in the Fed's forecasting prowess. In Period 2, the GFC years, from 2008 Q4 until 2010 Q4, the forecasts were considerably better. By now, the Fed was focusing on PCE. Despite GFC, the Fed only cut its forecast (of PCE two years hence) from about 2 to about 1.5 and inflation fell by about the same amount. There were no divergences greater than 2, so Criterion 1 is fully met. There were only 3 consecutive quarters of divergences, of the same sign, greater than 1, so Criterion 2 is largely met.

The single correlation has the coefficient equal to unity, and so Criterion 3 is also met:-

Coefficient on Forecast	S.E.	t
1.11	0.11	9.9

R^2 = -0.18 D.W. = 0.86

,

Such relative forecasting success continued into Period 3. Again divergences remained low, below 2%, until the very end of the period, (for forecasts made at the end of 2019 for the second half of 2021). So Criterion 1 was largely met. There was one stretch, for forecasts made in 2013, for 2015, when actual PCE inflation fell to below 1%, but forecasts remained close, but just under, 2%; but otherwise Criterion 2 was well met. Overall, the Fed slightly overestimated its ability in this period to bring inflation back up to target, but the coefficient of inflation forecast on actual inflation, though below unity, is not significantly so.

Coefficient on Forecast	S.E.	t
0.91	0.10	9.6

R^2 = .08 D.W. = 0.30

Again a success. But that has now come to an end, with Period 4 ushering in the worst forecasting (and policy) errors since the start of IT, as shown below:-

Forecast			Actual	Divergence
Made in	For	Was		
2020 Q1	2022 Q1	2.1	6.4	4.3
2020 Q2	2022 Q2	2.1	6.6	4.5

2020 Q3	2022 Q3	2.1	6.3	4.2

.

If one just takes the full period for which the Fed was forecasting PCE on a quarterly basis between 2009 Q4 until 2019 Q4, the simple regression of forecasts on outcomes looks good:-

Coefficient on Forecast	**S.E.**	**t**
1.00	0.10	10

R^2 = 0.10 D.W. = 0.23

But this is partly because it omits most of Period 1 and all of Period 4 when the Fed's forecasts were poor.

A nice summary statistic of forecasting prowess is the Mean Absolute Divergence (MAD), which can usefully be compared across Central Banks and across periods. The results of this exercise are as follows:-

Mean Absolute Divergence

Period	**BoE**	**ECB**	**Fed**
0	NA	NA	0.67
1	0.64	0.75	1.44
2	2.41	1.06	0.67
3	0.74	0.85	0.68
4	5.40	6.30	4.37

What this reveals (again) is how badly the Fed forecast in Period 1, when they totally failed to capture the above target outcomes for CPI from 2005 to 2008, and what a mess the BoE made of its forecasts during the GFC! Otherwise, up until the present inflationary crisis, by this rubric the forecasting experience was quite good. If you exclude Period 1 for the USA and Period 2 for the UK, then the Fed has been best, and ECB worst. But if you just add Periods 1-3, the ECB has been best, since it never had a really bad forecasting period. But the present forecasting (and policy) failure is significantly worse than anything that has occurred previously during the IT regime.

Section 5

Expectations: And the Causes of Joint Divergences

In the previous Section (Section 4), we provided evidence that in normal (non-crisis) periods, our Central Banks have habitually overstated their ability to return inflation to target (Periods 1 and 3), whereas the reverse tended to be the case during our crisis periods (2 and 4), wherein CBs, initially at least, were far too pessimistic about the ability of policy (fiscal as well as monetary) to restore inflation to target. In this Section we concentrate on the overstatement of monetary policy efficacy in the normal, and longer-lasting, periods 1 and 3.

In the Introduction we dismissed out-of-hand two possible explanations, that forecasts were just fake news for public consumption, and that the direct interest rate transmission effect was actually smaller than generally estimated. We do not feel any call to reprise that judgement here. Instead we shall focus on two remaining issues in this Section. The first is that expectations of households and firms, who between them actually set wages and prices, are much less forward looking, and well anchored, than generally assumed by CBs. The second is that during these long normal periods there were underlying disinflationary trends, to which CB forecasters gave inadequate weight. A problem with this latter hypothesis is that it comes in two guises, from the demand side, e.g. secular stagnation and a savings glut, and from the supply side, e.g. a surge in labour supply and an accompanying fall in labour bargaining power. But these two alternative hypotheses, while not mutually exclusive, (they could both be partially correct), should have quite different implications for divergences between forecast and actual output. If there was under-appreciated secular stagnation (demand weakness) shortfalls of inflation from forecast should have been accompanied by shortfalls of output from forecast. Whereas, if the underlying unforecast shock came from the supply side,

shortfalls of inflation from forecast should have been accompanied by more output than forecast. So in the second part of this Section, we look at the correlations between inflation and output forecast divergences. To the best of our knowledge we are the first to examine this approach.

Expectations

Turning back to expectations, we do appreciate that financial market members, academic economic, and professional, forecasters, all consciously seek to look forward, when setting their expectations, and are influenced by Central Bank communication, e.g. published forecasts and other forms of Forward Guidance. In return, Central Bank forecasters are influenced in some part by the mainstream academic consensus on modelling the macro-economy, and also by developments in financial markets. It is an echo chamber.

But our position is to claim that both such forward-looking capacity, and responsiveness to Central Bank Forward Guidance, is far less in the case of households and firms. We shall do so in two parts, first a literature review of studies of such expectations (households and firms), and second a brief econometric study whether such expectations are more closely related to past or to future inflation.

We are fortunate in that survey papers on empirical studies on such expectations (households and firms) have recently appeared. For households, see D'Acunto, Malmendier and Weber, 'What do the Data tell us about Inflation Expectations', NBER WP 29825, March 2022. They find that household inflation expectations are systematically higher than that of financial market participants, and tend to be systematically skewed with the mean about 1pp above the median. Their results hold even when controlling for outliers, financial sophistication, education, income and other individual traits. How are these expectations formed? The results suggest that rather than simply looking at published inflation data for the economy, consumers form expectations based on the prices they observe while shopping. Specifically, "the salience of observed price signals, including the frequency of exposure, exerts a strong influence on individual expectations". Grocery prices play a key role in the expectations-forming process of households. Overweighting frequently purchased goods helps explain German household inflation expectations (Brachinger (2008)), while changes in individual inflation expectations can be traced back to the changes in the price of specific groceries (Cavallo et al, 2017). Some of this innovative research is slowly finding its way into central bank conferences and

even modestly into central bank research. A recent Banque de France Bulletin ("French households and inflation in 2022", Nov-Dec 2022, 243/1) exploring the topic of microeconomic formation of household inflation expectations argues that "there is a very strong correlation between households' inflation expectations for the next 12 months and their perception of inflation (see Chart 5). This suggests that households form their one-year ahead inflation expectations based largely on how they perceive price rises today."

These findings have, however, not yet found their way into official central bank speeches, statements or minutes. The fact that households pay less attention to central bank communications also implies that central banks miss the powerful influence of daily price stimuli on their inflation expectations. Traditional models that take the perspective of the representative household via an aggregate statistic are subject to the same criticism. The authors of the survey comment, "Why the information provided by trusted institutions is ignored by decision-makers is an open puzzle", and there is much to agree with them, in our view. In summary, the authors argue, ""The wealth of new facts in the domains of inflation expectations and other economic and financial expectations indicate a pervasive deviation of subjective expectations from the FIRE paradigm."

Nor is evidence from studies of firms' expectations any more aligned with the Full Information Rational Expectations [FIRE] paradigm. Here again we have a recent survey by Candia, Coibion and Gorodnichenko, 'The Macroeconomic Expectations of Firms', NBER WP 30042, May 2022. The characteristics of a manager's expectations, the authors argue, are not dissimilar in nature to that of households. In an eerily similar manner to the discussion regarding households, "managers' expectations may be sensitive to salient price changes for homogenous, frequently-purchased goods like food or gasoline for advanced economies or to variation in the exchange rate for countries with a history of dollarization or chronically high inflation (e.g., Coibion and Gorodnichenko 2015b)". Not only that, the similarity to households may extend to disagreement (*and* the qualitative amount of disagreement) surrounding inflation expectations because the shopping experience of managers differs from individual to individual.

Firms' expectations differ from that of both households and professional forecasters, but firms' average expectations are closer to that of households for both inflation and other macroeconomic variables.

Most interestingly, revisions to short- and long-horizon forecasts of firms are highly correlated. To the extent that many shocks to prices are transitory, the correlation should really be low, particularly in countries where long-run inflation expectations are supposed to be 'well anchored' – it isn't. As a result, the authors argue, "firms' inflation forecasts, at least in countries with a history of low and stable inflation, cannot be characterized as well-anchored".

Finally, some amount of 'rational inattention' may help explain why short- and long-term expectations of firms deviate substantially from actual values. "The degree of inattention", the authors argue, "varies with the level of inflation. Using cross-country firm survey data, we show that, when countries experience higher inflation rates, the forecasts of firms are closer to those of professional forecasters, i.e., more informed, than when inflation rates are low. We observe a similar pattern for households. How inattentive agents are to macroeconomic conditions, and inflation in particular, depends on the economic environment."

There is a certain irony in this last result. It may imply that households' and firms' forecasts may be closer to that of professional forecasters' when inflation itself is hard to forecast. How good can the forecasts themselves then be, and how much comfort is the convergence among the forecasts of different categories of forecasters? On the other hand, when there is a case for rational inattention, when inflation is less worrisome, households' and firms' expectations can deviate significantly from that of professional forecasters and actual values – that's hardly comforting either.

Even beyond the wealth of papers cited in these two surveys, there are several more, e.g. Savignac, et al, 'Firms' Inflation Expectations: New Evidence from France', CEPR DP 17011, January 2022; and Kuchler, et al, 'Housing Market Expectations', CEPR DP 17158, March 2022, that go in the same direction. Also see Blinder, et al., 'Central Bank Communication with the General Public: Promise or False Hope?', CEPR DP 17441, July 2022. This is that household and firm expectations are based on their own salient prior experience, and neither react much to Central Bank forecasts, or forward guidance, nor are remotely 'well anchored'.

If so, such expectations should be more closely related to past inflation experience than to actual future outcomes. To that end, we test backward- and forward-looking links embedded in survey data on household inflation expectations. Our ideal horizon would have been 2-year inflation expectations, as these would have allowed near-term/ongoing shocks to be excluded from the household forecast, and it would have coincided conveniently with the 2-year ahead central bank forecasts we have dealt with so far. Unfortunately, US surveys collect only 1-year and 5-year ahead inflation forecasts.

Our prior expectation was that inflation expectations one year ahead would be significantly closer to the actual outturn than to current inflation, for three reasons. First, if there is a demand shock, the generally accepted outcome is for that to affect output, and thus the output gap, in the first year and inflation increasingly in the second year. So, when there is a positive demand shock, agents would see the output gap becoming stronger and should then raise their expectations of inflation for the forthcoming year, relative to current inflation.

Second, when there is a (temporary) supply shock, this can often affect inflation in the first year, but that can fall away, or even reverse in the second year. Perhaps an extreme example has been the Ukraine war, which helped to drive up inflation towards 10% towards the end of 2022. But this is not expected to get worse, and may well reverse, in 2023 with the result that inflation is now expected to go down again towards 3 or 4%. While this is an extreme example, the timings may well be typical for other supply shocks.

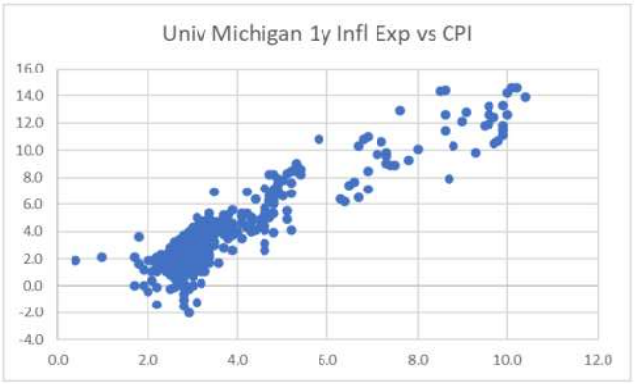
Third, the media are usually full of commentary about the likely outcome of inflation in the year ahead. So, even agents with rational inattention would find it hard to be completely unawares of mainstream expectations for inflation in the coming year. Admittedly this is much greater when inflation is comparatively high, as now. But even so, predictions of inflation over the coming year are always commonplace and much more frequent than predictions for longer dates ahead.

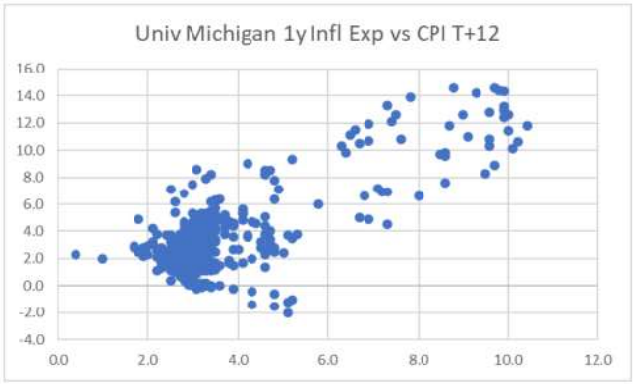
So we were rather surprised when our regression studies for the three sets of one-year forecasts, the Conference Board, University of Michigan and the Survey of Professional Forecasters, showed

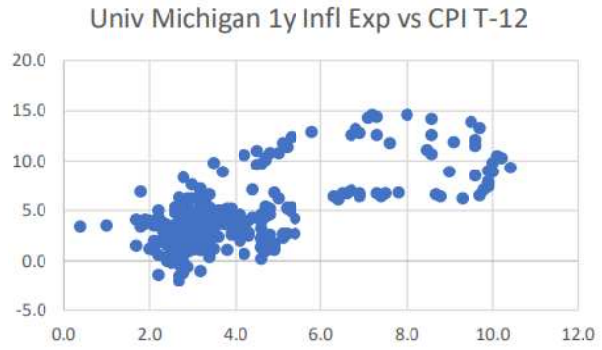
that the relationship between the survey and CPI, indicated that the strongest relationship was with the current level of CPI, the next strongest relationship was with the level of CPI lagged one year, and the lowest relationship was for the CPI one year ahead. This is shown in the Table and Charts below. Overall the relationships between surveys and outcomes were weak with no cointegration between the two.

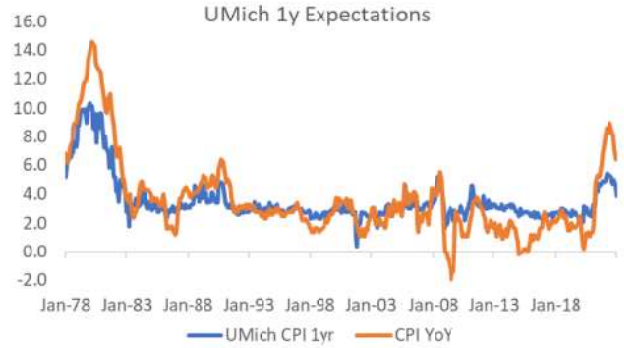
SPFly on	**Coeff**	**p-value**
CPI	0.45	0.00
CPI(T+1y)	0.28	0.00
CPI(T-1)	0.41	0.00
UMichly on	**Coeff**	**p-value**
CPI	0.39	0.00
CPI(T+1y)	0.20	0.00
CPI(T-1)	0.25	0.00

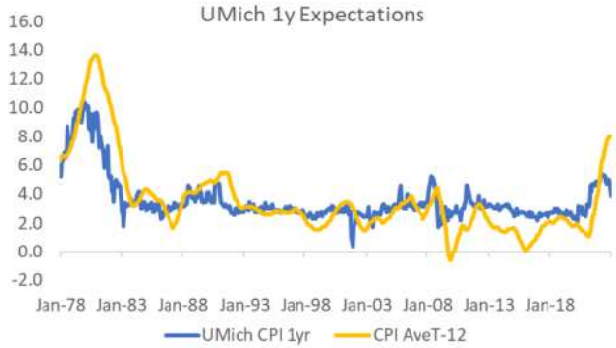
University of Michigan 1-year Ahead Inflation Expectations



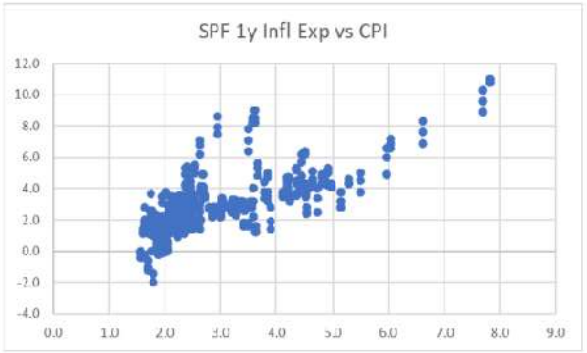


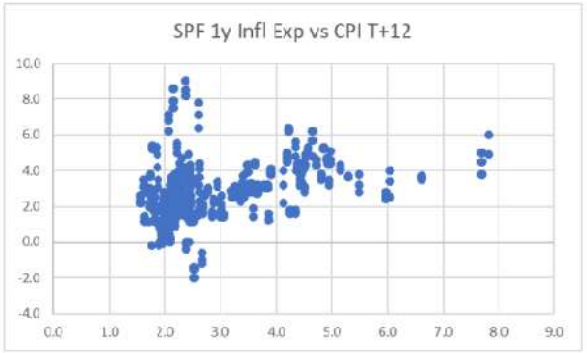


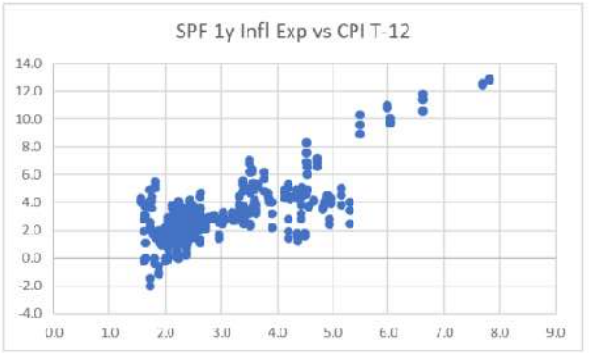




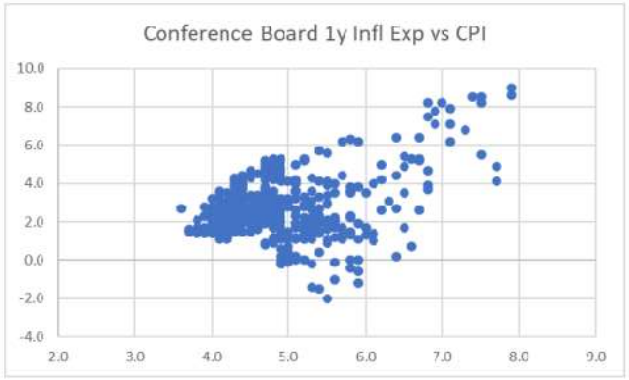
Survey of Professional Forecasters 1-year Ahead Inflation Expectations

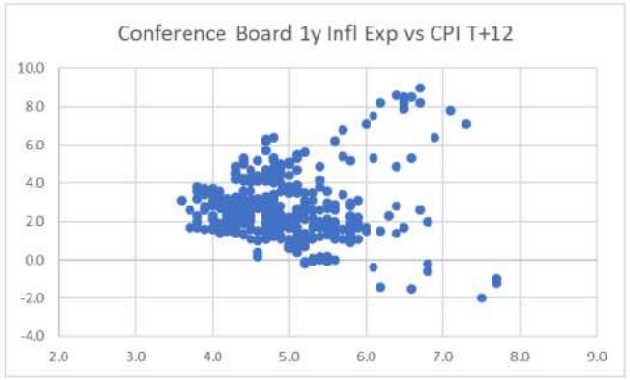


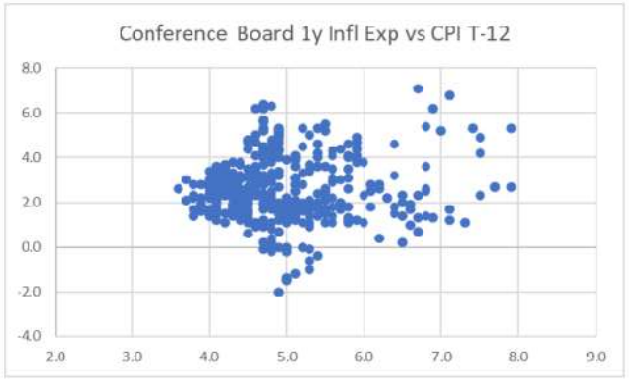


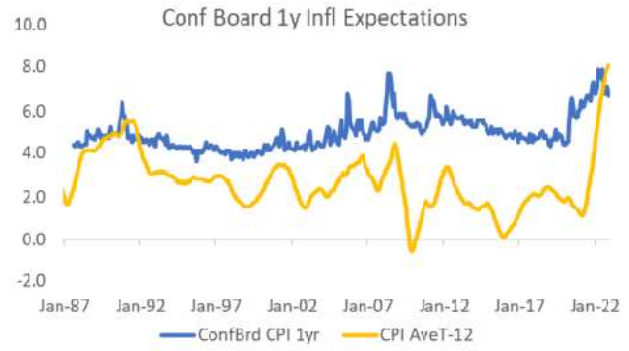


Conference Board 1-year Ahead Inflation Expectations



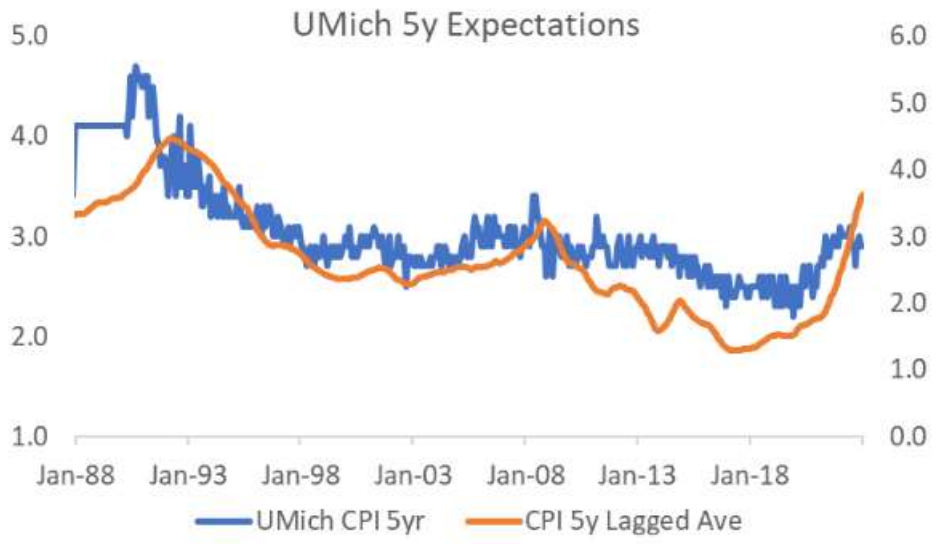


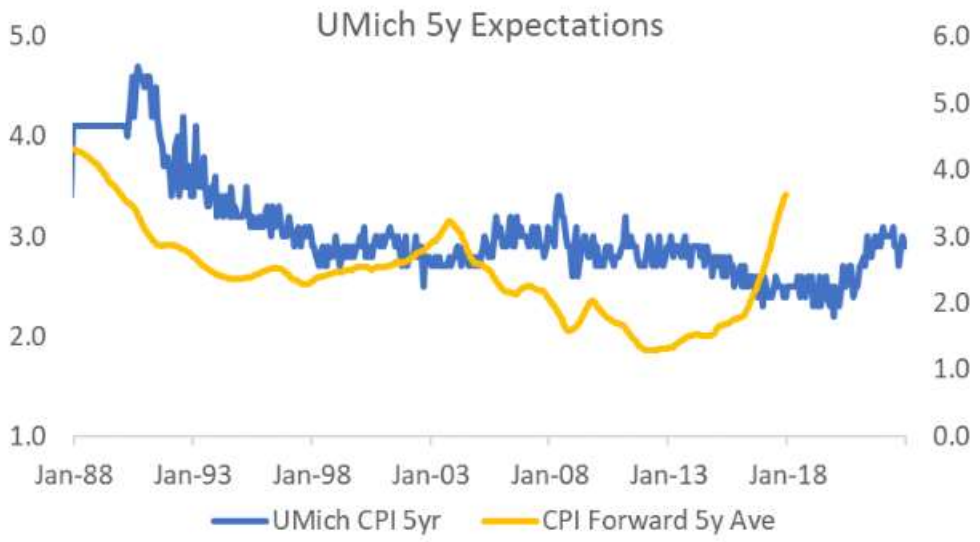




At the longer 5-year horizon, results, and the narrative therein, become far clearer for household expectations. Engle-Granger tests suggest that a cointegrating relationship exists between the University of Michigan 5-year inflation expectation series and the average value of CPI inflation over the last five years. Since today's inflation expectations cannot influence past inflation outcomes, we can run the cointegrating relationship with inflation expectations as the dependent variables. The results below suggests that a third of the deviation between the two variables (one of which is a slow moving 5-year moving average) tends to be corrected in each period. Using a sample from 1990 onwards (to leave aside the period when the survey was quarterly), the error correction term loading becomes stronger but the overall explanatory power of the relationship weakens (since we leave behind the strong changes in the 1980s that would drive econometric identification).

When it comes to the forward-looking relationship, however, the hypothesis of NO cointegrating relationship between 5-year inflation expectations and the average value of CPI over the next five years cannot be rejected. A visual check helps understand the statistical results – there is no discernible relationship between expectations and the future they tried to predict. However, past inflation tracks expectations very well.





The ineluctable conclusion of this part of this Section is that any reliance on 'well-anchored' expectations amongst households and firms to help drive inflation back to target is a mirage, a fatuus ignis, a will-of-the-wisp. Such inflation expectations may be near target, because inflation has been kept near target, not vice versa.

For a discussion of the importance of whether such forecasts, by households and firms, are primarily backwards or forwards looking, see Mann (2023)

Unforeseen Disinflationary Trends

Of course the tendency for Central Banks to overestimate the ability of their policies to return inflation to target during 'normal' periods may be due to their underestimation of underlying (disinflationary) trends, rather than from undue reliance on 'well-anchored' expectations. But theories about such disinflationary trends come in two guises, as already noted, a demand-side approach (secular stagnation and savings glut) and a supply side version (surge in labour supply and reduced labour bargaining power). While they both predict lower inflation than forecast, they would imply very different outcomes for divergences in growth forecasts, down for demand side, up for supply side effects.

But, even outside of our 'normal' periods, the relationship between divergences in inflation forecasts and those in growth forecasts may provide clues to what was currently happening. Indeed, we shall start by looking at the relationships between inflation and growth forecasts during crisis periods. The two main crises, the Great Financial Crisis (GFC), and then Covid, really struck, (though the GFC was preceded by a few tremors) in 2008 Q4 and then 2020 Q1.

In both cases the results were consistent for all three CBs with a major, unforeseen *demand* shock, with output, and, with a slight lag, inflation dropping significantly below their prior forecast levels. It may seem, superficially, surprising that the Covid outcome appears as large a demand shock as GFC, given the emphasis on supply-side shocks during Covid. But while much of the service sector was shut down, e.g. entertainment, hotels, transportation, etc., some remained open. The lock-down restrictions then meant that those restaurants, hotels, airplanes, etc., that did remain open, felt such a drop in demand that they struggled to fill their seats, and generally *lowered* prices. So, while there was some increase in goods prices, exacerbated by supply shocks, this was offset by declines in services prices, where the cut in demand exceeded the cut in supply. A clear adverse supply shock only kicked in in 2022 for the EU and UK when the Ukraine war drove prices further above and output below the prior forecast levels.

When the GFC struck, from 2008 Q4 and for the next few quarters, our Central Banks temporarily lowered their expectations of the inflation level that they could hit two years hence, as already noted in Section 3. What is remarkable is that just as the CBs became uncertain of their ability to return inflation back to target, and to restore growth, so the outcome results for 2011/12 showed a recovery in inflation, to above target levels, and growth significantly above forecast. Once more, another clear sign of a positive demand effect in the stronger than forecast recovery in both inflation and output after the worst of the GFC was past.

When Covid struck, in 2020 Q1, our three Central Banks, unlike their post GFC response, made absolutely no change to their two year forward forecasts for inflation, perhaps because they expected supply side-effects to cancel out demand side effects, or were more confident in their own powers to bring inflation back to target. Initial outcomes again indicated a demand shock, with both inflation falling (slightly) below forecast in 2020, whereas output fell massively below. Once again the forecasts for inflation and output were largely below outcomes during the recovery in 2021,

another clear demand shock. Then, as noted earlier, 2022 saw the arrival of a clear supply shock (Ukraine war) with inflation surging above, and output falling below forecasts, especially in the EU and UK.

There is, however, yet another problem. Whereas a supply shock, either adverse as in the case of the Ukraine war or beneficial as in the case of China's entry into the WTO, is likely to affect both output and inflation contemporaneously, a demand shock may in some instances have a contemporaneous effect, e.g. Covid lockdown, while in other cases the demand shock could reduce output several quarters, up to a year, *before* it feeds through into inflation. We attempt to deal with this by looking at the correlations between inflation forecast errors and growth forecast errors not only contemporaneously, but also with the growth forecast errors lagged up to four quarters previously.

We show the coefficients relating forecast inflation divergences to growth forecast divergences below, using the divergence in the growth forecast from the initial estimate of actual output growth.

ECB

	Period 1	Period 2	Period 3	Period 4
Y(t-4), Pi(t)	0.42	0.71	-0.10	-0.45
Y(t-3), Pi(t)	0.24	0.92	-0.19	0.42
Y(t-2), Pi(t)	0.10	0.83	-0.28	0.58
Y(t-1), Pi(t)	-0.12	0.40	-0.37	0.59
Y(t), Pi(t)	-0.35	-0.19	-0.45	0.57

Fed

	Period 1	Period 2	Period 3	Period 4
Y(t-4), Pi(t)	-0.05	-0.39	0.35	-0.01
Y(t-3), Pi(t)	-0.09	-0.14	0.28	0.49
Y(t-2), Pi(t)	-0.13	0.24	0.19	0.70
Y(t-1), Pi(t)	-0.22	0.49	0.15	0.87
Y(t), Pi(t)	-0.38	0.65	0.17	0.58

Bank of England

	Period 1	Period 2	Period 3	Period 4
Y(t-4), Pi(t)	0.32	0.10	-0.65	-0.49
Y(t-3), Pi(t)	0.35	0.43	-0.64	0.44
Y(t-2), Pi(t)	0.24	0.72	-0.63	0.66
Y(t-1), Pi(t)	0.10	0.76	-0.58	0.63
Y(t), Pi(t)	-0.28	0.42	-0.56	0.61

Given all the emphasis on supply constraints in the Covid crisis, are not the results for Period 4 surprising? Not so in our view. The lockdown restricted demand for services severely, e.g. travel, entertainment, etc. The few remaining competitive service providers had to cut their prices quite sharply. Conversely in the subsequent upturn they were short of staff and raised prices markedly.

The positive relationships between growth and inflation forecast divergences did *not* just depend on the common, unforecast, sharp decline at the outset of the crisis. It also relates to common failures to see the rebounds both in growth and inflation as the crisis abated.

Next in Period 3 it is clear for the BoE and ECB that the correlation between divergences in inflation and growth forecasts is predominantly and quite strongly negative. This is consistent with our prior thesis of the importance and relevance of supply shocks during these years. Equally it is inconsistent with the hypothesis that underlying demand shocks (savings glut and secular stagnation) were a major global driving force.

Finally in Period 1, the results are less clear. The contemporaneous correlation is negative, consistent with supply shocks dominating, but the correlations with lagged growth divergences are positive, consistent with demand shocks being dominant. Not a clear message.

Perhaps not surprisingly, the Fed also had a quite strong positive correlation, indicating a demand shock, between (two year) growth and inflation divergences in the two crisis Periods (2 and 4), and no doubt for the same reasons. But during the normal Periods (1 and 3), the pattern in the USA was

somewhat different from that for the BoE and ECB. Whereas in Period 1 in Europe, there was no clear correlation, with the Fed, between 2003 and 2008, the correlation was negative, suggesting a supply shock. Then in Period 3, when in Europe, both BoE and ECB had negative correlations, the Fed had a positive correlation, though rather weak, implying more of a demand shock. In terms of our interpretation of the impact of the emergence of China, it had more of the characteristics of a supply shock on the USA in the earlier years of this century, and more of the characteristics of a demand shock (savings glut, etc.,) between the GFC and Covid crises. In any case, what happens in the USA is *not* necessarily representative of what is taking place elsewhere.

Section 6

The Bank of England's Fan Chart: The Experience so far

The Bank of England first used a fan chart to illustrate its forecast, under the guidance of Mervyn King, then its Chief Economist, later its Governor, in February 1996, in advance of being granted its independence in 1997. The purposes of doing so were several. The first aim was to reduce the excessive focus on a single (modal) point forecast. Even if the central forecast was (believed to be) the most likely; its exact attainment had a very low probability. Focussing on just one (central) number would give observers an undue expectation of what Central Banks could, and should, be expected to achieve. Second, the expected degree of (future) variance volatility in inflation (or in any other macro variable, such as the growth rates of GDP), can, and does, vary over time; compare, for example, the volatility of inflation (and output), in the disturbed years from 1973 to 1982, with that during the Great Moderation, between 1992 and 2007. Similarly, the risks of inflation, even at a two-year horizon, may sometimes seem to be more to one side, or another, greater risk of deflation, or inflation, relative to the central tendency. Thus, during our third period, 2011-19, most commentators were worried about a downside, deflationary risk; whereas currently in 2022, most commentators are worried about higher potential inflation, even at a two year horizon.

As in the remainder of this paper, we concentrate solely on the two-year ahead forecasts by the Bank of England, and we look at just two statistics. The first is a measure of the expected variance,

volatility, of inflation at this horizon. Our statistic is simply the measured distance between the top and bottom lines in the fan chart, its width.

The resultant data series are shown in Table 4 in the Data Appendix . The result is rather straightforward. The width started at a level of about 4, probably largely based on the experience of prior years. It then came down steadily, almost monotonically, to a minimum of around 1.6/1.7 in 2004/2005. During these years the BoE successfully held outcomes (at the two-year horizon) close to its (2.5 RPIX, then 2.0% CPIX) target. Ken Wallis in several articles, notably 1994, 2003 and 2004, argued that the new policy regime not only had, but could be expected to continue to, reduce(d) the variance of inflation outcomes so much that the forecast width/variance of the fan (diversity) remained excessive.

Nevertheless, the experience of somewhat enhanced inflation in 2006/7 led to an upwards revision in width (variance) to about 2.5, quickly followed by the Great Financial Crisis, with the worst effects starting in the second half of 2008. Thus led to a surge in the reported width/variance, initially back to its starting level of just under 4, but not peaking (at over 5) until the forecasting round of May 2010.

Perhaps somewhat chastened by that experience, even after the GFC was clearly brought under control, the Bank's forecasters, from 2010 onwards held the (forecast) variance/width more, or less, absolutely constant at 4.6/4.7 (n.b. above the 1996/97 starting point, and more than double the optimistic hopes of the early 2000s). But even that became viewed as excessively optimistic, once Covid struck at the start of 2020. Immediately then the variance was increased to almost 7, but has now retreated somewhat to slightly below 6.

The implication of all this is that forecast variance/width rises sharply once unforeseeable shocks have hit. During 'normal' times actual variances has tended to decline, but the prediction of variance is in large part a prediction of the occurrences of the event and scale of future shocks, and such prediction is by definition virtually impossible.

We then turn to our second measure, of the skew, or bias, to the fan chart, indicating whether the risks of greater inflation, or disinflation, appear to be greater. Our statistic for this is to measure the distance from the mode to both the upper and lower edges of the fan chart (again only at the two-year horizon). We then divide distance up by distance down. Any data point over 1.1 we count as suggesting greater inflation risks; below 0.9 suggests greater disinflationary risks; and between 0.9 and 1.1 a roughly even balance.

The results of this exercise are shown in Table 5. Between 1997 and 2003 there was a continuous attempt to assess relative riskiness; there was some expectation of greater inflation risks initially in forecasts in 1997 and early 1998, which turned out to be incorrect. Such forecasts then swung rather wildly until 2001. Then a short period of expectations of disinflation risk (2001) was followed by a brief sequence of higher forecast inflation risks (2002), both broadly correct. From 2003 until 2006, risks were assessed as broadly even, though at times on the disinflationary side (incorrect). That was then followed by a period, 2007 to August 2008, when forecasts were for greater inflationary risks, as later shown by the GFC to be notably incorrect. Once the economy emerged from the GFC in 2010/2011, prediction was, once again, for inflation risks to predominate, which once more proved well wide of the mark.

Perhaps chastened by the experience of getting future relative riskiness absolutely wrong, (both 2007/8, and then again in 2010/2011), the Bank forecasters abjured from making *any* such forecasts, from 2012 until 2022. They assumed that the risks remain evenly balanced, a symmetric forecast for the fan chart, continuously. This has been so even though we believe that most outside observers would have expected a downside skew, greater disinflationary risks, in the years up until mid-2021, and the reverse (higher inflationary risks) since then. That inflationary risks predominate has currently been accepted by BoE forecasters.

Given the impossibility of forecasting future shocks, and the overall difficulties of forecasting, even absent shocks, the unwillingness shown, since 2012, by Bank forecasters to take a punt on relative future riskiness is understandable. But we think that there is a better way of assessing riskiness, than just assuming an even balance of risks, as done until 2022. We outline this in our Conclusions, next in Section 7.

Section 7

Conclusions

Forecasting is hard. As the Italian song 'Che Sera' has it, 'The future is not ours to see'. This is particularly so in the aftermath of severe crises. In both cases (GFC and Covid/Ukraine) our Central Banks grossly *underestimated* the power of (monetary) policies, and other factors (e.g. the arrival of effective Covid vaccines and, perhaps, the natural resilience of the economy), to bring about a strong recovery in inflation. The archetypal occasion was when the BoE in the depth of the GFC, 2009 Q1, forecast that CPI inflation two years hence would still be lingering at 0.5%! But our two other Central Banks were somewhat similarly pessimistic, as shown below:-

Inflation

	Forecast made in 2009 Q1 for 2011 Q1	Actual 2011 Q1
BoE	0.5	2.4
ECB	1.0	2.4
Fed	1.3	1.8

And much the same has happened with Covid, taking 2020 Q2 as the worst of the shock:-

Inflation

	Forecast made in 2020 Q2 for 2022 Q2	Actual 2022 Q2
BoE	2.0	5.5
ECB	1.5	6.1
Fed	2.1	6.3

There are, of course, several reasons for such underestimation of the bounce-back of inflation after such severe adverse shocks. The shocks were completely new and unexpected. There was the prior example of the inter-war Great Depression when there had been no such bounce-back. Some of the policy measures were new and innovative, such as QE, stress testing and TARP, so a degree of

humility about their likely effects was in order. In the second crisis the successful delivery of effective vaccines and the Ukraine war could hardly have been predicted in advance.

Even so, there is, maybe, a hint of myopia here. When a shattering event occurs, we, humans, tend to over-estimate its longer term impact on our lives, society and economy. Central Bank forecasters may also suffer from innate myopia, giving too much weight to shorter run (ephemeral) events, (and too little to longer run trends).

That apparent underestimation of the power of monetary policies during crisis periods was, however, reversed during more normal periods, our Periods 1 and 3. In these latter periods, the tendency was for our Central Banks to over-estimate their capacity to bring inflation back to target, though this was less marked in Period 1 than in Period 3. In Period 1 the ECB's forecast regularly understated slightly above target inflation, while the BoE was on target, and the Fed's forecasting was, during this period, rather poor overall. In Period 3 all our Central Banks habitually forecast that inflation would turn out to be higher (two years hence) than turned out to be the case, even though the ECB cut its forecast to below target (Section 3). Thus the coefficient relating target to outcome is below unity in all three cases, though only marginally significantly so.

Pointing to the Effective Lower Bound for interest rates is not an adequate excuse/explanation for such a forecasting error, since the forecasters could, and should, at least in principle, have taken this into account. A more probable explanation, in our view, was a developing supposed nexus between the maintenance of 'well-anchored' expectations and the achievement of the inflation target. Thus, so long as the Central Bank was convincingly committed to price stability, i.e. the inflation target, it was thought, and the models used suggested, that private sector (rational) expectations would do much of the job of returning inflation to target, without the Central Bank having to vary interest rates so much. This interaction between, supposedly 'rational', expectations and Central Bank 'credibility' meant that our Central Banks became keen to forecast inflation two years hence as being, almost exactly, at target, and at the same time came to believe that such 'rational' expectations would do much of the work in bringing actual inflation back to target.

This enhanced tendency to forecast inflation at the two-year horizon to be either exactly at or very close to, target has been reinforced by the very mixed experience, during the IT years, in actually forecasting the, relative minor up till now, fluctuations in inflation around target. As a result the two year forecast of inflation has recently become rather formulaic. In some ways this has been most obvious with the BoE's forecast. Not only has the central forecast been held religiously close to 2.0 in recent years, but also the width of the fan chart was held constant from 2011 until 2020 (it has been increased since then) and risks have been assumed absolutely symmetrical (zero skew) from 2012 until 2022, see Section 6. In other words, apart from the recent widening of the fan chart and inflation skew, the two year ahead forecast is not so much a forecast any longer, but rather an assumption, with inflation at target, and a constant fan chart, whose width has been, until recently, kept constant, and whose skew is simply taken to be zero.

This assumption, about the outlook for inflation, at the two year horizon, has been strained, perhaps beyond credulity, by the recent upsurge in inflation, much higher and more prolonged than Central Banks expected. Whereas quite a lot of this has been due to unforecastable events, e.g. the rapid roll-out of vaccines, and then the Ukraine war, much of the upturn in inflation was in place before February 2022.

What we would suggest is as follows:-

1) Recognise that the expectations of households and firms are largely adaptive (not rational), and react to recent experience, especially of salient price changes (see Section 5).

2) The most salient prices for households are energy and food. These also have the highest price spillovers to prices in other sectors, (BIS Annual Economic Report, 2022, p. 48). Consequently headline measures of inflation should be preferred, rather than core measures.

3) Keep the Bank of England's fan chart, but base the estimates of the likely volatility of inflation and the skew of risk on financial market expectations, based on some combination of surveys and option pricing.

4) Recent experience will have seriously shaken people's confidence about the reliability of Central Bank forward (two year) forecasts. In this context reiterating that inflation will be, almost exactly, back to target by then in the near future may be almost counter-productive. What will be more important will be getting the forecast closer to reality. Since that will continue to be extremely difficult, because shocks inevitably continue, there needs to be a more convincing narrative about the basis of the forecasts currently being made, and a serious attempt to provide an explanation for the divergences of prior forecasts, (perhaps especially those made two years previously).

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APPENDIX TABLES

Table 1: Bank of England

Inflation and Growth: Forecasts vs Realised (Reference period: quarter for which the forecast was made)

	Inflation						Growth			
Forecast made in	Forecast made for	RPIX Forecast	CPIX Equivalent	CPI Forecast	Actual CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Jun 97	Jun 99	2.4	1.9		1.9	0.0				
Sep 97	Sep 99	2.4	1.9		1.6	-0.3				
Dec-97	Dec-99	2.6	2.1		1.5	-0.6	2.3	2.5	3.9	0.2
Mar-98	Mar-00	2.3	1.8		1.1	-0.7	2.5	2.9	4.3	0.4
Jun-98	Jun-00	2.5	2.0		1.1	-0.9	2.5	2.9	4.7	0.4
Sep-98	Sep-00	2.4	1.9		1.2	-0.7	2.4	2.6	3.4	0.2
Dec-98	Dec-00	2.5	2.0		1.4	-0.6	2.4	2.8	2.3	0.4
Mar-99	Mar-01	2.4	1.9		1.2	-0.7	2.7	2.9	2.2	0.2
Jun-99	Jun-01	2.6	2.1		1.8	-0.3	3.1	2.2	2.0	-0.9
Sep-99	Sep-01	2.5	2.0		1.8	-0.2	3.2	1.7	2.1	-1.5
Dec-99	Dec-01	2.6	2.1		1.4	-0.7	2.8	2.1	2.0	-0.7
Mar-00	Mar-02	2.6	2.1		1.8	-0.3	2.3	1.4	1.7	-0.9
Jun-00	Jun-02	2.7	2.2		1.3	-0.9	2.7	1.3	1.9	-1.4
Sep-00	Sep-02	2.5	2.0		1.4	-0.6	2.8	1.8	2.1	-1.0
Dec-00	Dec-02	2.5	2.0		1.6	-0.4	2.5	2.3	2.8	-0.2
Mar-01	Mar-03	2.5	2.0		1.5	-0.5	2.9	2.6	2.8	-0.3
Jun-01	Jun-03	2.4	1.9		1.4	-0.5	2.4	2.3	2.9	-0.1
Sep-01	Sep-03	2.4	1.9		1.3	-0.6	2.1	1.6	3.2	-0.5
Dec-01	Dec-03	2.3	1.8		1.3	-0.5	2.7	2.0	3.1	-0.7
Mar-02	Mar-04	2.6	2.1		1.4	-0.7	2.6	3.3	3.0	0.7
Jun-02	Jun-04	2.5	2.0		1.3	-0.7	3.2	3.6	2.8	0.4
Sep-02	Sep-04	2.4	1.9		1.3	-0.6	2.5	3.6	2.0	1.1
Dec-02	Dec-04	2.5	2.0		1.5	-0.5	2.4	2.8	1.6	0.4
Mar-03	Mar-05	2.4	1.9		1.8	-0.1	2.2	2.7	1.8	0.5
Jun-03	Jun-05	2.5	2.0		1.9	-0.1	2.4	2.6	2.2	0.2
Sep-03	Sep-05	2.3	1.8		2.4	0.6	2.5	2.1	2.8	-0.4
Dec-03	Dec-05	2.6	2.1		2.3	0.2	2.9	2.0	3.6	-0.9
Mar-04	Mar-06			2.0	2.1	0.1	2.9	2.4	3.5	-0.5
Jun-04	Jun-06			2.3	2.4	0.2	2.2	2.6	2.9	0.4
Sep-04	Sep-06			2.0	2.6	0.5	2.1	3.1	2.2	1.0
Dec-04	Dec-06			2.0	2.7	0.7	3.0	2.9	1.8	-0.1
Mar-05	Mar-07			2.2	2.8	0.6	3.0	3.0	2.0	0.0
Jun-05	Jun-07			2.0	2.5	0.5	3.0	2.9	2.1	-0.1
Sep-05	Sep-07			2.2	2.0	-0.2	3.3	3.0	2.6	-0.3
Dec-05	Dec-07			2.0	2.3	0.3	3.2	3.3	2.3	0.1
Mar-06	Mar-08			2.0	2.5	0.5	3.0	2.8	2.2	-0.2
Jun-06	Jun-08			2.0	3.4	1.4	2.7	2.3	1.2	-0.4
Sep-06	Sep-08			2.1	4.5	2.4	2.7	1.1	-1.0	-1.6

	Inflation						Growth			
Forecast made in	Forecast made for	RPIX Forecast	CPIX Equivalent	CPI Forecast	Actual CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Dec-06	Dec-08			2.0	3.7	1.7	2.9	-0.8	-3.3	-3.7
Mar-07	Mar-09			2.0	3.0	1.0	2.8	-3.4	-5.6	-6.2
Jun-07	Jun-09			2.0	2.0	0.0	2.8	-4.8	-5.5	-7.6
Sep-07	Sep-09			2.0	1.3	-0.7	2.5	-4.7	-4.0	-7.2
Dec-07	Dec-09			2.0	1.6	-0.4	2.8	-3.0	-1.7	-5.8
Mar-08	Mar-10			2.2	2.3	0.1	2.4	0.1	0.8	-2.3
Jun-08	Jun-10			2.2	2.5	0.4	2.4	0.6	2.2	-1.8
Sep-08	Sep-10			1.8	2.3	0.5	2.4	2.4	2.9	0.0
Dec-08	Dec-10			0.9	2.7	1.9	2.4	2.9	2.7	0.5
Mar-09	Mar-11			0.5	3.6	3.1	3.6	2.3	2.4	-1.3
Jun-09	Jun-11			1.2	3.7	2.5	2.5	1.5	1.4	-1.0
Sep-09	Sep-11			1.4	4.1	2.7	3.0	1.4	1.0	-1.6
Dec-09	Dec-11			1.6	4.0	2.4	3.9	1.3	1.0	-2.6
Mar-10	Mar-12			1.2	3.1	1.9	3.5	1.0	1.2	-2.5
Jun-10	Jun-12			1.4	2.5	1.2	3.6	0.2	1.1	-3.4
Sep-10	Sep-12			1.3	2.2	0.9	3.1	0.0	2.0	-3.1
Dec-10	Dec-12			1.5	2.4	1.0	3.3	0.4	1.6	-2.9
Mar-11	Mar-13			1.6	2.5	0.8	3.1	0.6	1.4	-2.5
Jun-11	Jun-13			1.9	2.4	0.5	2.7	1.6	2.1	-1.1
Sep-11	Sep-13			1.7	2.4	0.7	2.8	1.6	1.6	-1.2
Dec-11	Dec-13			1.3	2.0	0.7	3.0	2.7	2.4	-0.3
Mar-12	Mar-14			1.8	1.6	-0.1	3.0	3.5	2.9	0.5
Jun-12	Jun-14			1.6	1.6	0.0	2.5	3.5	3.1	1.0
Sep-12	Sep-14			1.7	1.5	-0.2	2.0	3.5	3.0	1.5
Dec-12	Dec-14			1.8	1.0	-0.8	2.0	3.4	3.0	1.4
Mar-13	Mar-15			2.3	0.4	-1.9	1.9	3.1	2.7	1.2
Jun-13	Jun-15			2.0	0.4	-1.7	2.1	2.5	2.6	0.4
Sep-13	Sep-15			2.1	0.3	-1.8	2.5	2.8	2.5	0.3
Dec-13	Dec-15			1.9	0.4	-1.6	2.5	2.4	2.6	-0.1
Mar-14	Mar-16			1.9	0.7	-1.2	2.7	2.2	2.4	-0.5
Jun-14	Jun-16			1.9	0.8	-1.1	2.9	2.0	2.3	-0.9
Sep-14	Sep-16			1.8	1.0	-0.7	2.8	1.9	2.2	-0.9
Dec-14	Dec-16			1.8	1.5	-0.3	2.8	2.1	2.2	-0.7
Mar-15	Mar-17			2.0	2.2	0.2	2.7	2.3	2.4	-0.4
Jun-15	Jun-17			2.0	2.6	0.6	2.4	2.0	2.2	-0.4
Sep-15	Sep-17			2.0	2.7	0.7	2.5	1.6	2.1	-0.9
Dec-15	Dec-17			2.1	2.8	0.7	2.5	1.5	1.8	-1.0
Mar-16	Mar-18			2.1	2.5	0.4	2.4	1.7	1.4	-0.7
Jun-16	Jun-18			2.1	2.3	0.2	2.3	1.4	1.6	-0.9
Sep-16	Sep-18			2.4	2.3	-0.1	1.9	1.5	1.8	-0.4
Dec-16	Dec-18			2.7	2.1	-0.6	1.7	1.5	1.8	-0.2
Mar-17	Mar-19			2.6	1.8	-0.7	1.7	1.5	2.2	-0.2
Jun-17	Jun-19			2.2	1.9	-0.3	1.7	1.6	1.8	-0.1
Sep-17	Sep-19			2.2	1.8	-0.4	1.7	1.0	1.6	-0.7
Dec-17	Dec-19			2.2	1.4	-0.8	1.7	1.0	1.2	-0.7

	Inflation						Growth			
Forecast made in	Forecast made for	RPIX Forecast	CPIX Equivalent	CPI Forecast	Actual CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Mar-18	Mar-20			2.2	1.7	-0.5	1.7	0.4	-2.0	-1.3
Jun-18	Jun-20			2.0	0.8	-1.2	1.7	-27.0	-22.6	-28.7
Sep-18	Sep-20			2.1	0.8	-1.3	1.7	-10.0	-10.3	-11.7
Dec-18	Dec-20			2.1	0.7	-1.4	1.7	-11.0	-9.2	-12.7
Mar-19	Mar-21			2.1	0.9	-1.2	1.7	-9.2	-7.7	-10.9
Jun-19	Jun-21			2.1	2.1	0.0	2.1	21.5	24.4	19.4
Sep-19	Sep-21			2.2	2.7	0.4	2.4	7.7	8.5	5.3
Dec-19	Dec-21			2.0	4.4	2.4	1.8	6.7	8.9	4.9
Mar-20	Mar-22			2.0	5.5	3.5	1.6	7.8	10.5	6.2
Jun-20	Jun-22			2.1	7.9	5.9	N/A	3.2	3.9	N/A
Sep-20	Sep-22			2.0	8.8	6.8	3.0	2.3	1.9	-0.7
Dec-20	Dec-22			2.0	9.2	7.2	3.1		0.4	
Mar-21	Mar-23			2.1			1.3			
Jun-21	Jun-23			2.0			1.4			
Sep-21	Sep-23			2.1			1.3			
Dec-21	Dec-23			2.2			1.1			
Mar-22	Mar-24			2.2			1.1			
Jun-22	Jun-24			2.1			0.2			
Sep-22	Sep-24			2.0			0.0			
Dec-22	Dec-24			1.4			-0.1			
Mar 22	Mar-24			1.0			0.2			

Table 2: European Central Bank

Inflation and Growth: Forecasts vs Realised (Reference period: quarter for which the forecast was made)

	Inflation				Growth			
Forecast made in	Forecast made for	Forecast	CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Mar-99	Mar-01	1.4	2.1	-0.7				
Jun-99	Jun-01	1.5	2.9	-1.4				
Sep-99	Sep-01	1.5	2.4	-0.9				
Dec-99	Dec-01	1.7	2.1	-0.4				
Mar-00	Mar-02	1.7	2.6	-0.9				
Jun-00	Jun-02	1.8	2.1	-0.3				
Sep-00	Sep-02	2.0	2.1	-0.1				
Dec-00	Dec-02	1.9	2.3	-0.4				
Mar-01	Mar-03	1.7	2.3	-0.6				
Jun-01	Jun-03	1.7	2.0	-0.3				
Sep-01	Sep-03	1.5	2.1	-0.6				
Dec-01	Dec-03	1.7	2.1	-0.4	2.7	0.6	1.0	-2.1
Mar-02	Mar-04	1.6	1.7	-0.1	2.9	0.9	1.9	-2.0
Jun-02	Jun-04	1.9	2.3	-0.4	3.0	1.2	2.4	-1.8
Sep-02	Sep-04	1.8	2.3	-0.5	3.0	1.6	2.1	-1.4
Dec-02	Dec-04	1.8	2.3	-0.5	3.1	1.7	1.7	-1.4
Mar-03	Mar-05	1.6	2.1	-0.5	3.0	1.7	1.5	-1.3
Jun-03	Jun-05	1.4	2.0	-0.6	3.0	1.6	1.4	-1.4
Sep-03	Sep-05	1.5	2.3	-0.8	2.9	1.6	1.9	-1.3
Dec-03	Dec-05	1.7	2.4	-0.7	2.7	1.6	2.2	-1.1
Mar-04	Mar-06	1.6	2.3	-0.7	2.7	1.8	2.9	-0.9
Jun-04	Jun-06	1.6	2.5	-0.9	2.7	2.1	3.4	-0.6
Sep-04	Sep-06	1.6	2.2	-0.6	2.6	2.2	3.2	-0.4
Dec-04	Dec-06	1.6	1.8	-0.2	2.7	2.5	3.8	-0.2
Mar-05	Mar-07	1.8	1.9	-0.1	2.7	2.4	3.5	-0.3
Jun-05	Jun-07	1.5	1.9	-0.4	2.7	2.3	3.1	-0.4
Sep-05	Sep-07	1.7	1.9	-0.2	2.7	2.2	3.0	-0.5
Dec-05	Dec-07	2.1	2.9	-0.8	2.6	1.9	2.3	-0.7
Mar-06	Mar-08	1.8	3.4	-1.6	2.5	1.7	2.2	-0.8
Jun-06	Jun-08	1.7	3.7	-2.0	2.4	1.3	1.1	-1.1
Sep-06	Sep-08	1.8	3.9	-2.1	2.4	0.9	0.2	-1.5
Dec-06	Dec-08	1.9	2.4	-0.5	2.4	0.1	-2.2	-2.3
Mar-07	Mar-09	2.1	1.0	1.1	2.4	-1.2	-5.7	-3.6
Jun-07	Jun-09	2.0	0.2	1.8	2.3	-1.9	-5.4	-4.2
Sep-07	Sep-09	2.0	-0.4	2.4	2.2	-1.9	-4.5	-4.1
Dec-07	Dec-09	1.8	0.4	1.4	2.1	-1.2	-2.3	-3.3
Mar-08	Mar-10	2.0	1.1	0.9	2.0	-0.1	1.2	-2.1
Jun-08	Jun-10	1.9	1.6	0.3	2.0	1.1	2.2	-0.9
Sep-08	Sep-10	1.9	1.7	0.2	2.1	1.3	2.3	-0.8
Dec-08	Dec-10	1.8	2.0	-0.2	2.2	1.3	2.4	-0.9

	Inflation				Growth			
Forecast made in	Forecast made for	Forecast	CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Mar-09	Mar-11	1.0	2.5	-1.5	2.3	1.7	2.9	-0.6
Jun-09	Jun-11	1.2	2.8	-1.6	2.4	1.3	1.9	-1.1
Sep-09	Sep-11	1.5	2.7	-1.2	2.3	1.2	1.6	-1.1
Dec-09	Dec-11	1.3	2.9	-1.6	2.2	0.7	0.6	-1.5
Mar-10	Mar-12	1.8	2.7	-0.9	2.1	0.1	-0.5	-2.0
Jun-10	Jun-12	1.5	2.5	-1.0	2.0	-0.2	-0.7	-2.2
Sep-10	Sep-12	1.6	2.5	-0.9	2.0	-0.6	-1.0	-2.6
Dec-10	Dec-12	1.5	2.3	-0.8	1.9	-0.8	-1.0	-2.7
Mar-11	Mar-13	1.8	1.9	-0.1	1.7	-0.8	-1.2	-2.5
Jun-11	Jun-13	1.6	1.4	0.2	1.5	-0.6	-0.4	-2.1
Sep-11	Sep-13	1.6	1.3	0.3	1.4	-0.3	0.0	-1.7
Dec-11	Dec-13	1.4	0.8	0.6	1.5	0.4	0.8	-1.1
Mar-12	Mar-14	1.6	0.6	1.0	1.7	0.9	1.5	-0.8
Jun-12	Jun-14	1.5	0.6	0.9	1.9	1.1	1.2	-0.8
Sep-12	Sep-14	1.4	0.4	1.0	2.0	1.3	1.4	-0.7
Dec-12	Dec-14	1.4	0.2	1.2	2.0	1.2	1.5	-0.8
Mar-13	Mar-15	1.4	-0.3	1.7	2.0	1.2	1.7	-0.8
Jun-13	Jun-15	1.4	0.4	1.0	2.0	1.4	2.0	-0.6
Sep-13	Sep-15	1.4	0.4	1.0	1.9	1.4	1.9	-0.5
Dec-13	Dec-15	1.4	0.3	1.1	1.8	1.6	2.0	-0.2
Mar-14	Mar-16	1.4	0.1	1.3	1.7	1.5	1.9	-0.2
Jun-14	Jun-16	1.4	-0.1	1.5	1.6	1.3	1.7	-0.3
Sep-14	Sep-16	1.5	0.3	1.2	1.6	1.3	1.7	-0.3
Dec-14	Dec-16	1.4	0.7	0.7	1.6	1.4	2.0	-0.2
Mar-15	Mar-17	1.8	1.7	0.1	1.6	1.6	2.2	0.0
Jun-15	Jun-17	1.8	1.5	0.3	1.6	1.8	2.7	0.2
Sep-15	Sep-17	1.7	1.5	0.2	1.7	2.0	3.0	0.3
Dec-15	Dec-17	1.7	1.4	0.3	1.7	2.1	3.1	0.4
Mar-16	Mar-18	1.5	1.3	0.2	1.7	2.3	2.4	0.6
Jun-16	Jun-18	1.6	1.7	-0.1	1.7	2.3	2.2	0.6
Sep-16	Sep-18	1.6	2.1	-0.5	1.6	2.2	1.5	0.6
Dec-16	Dec-18	1.6	1.9	-0.3	1.6	2.0	1.2	0.4
Mar-17	Mar-19	1.7	1.4	0.3	1.7	1.5	1.9	-0.2
Jun-17	Jun-19	1.6	1.4	0.2	1.8	1.2	1.6	-0.6
Sep-17	Sep-19	1.5	1.0	0.5	1.8	0.9	1.8	-0.9
Dec-17	Dec-19	1.6	1.0	0.6	1.9	0.7	1.2	-1.2
Mar-18	Mar-20	1.6	1.1	0.5	1.8	0.6	-2.8	-1.2
Jun-18	Jun-20	1.6	0.2	1.4	1.7	-12.6	-14.2	-14.3
Sep-18	Sep-20	1.7	0.0	1.7	1.7	-4.3	-3.8	-6.0
Dec-18	Dec-20	1.7	-0.3	2.0	1.6	-6.7	-4.1	-8.3
Mar-19	Mar-21	1.6	1.1	0.5	1.6	-7.2	-0.8	-8.8
Jun-19	Jun-21	1.6	1.8	-0.2	1.6	7.2	14.2	5.6
Sep-19	Sep-21	1.5	2.8	-1.3	1.6	1.2	4.0	-0.4
Dec-19	Dec-21	1.5	4.6	-3.1	1.6	3.6	4.8	2.0
Mar-20	Mar-22	1.5	6.1	-4.6	1.6	5.1	5.5	3.5

	Inflation				Growth			
Forecast made in	Forecast made for	Forecast	CPI	Actual minus Forecast	Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Jun-20	Jun-22	1.5	8.0	-6.5	2.8	3.9	4.3	0.9
Sep-20	Sep-22	1.5	9.3	-7.8	2.8	2.1	2.4	-0.7
Dec-20	Dec-22	1.1	9.9		2.8	1.8	1.8	-1.0
Mar-21	Mar-23	1.4			2.0			
Jun-21	Jun-23	1.4			2.0			
Sep-21	Sep-23	1.5			1.6			
Dec-21	Dec-23	1.8			1.6			
Mar-22	Mar-24	1.9			1.6			
Jun-22	Jun-24	2.1			2.0			
Sep-22	Sep-24	2.3			2.0			
Dec-22	Dec-24	3.4			2.0			

Table 3: Federal Reserve

Inflation and Growth: Forecasts vs Realised (Reference period: quarter for which the forecast was made)

	Inflation						Growth				
Forecast made in	Forecast made for	Green Book CPI Forecast	SEP PCE Forecast	CPI	PCE	Actual minus Forecast	Green Book Forecast	SEP Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Dec-84	Dec-86	4.1		1.3	1.7	-2.8					
Mar-85	Mar-87	4.2		2.0	2.0	-2.1					
Jun-85	Jun-87	4.2		3.7	3.1	-0.5					
Sep-85	Sep-87	4.0		4.2	3.5	0.2					
Dec-85	Dec-87	3.8		4.4	3.8	0.6					
Mar-86	Mar-88	3.8		4.0	3.6	0.2					
Jun-86	Jun-88	4.0		4.0	3.8	0.0					
Sep-86	Sep-88	4.3		4.1	4.1	-0.1					
Dec-86	Dec-88	4.7		4.3	4.2	-0.4	2.5		2.7	3.8	0.2
Mar-87	Mar-89	4.9		4.7	4.6	-0.3	2.8		3.4	4.3	0.6
Jun-87	Jun-89	4.9		5.2	4.8	0.2	3.0		3.1	3.7	0.0
Sep-87	Sep-89	4.9		4.7	4.2	-0.2	3.2		2.8	3.9	-0.4
Dec-87	Dec-89	4.7		4.6	3.9	-0.1	3.3		2.9	2.7	-0.4
Mar-88	Mar-90	4.8		5.2	4.2	0.5	3.0		1.7	2.8	-1.3
Jun-88	Jun-90	4.9		4.6	3.8	-0.3	2.9		1.7	2.4	-1.2
Sep-88	Sep-90	4.8		5.6	4.5	0.7	2.7		1.5	1.7	-1.2
Dec-88	Dec-90	4.8		6.3	5.0	1.5	2.6		0.5	0.6	-2.1
Mar-89	Mar-91	4.7		5.3	4.1	0.6	2.6		0.0	-1.0	-2.7
Jun-89	Jun-91	4.5		4.8	3.7	0.3	2.5		-0.7	-0.5	-3.1
Sep-89	Sep-91	4.4		3.9	3.1	-0.6	2.4		-0.2	-0.1	-2.6
Dec-89	Dec-91	4.4		3.0	2.5	-1.5	2.2		0.6	1.2	-1.6
Mar-90	Mar-92	4.3		2.9	2.6	-1.4	1.8		1.4	2.9	-0.4
Jun-90	Jun-92	4.1		3.1	2.7	-1.0	1.5		1.9	3.2	0.5
Sep-90	Sep-92	3.9		3.1	2.7	-0.8	1.4		1.6	3.7	0.3
Dec-90	Dec-92	3.7		3.1	2.7	-0.6	1.2		1.8	4.4	0.7
Mar-91	Mar-93	3.4		3.2	2.6	-0.3	1.5		2.1	3.3	0.6
Jun-91	Jun-93	3.4		3.1	2.6	-0.2	1.6		2.1	2.8	0.5
Sep-91	Sep-93	3.2		2.8	2.4	-0.4	1.8		2.3	2.3	0.5
Dec-91	Dec-93	2.9		2.8	2.3	-0.2	2.0		2.8	2.6	0.8
Mar-92	Mar-94	2.8		2.5	2.1	-0.3	2.2		2.9	3.4	0.7
Jun-92	Jun-94	2.8		2.4	1.9	-0.4	2.7		3.4	4.2	0.7
Sep-92	Sep-94	2.8		2.9	2.2	0.1	2.8		3.6	4.3	0.7
Dec-92	Dec-94	2.9		2.6	2.1	-0.3	3.2		3.6	4.1	0.4
Mar-93	Mar-95	3.1		2.8	2.3	-0.2	3.4		3.4	3.5	0.0
Jun-93	Jun-95	3.0		3.1	2.3	0.1	3.3		2.6	2.4	-0.8
Sep-93	Sep-95	3.0		2.7	2.0	-0.3	3.4		2.4	2.7	-1.0
Dec-93	Dec-95	3.0		2.6	1.9	-0.4	3.2		2.1	2.2	-1.1
Mar-94	Mar-96	2.9		2.8	2.0	-0.1	3.0		2.1	2.6	-0.9
Jun-94	Jun-96	2.9		2.8	2.1	-0.1	2.9		2.7	4.0	-0.2
Sep-94	Sep-96	2.9		2.9	2.1	0.0	2.7		2.8	4.0	0.1

	Inflation						Growth				
Forecast made in	Forecast made for	Green Book CPI Forecast	SEP PCE Forecast	CPI	PCE	Actual minus Forecast	Green Book Forecast	SEP Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Dec-94	Dec-96	3.0		3.2	2.4	0.3	2.6		2.6	4.4	0.0
Mar-95	Mar-97	3.0		2.9	2.2	0.0	2.5		2.4	4.3	-0.1
Jun-95	Jun-97	3.0		2.3	1.8	-0.7	2.3		2.0	4.3	-0.4
Sep-95	Sep-97	3.1		2.2	1.6	-0.9	2.3		1.9	4.7	-0.4
Dec-95	Dec-97	3.1		1.9	1.3	-1.2	2.1		2.3	4.5	0.3
Mar-96	Mar-98	3.1		1.5	0.8	-1.6	2.0		2.6	4.9	0.6
Jun-96	Jun-98	3.0		1.6	0.8	-1.4	2.1		2.7	4.1	0.7
Sep-96	Sep-98	2.9		1.6	0.8	-1.3	2.1		2.7	4.1	0.6
Dec-96	Dec-98	2.7		1.5	0.8	-1.2	2.4		2.4	4.9	0.0
Mar-97	Mar-99	2.5		1.7	1.0	-0.8	2.3		2.4	4.8	0.1
Jun-97	Jun-99	2.3		2.1	1.3	-0.2	2.3		2.6	4.7	0.4
Sep-97	Sep-99	2.2		2.3	1.6	0.2	2.2		2.9	4.8	0.7
Dec-97	Dec-99	2.1		2.6	1.9	0.5	2.1		3.4	4.8	1.4
Mar-98	Mar-00	2.2		3.3	2.6	1.1	2.2		3.8	4.2	1.6
Jun-98	Jun-00	2.2		3.3	2.5	1.1	2.1		4.2	5.2	2.1
Sep-98	Sep-00	2.3		3.5	2.6	1.2	2.1		4.2	4.0	2.1
Dec-98	Dec-00	2.4		3.4	2.5	1.1	2.0		4.0	2.9	2.1
Mar-99	Mar-01	2.2		3.4	2.4	1.2	1.9		3.2	2.2	1.4
Jun-99	Jun-01	2.3		3.3	2.4	1.0	1.9		2.1	1.0	0.2
Sep-99	Sep-01	2.3		2.7	1.8	0.4	1.9		1.5	0.5	-0.4
Dec-99	Dec-01	2.3		1.9	1.3	-0.4	1.9		0.0	0.2	-1.9
Mar-00	Mar-02	2.3		1.2	0.8	-1.0	1.7		0.8	1.3	-1.0
Jun-00	Jun-02	2.1		1.3	1.0	-0.8	2.2		1.1	1.3	-1.1
Sep-00	Sep-02	2.1		1.6	1.5	-0.5	2.6		1.5	2.1	-1.1
Dec-00	Dec-02	2.0		2.3	1.9	0.3	3.0		2.4	2.0	-0.6
Mar-01	Mar-03	2.0		3.0	2.5	1.0	3.7		2.0	1.7	-1.7
Jun-01	Jun-03	2.0		2.0	1.9	0.1	3.5		2.0	2.0	-1.5
Sep-01	Sep-03	1.9		2.2	2.0	0.3	3.8		2.2	3.2	-1.5
Dec-01	Dec-03	1.8		2.0	2.0	0.2	3.8		3.1	4.3	-0.8
Mar-02	Mar-04	1.7		1.8	2.0	0.1	3.8		3.6	4.4	-0.2
Jun-02	Jun-04	1.6		2.8	2.6	1.2	3.7		4.3	4.2	0.6
Sep-02	Sep-04	1.4		2.7	2.4	1.3	3.4		4.3	3.5	0.9
Dec-02	Dec-04	1.2		3.4	2.8	2.2	3.3		4.1	3.4	0.8
Mar-03	Mar-05	1.2		3.0	2.6	1.9	3.4		3.9	3.9	0.5
Jun-03	Jun-05	1.1		2.9	2.6	1.8	3.6		3.7	3.6	0.1
Sep-03	Sep-05	1.3		3.8	3.2	2.6	3.8		3.8	3.4	0.0
Dec-03	Dec-05	1.4		3.7	3.1	2.3	3.9		3.8	3.3	0.0
Mar-04	Mar-06	1.5		3.7	3.1	2.2	4.1		4.0	3.2	-0.1
Jun-04	Jun-06	1.6		3.9	3.3	2.3	4.3		4.1	3.0	-0.2
Sep-04	Sep-06	1.8		3.3	2.9	1.6	4.6		3.5	2.3	-1.1
Dec-04	Dec-06	1.9		2.0	2.0	0.1	4.8		3.2	2.6	-1.6
Mar-05	Mar-07	2.1		2.4	2.4	0.3	4.6		2.4	1.5	-2.2
Jun-05	Jun-07	2.2		2.7	2.3	0.5	4.4		2.2	1.9	-2.2
Sep-05	Sep-07	2.3		2.3	2.2	0.1	4.1		2.2	2.4	-1.9

	Inflation						Growth				
Forecast made in	Forecast made for	Green Book CPI Forecast	SEP PCE Forecast	CPI	PCE	Actual minus Forecast	Green Book Forecast	SEP Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Dec-05	Dec-07	2.4		4.0	3.4	1.7	3.9		1.9	2.2	-1.9
Mar-06	Mar-08	2.3		4.1	3.3	1.8	3.8		1.6	1.4	-2.2
Jun-06	Jun-08	2.4		4.3	3.4	2.0	3.7		0.6	1.4	-3.1
Sep-06	Sep-08	2.3		5.3	3.9	3.0	3.6		0.2	0.2	-3.4
Dec-06	Dec-08	2.1		1.6	1.2	-0.5	3.3		-0.5	-2.5	-3.7
Mar-07	Mar-09	2.0		-0.2	-0.3	-2.1	3.1		-2.1	-3.3	-5.2
Jun-07	Jun-09	1.8		-0.9	-0.8	-2.7	3.0		-2.2	-4.0	-5.1
Sep-07	Sep-09	1.9		1.6	1.2	-3.5	2.8		-2.1	-3.1	-4.9
Dec-07	Dec-09	1.9		1.5	1.2	-0.4	2.7		-1.1	0.1	-3.8
Mar-08	Mar-10	1.7		2.4	2.3	0.6	2.5		1.1	1.8	-1.4
Jun-08	Jun-10	1.7		1.8	2.0	0.1	2.3		2.3	2.9	0.0
Sep-08	Sep-10	1.4		1.2	1.5	-0.2	2.3		2.7	3.3	0.5
Dec-08	Dec-10	1.3		1.2	1.4	-0.1	2.2		2.6	2.8	0.5
Mar-09	Mar-11	1.4		2.1	1.8	0.8	2.2		3.0	2.0	0.8
Jun-09	Jun-11	1.3		3.3	2.7	2.0	2.3		2.9	1.7	0.6
Sep-09	Sep-11	1.2		3.7	3.0	2.5	2.4		3.0	0.9	0.6
Dec-09	Dec-11	1.2	1.9	3.3	2.6	2.2	2.2		3.0	1.5	0.8
Mar-10	Mar-12	1.0	1.9	2.8	2.5	1.8	1.8		2.6	2.6	0.8
Jun-10	Jun-12	1.1	1.9	1.9	1.7	0.8	1.7		2.3	2.4	0.7
Sep-10	Sep-12	1.2	1.9	1.7	1.5	0.5	1.9		2.0	2.6	0.1
Dec-10	Dec-12	1.3	1.6	1.9	1.8	0.6	2.6		1.9	1.6	-0.8
Mar-11	Mar-13	1.4	1.3	1.7	1.5	0.3	3.5		2.1	1.6	-1.4
Jun-11	Jun-13	1.5	1.5	1.4	1.3	-0.1	4.0		2.0	1.3	-2.0
Sep-11	Sep-13	1.5	1.6	1.5	1.4	0.0	4.1		2.2	1.9	-2.0
Dec-11	Dec-13	1.5	1.5	1.2	1.3	-0.2	4.2		2.2	2.5	-2.1
Mar-12	Mar-14	1.5	1.7	1.4	1.4	-0.1	4.2		1.9	1.3	-2.4
Jun-12	Jun-14	1.5	1.6	2.1	1.8	0.6	4.2		2.4	2.5	-1.8
Sep-12	Sep-14	1.5	1.4	1.8	1.7	0.3	4.0		2.7	2.8	-1.3
Dec-12	Dec-14	1.5	1.5	1.2	1.2	-0.4	3.6		2.9	2.6	-0.7
Mar-13	Mar-15	1.6	1.6	-0.1	0.3	-1.7	3.1		3.0	3.8	-0.2
Jun-13	Jun-15	1.6	1.7	0.0	0.2	-1.5	2.7		2.7	3.0	0.0
Sep-13	Sep-15	1.7	1.8	0.2	0.2	-1.5	2.5		2.2	2.2	-0.3
Dec-13	Dec-15	1.8	1.8	0.4	0.2	-1.4	2.6		2.0	1.9	-0.6
Mar-14	Mar-16	1.9	1.9	1.0	0.7	-0.9	2.7		2.1	1.6	-0.6
Jun-14	Jun-16	2.0	1.8	1.1	0.8	-0.9	2.8		2.0	1.4	-0.7
Sep-14	Sep-16	2.1	1.8	1.2	1.0	-0.9	3.0		2.3	1.6	-0.8
Dec-14	Dec-16	2.1	1.8	1.8	1.5	-0.3	3.1		2.3	2.0	-0.9
Mar-15	Mar-17		1.9	2.6	2.1	0.2	3.3		2.1	1.8	-1.2
Jun-15	Jun-17		1.8	1.9	1.7	-0.1	3.3		2.2	2.0	-1.1
Sep-15	Sep-17		1.8	1.9	1.7	-0.1	3.3		2.4	2.3	-0.9
Dec-15	Dec-17		1.8	2.1	1.9	0.1	3.0		2.5	2.8	-0.5
Mar-16	Mar-18		1.9	2.2	2.0	0.1	2.9		2.7	3.1	-0.2

	Inflation						Growth				
Forecast made in	Forecast made for	Green Book CPI Forecast	SEP PCE Forecast	CPI	PCE	Actual minus Forecast	Green Book Forecast	SEP Forecast	Actual at t=0	Actual Latest	Actual (t=0) minus Forecast
Jun-16	Jun-18		1.8	2.7	2.3	0.5	2.7		2.8	3.3	0.1
Sep-16	Sep-18		1.9	2.6	2.3	0.4	2.4		3.1	3.2	0.8
Dec-16	Dec-18		1.9	2.2	2.0	0.2	2.3		3.0	2.3	0.7
Mar-17	Mar-19		2.0	1.6	1.5	-0.5		1.9	2.1	2.2	0.2
Jun-17	Jun-19		2.0	1.8	1.6	-0.4		1.9	2.1	2.1	0.2
Sep-17	Sep-19		1.9	1.8	1.5	-0.4		1.8	2.2	2.3	0.4
Dec-17	Dec-19		1.9	2.0	1.5	-0.4		2.1	2.2	2.6	0.1
Mar-18	Mar-20		2.0	2.1	1.6	-0.3		2.0	-7.0	0.8	-9.0
Jun-18	Jun-20		2.0	0.4	0.5	-1.4		2.0	-6.5	-8.4	-8.5
Sep-18	Sep-20		1.9	1.3	1.1	-0.8		2.0	-3.7	-2.0	-5.7
Dec-18	Dec-20		2.0	1.2	1.2	-0.8		2.0	-2.4	-1.5	-4.4
Mar-19	Mar-21		2.0	1.9	1.9	-0.1		1.8	6.5	1.2	4.7
Jun-19	Jun-21		2.0	4.8	4.0	2.0		1.8	7.0	12.5	5.2
Sep-19	Sep-21		2.0	5.3	4.5	2.5		1.9	5.9	5.0	4.0
Dec-19	Dec-21		2.0	6.7	5.7	3.7		1.9	5.5	5.7	3.6
Mar-20	Mar-22		2.1	8.0	6.4	4.3		4.0	2.8	3.7	-1.2
Jun-20	Jun-22		2.1	8.6	6.6	4.5		3.5		1.8	
Sep-20	Sep-22		2.1	8.3	6.3	4.2		3.0		1.9	
Dec-20	Dec-22		2.0	7.1	5.7	3.7		3.2		0.9	
Mar-21	Mar-23		2.1					2.2			
Jun-21	Jun-23		2.2					2.4			
Sep-21	Sep-23		2.1					2.5			
Dec-21	Dec-23		2.1					2.2			
Mar-22	Mar-24		2.3					2.0			
Jun-22	Jun-24		2.2					1.9			
Sep-22	Sep-24		2.0					1.7			
Dec-22	Dec24		2.1					1.6			

Table 4: Width of fan-chart indicating expected volatility

Year	Month	No.	Width of Inflation Fan Charts (%)
1997	2	1	3.97
1997	5	2	3.97
1997	8	3	3.72
1997	11	4	3.01
1998	2	1	2.98
1998	5	2	3.26
1998	8	3	3.04
1998	11	4	2.94
1999	2	1	2.83
1999	5	2	2.78
1999	8	3	2.55
1999	11	4	2.50
2000	2	1	2.41
2000	5	2	2.44
2000	8	3	2.30
2000	11	4	2.53
2001	2	1	2.59
2001	5	2	2.49
2001	8	3	2.46
2001	11	4	2.53
2002	2	1	2.73
2002	5	2	2.35
2002	8	3	2.29
2002	11	4	2.25
2003	2	1	2.46
2003	5	2	2.15
2003	8	3	2.03
2003	11	4	1.90

Year	Month	No.	Width of Inflation Fan Charts (%)
2004	2	1	1.82
2004	5	2	1.76
2004	8	3	1.67
2004	11	4	1.86
2005	2	1	1.77
2005	5	2	1.67
2005	8	3	1.68
2005	11	4	1.67
2006	2	1	1.71
2006	5	2	1.75
2006	8	3	2.09
2006	11	4	2.09
2007	2	1	2.33
2007	5	2	2.42
2007	8	3	2.42
2007	11	4	2.63
2008	2	1	2.60
2008	5	2	2.74
2008	8	3	3.41
2008	11	4	3.89
2009	2	1	3.95
2009	5	2	3.89
2009	8	3	3.89
2009	11	4	4.79
2010	2	1	4.95
2010	5	2	5.31
2010	8	3	4.82
2010	11	4	4.82
2011	2	1	4.85

Year	Month	No.	Width of Inflation Fan Charts (%)
2011	5	2	4.69
2011	8	3	4.79
2011	11	4	4.59
2012	2	1	4.69
2012	5	2	4.73
2012	8	3	4.67
2012	11	4	4.69
2013	2	1	4.69
2013	5	2	4.70
2013	8	3	4.69
2013	11	4	4.73
2014	2	1	4.67
2014	5	2	4.69
2014	8	3	4.70
2014	11	4	4.70
2015	2	1	4.69
2015	5	2	4.69
2015	8	3	4.72
2015	11	4	4.73
2016	2	1	4.71
2016	5	2	4.67
2016	8	3	4.66
2016	11	4	4.66
2017	2	1	4.72
2017	5	2	4.60
2017	8	3	4.60
2017	11	4	4.66
2018	2	1	4.85
2018	5	2	4.70

Year	Month	No.	Width of Inflation Fan Charts (%)
2018	8	3	4.60
2018	11	4	4.65
2019	2	1	4.63
2019	5	2	4.60
2019	8	3	4.63
2019	11	4	4.62
2020	2	1	4.60
2020	5	2	4.36
2020	8	3	6.75
2020	11	4	6.80
2021	2	1	6.94
2021	5	2	5.70
2021	8	3	5.73
2021	11	4	5.94
2022	2	1	5.83
2022	5	2	7.71
2022	8	3	8.05
2022	11	4	8.05
2023	2	1	9.60

Table 5: Skew as measured by difference between up and down

Year	Month	No.	UP/Down	Corresponding fan charts (on a separate Word file)
1997	2	1	1.10	Figure 1997-02
1997	5	2	1.12	Figure 1997-05
1997	8	3	1.72	Figure 1997-08
1997	11	4	1.61	Figure 1997-11
1998	2	1	1.52	Figure 1998-02
1998	5	2	1.28	Figure 1998-05
1998	8	3	1.39	Figure 1998-08
1998	11	4	0.96	
1999	2	1	0.92	Figure 1999-02
1999	5	2	1.27	Figure 1999-05
1999	8	3	1.14	Figure 1999-08
1999	11	4	0.70	Figure 1999-11
2000	2	1	1.30	Figure 2000-02
2000	5	2	0.94	
2000	8	3	0.85	Figure 2000-08
2000	11	4	1.02	
2001	2	1	0.72	Figure 2001-02
2001	5	2	0.84	Figure 2001-05
2001	8	3	0.82	Figure 2001-08
2001	11	4	1.40	Figure 2001-11
2002	2	1	1.75	Figure 2002-02
2002	5	2	1.42	Figure 2002-05
2002	8	3	1.25	Figure 2002-08
2002	11	4	1.21	Figure 2002-11
2003	2	1	1.24	Figure 2003-02
2003	5	2	1.03	
2003	8	3	0.88	Figure 2003-08
2003	11	4	0.98	
2004	2	1	1.00	
2004	5	2	1.02	
2004	8	3	1.04	
2004	11	4	0.66	Figure 2004-11
2005	2	1	0.65	Figure 2005-02
2005	5	2	1.00	
2005	8	3	0.82	Figure 2005-08
2005	11	4	1.00	
2006	2	1	1.00	
2006	5	2	1.00	
2006	8	3	1.00	
2006	11	4	1.02	
2007	2	1	1.30	Figure 2007-02
2007	5	2	1.29	Figure 2007-05
2007	8	3	1.18	Figure 2007-08
2007	11	4	1.00	
2008	2	1	1.00	

Year	Month	No.	UP/Down	Corresponding fan charts (on a separate Word file)
2008	5	2	1.26	Figure 2008-05
2008	8	3	1.44	Figure 2008-08
2008	11	4	1.00	
2009	2	1	0.80	Figure 2009-02
2009	5	2	1.13	Figure 2009-05
2009	8	3	1.00	
2009	11	4	1.00	
2010	2	1	1.32	Figure 2010-02
2010	5	2	1.18	Figure 2010-05
2010	8	3	1.40	Figure 2010-08
2010	11	4	1.33	Figure 2010-11
2011	2	1	1.39	Figure 2011-02
2011	5	2	1.15	Figure 2011-05
2011	8	3	1.15	Figure 2011-08
2011	11	4	1.00	
2012	2	1	1.01	
2012	5	2	1.16	Figure 2012-05
2012	8	3	1.01	
2012	11	4	1.01	
2013	2	1	1.02	
2013	5	2	1.01	
2013	8	3	1.02	
2013	11	4	1.02	
2014	2	1	1.02	
2014	5	2	1.02	
2014	8	3	1.01	
2014	11	4	1.01	
2015	2	1	0.99	
2015	5	2	0.98	
2015	8	3	0.99	
2015	11	4	0.96	
2016	2	1	0.99	
2016	5	2	1.02	
2016	8	3	1.03	
2016	11	4	1.04	
2017	2	1	1.00	
2017	5	2	1.00	
2017	8	3	1.00	
2017	11	4	1.01	
2018	2	1	1.00	
2018	5	2	1.00	
2018	8	3	1.00	
2018	11	4	1.00	
2019	2	1	1.03	
2019	5	2	1.00	
2019	8	3	1.00	
2019	11	4	1.00	
2020	2	1	1.00	

Year	Month	No.	UP/Down	Corresponding fan charts (on a separate Word file)
2020	5	2	1.00	
2020	8	3	0.94	
2020	11	4	1.00	
2021	2	1	1.00	
2021	5	2	1.00	
2021	8	3	1.00	
2021	11	4	1.00	
2022	2	1	1.09	
2022	5	2	1.00	
2022	8	3	1.12	Figure 2022-08
2022	11	4	1.26	Figure 2022-11
2023	2	1	1.50	Figure 2023-02