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Do inflation expectations respond to monetary policy? An empirical analysis for the United Kingdom

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Abstract

This paper studies how monetary policy impacts inflation expectations in the United Kingdom. Using higher moments of the distribution of inflation expectations, I construct a summary measure of expectations for households, firms, professional forecasters and financial markets. In a Bayesian VAR identified using a high frequency-identified monetary policy shock series, I find that a monetary policy tightening causes significant variation in the response of inflation expectations across groups: firms' and financial market median expectations fall, while households' inflation expectations rise. I document that monetary policy decisions act as a stabilisation mechanism by reducing the dispersion of expectations 12–18 months following a shock.

Key words: Inflation expectations, monetary policy transmission, structural VAR.

JEL classification: C38, E31, E52, E58.

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1 Introduction

In standard New Keynesian models of the economy (such as in Galí (2015)), output and inflation are determined by agents' expectations about the future of the economy. In theory, these expectations are assumed to be rational and homogenous across agents. In reality, expectations may be formed only on a subset of all available information, or differ between economic agents. These departures from the assumption of full information and rational expectations (FIRE) may introduce non-standard dynamics in macroeconomic outcomes, or alter the transmission of shocks. Empirical work has often struggled to document the role of monetary policy in determining inflation expectations, consistent with this theory.

Empirical evidence in particular is sparse for non-US economies, and sometimes partial by focusing only on one particular type of agent, and thus often leads to contradictory results. This ambiguity in empirical evidence supporting the ability of monetary policy to affect inflation expectations has resulted in disagreement across monetary policymakers on the importance and effectiveness of the expectations channel for policy transmission.[1] That debate typically also extends beyond inflation expectations, to other measures of expectations, for instance of the economic outlook, or future interest rates.

In the context of this mix of theoretical predictions and empirical results, in this paper I ask how inflation expectations react to changes in monetary policy, providing empirical evidence for the United Kingdom (UK). There are a wide range of inflation expectation measures available for households, firms, financial markets, and professional forecasters ('economic agents') in the UK, though over varying sample periods and frequencies, and at different maturities. To combine information from a range of inflation expectations measures available, I construct a summary index of inflation expectations using a principal component analysis technique developed for an unbalanced panel dataset. I create separate indices to summarise the first three moments of the inflation expectations distributions respectively, across economic agents. By means of a Bayesian proxy vector autoregression (BVAR) model, and instrumenting UK monetary policy with a high-frequency identified monetary policy shock series, I then determine the causal impact of monetary policy on inflation expectations.

I find evidence that inflation expectations, in aggregate, fall in response to a contractionary monetary policy shock, with significant heterogeneity among agents: firms and financial markets decrease expectations, while results suggest that households' inflation expectations increase in response to a tightening in monetary policy. In addition, I document that monetary policy decisions act as a stabilisation mechanism, by reducing the dispersion of expectations following a shock.

This paper contributes to three strands of the literature on inflation expectations. First, it provides empirical work on the impact of monetary policy on inflation expectations for the UK. To the best of my knowledge, and at the time of writing, little work exists to produce comparable estimates of the impact of UK monetary policy on inflation expectations across economic agents. Blanchflower and

[1] For a more detailed discussion of the expectations channel of monetary policy, see Burr and Willems (2024).

MacCoille (2009) empirically assess the formation of household inflation expectations in the UK, and find heterogeneity across characteristics such as age, gender, education and income. While they do acknowledge a role for monetary policy, the authors do not empirically test for it. Bandera et al. (2023), focusing only on household inflation expectations, and by means of a structural VAR, find no significant response to either anticipated or unanticipated monetary policy shocks. Di Pace et al. (2024) provide empirical evidence for the impact of monetary policy on the distribution of firms' inflation expectations. However, both papers focus only on one type of economic agent. I therefore contribute to this strand of the literature by providing empirical evidence for the UK, and documenting the heterogeneity of responses across households, firms, financial markets and professional forecasters.[2]

In the context of monetary policy and inflation expectations, the UK is interesting to study given its institutional set-up, and as a small open economy. This is particularly true in comparison with the US, where results on the impact of monetary policy on inflation expectations are more widely available. Specifically, different sizes and degrees of openness of economies may create diverging results and limit the applicability of US results to the UK context. As a small open economy, international spillovers play a large role for the UK, also in the context of monetary policy. UK variables may respond not just to domestic, but also to international monetary policy shocks, and in different ways. Secondly, the monetary policy mandate differs in the UK and US. The Fed has a dual mandate across inflation and employment, whereas the BoE's primary objective is price stability. This affects the reaction function of monetary policymakers to deviations in inflation and output from equilibrium, and thus may lead to differences in the response of inflation expectations.[3] Inflation expectations might reasonably react differently to a monetary policy shock generated by a single vs. a dual mandate monetary policymaker. It follows that results using UK data may be of wider interest than just for UK policymakers. Its structural traits as a small, open economy with a well-established and independent inflation-targeting central bank has read-across to other countries with a similar institutional setup, where inflation expectations data may not be as widely available.

[2]Results for the US are more mixed. Evidence by Diegel and Nautz (2021) and Jarocinski and Karadi (2020) suggest that contractionary monetary policy decreases inflation expectations. Adams and Barrett (2024) on the other hand find that household and firm inflation expectations *increase* in response to a contractionary shock. Gertler and Karadi (2015) and Gambetti and Musso (2017) find no evidence of an impact of monetary policy on inflation expectations. By contrast, literature such as Castelnuovo and Surico (2010) found that the omission of inflation expectations in models can help explain the so-called 'prize puzzle', which describes the common finding that contractionary monetary policy increases inflation, rather than decreases.

[3]Bohl et al. (2023), by comparing speeches from the Fed and the ECB, find evidence that the mandate of the central bank affects speech sentiment and tone. In particular, unemployment expectations drive the tone of Fed speeches, while inflation expectations influence those of the ECB. However, it is important to acknowledge that the differences in mandates are difficult to distinguish in practice. Since inflation and employment are jointly determined, it would be false to present a single vs a dual mandate as a choice between focusing on inflation or output. Central banks with a single mandate, such as the ECB and the BoE, have a reference to supporting employment as a secondary objective. In addition, the weight placed by policymakers on output and inflation in their monetary policy rule (the lambda, see Carney (2017)) may be time-varying and judgement-based.

Second, this paper contributes to the strand of literature around higher moments of inflation expectation distributions, and in particular the impact of monetary policy on these higher moments. Grigoli et al. (2020) for instance document that US monetary policy surprises increase the dispersion in analyst inflation expectations. Reis (2021a), using US data, makes use of higher moments of the distribution of inflation expectations, in particular the cross-sectional mean, variance and skewness, due to the additional information content in particular relating to inflation *risks* perceived by agents. He finds qualitative evidence that the second and third moments, across a panel of countries, help predict inflation. Meeks and Monti (2023) provide quantitative evidence for the statistical power of using higher moments of expectations in explaining consumer pricing decisions. I therefore contribute UK evidence on the impact of monetary policy on higher moments of the inflation expectation distribution.

Third, this paper contributes to literature on the heterogeneity of expectations among economic agents. Reis (2021b) for instance looks at the discrepancy between market-based, financial market measures of expectations, and those of households using US data to measure the underlying fundamental expected inflation. By focusing on various inflation expectation measures, namely those of households, firms, professional forecasters and financial markets, I provide an additional perspective on heterogeneity between groups. I summarise the information from multiple measures of the inflation expectation distribution from with the same economic agent group in an inflation expectations summary index, following Ahn and Fulton (2020) for the US.

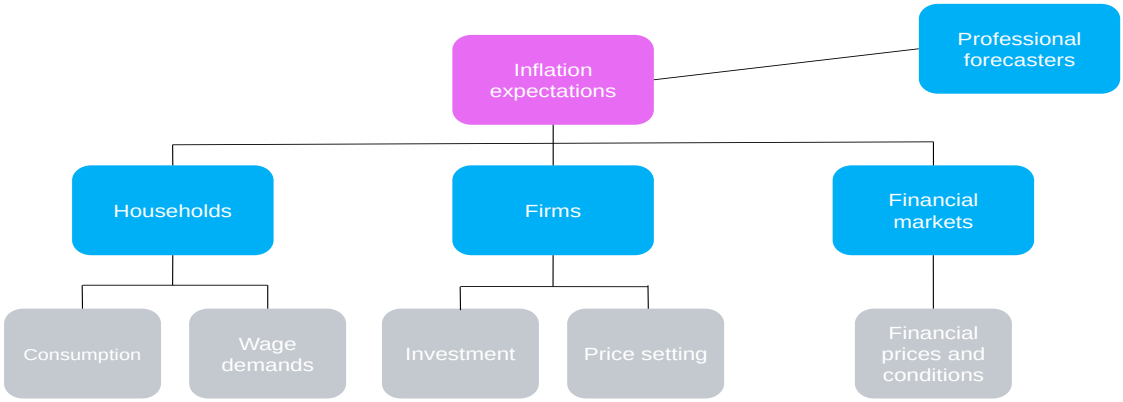
The paper is structured as follows. Section 2 briefly makes the case for why inflation expectations matter for monetary policy. Section 3 details the data on inflation expectations available for the UK across economic agents. Section 4 outlines the empirical setup - first discussing the principal component analysis creating a summary measure of inflation expectations, and secondly a Bayesian VAR model built to determine the impact of monetary policy on inflation expectations. Section 5 discusses the monetary policy implications of the headline results before offering concluding remarks.

2 The macroeconomic relevance of inflation expectations

If inflation expectations do not feed into the inflation determination process, it is a futile exercise to ask how monetary policy affects inflation expectations. While this paper does not provide empirical evidence on the former, there is a theoretical framework to support the case of macroeconomic relevance. Figure 1 provides a stylised representation of how inflation expectations of economic agents matter for monetary transmission and the determination of inflation. As Blanchflower (2009) argues: "what matters most for inflation, are the expectations of those directly involved in setting prices and wages". This applies particularly when wages and prices are sticky and set infrequently, implying agents need to incorporate expectations about the future economic outlook, the outlook for firms' input costs, as well as the inflation outlook when setting wages and prices contemporaneously, for some future period.

Beginning with household inflation expectations. In theory, these matter first via the channels of household consumption and saving decisions through their impact on the real discount rate, and secondly, by feeding into wage demands. For a constant nominal interest rate, a change in inflation expectations affects the perceived real discount rate, and thus consumption in current and future periods. As inflation expectations rise, ceteris paribus, the discount rate falls, causing present consumption to increase, and the savings rate to fall. Inflation expectations also feed into wage negotiations, by determining the perceived real value of wages by households (Bonatti et al., 2022). Despite the fact that it has been argued that the average household is "deeply uninformed about inflation and monetary policy" (Coibion et al., 2021), empirical evidence suggests that household inflation expectations affect their spending decisions (Coibion et al. (2021); Duca et al. (2018)).

Figure 1: Stylised diagram of the transmission channels of inflation expectations



Source: Adapted from European Central Bank (2021)

For firms, inflation expectations affect investment decisions over current and future periods again through the channel of the real discount rate. Firms' expectations also feed into their forward-looking pricing decisions. Changes in wage demands, that are affected by household inflation expectations, may translate into higher wages, an important input cost to most firms, that in turn affects their pricing decisions (Clark & Davig, 2009), particularly when prices are sticky. As firms cannot costlessly change prices, they must anticipate future economic conditions when setting prices today. Therefore, it is expectations about inflation in the short-to-medium-term that affect firms' decisions in the present (Werning, 2022).

Financial market expectations have macroeconomic effects via their impact on asset prices and broader financial conditions that households and businesses face when making consumption, investment and financing decisions. This forms the important first stage of the transmission of monetary policy (Burr and Willems (2024); Mann (2023)).

Finally, from an economic perspective professional forecasters do not represent a group of economic agents (European Central Bank, 2021), so strictly speaking a monetary policymaker should not be concerned by their expectations directly. However, to the extent that these expectations feed into the formation of household, firm and financial market expectations, they are nevertheless relevant. Carroll (2003) for instance finds, using US data, that household inflation expectation dynamics are well characterised by a model in which they derive their inflation expectations from professional forecasters.

Since true inflation expectations are unobservable, challenges include the different frequencies and historical time horizons over which the survey and market price measures of inflation expectations are available.[4] Secondly, the definition of 'short-term' and 'medium-term' may differ considerably across groups. For a household, the medium-term might be 3 years ahead, for financial markets, this may be 5-7 years.[5] Challenges aside, Grothe and Meyler (2015) find that both market- and survey-based measures are informative in predicting inflation, and outperform statistical forecasts.

Since inflation expectations matter for various channels of the monetary transmission mechanism and thus the inflation determination process, monetary policymakers should be aware of their own power to affect them by responding to deviations from the inflation target. In this paper, I focus on short- and medium-term measures of inflation expectations, because these are the measures one would expect to move in response to shocks. It is these fluctuations that econometric models can exploit to make inferences. Long-term measures, if anchored at the central bank target, are not expected to move in response to transitory shocks (such as monetary policy).[6]

3 Data

Since inflation expectations are not directly observable, economists rely either on survey-based measures or observed market prices,[7] where a wide range of measures exist across economic agents.

Focusing on the UK, I construct a panel dataset from June 1997, when the Bank of England gained operational independence for the conduct of monetary policy through the establishment of the Monetary

[4] For instance, the informational content of daily market-based measures is significantly reduced by aggregation to monthly or quarterly frequency, in order to be analysed in conjunction other measures.

[5] See Figure A.11 for a stylised diagram on how to reconcile horizons across survey and financial market measures.

[6] While the topic of the anchoring of inflation expectations is not the focus of this paper, it is nevertheless important to note. In the literature, it is long-term measures that are mentioned in this context. Williams (2022) argues that expectations are anchored when they are insensitive to macroeconomic shocks, and in line with the central bank target. The latter part of this definition is particularly important, as long-run expectations can be anchored at target-inconsistent levels. In fact, expectations are considered de-anchored "when long-run inflation expectations change significantly in response to developments in inflation or other economic variables, and begin to move away from levels consistent with the central bank's [...] inflation objective" (Armantier et al., 2022).

[7] These differ from 'true' inflation expectations, which feed into economic agents' decisions. Market measures for instance also contain risk premia, discussed in more detail in the financial markets part of this section.

Policy Committee, to December 2019.[8] I collect, where available, data on the first three moments of the inflation expectation distribution.[9] I aim to exploit the cross-sectional and time-series variation of the data, and as Reis (2021a), Reis (2021b) and Meeks and Monti (2023) highlight, the informational content in the distributions of expectations. Survey medians represent an aggregation of individual views (Grothe & Meyler, 2015) (or in the case of prices, the view of the marginal financial market participant (Reis, 2021b)) and, by design, reduce the informational content available from the distribution. Considering more than just the central tendency of the distribution allows to reflect additional views from those in the distribution tails.

This section describes the inflation expectation measures collected for each economic agent type in turn. Table 1 summarises key information about each metric.

Households. I use the quarterly BoE/Ipsos Inflation Attitudes Survey, surveying 2,200 households across the UK (Bank of England, 2022b), and a one-year household inflation expectations series available from the Bank of England's Millennium dataset.[10] The Ipsos survey provides data for two-year ('short-term') and five-year ('medium-term') ahead expectations, and is available since 2009. It is notable, but not unique to the UK that household expectations, on average, are above the 2% inflation target, and therefore appear upwardly-biased (Weber, 2023). There are several ways to explain this perceived inconsistency. The first is to point out that this need not be an inconsistency at all, as households are not generally asked for their CPI expectations in surveys, but rather about "price developments" more generally, which could explain any inconsistency with the central bank inflation target. Another reason, as Bonatti et al. (2022) argue, is household inattention. Importantly, the authors also mention that this alone should not be a concern for monetary policy - provided households continue to act consistently to change their expectations in response to news. An alternative explanation is salience: households form their expectations from prices they are exposed to most frequently, for instance food or utility prices which are more volatile than headline inflation (Rowe (2016); D'Acunto et al. (2019); De Fiore

[8] I end the sample before the post-Covid high-inflationary period to avoid the issue of potential structural breaks in the impact of monetary policy on inflation expectations. I leave the discussion of state-dependent effects of monetary policy on inflation expectations (relating for instance to states of high and low inflation) to future work.

[9] Without access to the survey microdata, I approximate dispersion and skewness following Ferreira (2018) as $(p80 - p20)$ and $(p80-p50)-(p50-p20)$ respectively, where $p20$, $p50$ and $p80$ represent the 20th, 50th (i.e. median) and 80th percentile of the distribution. Some survey sample sizes were not large enough to determine meaningful percentiles further into the tail of the distribution. For financial markets, I am limited to the 25th and 75th percentile. I select median over mean measures to avoid results being driven by outliers in the tail of the distribution, which I examine separately through the second and third moment. The median therefore represents a more accurate measure of central tendency, particularly when the distribution is skewed. An added complication over the sample period since June 1997 is that the BoE's inflation target changed over time. The 2% Consumer Price Index (CPI) target was adopted in 2003 (Bank of England, 2003). No adjustments to the data have been made to account for this. Data is standardised when performing the PCA analysis. Additionally, the underlying inflation metric the survey is asking respondents to provide expectations of is not explicitly specified in all cases, see 1.

[10] See Figure A.12 for a time series representation of the Ipsos 2-year and 5-year ahead inflation expectations, and Figure A.13 for the Millennium database series.

et al. (2022)),[11] and can therefore bias surveyed inflation expectations. Two-year household inflation expectations are also highly correlated with current period consumer price inflation (CPI), but less so with core inflation, which excludes food and energy.[12] This suggests that household expectations may be adaptive, or backward-looking. If this is the case, then current monetary policy would only be able to affect past expectations.

Businesses. The availability, quality and scope of surveys capturing firms' inflation expectations has been limited historically (Coibion et al., 2020). To measure firms' inflation expectations, I use the monthly Decision Maker Panel (DMP) survey, capturing business expectations of a panel of financial officers from small, medium and large firms across the UK, with 2,500 monthly responses (Decision Maker Panel, 2019).[13] Data for one-year ('short-term') and three-year ahead ('medium-term') CPI expectations is available since May 2022. Di Pace et al. (2024), using DMP microdata, find that announced changes in the interest rate caused a reduction in firms' price expectations, and their uncertainty associated with future prices.

I complement this short time series with data from the quarterly Confederation of British Industry (CBI) survey of 126 large and small firms across the UK (Confederation of British Industry, n.d.),[14] providing a one-year ahead measure of price expectations.

Financial markets. In the UK, the Debt Management Office issues nominal and inflation-linked government bonds (Debt Management Office, n.d.). One 'market-based' measure of inflation expectations is derived from the difference between yields on nominal and inflation-linked bonds, available from 1987. The value of inflation-linked bonds increases with inflation, and thus hedges the bondholder against erosion of the value of debt by inflation.[15] I use the 2-year bond, 5 years ahead (5y2y) as a measure of medium-term expectations, and the 1-year bond, 1 year ahead as a measure of short-term expectations.[16]

[11] Over the sample period from June 1997 to December 2019, the variance of food and utility price inflation was 8.9 and 9.5 respectively, compared to 1.1 for headline CPI inflation and 0.5 for core inflation. Headline CPI inflation averaged 2%, whereas food and utility price inflation averaged 2.1% and 3.3% respectively.

[12] The correlation between the Ipsos 2-year ahead household inflation expectation median and headline CPI is 0.68, compared to 0.58 with core inflation. Correlations with contemporaneous food and utilities price inflation is actually *lower*, at 0.56 and 0.58 respectively. However unlike with headline and core inflation, the correlation increases with lags of the inflation measure. For instance, correlations with lagged food price inflation peaks at two months, with 0.61, and for utilities price inflation at 0.83 with six lags.

[13] See Figure A.14 for one-year and three-year ahead expectations from the DMP. I focus on the results of the question around CPI expectations, which entered the survey in May 2022. The DMP also provides data on "own-price expectations" which has a longer time series, and this is the data Di Pace et al. (2024) use. Given the sample of firms in the DMP are both consumer- and business-facing, aggregating up own-price expectations are not directly comparable to consumer prices.

[14] I use the Distributive Trades survey rather than the composite measure, as this has correlated better with inflation outturns historically. See Figure A.15 for a time series of these expectations.

[15] Alternatively, financial market inflation expectations can also be derived from inflation-linked swaps, a type of derivative available from 2005 in the UK. See Figure A.16 for a time series of both financial instruments.

[16] In addition, I use the 25th and 75th percentile of the option-implied probability density functions of these measures respectively.

Market-based measures are advantageous on account of their timeliness, as well as their availability at daily frequency and a range of maturities. However they also pose several challenges.

Firstly, liquidity may vary across time and maturity (Grothe & Meyler, 2015). Secondly, on the one hand, price-derived expectations are likely a more accurate reflection of true expectations than survey-based measures, as "investors are willing to put money behind their opinions" (Lucca & Schaumburg, 2011), reflecting that market-based measures are a realisation of expectation trading. On the other hand, financial market measures are not a pure measure of inflation expectations. Financial market prices contain an inflation risk premium (Camba-Mendez & Werner, 2017), as well as other risk premia (relating to, for instance, liquidity risk or market technical factors). A time-varying term structure model is required to estimate the contribution of risk premia, in order to be able to extract 'true' CPI expectations from financial market prices (Burban et al., 2021). A complicating factor of using financial market prices is that for UK instruments in particular, the underlying asset is the Retail Price Index (RPI), rather than CPI. Therefore, to obtain CPI expectations for UK inflation-linked bonds or swaps, the analyst must take into consideration the CPI-RPI wedge (as well as expectations thereof for the future, over the maturity of the asset), which is time-varying (Office for Budget Responsibility, 2015), and expectations of the wedge may differ from the realised value, given the publication lag of inflation data. I adjust the data using the historical wedge between RPI and CPI indices over the sample period.

Generally speaking, financial market measures are not highly correlated with other measures of inflation expectations or realised inflation, most likely due to the more forward-looking nature of financial markets.[17]

To complement this market-based measure, I include inflation expectations from the BoE's Market Participants Survey (MaPS). The survey is run eight times a year, aligned with the policy decision cycle of the Monetary Policy Committee (MPC), however only available since December 2021. The survey encompasses respondents from a broad set of market participants, selected based on relevant criteria such as relevant market activity and expertise in UK rates markets and/or UK monetary policy (Bank of England, 2022a).[18]

Professional forecasters. I consider two measures. The quarterly HMT (Treasury) independent forecasts (HM Treasury, 2023), and the Survey of External Forecasters (SEF), which is a quarterly survey conducted by the BoE before the publication of its forecast, collecting CPI forecasts since 2004. For both surveys, participants include a panel of financial institutions, economic consultancies, academics, and super-national organisations (Boero et al., 2008). The survey size comprises 20-50 respondents on average.

I find very little variation in the expectations of these measures, and they average close to the 2%

[17]The 5y2y bond yield has 0.2 correlation with contemporaneous CPI inflation, and shorter-term measures are close to uncorrelated.

[18]See Figure A.17 for a time series of the MaPS responses at various horizons.

inflation target throughout the sample. There are a few plausible explanations for the little variation over time. The most optimistic view is that professional forecasters look through short-term macroeconomic developments and smooth expectations, or they are simply confident in the BoE achieving their target. The European Central Bank (2021), for instance, find that professional forecasts in the euro area tend to follow the ECB's macroeconomic projections quite closely. The more pessimistic take would be that professional forecasters are inattentive, and therefore don't often revise their expectations in response to news (as Andrade and Le Bihan (2013) document for the euro area for instance). Dovern et al. (2014) show that while in aggregate professional forecasters seem inattentive, this is not the case at the individual level. This suggests that information stickiness (not updating forecasts in a long time) is not the main source of persistence in professional forecaster's expectations - instead this could rather represent noise around the models of information processing that feed into the expectations formation process (Coibion, 2015).

Table 1: Inflation expectations data: summary information

	Type	Start	Frequency	Tenor	Inflation metric
Households					
BoE/Ipsos	Survey	2009	Quarterly	2y and 5y	Unspecified
Millennium data	Survey	1961	Quarterly	1y	Unspecified
Firms					
DMP	Survey	05-2022	Monthly	1y and 3y	CPI
CBI	Survey	2008	Quarterly	1y	Unspecified
Financial markets					
MaPS	Survey	12-2021	8 times/year	1y, 2y, 3y and 5y	CPI
Inflation-linked bonds	Market price	1987	Daily	1y1y and 5y2y	RPI
Professionals					
HMT	Survey	2004	Monthly	1y, 2y, 3y	CPI
SEF	Survey	2000	Quarterly	1y, 2y, 3y	CPI

Note: The full survey questions can be found in Section A.12 of the appendix.

4 Methodology

4.1 A combined measure of inflation expectations

I begin with an unbalanced panel dataset: various UK inflation expectations measures available over different, but overlapping time horizons, at various frequencies, for different groups of economic agents and various moments of the distribution over a period from June 1997 to December 2019.[19] To summarise the information contained across the panel, I run principal component analysis (PCA) akin to US work

[19]For daily data, data for month-end is used.

by Ahn and Fulton (2020) on various splits of the data.

The motivation for creating a summary statistic of inflation expectations is simple. As a dimensionality reduction technique, PCA decomposes the covariance structure of selected series into factors that are common to all, and idiosyncratic 'noise', therefore permitting to combine a set of explanatory variables that are closely related and likely co-move (which is the case for inflation expectations), and maximising the information that is common across indicators. It therefore assigns weights to individual data series based on the degree of co-movement of these variables with other variables in the model. I follow Ahn and Fulton (2020) in retaining only the first factor, such that the interpretation of the resulting index is one that is expected to respond to broad changes in inflation expectations across the macroeconomy. Presenting a summary index that incorporates information from a wide range of inflation expectation indicators is also a simpler way to communicate with policymakers.

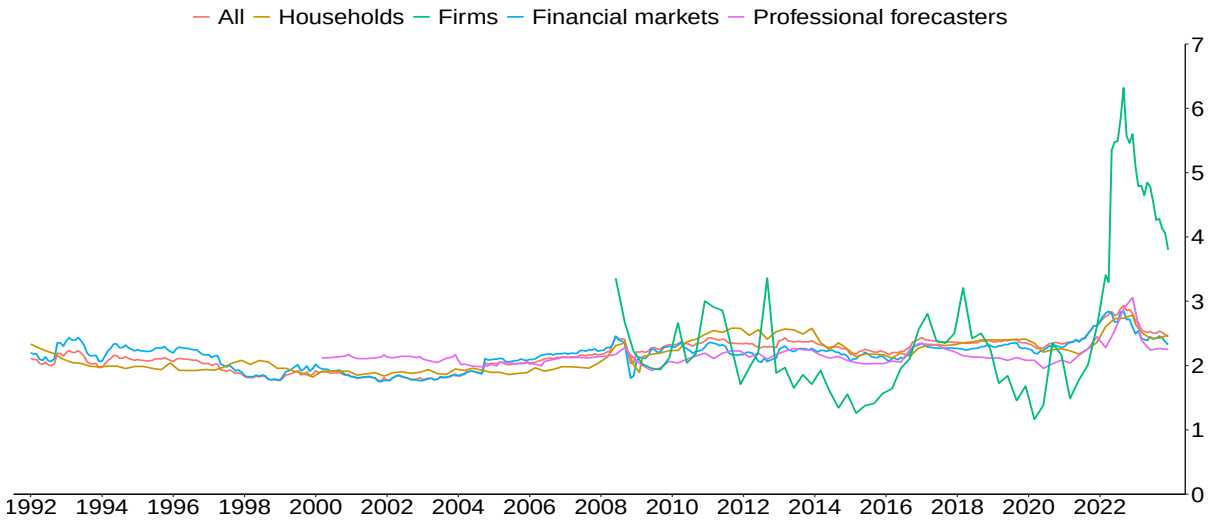
For PCA to work on data with missing observations, I follow the methodology proposed by Stock and Watson (2002). For this to work, for each index at least one series must be available over the entire sample period. Or in more practical terms, the longest series determines the length over which the principal component can be estimated. The first step in the proposed methodology is to estimate principal components for the balanced panel. The variables with missing observations (including those at frequencies lower than monthly) are then linearly projected on the principal components of variables available over the full sample period. This process is repeated until convergence of principal components across iterations (Erdem & Tsatsaronis, 2013).

I slice the data in multiple ways, into the first three moments and by economic agent. That means for each group of economic agent (households, firms, financial markets and professional forecasters), I obtain a separate principal component summarising the median, dispersion and skewness of expectations respectively. To create a benchmark, I also estimate a principal component for each moment using inflation expectations of all agents combined (which I refer to as the aggregate inflation expectations measure).

A summary index of median inflation expectations. These summary indices feed into the baseline specification of the model, as they are available over the full sample period. Figure 2 plots the first principal component summarising information from the median of the inflation expectation distribution. First, I combine median inflation expectations measures across all economic agents together into one factor (labelled "all"), including at different horizons. I then create additional PCs that split out the median inflation expectation measures into individual groups of economic agents, estimating a separate component using households', firms', financial markets' and professional forecasters' expectations respectively.[20]

[20]The PC labelled "all" combines all median inflation expectations measures listed in the Data section. The PC labelled "Households" contains only those measures listed under that relevant subsection, i.e. the BoE/Ipsos survey measures (2y and 5y) as well as the measure from the Millennium database. This carries forward to the PCs of firms, financial markets and professional forecasters respectively. The first factor for all economic agents explains 60.6% of total variation in the

Figure 2: Summary measure of median inflation expectations



Source: Author's calculations

All data is standardised before entering the model.[21] In order for the resulting factor to obtain economic interpretation, I adjust the series to have the same mean as a medium-term inflation expectation measure, as in Ahn and Fulton (2020) - such that this can be interpreted as the 'level' factor of inflation expectations.

It is notable that firms' expectations are a lot more volatile than the rest. Candia et al. (2024) document that, for the US, expectations of businesses behave differently to those of households and professional forecasters. One candidate explanation for this is firm inattention to inflation and monetary policy.

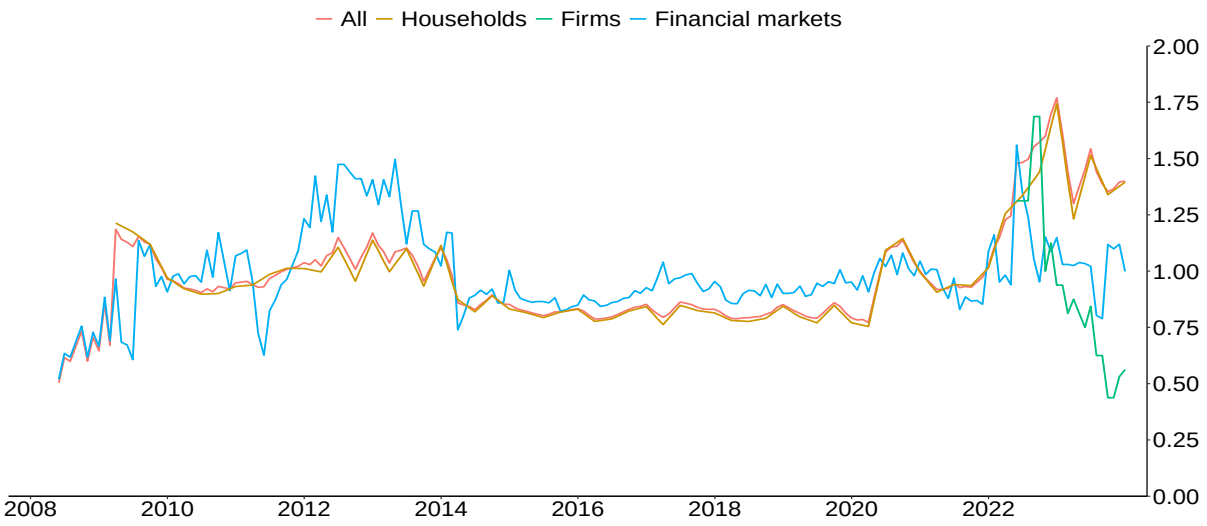
A summary index of the dispersion of inflation expectations. I construct the equivalent principal components for all, and individual economic agent groups using the dispersion of inflation expectations. To construct the PC labelled "all", I combine all measures of the dispersion of inflation expectations listed in the Data section. I then construct separate PCs for individual economic agent groups using dispersion measures only from those respective groups. The dispersion summary measure is only available over a shorter time period, and for a smaller subset of economic agents due to the data availability of survey measures. The summary measure for dispersion is shown in Figure 3.[22]

data. The total variation explained by the first factor for households, firms, financial markets and professional forecasters respectively is 49.7%, 55.1%, 70.7% and 62.3%.

[21] While all data shown in the figures are up to December 2023, the factors entering the BVAR are restricted to end in December 2019.

[22] The first factor, for all economic agents explains 49.8% of total variation in the data. The total variation explained by the first factor for households, firms and financial markets respectively is 36.3%, 32.4% and 56.9%.

Figure 3: Summary measure of the dispersion of inflation expectations



Source: Author's calculations.

Dispersion is a measure of disagreement across the distribution of inflation expectations. The larger the dispersion, the wider the distribution. During the high inflationary period of 2021-23, while measures of dispersion across all economic agents rose, those of households remained persistently more dispersed, until the end of the sample in end-2023. The wide dispersion of household inflation expectations is documented for instance by Andrade et al. (2023) and D'Acunto et al. (2023). Dispersion across different economic agents is documented by Coibion and Gorodnichenko (2015) and Mankiw et al. (2003), who find a larger dispersion among household's than professionals' expectations. Baumann et al. (2024) on the other hand document that, for the euro area, disagreement is higher in firms than professional forecasters,[23] but less than households.

Dispersion should also be thought of as a measure of disagreement among the inflation expectations of individuals. This may in turn reflect higher uncertainty about the future outlook for inflation across the cross-section of survey respondents.[24] Theory (for instance in the form of FIRE) typically assumes that all agents have access to the same information, and process that information in the same way.[25] This would, at its extreme, predict little-to-no dispersion. The observed dispersion in inflation expectations in the data therefore, as documented for instance in Coibion and Gorodnichenko (2015) and Mankiw and Reis (2002), is consistent with a deviation from FIRE and a world of sticky information, albeit to varying degrees across groups of economic agents.

A summary index of the skew of inflation expectations. I construct the equivalent principal components

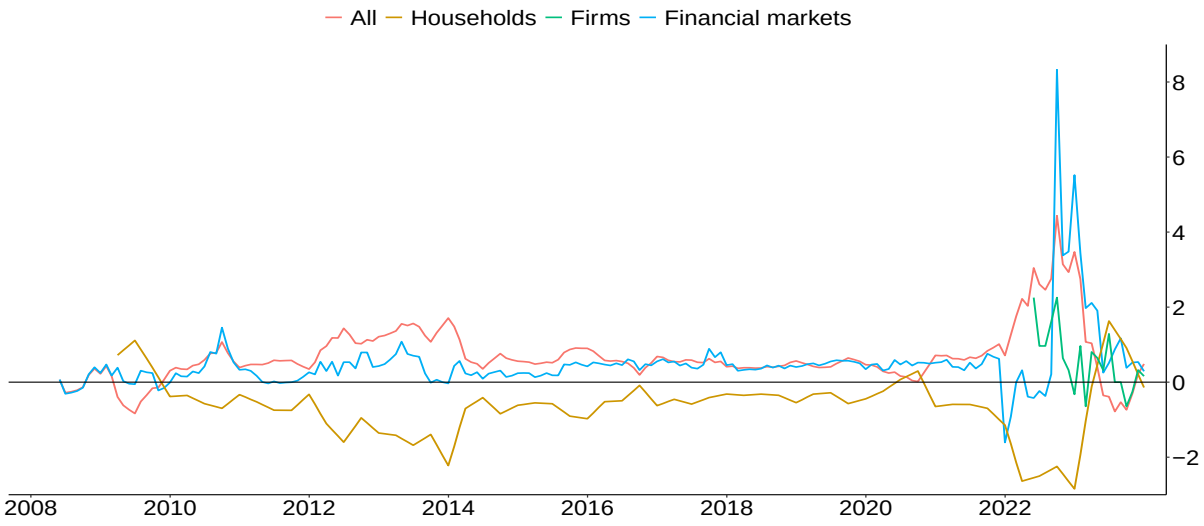
[23] The dispersion of professional forecasters' expectations is not shown on this chart due to the inability to access the survey microdata, beyond the median measure.

[24] I refer to cross-sectional dispersion here, which is distinct from uncertainty of the individual about the inflation outlook. Survey respondents do not report their own distribution of expected inflation (which would provide an indicator of individual uncertainty), but rather the distribution reflects the disagreement among individuals of their median outlook for inflation.

[25] More recently, the literature has developed a series of models that allow for agent heterogeneity in the inflation expectations process, such as Pedemonte et al. (2023), Madeira and Zafar (2015) and Darracq Pariès and Zimic (2021).

for all, and individual economic agent groups using the skew of inflation expectations. This measure is only available over a shorter time period and for a smaller subset of economic agents, due to data availability of survey measures. The summary measure for the skew is shown in Figure 4.

Figure 4: Summary measure of inflation expectation skew



Source: Author's calculations.

The skewness of the distribution measures the relative size of the two tails of the distribution. Therefore, a positive skew means the right tail of the inflation expectations distribution is larger than the left tail, and risks to inflation outturns are said to be skewed to the upside, meaning more agents expect a higher, rather than lower future inflation outturn. It also means that households collectively place more probability on upside than downside risks to inflation occurring.[26] Throughout the post-GFC period, household expectations are negatively skewed, whereas financial market expectations were slightly positively skewed. The divergence is particularly noticeable during the period of high inflation post-Covid.

To summarise this section, measures of the first three moments of the inflation expectations distribution vary considerably across economic groups. The next subsection discusses the model used to analyse the effects of monetary policy shocks on individual moments of different agents' inflation expectations, while Section 5 discusses the results.

4.2 A Proxy Bayesian VAR model

How does monetary policy affect the inflation expectations distribution? To analyse the effects of monetary policy on inflation expectations, I use a monetary policy surprise measure as an instrument for the monetary policy shock. The biggest econometric challenge to analysing the effects of monetary policy on inflation expectations is

[26] Though this does not need to hold for the probability distribution of individuals, which is not taken into account explicitly in this measure.

the endogeneity of monetary policy to inflation expectations. Monetary policy may affect inflation expectations, and inflation expectations likely affect monetary policy, to the extent they are believed to be relevant for the determination of inflation. To address this, the literature, following Stock and Watson (2012) typically use high-frequency identification of monetary policy shocks to capture an exogenous effect for statistical analysis. A valid instrument, as outlined in Ramey (2016), should be conditionally exogenous to all endogenous variables in the model, and contemporaneously uncorrelated with other exogenous shocks (exogeneity condition). Second, it ought to explain or predict a significant amount of variation in the reduced form error in the equation representing the policy rule (relevance condition). The shock will then represent either unanticipated moves in the policy rate, or news about anticipated future movements. I use the UK monetary policy surprises series developed by Cesa-Bianchi et al. (2020), identified using intraday changes in interest rate futures, which accounts for, and strips out the endogeneity of systematic monetary policy to the macroeconomic environment.

To identify the reaction of inflation expectations to monetary policy, I use a BVAR partially identified using the monetary policy proxy, but introduced as an external instrument (Stock & Watson, 2018). Using a proxy allows to "identify the shock without imposing any theoretical structure" (Dieppe, 2023). The reduced form representation of the model is as follows (with 2 lags[27] and intercept c):

$$\mathbf{Y_t} = \mathbf{A_1 Y_{t-1}} + \mathbf{A_2 Y_{t-2}} + \mathbf{c} + \mathbf{u_t} \tag{1}$$

Here $\mathbf{Y_t}$ denotes the (9×1) vector of endogenous variables at time t, $\mathbf{A_i}$ denotes the (9×9) coefficient matrix associated with the i-th lag of Y_t, and $\mathbf{u_t}$ is a (9×1) vector of reduced-form innovations at time t, with variance-covariance matrix $\Sigma_u = E(\mathbf{uu}')$.

The reduced-form innovations are related to the structural form through

$$\mathbf{u_t} = \mathbf{A_0}\epsilon_\mathbf{t} \tag{2}$$

where $\mathbf{A_0}$ is a (9×9) non-singular matrix and $\epsilon_\mathbf{t}$ represents the structural shocks, which are assumed to be serially uncorrelated and independent of each other, with variance-covariance matrix $\Sigma_\epsilon = E(\epsilon\epsilon') = I$. Thus, the reduced-form innovations are a linear combination of structural shocks, where $\mathbf{A_0}$ carries information on the contemporaneous effect of the structural shock (monetary policy) on Y_t, the impact matrix.

As there are likely to be co-integrating relationships between the endogenous variables, and following Sims et al. (1990), I estimate the BVAR in levels. I do not explicitly model these co-integrating relationships, but all variables enter the model in log levels, unless already expressed in percentage points (interest rates).

I use monthly data for the UK from June 1997 to December 2019.[28] The choice of endogenous variables captured in Y_t, follows the spirit of Cesa-Bianchi et al. (2020) by including a small set of variables that intend to capture the various transmission channels of monetary policy. I use CPI as a measure of the aggregate price level; real GDP to measure activity; GDP expectations[29]; the nominal effective sterling exchange rate (£ERI); investment-

[27] 2 lags are identified as optimal using the Bayesian Information Criterion.

[28] I use a canonical Normal-Wishart prior distribution which is naturally conjugate. I then take 1000 draws from the posterior distribution over the structural parameters.

[29] Similar to inflation expectations, expectations about the future performance of the economy feed into the economic

grade UK and US[30] corporate bond spreads, and UK mortgage spreads (reflecting the importance of the financial channel, documented by Miranda-Agrippino and Rey (2021); the 1-year nominal UK government bond yield; and finally, the inflation expectation summary index.[31] The 1-year government bond yield is assumed to be the policy instrument so the proxy is used to identify structural variation in its reduced-form error. The 1-year nominal UK government bond yield is chosen over the policy rate, to avoid issues during periods in which the policy rate was at the effective lower bound. It also allows to incorporate information about (short-term) future interest rate expectations.[32]

The choice of methodology, a Bayesian proxy VAR, is in line with previous literature (for instance Bandera et al. (2023); Diegel and Nautz (2021); and Jarocinski and Karadi (2020)). The choice over local projections is motivated by the bias-variance trade-off. Since I am interested in particular in monetary policy, and the monetary policy horizon is generally short (usually three years), Li et al. (2024) for instance have documented that VARs have a superior performance over that time horizon, and generally VAR estimators have lower variance (though higher bias). Relatedly, local projections do not impose a return to some notion of steady-state in the long run. Having a prior that macroeconomic variables do return to some steady-state, a VAR was a natural choice.

5 Results and discussion

5.1 Median inflation expectations

How should monetary policy affect median inflation expectations? In principle, a contractionary monetary policy shock should reduce inflation expectations. Agents observe the central bank action, and anticipating that contractionary policy reduces inflation, inflation expectations fall.

Figure 5 shows the impulse response functions (IRF) from the baseline specification in Equation 1, to a contractionary monetary policy shock that increases the 1-year gilt yield by 1 percentage point. In line with theoretical priors, financial market variables respond on impact of the shock: the exchange rate appreciates, and spreads widen.[33] On the real economy side, activity contracts with a lag of 6 months after the tightening shock, and reaches a peak impact of -1.5% after 2 years. This is consistent with results reported in Burr and Willems (2024) for the UK. Consistent with the fall in GDP, 1-year ahead GDP growth expectations also fall, with a peak impact one year earlier. The level of consumer prices falls on impact, and remains at a lower level throughout 3 years.

decisions of households, firms, and financial markets. Financial markets' GDP growth expectations could be reflected in future earnings expectations, and therefore asset prices. Firms' expectations about future economic growth influence their future sales expectations, and their employment decisions. For an evaluation of consumers' macroeconomic expectations, see Dräger and Lamla (2024)

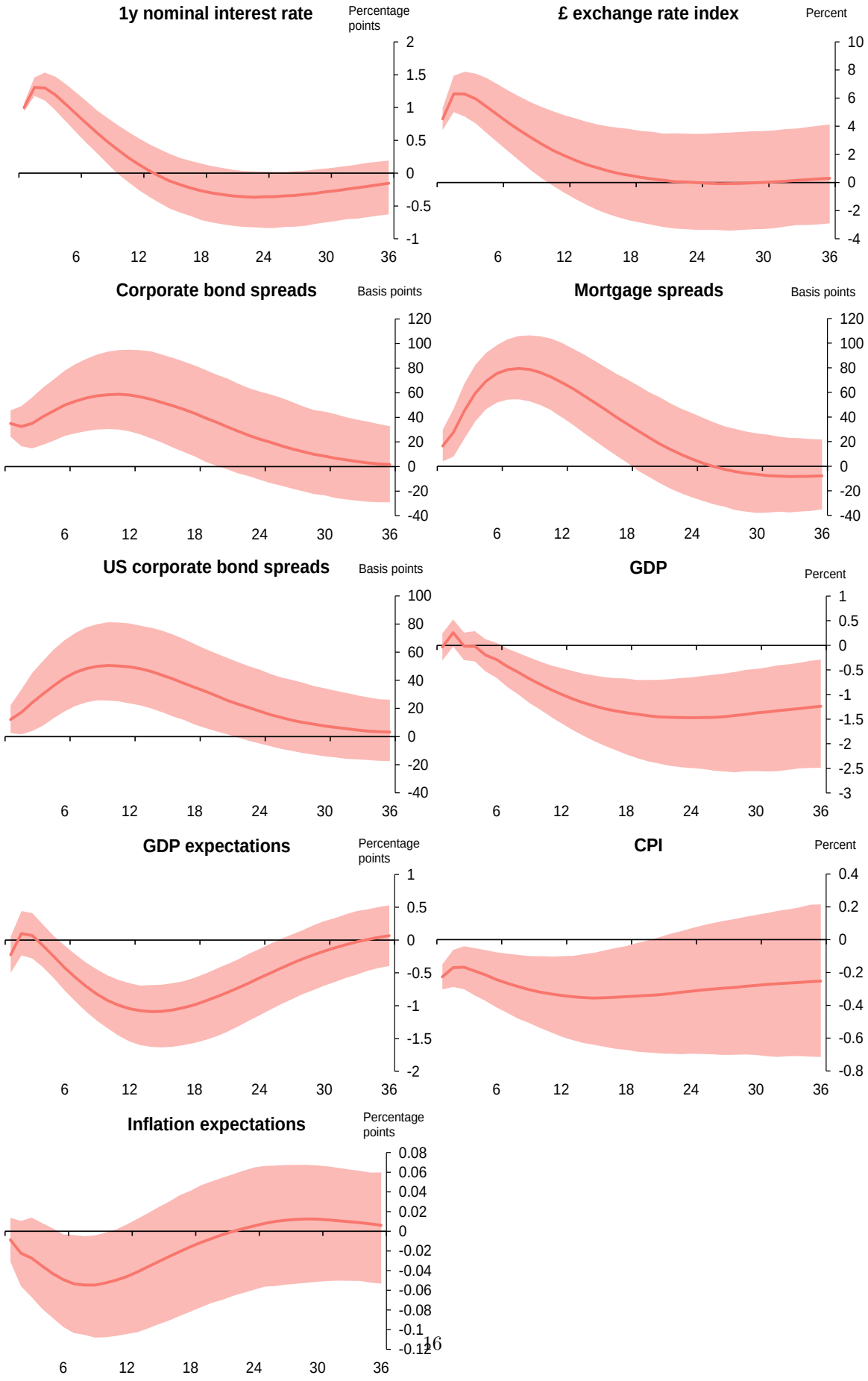
[30] To control for global financial conditions, as the UK is a small open economy (Akinci, 2012).

[31] See Appendix for a detailed description of the variables and sources.

[32] This reflects the yield to maturity of a zero coupon bond, as published on the Bank of England website. See Bank of England (n.d.-b)

[33] The impact on US corporate bond spreads is unexpectedly large. Akinci (2012) for instance imposes an exogeneity restriction to avoid this.

Figure 5: Impulse response functions for baseline specification using median aggregate inflation expectations



Note: Each panel shows the IRF of the specified variable to a monetary policy shock that increases the 1-year gilt yield by 1 percentage point on impact. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12.

While a significant on-impact effect of shocks on macroeconomic variables is a common finding in VAR analysis (e.g. Cesa-Bianchi et al. (2020)), it is surprising as under Friedman (1961)'s 'long and variable lags' of monetary policy, the impact of the tightening shock first works itself through financial markets and aggregate demand, before impacting price and wage-setting, activity and finally inflation. One reasonable explanation is the exchange rate channel, which works not only through activity by changing the relative prices of goods and services in the domestic economic, but directly affects import and domestic prices, without having to go through aggregate demand. In a small open economy such as the UK, it is not unreasonable to assume that this could be a significantly large transmission channel. Another explanation lies in the inflation expectations channel. Though not significantly, and with considerable uncertainty around the central estimate, inflation expectations (median, for all economic agents) decrease on impact of the shock, and fall further for 6 consecutive months, before returning to pre-shock levels after 2 years.[34] This has two important implications. Firstly, an exogenous tightening monetary policy shock leads to a fall in median inflation expectations. Secondly, this should have a direct impact on inflation, allowing inflation to respond to a monetary policy shock before real activity has adjusted.

A few specific characteristics of inflation expectations data that matter for the interpretation of results are the following. First, survey measures may be affected by biases and information rigidities (Coibion & Gorodnichenko, 2015). The degree and direction of bias, as Chen et al. (2022) document, is state-dependent. Nevertheless, over the last two decades, Chen et al.'s evidence from the euro area corroborates Coibion and Gorodnichenko, that inflation expectations underreact to news. Chiang and LaBelle (2022) show that the effects of a tightening monetary policy shock is larger for realised than expected inflation, again in line with the idea that economic agents underreact to monetary policy shocks. Second, for the UK, the available data predominantly covers a period defined by small fluctuations in inflation and expectations thereof. Models conditioned and estimated on historical data therefore are likely to underestimate effects, particularly when inflation expectations (and inflation) are far from central bank targets.[35]

The main challenge with using a Proxy BVAR approach is the quality of results depends on the quality of the proxy used. The proxy is assumed to be an exogenous instrument, however this may not be the case. In fact Ramey (2016) argues that "monetary policy is being conducted more systematically, so true monetary policy shocks are now rare", therefore shock measures may just be measuring the central bank private information effect,[36] rather than true exogenous shocks to monetary policy. In the absence of an obviously superior measure, I ran a robustness check using an additional measure of monetary policy shocks, presented by Braun et al. (2024),

[34]The summary measure is adjusted to the average of an inflation expectation measure, to obtain economic meaning. For comparability, Figure A.10 results using the raw inflation expectations data.

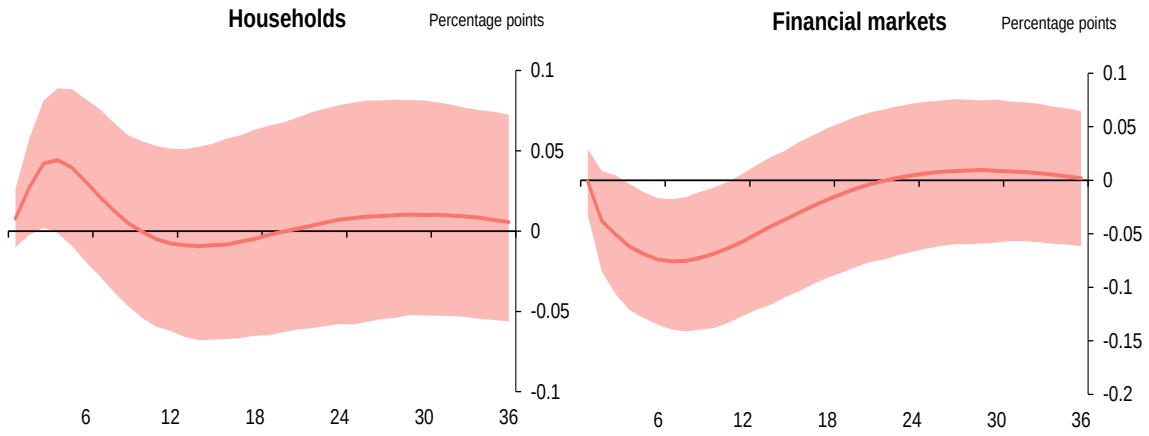
[35]The exception would be samples over the 1970s, where inflation was high due to oil price shocks. However, the applicability of results may be limited as the BoE was not yet inflation-targeting (King, 2002). Extensions to this analysis should consider estimating the model also over the 2021-23 period of high inflation, though adjustments, for instance through pandemic priors will be required over the Covid period.

[36]This effect stipulates that monetary policy shocks may not be a true exogenous measure, as surprises may reveal privately held information about the economic outlook, held by the central bank (Bauer & Swanson, 2022).

using a slightly different methodology to construct the high-frequency identified shocks.[37] The proxy is purged of inter-meeting information effects using the methodology proposed by Bauer and Swanson (2022). Figure A.9 shows the model results are robust to varying the proxy.

What these baseline results do not account for is the heterogeneity within groups. Staying with median measures for now, I also explore the results first for the household and financial market measures, which are available over the whole sample period. Figure 6 shows the resulting impulse response functions of median inflation expectations to monetary policy. Financial markets' median expectations move in line with the aggregate summary measure, they fall quickly in response to the monetary policy shock, and remain temporarily lower for around 18 months. As suggested by Mester (2022), it is possible that financial markets have more confidence than households in the MPC's ability to bring inflation back to its 2% target. Financial markets are generally also forward-looking, so they are able to incorporate the contractionary effect of monetary policy on inflation into contemporaneous expectations, for a period in the future. Jarocinski and Karadi (2020) find that financial market inflation expectations decrease in response to a monetary policy shock, but increase in response to a central bank information shock.[38]

Figure 6: Impulse response functions of household and financial market median inflation expectations to a monetary policy shock



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12. The full set of IRFs can be found in Figure A.2 and Figure A.3 in the Appendix.

[37] Specifically, I use the authors' target factor.

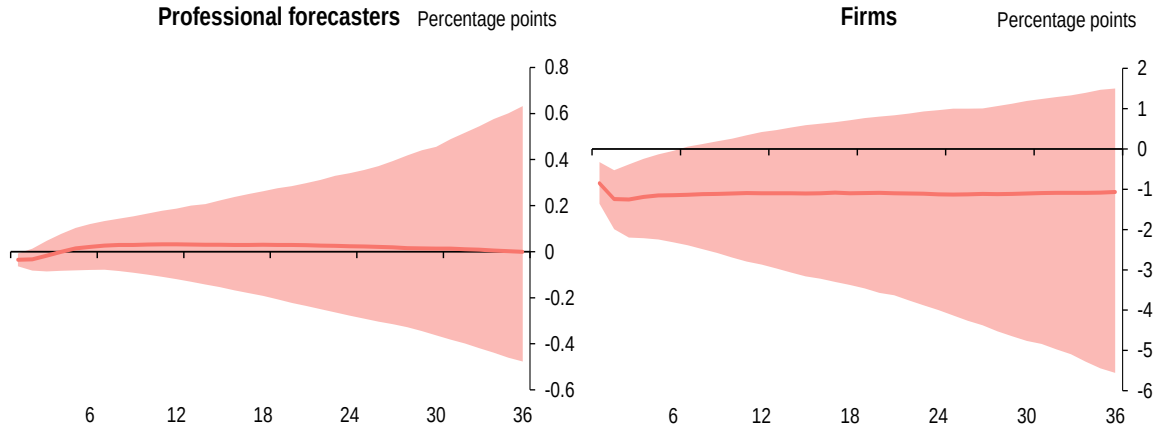
[38] For the purpose of the PCA, I combine market prices and survey measures of financial market expectations. In Section A.9 of the appendix, I show results using a single measure, the 5y2y inflation bond-implied measure of inflation compensation, adjusted for the historical RPI-CPI wedge. The results are similar: financial market-implied expectations fall in response to a contractionary monetary policy shock, before returning to their pre-shock levels after around 18 months. This implies that the headline results are not sensitive to the PCA analysis, or to the combining of financial market prices and survey-derived expectations.

On the other hand, results suggest that households' median inflation expectations rise in response to a monetary policy surprise. This is in line with findings by Andre et al. (2022) for the US, showing that a majority of households' expected inflation to increase following a tightening in monetary policy. Though results are not statistically significant across the whole IRF horizon, there are a few plausible explanations as to why household inflation expectations move in the opposite direction than theory would dictate, and deviate from other groups. The first is rational inattention of households. This would suggest that household inflation expectations do not respond to an exogenous monetary policy shock, and that this could be explained by suggestions in the literature that households are inattentive to inflation and monetary policy, thus do not fully internalise the general equilibrium link between them (De Fiore et al., 2022), and are more backward-looking. If households' expectation formation is not rational, the monetary policy shock may in fact be instead perceived as a central bank information shock. Following this narrative, a contractionary monetary policy shock represents news about inflation, and signals that inflation is above target, leading household expectations to rise. Lastly, these results could be consistent with literature documenting that households have a "stagflationary view" of the economy, meaning their expectations for output and inflation often go in opposite directions. Binetti et al. (2024) document, with evidence from a large US household survey, that a large share of respondents believe that inflation increases in response to an increase in interest rates.[39]

While only available over a shorter sample, Figure 7 shows the IRFs of summary measures of median inflation expectations for firms and professional forecasters. This suggests that professional forecasters' median expectations do not react significantly to monetary policy shocks. Recall from Figure A.18 that professional forecasters' expectations were the least volatile, and the closest to the BoE target. In that context, this is not a surprising result. To explain this result, you must believe that either there is too little variation in the data for proper identification of the response to a monetary policy surprise, or that professional forecasters are confident in the ability of the BoE to meet its target, such that even their short- and medium-term inflation expectations remain unchanged. Firms' median expectations, on the other hand, fall on impact of the monetary policy shock, in line with the behaviour of forward-looking financial markets, but remain permanently lower. This is in line with findings by Di Pace et al. (2024) for the UK.

[39]I test the robustness of these results on various dimensions. First, I use a single household inflation expectation measure (rather than the summary index derived from the first factor of the PCA), which also shows that household expectations increase, though not significantly. This is detailed in Section A.10 of the Appendix, and further robustness checks are outlined in the appendix, including the use of an alternate proxy.

Figure 7: Impulse response functions of professional forecasters' and firms' median inflation expectations to a monetary policy shock



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant. The LHS is estimated over 2000M3-2019M12, and the RHS over 2008M5-2019M12. The full set of IRFs can be found in Figure A.4 and Figure A.5 in the Appendix.

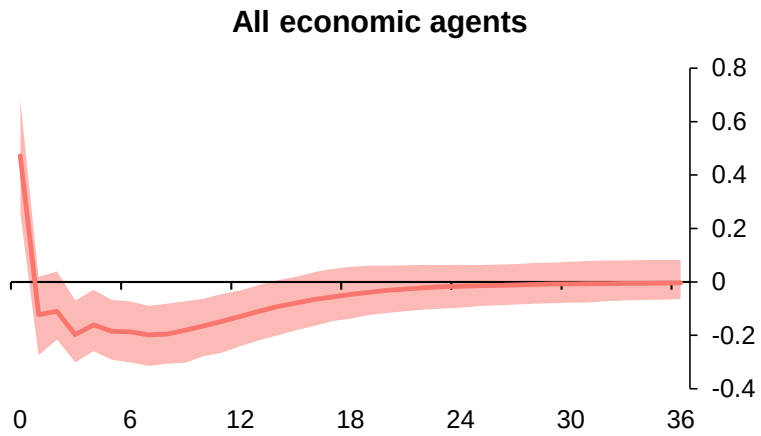
Finally, it is important to note that this model is linear in variables and parameters, so to the extent there are non-linear relationships, the model is unable to capture these. As the model is not time-varying, it does not allow for the effect of monetary policy on inflation expectations to be state-dependent. For instance, the formation of inflation expectations may change depending on the inflationary environment. In a high-inflationary environment, inflation expectations may be insensitive to monetary policy, as more agents become backward-looking when forming expectations (Cornea-Madeira & Madeira, 2022). Falck et al. (2021) find, using US data, that the effect of a contractionary monetary policy shock on inflation expectations is state-dependent. In particular, the authors find that when the dispersion of inflation expectations is high, contractionary monetary policy increases both inflation and inflation expectations. The results presented above should therefore be considered in this context, particularly given the sample period covers a period of near-target inflation at all times. Investigating state-dependent effects is left to further work.

5.2 Dispersion of inflation expectations

How should monetary policy affect the dispersion of inflation expectations? Grigoli et al. (2020), using US data, find that a contractionary monetary policy shock increased the dispersion of inflation expectations of professional forecasters, for up to nine months following the shock. In principle, a monetary policy shock might increase dispersion on-impact, but this should wash out by the next period. In the context of monetary policy as a macroeconomic stabilisation tool, one might even expect it to cause a reduction in dispersion.

Figure 8 shows the response of aggregate inflation expectation dispersion to a contractionary monetary policy shock that increases the 1-year gilt yield by 1 percentage point. In response to the shock, dispersion increases on impact, reflecting an initial increase in dispersion around the inflation outlook. This might be surprising in the context of monetary policy aiming to be a macroeconomic stabilisation tool. However, it is notable that despite the shock, dispersion falls quickly, which is in line with agents understanding that this is a one-period, temporary shock. I find that dispersion is subsequently below baseline in the following 12-18 months, reflecting the ability of monetary policy to reduce the dispersion perceived by agents in the economy about future inflation outturns.

Figure 8: Impulse response functions of inflation expectation dispersion to a monetary policy shock



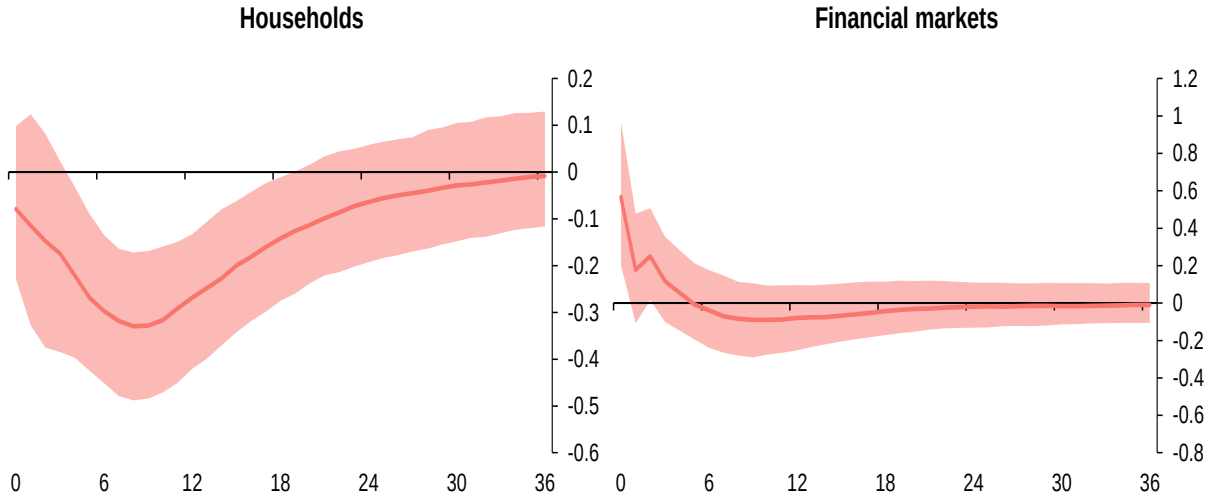
Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant. The model is estimated over 2008M5-2019M12.

As the second moment of the distribution, dispersion is a one-sided variable. This means it is expected to move in the same direction, regardless of the direction (i.e. sign) of the shock, and by definition it cannot be negative. This creates an estimation challenge for the symmetric BVAR model. To avoid this becoming a problem, I compute the absolute value of the monetary policy shock series before estimating the model parameters and computing the IRFs, following Grigoli et al. (2020).[40]

Now moving on to separating economic agents, in Figure 9, I plot the impulse response functions of household and financial market measures of the dispersion of expectations to a monetary policy shock. Households do not observe an increase in dispersion following the shock that the aggregate measure does - on the contrary, dispersion falls, by more than the aggregate measure and the effect is long-lasting. It is notable that the response of households is a lot less temporary than for all agents. In a world of full information and rational expectations, forward-looking agents observe a shock, understand it is temporary, and dispersion should return to 0 in period 2. Taking the evidence on the median and dispersion results for households: results suggest that median inflation expectations increase, while dispersion decreases, indicating that households disagree less about inflation potentially being higher on average following a contractionary monetary policy shock. This is consistent with the hypotheses outlined in discussion of the median results, but likely bad news for the monetary policymaker.

[40]See Figure A.6 for the full set of impulse response functions. Results are in line with findings of Mumtaz and Zanetti (2013) who show that a 100% increase in the variance of a monetary policy shock reduces the interest rate and inflation.

Figure 9: Impulse response functions of household and financial market's inflation expectation dispersion to a monetary policy shock



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant. The LHS is estimated over 2009M3-2019M12 and the RHS is estimated over 2008M5-2019M12.

Financial markets on the other hand see a short-lived increase in dispersion on impact of the shock, which dissipates after 3-6 months. It follows that, through the lens of the model, households perceive a larger reduction in the range of possible inflation outcomes following a monetary policy shock than financial markets. This may be due to the fact that financial markets tend to be volatile in the face of shocks and uncertainty, but these effects wash out quickly.[41]

5.3 Policy implications

Consistent with evidence that finds a statistically significant causal effect of monetary policy on inflation expectations, as in this paper, a subset of the literature examines the question that most naturally follows. Is managing inflation expectations an effective monetary policy tool? Rudd (2021) for instance argues that, given the unobserved nature of inflation expectations, in practice it is difficult and unrealistic for a monetary policymaker to target expectations with communications. Others argue that certain groups, households in particular, are difficult to reach even with targeted communications, due to inattention.

However, the challenge of influencing unobservable expectations is not a new task for central bankers. Expectations about the future path of the economy and interest rates (De Guindos, 2019) are part of what a central bank influences when providing forward guidance (Sutherland, 2022) - now a widely used unconventional monetary policy tool. However, the target remains important. Coibion et al. (2022) argue that targeting forward guidance

[41] See Section A.7 in the appendix for results of the skew, where I do not find a significant effect of monetary policy on the skew of inflation expectations, in aggregate or for households and financial markets individually.

at financial markets overlooks economically significant groups: households and firms. The authors find evidence that a targeted communication strategy influences household inflation expectations by up to 1 percentage point, subsequently leading to a 1.8% increase in spending. Coibion et al. (2020) suggest that central bank communications focusing on inflation expectations of households and firms lead to larger changes in perceived real interest rates, and thus generate larger macroeconomic effects. Communication strategies (Coibion et al., 2021) as well as other monetary policy tools should alter inflation expectations. "This implies that central bank communications can play an important role in keeping inflation expectations anchored and, [...] communications can help to mitigate the persistence of shocks to inflation" (Mester, 2022).

Stock and Watson (2001) highlight that "if the true structural equations involve expectations (say, an expectational Phillips curve), then the expectations will depend on the policy rule; thus in general all the VAR coefficients will depend on the rule." Therefore, changes in inflation expectations can allow for inference about the perceived policy rule of the central bank. This implies that monetary policy must be attentive to inflation expectations.

Also, if inflation expectations matter for price and wage setting and if inflation expectations react to monetary policy before the real economy, then this could increase the potency of monetary policy in the near-term. An advantage of an active inflation expectations channel in the monetary transmission mechanism is that a part of transmission occurs relatively quickly, and can directly impact price and wage setting rather than going first through the traditional mechanism of financial markets, through to aggregate demand (Mann, 2022).

The results presented in this paper suggest that monetary policy does significantly influence inflation expectations, albeit with considerable heterogeneity across groups of economic agents. Results suggest that household expectations move in the theoretically wrong' direction. If true, this would complicate the job of monetary policy. This corroborates suggestions in the literature that households are inattentive to inflation and monetary policy, more backward-looking, and that they do not fully understand the general equilibrium link between monetary policy and inflation (De Fiore et al., 2022). On the other hand, financial market measures, and aggregated inflation expectations of all agents fall in response to a monetary policy shock, suggesting that a monetary policymaker can, with caution (given results indicating that expectations of households could move in the other direction), rely on expectations to transmit changes in the monetary stance. Central banks would likely need to use a layered communication technique to affect household expectations in the right direction, such that they support rather than inhibit the monetary policy transmission (Assenmacher et al., 2021).

Finally, this methodology does not allow to distinguish the channels through which monetary policymakers influence inflation expectations: by affecting expectations directly, or by changing inflation in the future through the aggregate demand channel. This distinction is nevertheless important, because it affects the time required for monetary policy transmission. However, monetary policymakers need to be aware of the Lucas critique (Lucas, 1976) which stipulates that if policy were calibrated to target inflation expectations through communications, the way inflation expectations are formed, and possibly how they transmit would change. Model results estimated on historical data would no longer be applicable, given this change in policy regime.

6 Conclusion

The literature around the New Keynesian Phillips Curve relies on inflation expectations for the determination of inflation under the full information and rational expectations assumption, but empirical evidence has struggled to match these theoretical predictions. This paper discusses the importance of inflation expectations as an input to the wage and price setting process in the economy, feeding directly into changes in inflation, and thus is a key variable of concern for monetary policymakers.

This paper proposes a new application to the question of whether inflation expectations are impacted by monetary policy. I create a summary measure of inflation expectations in aggregate, and for households, firms, professional forecasters and financial markets individually. Exploiting the availability of inflation expectation distributions data, I use the median, dispersion and skewness of the inflation expectations distribution. By means of a Bayesian VAR, and using a measure of monetary policy shocks as an external instrument, I examine the impact of an exogenous monetary policy shock on the first three moments of inflation expectations. I find evidence that a tightening in monetary policy causes aggregate inflation expectations in the economy to fall. I also document that there is significant heterogeneity across economic agents. Professional forecasters do not significantly respond to monetary policy shocks, while financial market and firms' expectations fall in response to a tightening in policy. In contrast, results suggest that household inflation expectations rise in response to monetary policy tightening. While the dispersion in expectations increases immediately in response to a shock, monetary policy acts to lower dispersion over the subsequent 12-18 months. Across individual agents, monetary policy is also able to reduce the skew of the distribution, thereby reducing the relative size of right tails to left tail risks.

The results in this paper have important policy implications for monetary policymakers, and are consistent with the expectations channel of monetary policy transmission. They suggest that monetary policymakers have the potential to impact inflation expectations by changing their monetary policy stance. Further research is needed on communication strategies that could enable policymakers to maximise the effectiveness of this channel and use this as a credible policy tool, to support the effective transmission of monetary policy.

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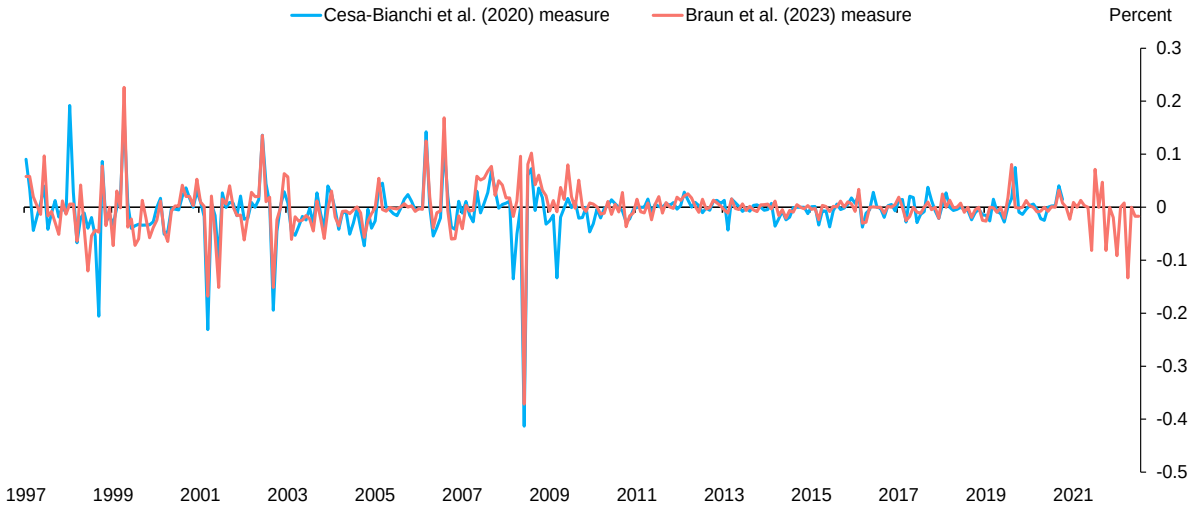
A Appendix

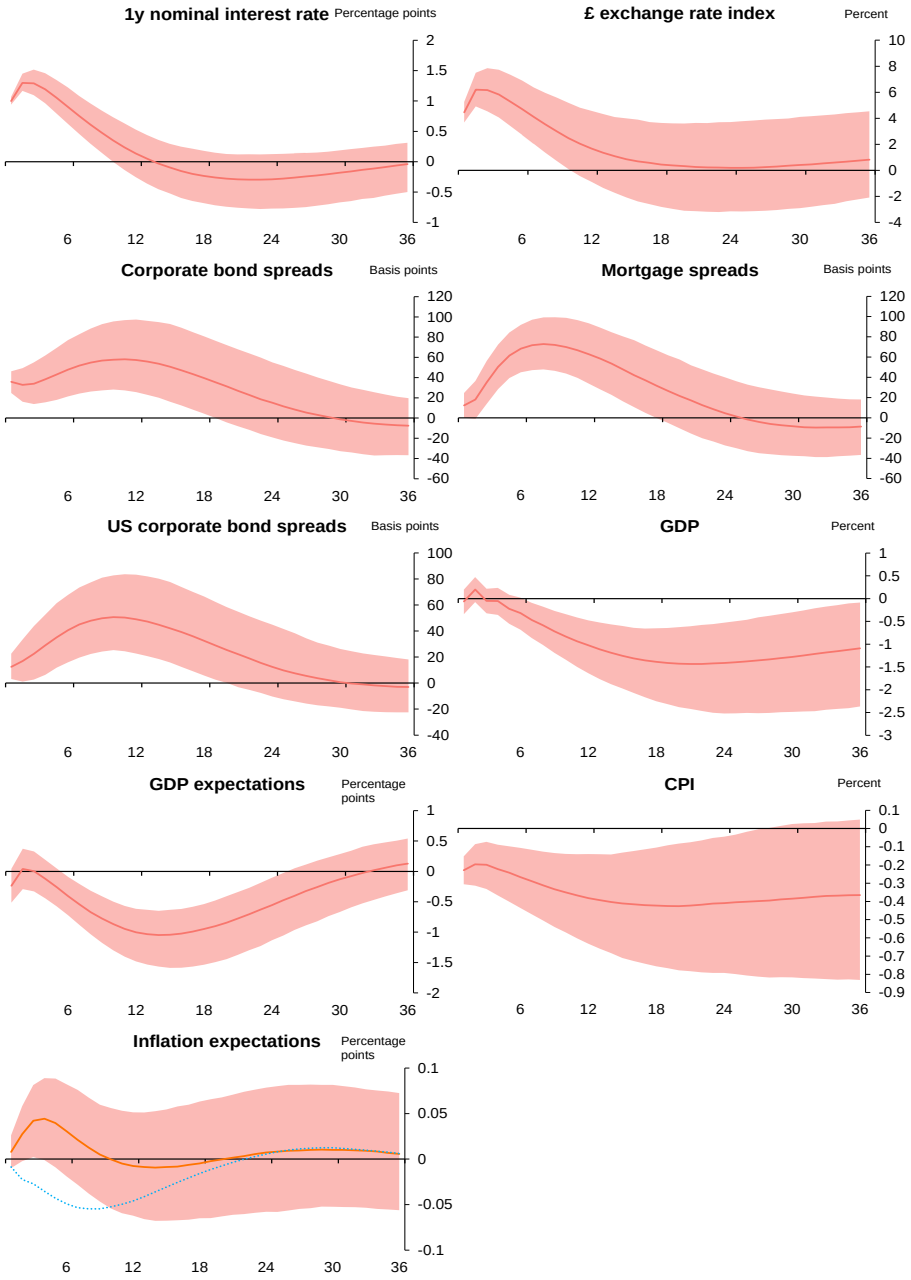
A.1 Monetary policy surprises

Figure A.1: Measures of monetary policy surprises



A.2 Full set of impulse response functions for baseline specification with household median inflation expectations

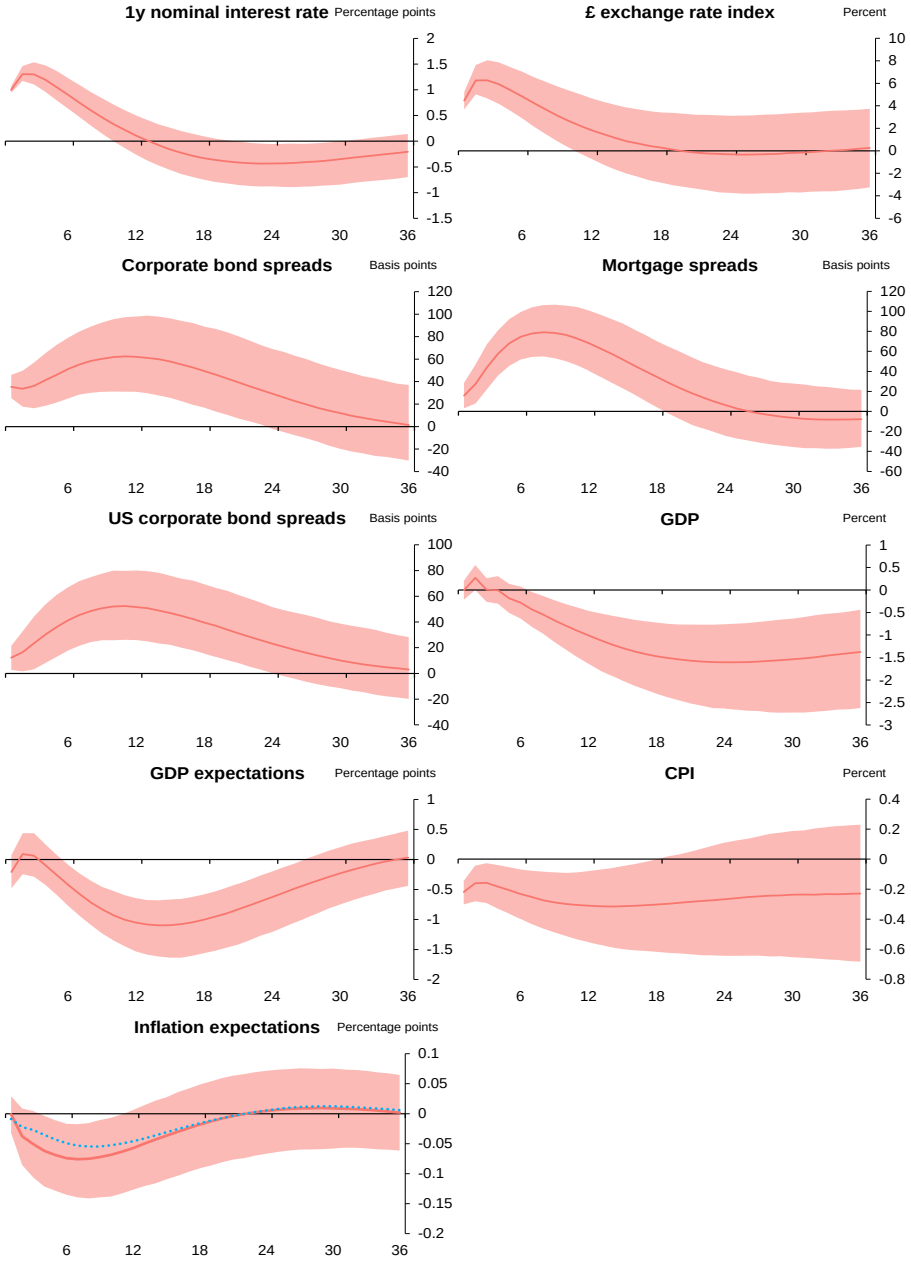
Figure A.2: Impulse response function using household inflation expectations



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.3 Full set of impulse response functions for baseline specification with financial market median inflation expectations

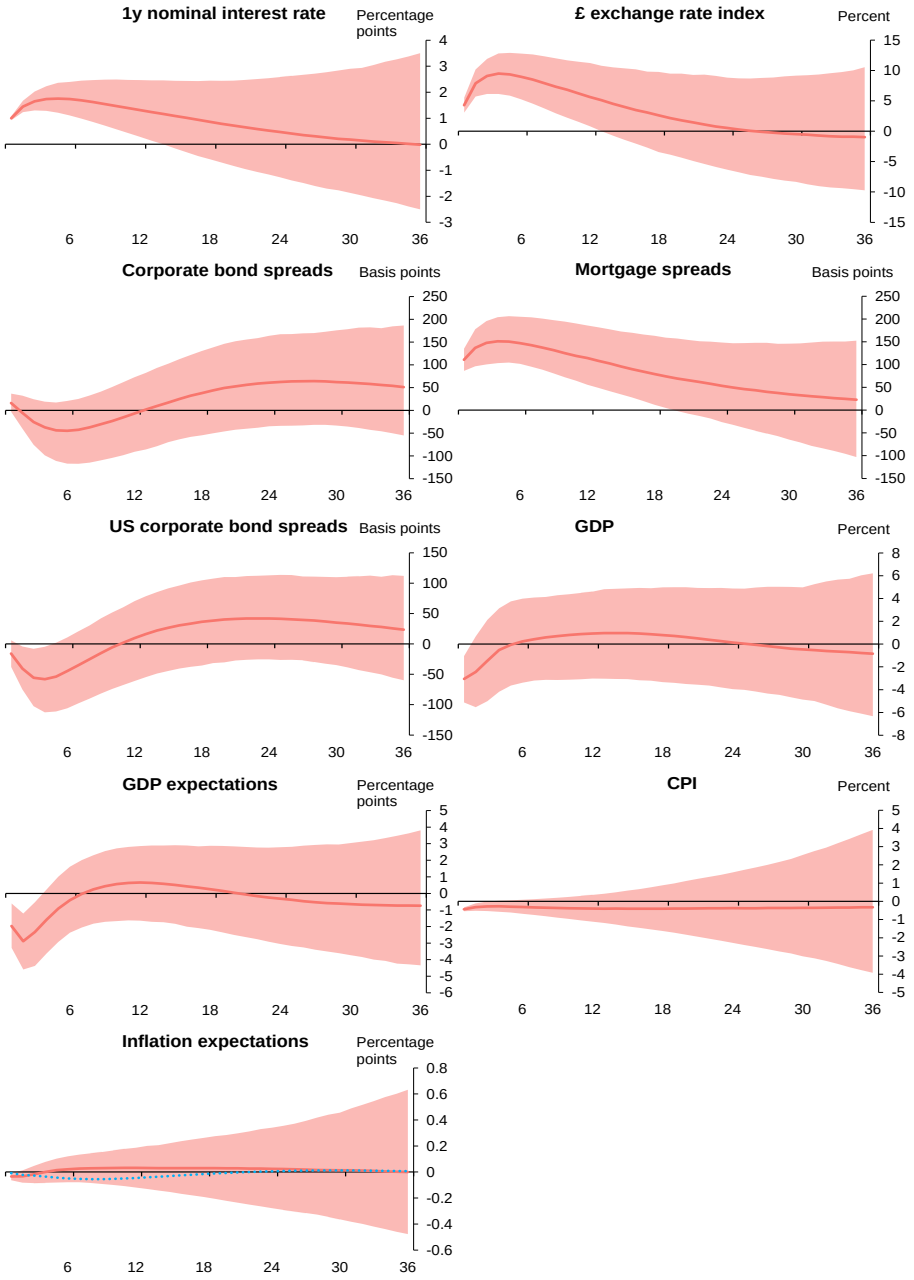
Figure A.3: Impulse response functions using financial market inflation expectations



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.4 Full set of impulse response functions for baseline specification with professional forecasters' median inflation expectations

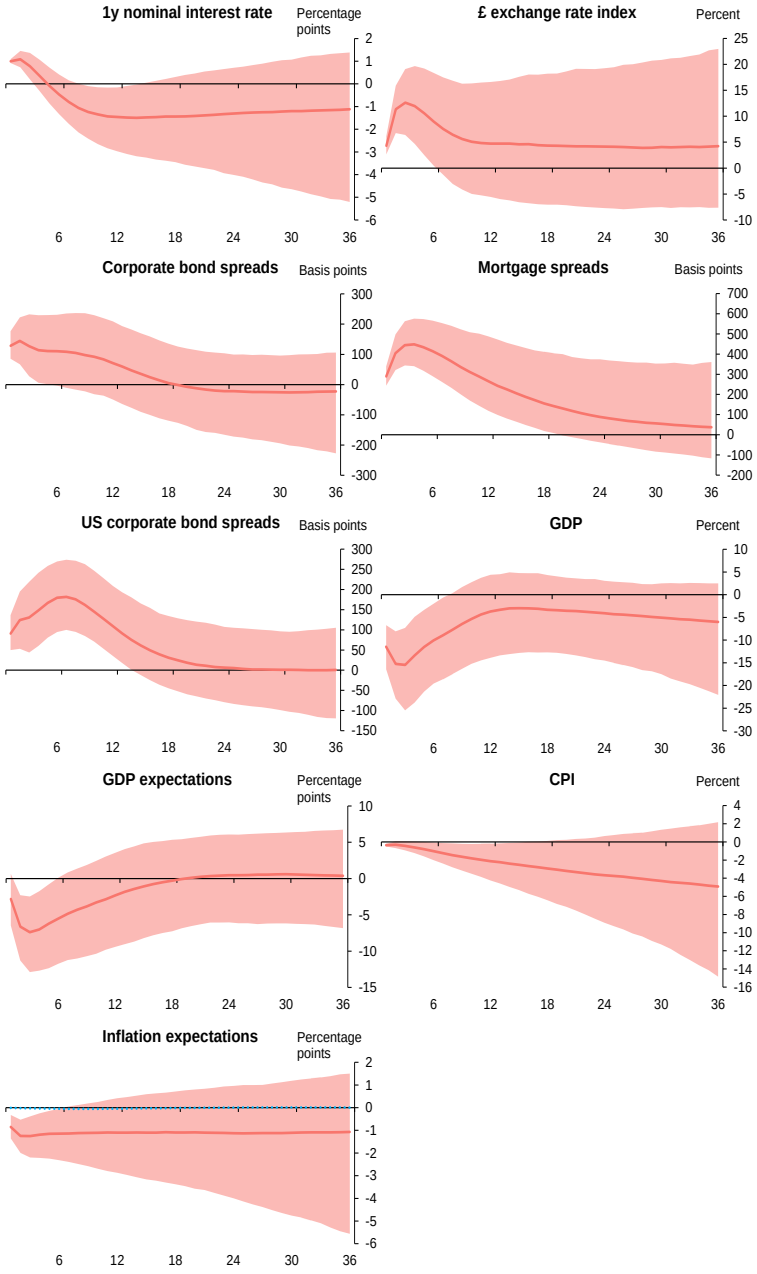
Figure A.4: Impulse response functions using professional forecasters' median inflation expectations



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 2000M3-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.5 Full set of impulse response functions for baseline specification with firms' median inflation expectations

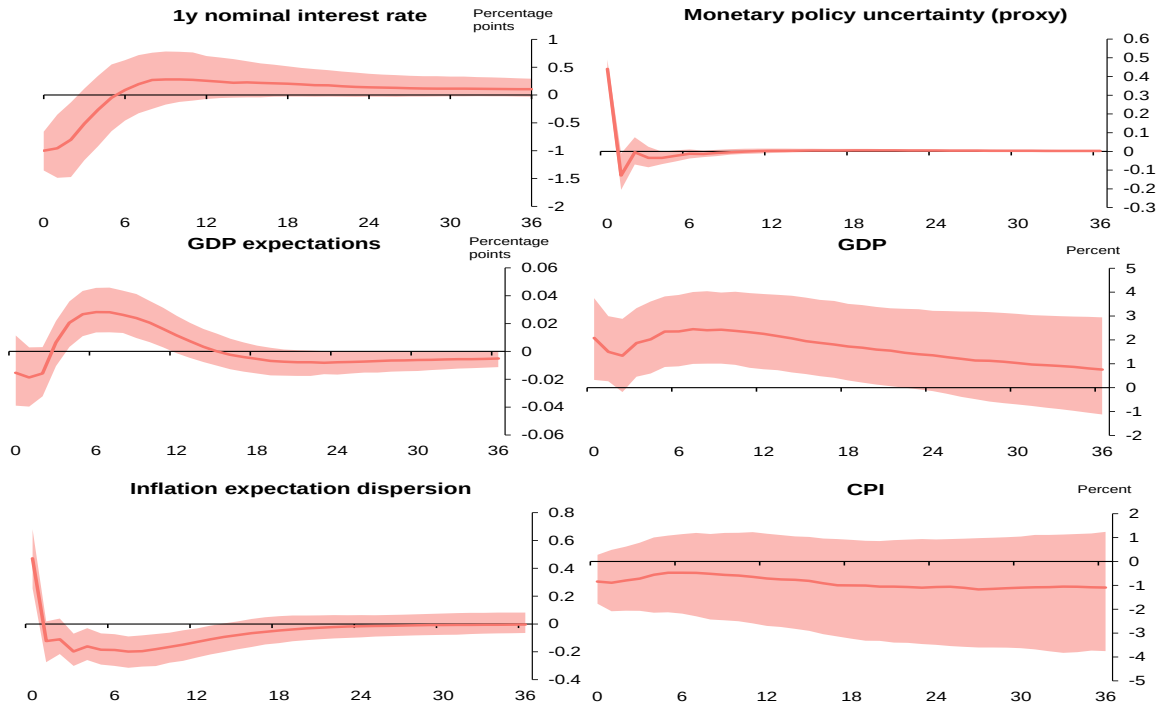
Figure A.5: Impulse response functions using firms' median inflation expectations



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 2008M5-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.6 Full set of impulse response functions for specification with the dispersion of inflation expectations

Figure A.6: Impulse response function using aggregate inflation expectation dispersion



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12.

A.7 Set of impulse response functions for specification with the skew of inflation expectations

Figure A.7 shows the response of the skewness of aggregate inflation expectations, across all agents.[42] The skew of inflation expectations does not respond significantly to monetary policy.

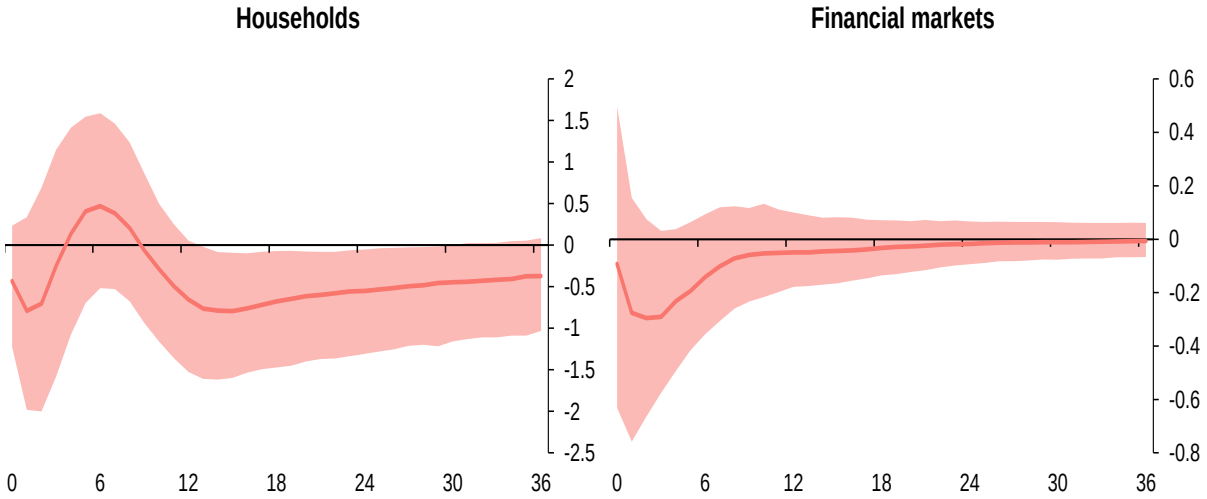
[42]This excludes professional forecasters, as in Figure 4, due to lack of data available across the distribution.

Figure A.7: Impulse response functions of the inflation expectation skew to a monetary policy shock

Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant. The model is estimated over 2008M5-2019M12.

Estimating the same results for individual economic agent groups, Figure A.8 shows the response of the skew of household inflation expectations on the left, and financial markets on the right. Households have a very volatile, yet also insignificant response.

Figure A.8: Impulse response functions of household and financial market's inflation expectation skew to a monetary policy shock

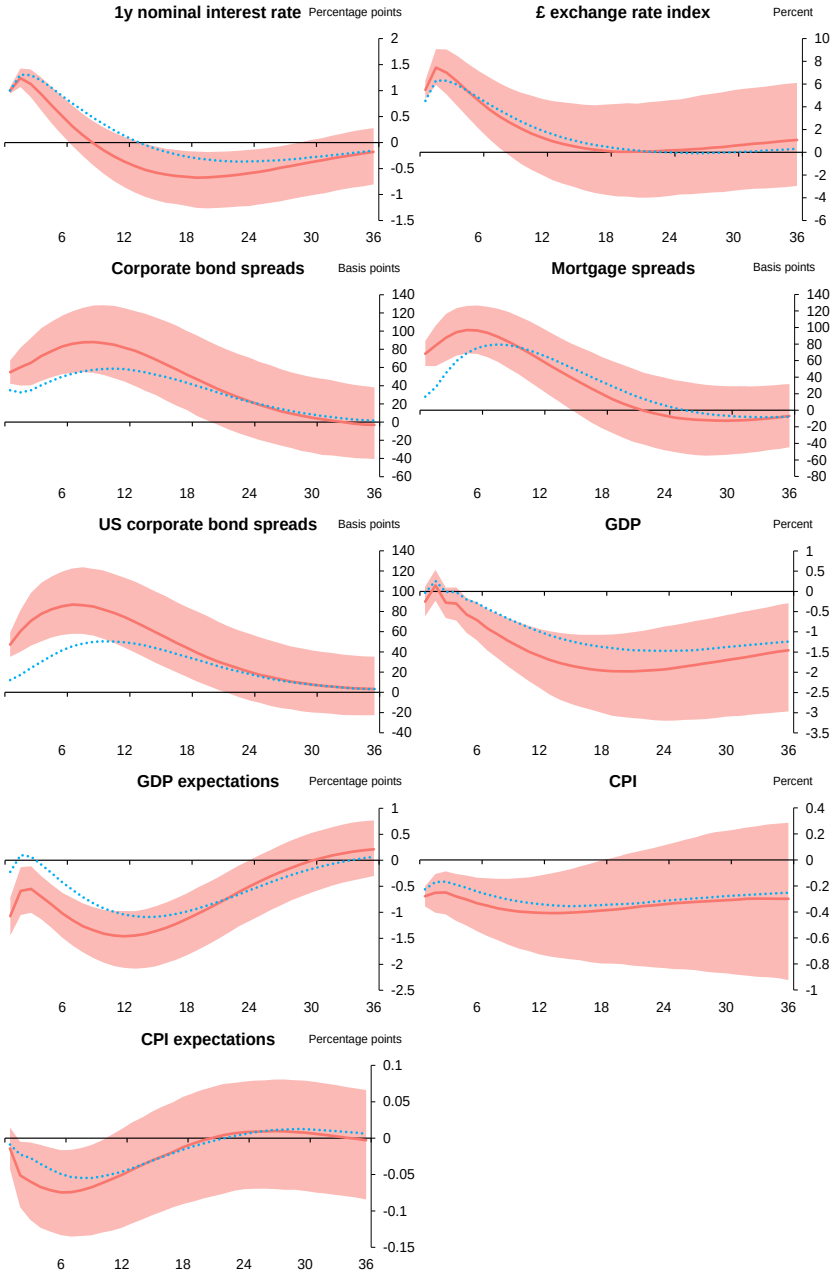


Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant. The LHS is estimated over 2009M3-2019M12 and the RHS is estimated over 2008M5-2019M12.

The skew of financial market measures declines, which is likely the most 'rational" response, in that the skew declines in response to a monetary policy tightening, as expectations shift further into the left tail - expecting inflation to fall. This is in line with the theoretical hypothesis, right tails risks of inflation in the future fall relative to left tail risks.

A.8 Robustness check: impulse response functions for model with alternative shock measure

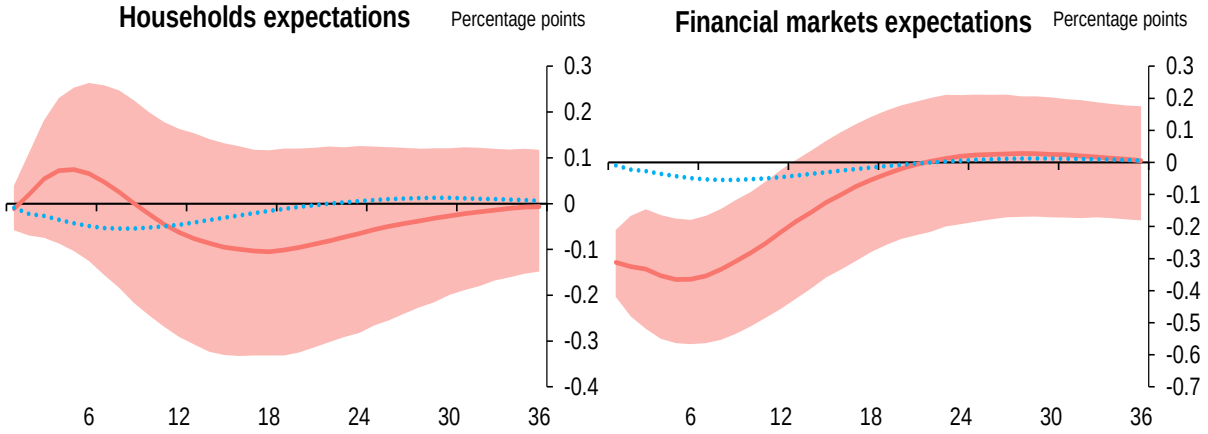
Figure A.9: Impulse response functions for median aggregate inflation expectations using an alternative proxy



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.9 Robustness check: impulse response functions for baseline specification using raw inflation expectations

Figure A.10: Impulse response functions for baseline specification using raw median inflation expectation measures



Note: Each panel shows the IRF of the specified variable to a monetary policy shock. Shaded areas show the 68% credibility bands, and solid lines show the median response. The model is estimated with 2 lags and a constant from 1997M6-2019M12. Blue, dotted lines denote the median response from the baseline specification in Figure 5.

A.10 Further robustness checks

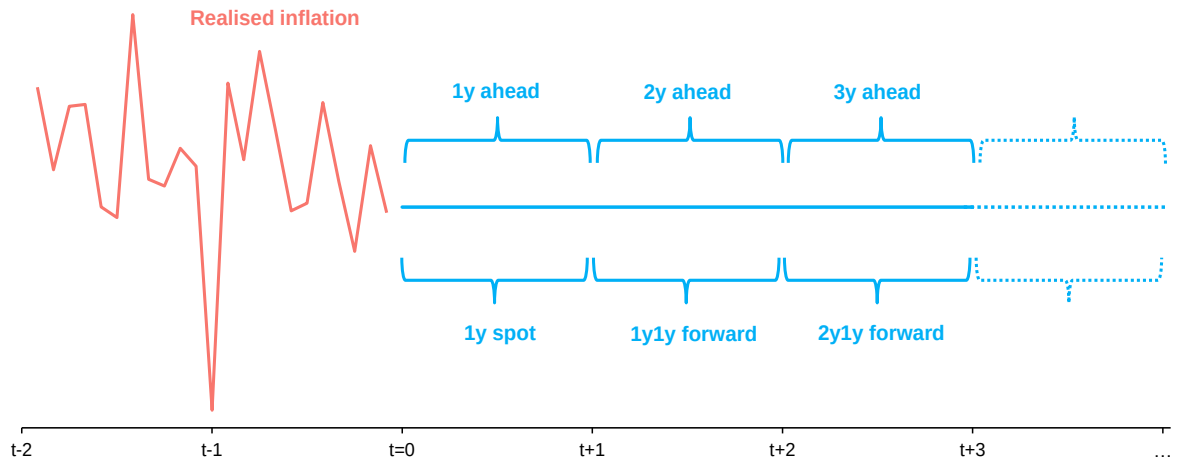
Using core CPI: a version of the model was run using core, rather than the headline measure of CPI. This is to account for the fact that headline inflation can be volatile, and driven by the volatile elements of food and inflation. Results did not differ greatly from the baseline specification.

Using a shadow rate: a shadow rate is a policy rate estimate that takes into account the effects of unconventional monetary policy tools. It is not bound by the effective lower bound on the monetary policymaker's short-term policy rate. The advantage of using this over of the 1-year nominal gilt yield is it allows to more accurately account for the effects of unconventional monetary policies, which is particularly relevant for the sample period post-2008, where central banks began using Quantitative Easing and forward guidance to lower their monetary stance below the effective lower bound their policy rate was bound by Busetto et al. (2022). Results

did not differ greatly from the baseline specification.

A.11 A stylised representation of inflation expectations

Figure A.11: Comparing horizons of survey-based and financial market measures



It is important to show how inflation expectation measures compare by horizon. This chart shows 1-year, 2-year and 3-year ahead expectations, as would be implied by survey measures. Below the horizontal line are measures as implied by financial market pricing. The most important point is that a household 2-year ahead expectations measure shows inflation expectations between 1 and 2-years from t=0, not inflation expectations over the next 2 years. This is akin to a 1-year, 1-year forward financial market measure, which represents a 1-year ahead expectations, 1 year from now.

A.12 Detail on inflation expectation metrics

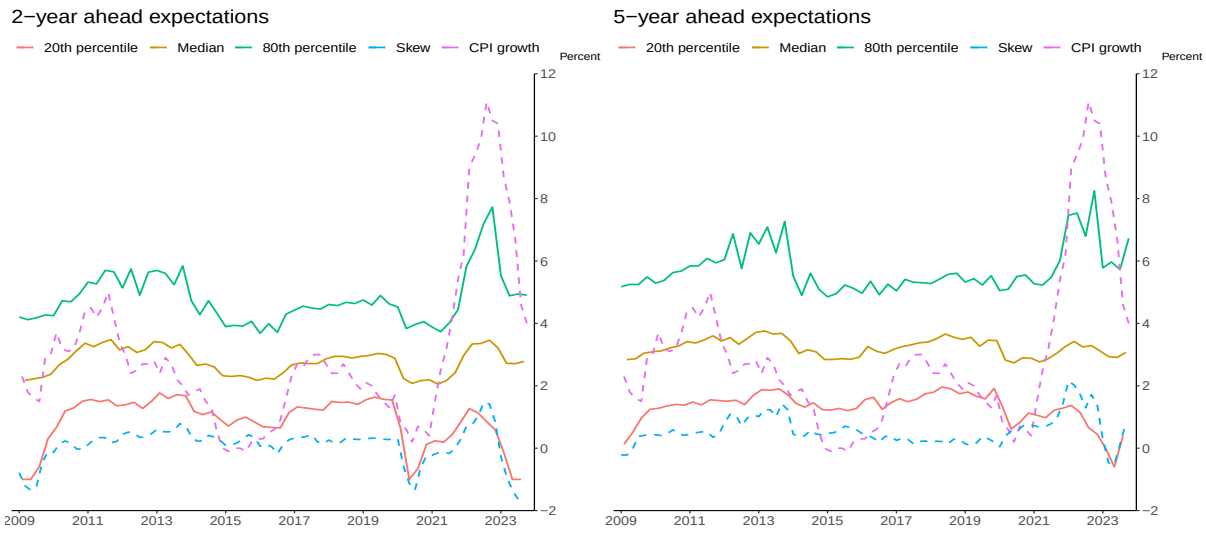
This section documents further detail on the inflation expectations measures described in the Data section, including the survey questions for relevant surveys, from which inflation expectations were derived.

A.12.1 Bank of England/Ipsos Inflation Attitudes survey

Inflation expectations are derived from answers to question 2 of the survey and subquestions: 1-year expectations from question 2a (How much would you expect prices in the shops generally to change over the next 12 months?), 2-year expectations from question 2b (And how about 12 months after that?) and 5-year expectations from question 2c (And how about the longer-term, say in five years' time. How much would you expect prices in the shops generally to change over a year then?).

Households respond in five buckets between 0% and 5%. This includes a 'don't know' option, which is unique to the household survey and arguably improves the quality of remaining responses. Over the sample on average, only 15% of households expect inflation to be around the 2% inflation target. Figure A.12 plots the two-year and five-year ahead median expectations.

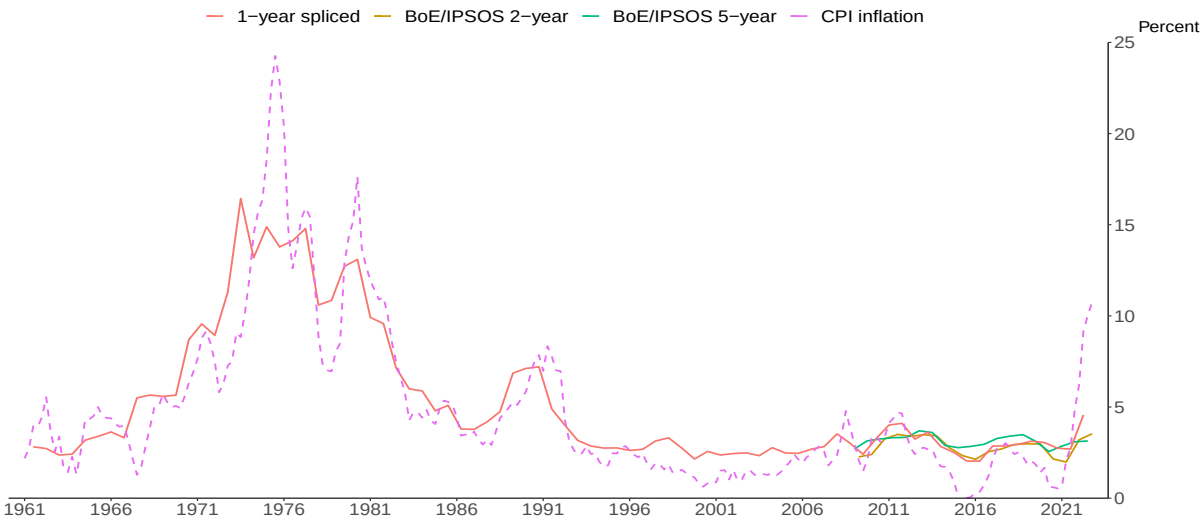
Figure A.12: Distribution of BoE/Ipsos survey-implied household inflation expectations



Source: Bank of England (2022b) and author's calculations

Figure A.13 shows a longer time series of median inflation expectations from the BoE Millennium dataset. It puts into perspective the little variation in the 21st Century, relative to the pre-inflation targeting period (due to the 1970s oil price shocks). It is noteworthy that household inflation expectations are consistently above the 2% inflation target, and therefore upwardly-biased, a common finding for household expectations (Weber, 2023).

Figure A.13: Longer-term household inflation expectations

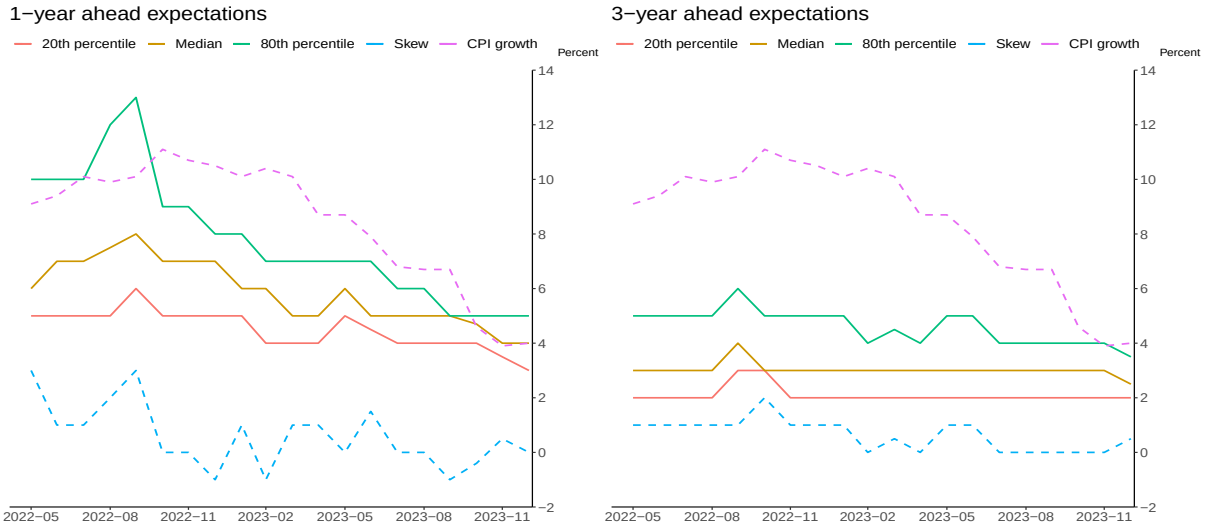


Source: Bank of England (2022b) and Chadha et al. (2019)

A.12.2 Decision Maker Panel survey

Figure A.14 plots the 1-year and 3-year median inflation expectations, derived from the following DMP survey question: 'What do you think the annual CPI inflation rate will be in the UK, one year from now and three years from now?' See Bunn et al. (2022) for additional analysis with this data.

Figure A.14: Distribution of DMP survey-implied firms' median inflation expectations

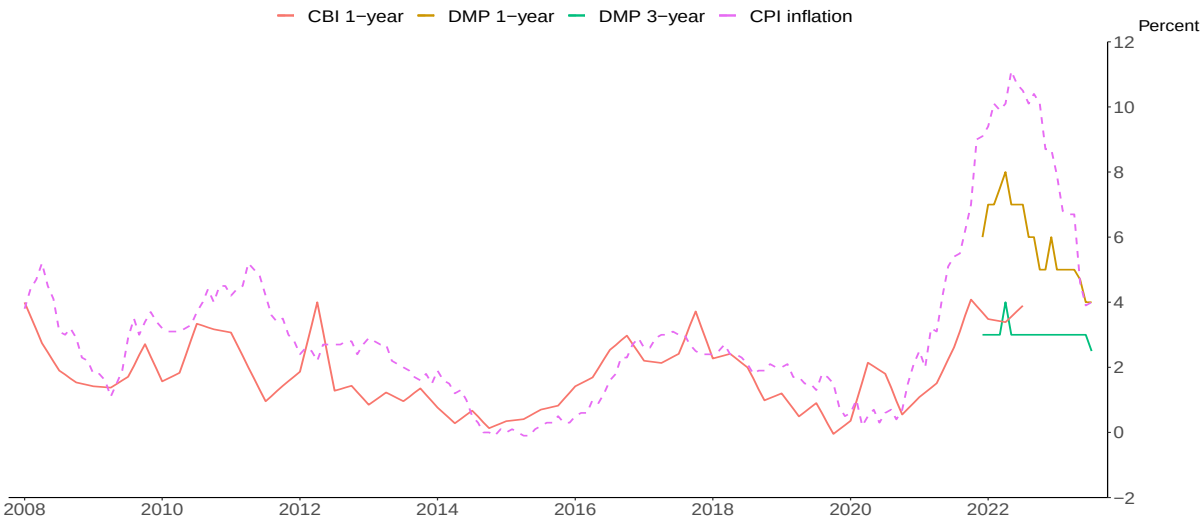


Source: Bank of England (2023c) and author's calculations

A.12.3 CBI survey

Figure A.15 shows the median indicator has been volatile, and unlike other measures, it frequently drops below the 2% inflation target. Despite these characteristics, CBI expectations are less elevated than DMP-implied measures.

Figure A.15: Series of survey-implied firms' median inflation expectations



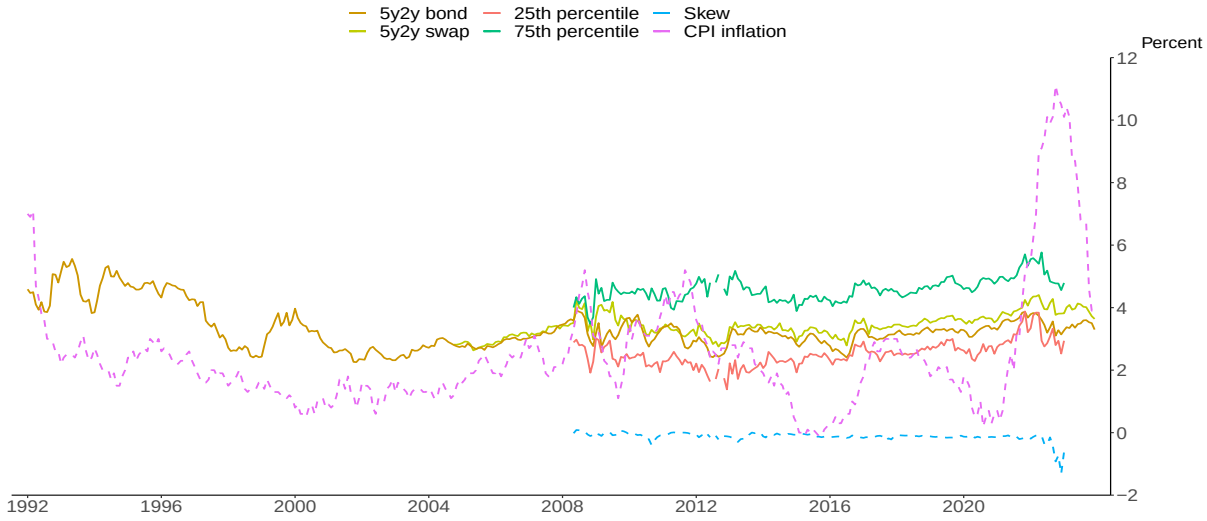
Source: Bank of England (2023c) and Confederation of British Industry (n.d.)

A.12.4 Financial market-based measures of inflation expectations

Figure A.16 plots parts of the option-implied risk-neutral probability distribution for market-implied inflation expectations, including skew.[43] It is notable that, unlike other measures, the distribution (as in Smith (2012)) is not skewed, even in response to post-Covid inflationary pressures.

[43] Risk-neutral probabilities are not directly comparable to 'physical' probabilities from a distribution of survey responses, due to risk premia in option-implied data. The European Central Bank (2021) find that risk-neutral probabilities overstate physical probabilities due to investor risk aversion. I use forward inflation rates, following Scholtes (2002) who finds that these are more informative for policymakers.

Figure A.16: inflation compensation measures derived from inflation-linked bonds and swaps



Source: Bloomberg Finance L.P., Tradeweb, ONS and Bank calculations

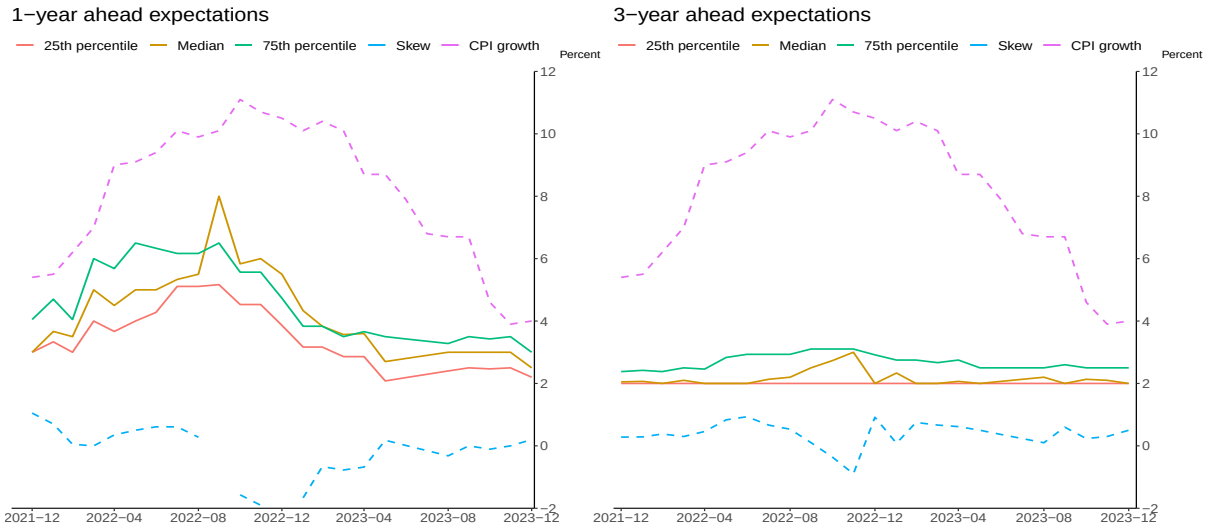
Note: 5y2y is the 2-year, 5-years ahead measure (5-7 year ahead expectation).

A.12.5 Market Participants Survey

One-, two-, three- and five-year ahead median expectations are obtained from the following survey question: "Question 2a: Please provide the level of CPI inflation – conditioned on your Bank Rate expectations (question 1a) – you see as most likely at each of the following time horizons. For reference, the most recent CPI print for March was 10.1%." (Bank of England, 2023b).

Figure A.17 shows various moments of the distribution of responses. Unlike swap-based measures the MaPS-implied distribution exhibits an upside skew recently.

Figure A.17: Distribution of MaPS survey-implied financial market inflation expectations

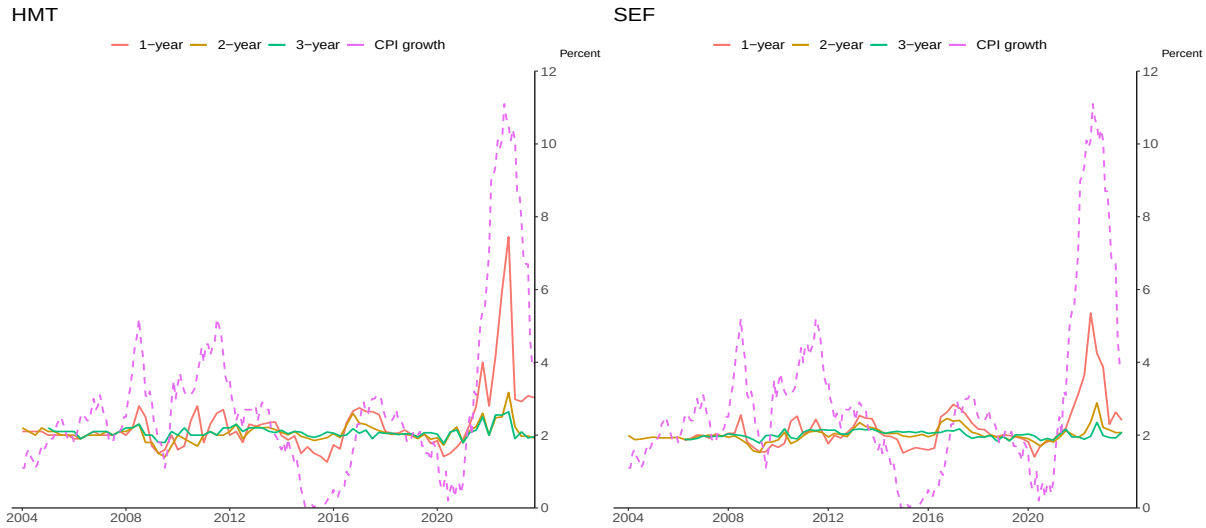


Source: Bank of England (2023b) and author's calculations

A.12.6 Professional forecasters

Figure A.18 shows the median one- to three-year ahead expectations for both measures.

Figure A.18: Survey-implied professional forecasters' median inflation expectations



Source: HM Treasury (2023) and Bank of England

A.13 Macroeconomic data

Interest rate: 1-year spot nominal UK government bond yield, month-end data of daily series, sourced from Bank of England (n.d.-b).

Exchange rate: sterling nominal exchange rate index in natural logarithms. This is a trade-weighted index of bilateral exchange rates. Month-end data of the daily series, sourced from Bank of England (2023a).

Corporate bond spreads: investment grade corporate spread index, sourced from ICE BoAML. Month-end data of daily series. Data for 1997, as in Cesa-Bianchi et al. (2020) is approximated as the yield on Debentures and Bank Rate, sources from Bank of England (n.d.-a).

Mortgage spreads: the difference of 2-year mortgage rates on a 75% LTV loan sourced from Moneyfacts, and the 2-year spot OIS yield. Month-end data of daily series.

US corporate bond spreads: Moody's BAA corporate yield less the US 10-year spot nominal government bond yield, as in Cesa-Bianchi et al. (2020), sourced from Federal Reserve Economic Data (n.d.).

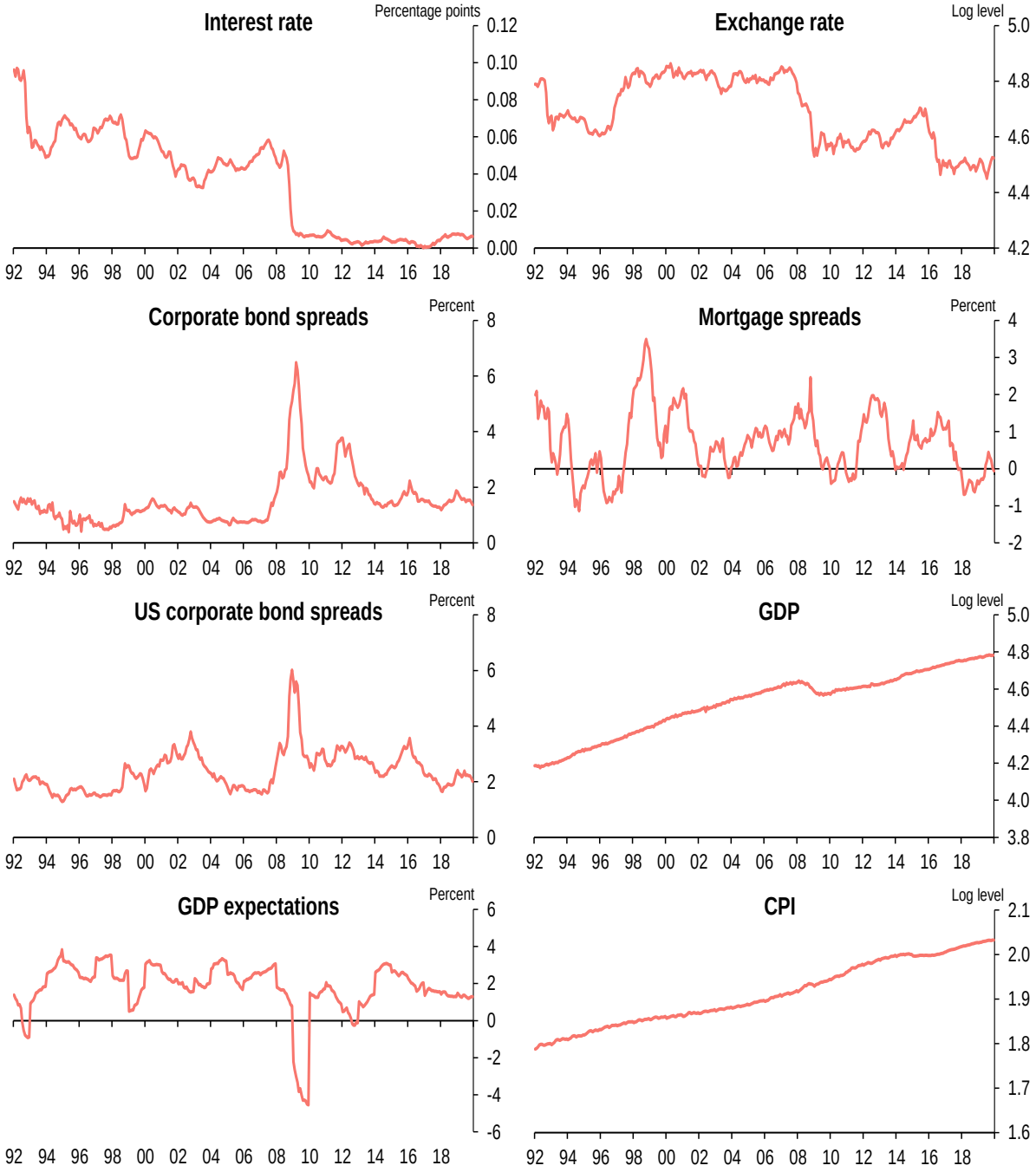
GDP: monthly real GDP levels in natural logarithms, sourced from the Office for National Statistics (2023b).

GDP expectations: Consensus real GDP expectations for the year ahead (in growth rates), sourced from Refinitiv Eikon by LSEG. As in Jarocinski and Karadi (2020), I transform the current and next year horizons of the Consensus expectations into a constant 1-year horizon, as follows: $\pi^e_{12m} = ((1-(i-1))/12)*\pi^e_{y0}+((i-1)/12)*\pi^e_{y1}$ where π^e_{12m} is the expectation one year ahead, π^e_{y0} and π^e_{y1} represent the Consensus current year and year-ahead inflation expectations.

CPI: monthly consumer price index levels in natural logarithms, sourced from the Office for National Statistics (2023a).

Inflation expectations: described in Section 3.

Figure A.19: Time series of macroeconomic variables



Source: As stated above.

Note: Each panel shows the variables as described in Section 3, with transformations already applied.