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Biases in Survey Inflation Expectations:

Evidence from the Euro Area

By Jiaqian Chen, Lucyna Gornicka, and Vaclav Zdarek

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Biases in Survey Inflation Expectations: Evidence from the Euro Area

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ABSTRACT: This paper documents five facts about inflation expectations in the euro area. First, individual inflation forecasts overreact to individual news. Second, the cross-section average of individual forecasts of inflation underreact to shocks initially, but overreacts in the medium term. Third, disagreement about future inflation increases in response to news when the current inflation is high, and declines when inflation is low, consistent with a zero lower bound of expectations. Fourth, overreaction of individual inflation forecasts to news increased after the global financial crisis (GFC). Fifth, the reaction of average expectations (and of actual inflation) to shocks became more muted post-GFC in the euro area, but not in the U.S.

JEL Classification Numbers:	E3, E4, E5, D83, D84
Keywords:	expectations formation; surveys of expectations; informational rigidities

The views expressed in this paper are those of the authors and do not necessarily represent those of the European Commission, Directorate-General for Economic and Financial Affairs (DG ECFIN), the International Monetary Fund, its Board or Management. We thank Roberta Friz and Christian Gayer for comments and help with BCS Survey data, Elena Bobeica and Marek Jarocinski for sharing their data and codes, Wouter van der Wielen for his advice on fiscal VAR. We thank Stephan Danninger, Christopher Erceg, Gaston Gelos, Gita Gopinath, Kenneth Kang, Jesper Linde, Pawel Zabczyk and other seminar participants at the IMF for useful comments. All remaining errors are under the full responsibility of the authors.

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WORKING PAPERS

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1 Introduction

Full-information rational expectations (FIRE) hypothesis plays a crucial role in modern macroeconomics. It has been a building block of modern general equilibrium models, the efficient markets theory, the theory of hyperinflation and the permanent income theory of consumption. Yet, FIRE imposes very strong assumptions on the way agents form their beliefs: not only do they fully understand the data-generating process but also know all relevant, past and current, information.

The realism of FIRE assumptions has been questioned in many papers, and many authors have proposed alternative models of expectations formation. Some have emphasized informational frictions (Mankiw and Reis (2002) and Maćkowiak and Wiederholt (2015)), biases to over-extrapolate the past (Bordalo et al. (2020)), while others have advocated for under-extrapolation such as cognitive discounting (Gabaix (2020)) and level-k thinking (García-Schmidt and Woodford (2019) and Farhi and Werning (2019)). Importantly, over the recent years empirical literature has provided new supporting evidence of deviations from the FIRE hypothesis as well (Coibion and Gorodnichenko (2012), Coibion and Gorodnichenko (2015), Angeletos, Huo and Sastry (2020) among others), although it remains inconclusive regarding the true expectations formation process.

In this paper, we provide new evidence on the properties of expectations of future inflation and unemployment that can help inform the choice between alternative theories of expectations formation. Our contributions are threefold.

First, while most empirical papers rely solely on the U.S. data, we use data on expectations from the euro area, including monthly surveys of consumers in 11 euro-area countries. This allows us to verify whether past evidence on expectations holds in a broader set of countries. Second, we document how the behavior of expectations changed after the global financial crisis (GFC) but before COVID: period associated with a decline in the average inflation level and with monetary policy at, or close to, the effective lower bound (Figure 1). Finally, we document two novel properties of inflation expectations process: i) following news, the extent of disagreement regarding future inflation among agents depends on the level of current inflation in a nonlinear way, ii) there is a zero lower bound (ZLB) on agents' inflation expectations.

We use survey expectations of both professionals and consumers for a panel of European countries. We use both *individual and cross-section average* inflation forecasts[1] of professional forecasters from Consensus Economics that are available at monthly frequency and go back until mid-1990s.[2] Expectations of consumers come from the Joint Harmonized European Union Program of Business and Consumer Surveys which contain information on one-year-ahead expectations of inflation and unemployment at a monthly frequency and are collected by the European Commission (EC). The EC surveys cover 27 European Union (EU) member states.[3] We take advantage of data for 11 euro-area member countries to study country level *cross-section average and standard deviation of the survey inflation and unemployment expectations*

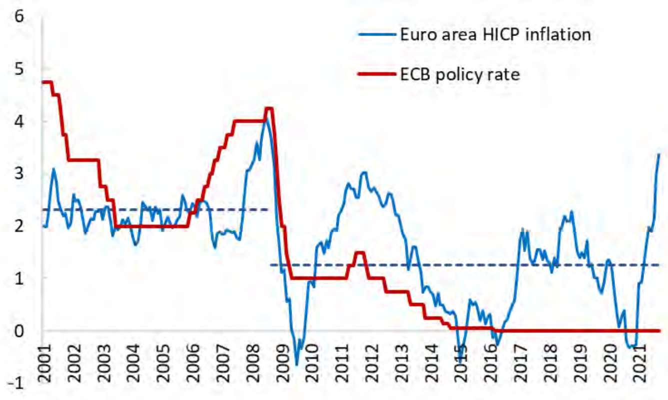
[1]Throughout the text we use terms "forecasts" and "expectations" interchangeably.

[2]For some countries individual forecast data is available as early as 1989.

[3]The United Kingdom participated the survey until December 2020. The EU candidate countries take part in the survey.

of consumers in the period between January 2004 and June 2019.

Figure (1) *Headline inflation and the central bank policy rate in the euro area*



Notes: euro area aggregates are weighted-averages of country-level values. The blue line shows the HICP year-on-year inflation, and the dashed lines correspond to pre-GFC and post-GFC averages. The red line shows the ECB refinancing rate. Source: Haver Analytics.

In our empirical analysis, we follow the approach established in the literature. That is, we look at i) the predictability of individual forecast errors and of the forecast error of the cross-section average forecast from past forecast revisions as in Coibion and Gorodnichenko (2015) and Bordalo et al. (2020), and ii) the reaction of the forecast error of the average forecast to a range of externally identified macroeconomic shocks as in Coibion and Gorodnichenko (2012) and Angeletos et al. (2020).[4] Using U.S. data on individual forecasters' short-term predictions for a range of macroeconomic variables, Bordalo et al. (2020) document a statistically significant and negative impact of new information on individual forecasters' ex-post forecast errors. They argue this is consistent with overreaction to news at the forecaster level. However, when looking at the forecast error of the cross-sectional average of individual forecasts in the U.S., Coibion and Gorodnichenko (2015) find that forecast revisions have a statistically significant and positive impact on the ex-post forecast error, consistent with underreaction of average expectations to news.

Turning to responses of expectations to externally identified shocks, Coibion and Gorodnichenko (2012) show that in the U.S. ex-post forecast errors of the average inflation expectations respond positively to a range of aggregate inflationary shocks, again indicative of underreaction of average expectations to news. Using a similar approach and the same data, Angeletos et al. (2020) also find a positive response of the average forecast errors to news, but only in the short term. Instead, over longer horizons the forecast error of average expectations becomes negative following inflationary news, consistent with an overreaction of average expectations in the medium term.

In turn, our main empirical findings are:

Stylized Fact 1: *Individual inflation expectations in the euro area overreact to news*

[4]We also look at the responses of actual inflation, average expectations, and of the standard deviation of expectations to shocks.

about inflation. In the regressions of individual forecast errors of professional forecasters' short-term inflation forecasts, the coefficients on past forecast revisions are negative and statistically significant. This implies that, on average, individual forecasters overreact to news about inflation. This is consistent with the findings of Bordalo et al. (2020).

Stylized Fact 2: *The average of individual inflation expectations underreacts to news initially, but overreacts in the medium term.* At the same time, in the regressions of the forecast error of the cross-section average of inflation expectations among the same professional forecasters, the coefficients on past forecast revisions are positive and statistically significant. This implies an underreaction of average expectations in the short term. In the medium term, however, average expectations of both professional forecasters and consumers overreact to news. In particular, in the regressions of average inflation expectations on externally identified macroeconomic shocks, average expectations tend to overshoot the actual outcomes one to two years after a shock happens. Medium-term overreaction is also present for the consumers' average expectations of unemployment. The pattern of initial underreaction and medium-term overreaction of average expectations to news is consistent with Angeletos et al. (2020) for the U.S., but at odds with with evidence in Coibion and Gorodnichenko (2012), who document an underreaction of average inflation expectations to news both in the short and in the medium term. Yet, when we rerun their regressions on a shorter sample that excludes the period of very high inflation in the U.S. in late 1970s and early 1980s, we again find evidence of overreaction at medium-term horizons (Section 6.5).

Stylized Fact 3: *Disagreement about future inflation responds to news in a different way depending whether current inflation is low or high.* Consumers' disagreement about future inflation increases in response to both inflationary and deflationary shocks when the current inflation is high, but declines when current inflation is low. The latter finding is at odds with the past literature on informational frictions, which has argued that disagreement about future inflation should increase following shocks, independently of the level of current inflation (Mankiw et al., 2003). Empirically, both Coibion and Gorodnichenko (2015) and Angeletos et al. (2020) find no evidence of disagreement responding to inflationary or deflationary shocks in the U.S. Looking closer at the data, we find that our results are driven by the lower percentiles of the expectations distribution being less responsive to news about inflation compared to upper percentiles, suggesting presence of a zero lower bound of expectations. Gorodnichenko and Sergeyev (2021) make a similar observation for the survey expectations in the U.S.

Dynamics of expectations changed considerably after the GFC, but only in the euro area. We investigate the state-dependence of expectation formation process by adding to our regressions the interactions of forecast revisions and macroeconomic shocks with a ZLB dummy for the ECB main policy rates, which broadly corresponds to the post-GFC period. We find that while the magnitude of overreaction of individual forecasts to news increased after the GFC (**Stylized Fact 4**), the reaction of average forecasts as well as of actual inflation to news became much more muted post-GFC (**Stylized Fact 5**). Consistent with the latter, the underreaction of average inflation expectations in the short-term and the overreaction in the medium-term became much weaker. Interestingly, we find no evidence of changes in the responsiveness of average expectations (and of actual inflation) to news the U.S. in the same period.

Facts 1 and 2 lend support to a combination of two mechanisms of expectations formation, as proposed in Angeletos et al. (2020): imperfect information and over-extrapolation. The former implies that although individual agents' expectations overreact to news, the *average* forecast among agents initially underreacts to the news due to the noise associated with the information that agents obtain. Yet, as time passes, this friction fades out and over-extrapolation starts to dominate, guaranteeing that the average expectations overreact in the medium term. The latter evidence points in the opposite direction of under-extrapolation implied by cognitive discounting or level-k thinking theories.

Facts 3-5 are, to our knowledge, novel to the literature. In a stylized theoretical framework, the post-GFC changes in the dynamics of actual inflation and of average inflation expectations that we document, are consistent with a less persistent impact of shocks on inflation and on inflation expectations. Such decline in persistence could be a result of several alternative drivers. These include i) presence of downward nominal price and wage rigidities together with a reinforcing feedback between low inflation and weaker passthrough from wage increases to inflation (Consolo et al., 2021), ii) changes in the firms' pricing behavior post-GFC (Koester et al., 2021), or iii) increased inattention to inflation developments on the side of agents in a low inflation environment. Overall, the ability of alternative theoretical models to produce expectations dynamics consistent with our evidence could help identify the correct model of expectations formation.

The properties of the expectation formation process that we document have several important policy implications. First, while shocks have initially more muted impact on average inflation expectations than FIRE models would predict, it masks a delayed overreaction in the medium-term. This suggests policymakers should remain vigilant even if average inflation expectations responded only modestly to the recent surge in inflation. Second, the nature of the shock matters. In particular, our empirical results point to a more persistent overreaction of average inflation expectations following a demand shock while the overreaction driven by an oil supply shock fades more quickly which could be explained by the observation that consumers tend to believe gas price inflation is slightly negatively autocorrelated (Binder 2018). Third, the nonlinear relationship between disagreement and current inflation highlights challenges to expectations anchoring in the high inflation environment. Finally, for countries experiencing low inflation, the presence of a zero lower bound on expectations implies that deflation episodes might be associated with lower economic costs than what predicted by models without this constraint.

The paper is organized as follows. Section 2 discusses related literature, Section 3 presents a stylized framework of expectations process to help understand our empirical approach and results, and Section 4 introduces the data. In Sections 5 and 6 we show evidence for individual expectations and for average expectations, respectively. Section 7 considers disagreement about future inflation. Section 8 presents evidence on inflation expectations when the monetary policy is at, or closer to, the ZLB. Section 9 connects the empirical evidence to existing theories of expectation formation. Section 10 concludes.

2 Literature

This paper contributes to the literature providing empirical evidence on formation of inflation expectations. It builds on the approaches developed in Coibion and Gorodnichenko (2012) (CG (2012) henceforth) and Coibion and Gorodnichenko (2015) (CG (2015) henceforth) which have been subsequently applied in Angeletos et al. (2020) and Bordalo et al. (2020). CG (2012) propose a simple ARMA regression of average forecast errors (for U.S. consumers and professional forecasters) on externally identified aggregate shocks. They find that average forecast errors underreact to shocks, consistent with models with information rigidities. CG (2015) take an alternative approach and look at the predictability of the average forecast errors across agents from average forecast revisions. They find a positive relationship between the average forecast errors and average forecast revisions, again consistent with presence of informational rigidities.

Most recently, Angeletos et al. (2020) apply the approach of CG (2012) to an alternative set of shocks. While they confirm the underreaction of average expectations immediately after a shock, they find average inflation and unemployment expectations overreact at medium-term horizons. Bordalo et al. (2020) use the approach of CG (2015) to show that while average forecasts underreact to news, individual forecasters typically overreact to news.

A growing literature analyzes expectations formation process using micro-level data from surveys of households, firms, and professionals. Several papers (e.g., Souleles 2004, Ehrmann, Pfajfar, and Santoro 2017) document links between inflation expectations and perceptions and various demographic characteristics of respondents. Ehrmann and Tzamourani (2012) and Malmendier and Nagel (2016) show that people who lived through a high inflation have systematically higher inflation expectations than generations which did not have this experience. D'Acunto et al. (2019) show that, to form aggregate inflation expectations, consumers rely on the price changes they face in their daily life such as grocery shopping or travelling. Most recently, Gorodnichenko and Sergeyev (2021) use survey data from the U.S., Europe and Japan to document that households do not expect deflation, even in environments where inflation has been low or negative.

Our paper is also related to a growing literature studying how inflation expectations of households relate to their decisions. While early papers point to little or insignificant correlation between households' inflation expectations and their desired consumption level using the Michigan Survey of Consumers (Bachmann et al., 2015), subsequent work has found stronger and positive correlation between expectations and consumption using the New Yord Fed's Survey of Consumer Expectations (Crump et al. 2021), a large scale survey on US households (Coibion et al. 2021), a micro-level dataset from Japan (Ichiue and Nishiguchi 2015), a German survey of households (Drager and Nghiem 2021), and a broader cross-section of European households (Duca-Radu et al. 2021). Moreover, Forsells and Kenny (2004) argue that households' expectations are a better predictor of actual inflation outcomes than expectations of professionals and a naive forecast. Coibion et al. (2018) find that they are also a better proxy of firms' pricing decisions than professional forecasters and financial market participants' predictions.[5] These papers underscore the importance of a better understanding of household expectation formation process.

Theoretical literature has proposed several models of expectations formation that can explain these empirically observed deviations from FIRE. Early papers emphasized informational frictions in the form of infrequent access to new information (Mankiw and Reis 2002) or settings where agents continuously update their information but face noisy signals about the economic fundamentals (Woodford 2003, Sims 2003, Maćkowiak and Wiederholt 2009, Maćkowiak and Wiederholt 2015). More recent literature considers various behavioral explanations as drivers of deviations from FIRE. These include diagnostic expectations of Bordalo et al. (2018) that cause agents to over-extrapolate the recent past, cognitive discounting of Gabaix (2020) where agents discount events far in the future much more heavily relative to a rational benchmark, and level-k thinking of García-Schmidt and Woodford (2019) and Farhi and Werning (2019) where agents are rational with respect to partial equilibrium effects, but do not fully internalize general equilibrium effects.

3 A simple model: understanding over- and under-reaction

Before diving into the empirical results, we use the partial equilibrium framework developed by Angeletos et al. (2020) to illustrate the behavior of expectations under FIRE and when households under- and overreact to news. The framework, albeit simple, incorporates two mechanisms of expectations formation: imperfect information and over-extrapolation. The former implies that although individual agents overreact to news, the *average* expectations initially underreact to news due to the noise associated with the information that agents obtain. In the absence of informational frictions, the latter would result in overreaction of average expectations as well.

Let x_t denote the inflation process that an agent i is trying to forecast. For simplicity, we assume x_t is exogenous to the agents' behavior and that it follows an AR(1) process with Gaussian errors:

$$x_t = \rho x_{t-1} + r\epsilon_t, \tag{1}$$

where $\rho \in (0,1)$ governs the persistence of the inflation process, $\epsilon_t \sim N(0,1)$ is a Gaussian innovation. Agents observe x_t with idiosyncratic noise. Specifically, each agent observes a signal $s_{i,t}$ given by:

$$s_{i,t} = x_t + \frac{u_{i,t}}{\sqrt{\hat{\tau}}}, \tag{2}$$

where $\hat{\tau}$ measures precision of the signal and $u_t \sim N(0,1)$ is idiosyncratic Gaussian noise.

[5] Either due to the fact that managers in firms are also consumers or via wage bargaining process with direct participation of workers (consumers).

Following Angeletos et al. (2020), we introduce a form of irrationality, by assuming that agents perceive x_t as evolving according to:

$$x_t = \hat{\rho} x_{t-1} + r\epsilon_t, \tag{3}$$

where $\hat{\rho}$ can be different from the true ρ. The case when $\hat{\rho} > \rho$ captures over-extrapolation of today's state to the next period. In other words, agents overreact to the shock that happens at period t. Conversely, the case with $\hat{\rho} < \rho$ captures under-extrapolation (i.e. underreaction to shocks).

Within this setup, individual one-period ahead inflation expectations can be written as:

$$E_{i,t}[x_{t+1}] = \hat{\rho} E_{i,t}[x_t] = \hat{\rho}[(1-\hat{g})\hat{\rho} E_{i,t-1}[x_t] + \hat{g} s_{i,t}], \tag{4}$$

where $\hat{g} = 1 - \frac{\hat{\lambda}}{\hat{\rho}}$ and $\hat{\lambda} = \frac{1}{2}\left(\hat{\rho} + \frac{1+\hat{\tau}}{\hat{\rho}} - \sqrt{(\hat{\rho} + \frac{1+\hat{\tau}}{\hat{\rho}})^2 - 4}\right)$.

We use this framework to simulate three scenarios with different parameter calibrations. The purpose is to illustrate the behavior of inflation, inflation expectations, and forecast errors under the FIRE and when households under- and overreact to shocks. Inflation forecast error is defined as actual inflation in period t minus the forecast of period-t inflation made in period $t-1$. Thus, if an agent underreacts (overreacts) to an inflationary shock, actual inflation would increase more (less) than inflation expectations, resulting a positive (negative) ex-post forecast error.

We use equations (1) and (4) to simulate path for inflation (x_t) and 200 individual inflation expectations ($E_{i,t}[x_{t+1}]$). We then compute average inflation expectations by averaging across individual expectations. The parameter calibration is shown in Table 1 and it draws on Angeletos et al. (2020).

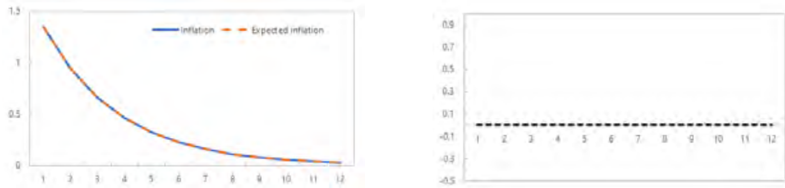
Table (1) *Parameter Calibration*

Parameter	Description	Value		
		FIRE	underreaction	overreaction
ρ	AR(1) coef. in inflation dynamic	0.7	0.7	0.7
r	standard deviation of error term	1	1	1
$\hat{\tau}$	perceived precision	10^{36}	0.15	10^{36}
$\hat{\rho}$	perceived AR(1) coef. in inflation dynamic	0.7	0.7	0.9
σ_u	standard deviation of error term	0.01	0.01	0.01

In Figures 2, 3 and 4, we show impulse responses of actual inflation, average expectations and average forecast errors to an inflationary shock. Under the FIRE, the two informational frictions are turned off by setting $\hat{\rho} = \rho$, and $\hat{\tau} \to \infty$. In this case, household expectations respond to the shock as much as the actual inflation, therefore the forecast error is zero (Figure 2). In turn, if households receive noisy signals, i.e. $\hat{\tau}$ takes a positive finite value, average inflation expectations underreact to shocks implying a positive forecast error (Figure 3). On the other hand, if households over-extrapolate the signal they get, i.e. $\rho < \hat{\rho}$, then they would overreact to the news resulting a negative forecast error of the average forecast (Figure 4).

Figure (2) *Simulated inflation, average inflation expectations and average forecast errors under FIRE*

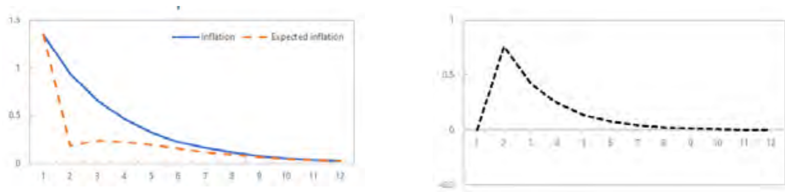
Inflation and expected inflation | Forecast errors



Note: The figure plots simulated inflation, expected inflation and inflation forecast errors. The simulations are based on equation (1) and (4) using parameters in Table 1.

Figure (3) *Simulated inflation, average inflation expectations and average forecast errors*

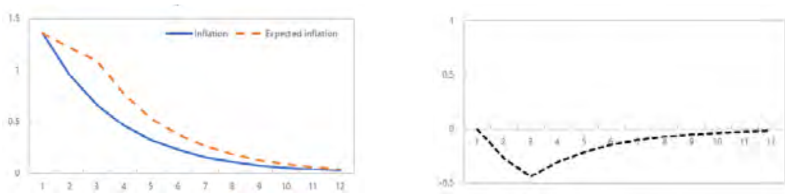
Inflation and expected inflation | Forecast errors



Note: The figure plots simulated inflation, expected inflation and inflation forecast errors. The simulations are based on equation (1) and (4) using parameters in Table 1.

Figure (4) *Simulated inflation, average inflation expectations and average forecast errors*

Inflation and expected inflation | Forecast errors



Note: The figure plots simulated inflation, expected inflation and inflation forecast errors. The simulations are based on equation (1) and (4) using parameters in Table 1.

4 Data

4.1 Data on consumers' expectations

Expectations of inflation. Inflation expectations of consumers come from the Joint Harmonized European Union (EU) Programme of Business and Consumer Surveys. These surveys are conducted in general on a rotating basis and published monthly by the European Commission (Directorate-General for Economic and Financial Affairs) and cover 27 EU member states and some other European (candidate) countries. The size of the survey sample varies across countries and tends to be larger in more populous member states, ensuring representativeness at the country level. Since the creation in the 1960s (1972 for the Consumer Survey, henceforth

Survey), the aim of the Surveys is to provide comparable results across a growing number of member states mainly in the form of qualitative assessments. Moreover, since May 2003 the Survey for the EU member states includes two quantitative questions concerning perceived and expected price changes.[6]

This paper uses information on averages and standard deviations of the quantitative responses regarding inflation expectations of consumers who are surveyed every month in the euro area countries.[7] The aggregated series of euro area-level inflation expectations and perceptions (also for the EU) are calculated and published every quarter by the European Commission (EC), including breakdowns by age, education, gender and income of respondents.
The relevant question (Q61) of the Survey is as follows[8]:

"By how many percent do you expect consumer prices go up/down change in the next 12 months? (Please give a single figure estimate)
Consumer prices will increase by ...,... % / decrease by ...,... %"

The question Q61 is asked only to the respondents who have indicated a perception of a positive or a negative change in prices in next twelve months in the question (Q6) of the Survey:

"By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will... increase more rapidly/increase at the same rate/increase at a slower rate/stay about the same/fall/don't know."

For respondents who have indicated that prices will "stay about the same", a zero percent change in Q61 is automatically imputed by the interviewer. Because of the "deliberately vague" (European Commission, 2019) construction of the two questions, consumers are not provided with sample answers nor forced to express their answer in terms of the costs of living, or a specific basket of goods or services. They are not guided in any other way neither, as it is the case in some other similar surveys, such as the University of Michigan Survey of consumers in the U.S. The response rate to Q61 varies across countries, but it is close to 75 percent for the euro area as a whole.

In this paper, we use data on *average* inflation expectations and the standard deviation of inflation expectations among respondents for 11 euro-area member states during the period January 2004–June 2019. While responses to the inflation expectations questions are available for more countries, we focus only on those that were members of the euro area and, thus, shared common monetary policy for the entire sample period. This leaves us with Austria, Belgium, Germany, France, Finland, Greece, Italy, Luxembourg, the Netherlands, Portugal and Spain.[9] Tables 8 and 9 in the Appendix show detailed summary statistics.

As illustrated in the literature, household inflation expectations tend to show much more dis-

[6] Quantitative inflation perceptions and expectations data was first gathered on an experimental basis, and since May 2010 it is collected on a regular basis. Therefore, data are missing for specific countries in some periods.

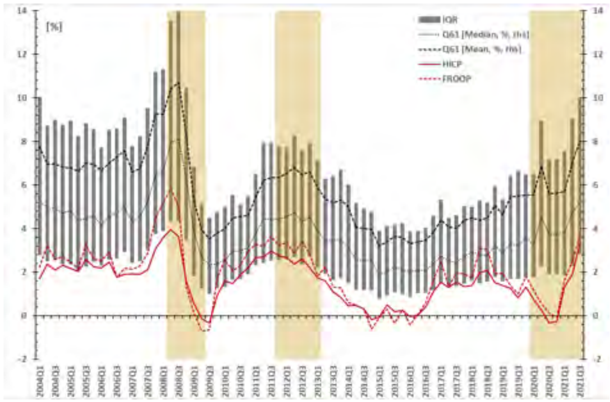
[7] Around 41 000 randomly chosen consumers across the euro area are asked every month to participate in filling in the questionnaire, be it in telephone surveys, online surveys or face-to-face interviews.

[8] There is a corresponding question on the current inflation perceptions of consumers. Several studies have recently used these quantitative data, such as Zekaite (2020) or Duca-Radu et al. (2020).

[9] For reasons related to prolonged periods of data unavailability, Ireland is not included in the euro area sample. In addition, few monthly observations are missing between 2004 and 2007 for France, in mid-2007 for Germany and in mid-2005 for Spain. There is a longer data-unavailability gap for the Netherlands (between May 2005 and June 2011). For further details especially on the first years of the survey see Arioli et al. (2017).

persion and extreme values than surveys of professional forecasters (Mankiw, Reis and Wolfers 2004, Coibion et al. 2020, among others).[10] To mitigate the impact of outliers or "implausible replies" (Arioli et al., 2017), the data are winsorised at the country level at the 5th and 95th percentiles.[11]

Figure (5) *Consumer inflation and inflation expectations of consumers in the euro area*



Notes: euro area aggregates are weighted-averages of country-level values. Vertical bars represent the inter-quartile range of median expectations across countries. Shaded yellow areas represent euro area recessions as defined by the Euro Area Business Cycle Dating Committee. FROOP – inflation for frequent-out-of-pocket items (special aggregate). Source: EABCDC (2021), EC (2021), Eurostat (2021), own adaptation.

For illustration, Figure 5 shows the (weighted-average) headline inflation and median inflation expectations of consumers in the euro area, starting in 2004. There is a clear co-movement between the median expectations and the actual inflation rate, although expectations stay above actual inflation throughout the period analyzed. The distance between the median expectations and headline inflation was relatively large before the Great Recession, while the post-2010 period has witnessed both a closing of the gap between the two series and a reduction of the dispersion of expectations across countries. This was particularly visible during the later years of the unconventional monetary policy of the ECB (2017–2018). However, starting in 2019 some decoupling between actual inflation and inflation expectations has occurred. Additionally, while average inflation expectations declined in the post-GFC period in most of the countries in our sample, there is considerable cross-country variation in the average expectations throughout the sample.[12]

Finally, in our analysis of inflation expectations, we also look at the behavior of disagreement about future inflation developments among agents. We measure disagreement by computing the

[10] Both Binder (2017) and Arioli et al. (2017) analyze other patters of consumer inflation expectations such as bunching at rounded values.

[11] Typically, the winsorised data include implausibly high inflation rates and very rarely some expectations of deflation in our sample. We use the STATA command WINSOR. Another (older) suggestion in the literature (three standard deviations, see Kangassalo and Takala, 2005) does not change the results significantly. It only keeps more extreme observations at both sides of the distribution of expectations, so the former is preferred in line with recent literature.

[12] If consumer inflation is measured with an index capturing frequent-out-of pocket purchases (being one determinant of expectations), this measure is even closer to median expectations in line with the literature.

standard deviation of answers from the winsorized sample at the country level. Figure 6 shows the dynamics of disagreement at the aggregated euro area level.

Figure (6) *Dispersion of inflation expectations of consumers in the euro area*

Notes: The Figure shows a weighted average of cross-section standard deviation of consumers' inflation expectations in eleven euro area countries. Shaded areas represent euro area recessions as defined by the Euro Area Business Cycle Dating Committee. Source: EABCDC (2021), EC (2021), own calculations.

Expectations of unemployment. The monthly Survey also includes questions aimed to capture the view of consumers on the economic developments over the next year. In particular, question Q7 of the Survey asks the consumers to qualitatively assess the expected change in unemployment[13]:

"How do you expect the number of people unemployed in this country to change over the next 12 months? The number will... increase rapidly (++)/increase slightly (+)/remain the same (=)/fall slightly (-)/fall sharply (- -)/Don't know (DN)."

To offer a quantitative representation of the answers, a so-called "balance" is calculated from the qualitative responses. The balance represents the difference between positive and negative answers provided to the question, and is measured as percentage points of total answers. For the question Q7, the balance (bal) is calculated using the weighed formula:[14]

$$bal = \left[(PP + \tfrac{1}{2} \cdot P) - (\tfrac{1}{2} \cdot M + MM)\right],$$

where bal ranges between -100 (all respondents choose the most negative option MM, i.e. "fall sharply") and $+100$ (all respondents choose the most positive option PP, i.e. "increase rapidly"), P and M stand for the percentage of respondents having chosen the positive ("increase slightly"), and the negative option ("fall slightly"), respectively.

[13]Consumers may be more familiar with labour market developments than with economic trends captured by the GDP. Understanding of the labour market situation is relevant, for example, for wage developments (negotiations) and the perceived risks can be relevant when deciding on how to finance purchases of durable assets.

[14]For further details see European Commission (2021a).

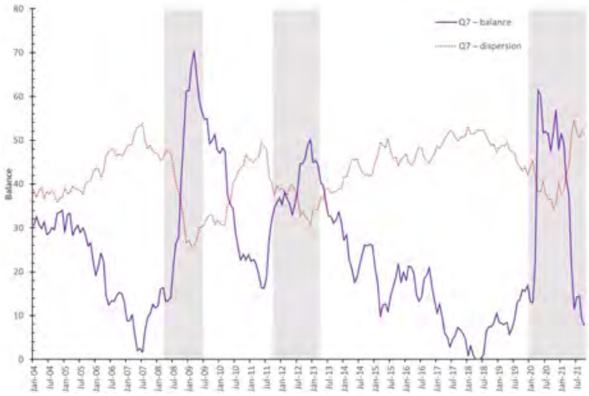
To compute the cross-sectional dispersion of unemployment expectations, $\sigma_{U,t}$, we follow EC (2016) and use the following formula:

$$\sigma_{U,t} = \sqrt{\left(r_t^+ + r_t^- - \left(r_t^+ - r_t^-\right)^2\right)}$$

where r_t^+ is the fraction of responses that indicate "increase" and r_t^- is the fraction of "fall" responses to the question Q7 in the survey at time t. Since the expectation question has more positive and negative answers, the very positive (++) and positive (+) answers are summed together, and similarly, the very negative (−−) and negative (−) answers.

For illustration, Figure 7 shows the variables *bal* and σ_U for the euro area, commencing in January 2004. The figure suggests that consumers typically expect unemployment to increase sharply during recessions, even though the *bal* variable can be viewed as a lagging indicator.

Figure (7) *Unemployment expectations of consumers in the euro area*



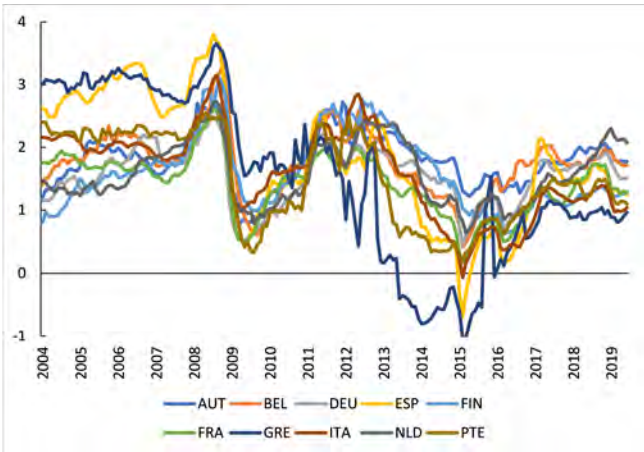
Notes: euro area aggregates are weighted-averages of country-level values. "Q7 dispersion" is calculated in line with the formula explained in the main text for the euro area aggregate. Shaded areas represent euro area recessions as defined by the Euro Area Business Cycle Dating Committee. Source: EABCDC (2021), EC (2021), own adaptation.

4.2 Data on professional forecasters' expectations

We also consider current calendar year and 12-months ahead inflation expectations of professionals from the Consensus Forecasts, available at monthly frequency. To analyze inflation expectations of individual forecasters, we use the current year forecasts. The individual forecaster data (including a forecaster identifier) is available for all countries in our sample except Luxembourg and goes back to 1989 for Germany, France and Italy, to mid-1990s for Netherlands and Spain, and starts in 2005 for Austria, Belgium, Finland, Greece and Portugal. The minimum number of forecasters per country-month is four, but for most of country-month observations there are at least eight to ten individual forecasts available.

We also use the average Consensus forecasts at the country level. In regressions of forecast errors on forecast revisions, we use average forecasts for the current calendar year. When we investigate the reaction of average expectations to macroeconomic shocks, we construct a series of average one-year ahead inflation expectations using a weighted average of current and next calendar year (average) forecasts as in Dovern et al. (2009). Tables 10 and 11 in the Appendix show summary statistics for the Connsensus forecasts. A comparison with the Tables 8 and 9 for consumer expectations confirms two facts documented in the literature. First, consumers tend to have higher average inflation expectations than professional forecasters. Second, the dispersion of forecasts is also larger for consumers.

Figure (8) *Average one-year ahead inflation expectations of professional forecasters by country.*



Source: Consensus Economics.

Figure 8 shows average year-on-year forecasts of professional forecasters for 10 countries, between January 2004 and June 2019. The forecasts show a clear co-movement pattern across countries over time, especially around the GFC. At the same time, there is considerable cross-section variation in expectations over the entire sample. Finally, in most countries the average expectations of year-ahead inflation seem to be at a somewhat lower level in recent recent years compared to pre-GFC.

4.3 Other data

The headline inflation (harmonized consumption price index, HICP) data comes from Eurostat. Finally, we also use several structural shocks that come from various external sources:

- Global demand shock series come from Kilian (2009), who identifies oil supply and demand shocks from a structural VAR(3) model. Given the low contribution of oil supply shocks to inflation in our country sample, we focus on the oil demand shocks that are extended for the sample span.

- Global demand and global oil supply shock series are based on Bobeica and Jarociński (2019) medium-scale VAR for the euro area, which we extended to cover our sample of consumers' inflation expectations.

- Euro area monetary shocks are from Jarociński and Karadi (2020), who identify the two shocks from a VAR for the euro area with zero and sign restrictions.

- Oil supply news shock series are from Kanzig (2021), who uses high-frequency surprises around OPEC announcements as the external instrument to identify structural oil supply news shocks in a VAR(6) model.[15]

5 Individual inflation expectations

We first analyze the behavior of individual expectations. For this purpose, we use the approach proposed in CG (2015) and applied by Bordalo et al. (2020) and Angeletos et al. (2020). The underlying idea is that under the FIRE hypothesis, ex-post forecast errors should not be predictable from past forecast revisions. Consider the following regression for inflation forecast errors:

$$\underbrace{\pi^{j}_{t+k,t} - \pi^{i,j}_{t+k,t|t+l}}_{\text{forecast error of forecaster } i} = \beta^p_0 + \beta^p_1 \underbrace{(\pi^{i,j}_{t+k,t|t+l} - \pi^{i,j}_{t+k,t|t+l-m})}_{\text{forecast revision of forecaster } i} + \varepsilon^{i,j}_{t+k}, \tag{5}$$

where $\pi^{i,j}_{t+k,t|t+l}$ and $\pi^{i,j}_{t+k,t|t+l-m}$ correspond to forecasts for inflation between months t and $t+k$ in country j made in months $t+l$ and $t+l-m$ by forecaster i, with $l<k$; $\pi^{j}_{t+k,t}$ stands for actual inflation between months t and $t+k$ in country j. As in Bordalo et al. (2020), the superscript p on the coefficients refers to pooling of individual-level data. If the coefficient β^p_1 on the forecast revision is positive (negative), professional forecasters update their own forecasts by "too little" (too much), which results in positive (negative) forecast errors. Instead, $\beta^p_1 = 0$ under rational expectations.

Since the EC Consumer Survey does not track answers of the same respondents over time, we rely on individual inflation forecasts of professional forecasters from Consensus Economics. We take advantage of the fact that, each month, Consensus Forecast ask the same set of respondents about inflation in the current calendar year. As the time of the year passes, the distance between the time of making the forecast and the end-point of the period for which the forecast is made, gets smaller. This allows us to estimate regression (5). Table 2 shows the results when using 1-month and 3-month revisions. In each case we control for country-forecaster fixed effects. We also add dummies for months of the year, to control for the varying horizon of the forecast over a year. The sample is unbalanced, and includes individual forecasts in 10 countries, going back to as early as 1997.[16] In both specifications the coefficient on the forecast revision is negative and highly statistically significant, suggesting overreaction to news about inflation at the individual forecaster level. The results are robust to including year fixed effects.

Figure 9 plots coefficients β^p_1 obtained from the regression (5) estimated for each month of a year separately. Each point on the horizontal axis corresponds to the month of the forecast for which the equation (5) was estimated. For example, number 4 corresponds to April, number 5 to May, and so on. Across the horizons, the coefficients on forecast revisions are negative and

[15] Past literature has frequently used the Hamilton (1996) oil supply shocks. In Hamilton (1996) a shock takes a positive value in months in which the oil price exceeds the maximum oil price over the last 12 months. The shock is then equal to the difference between the current price and the maximum over the last 12 months, and zero otherwise. We prefer to use the Kanzig (2021) shocks instead, as it allows us to have more non-zero observations when we consider expectations post-GFC.

[16] For the period before 1997 we could only obtain individual-level forecasts for Germany, France and Italy.

Table (2) *Individual inflation forecast error on forecast revision regression results*

	(1)	(2)
1-month revision	-0.280***	
	(0.010)	
3-month revision		-0.097***
		(0.008)
Observations	30,471	24,625
Country-forecaster FE	YES	YES
Month FE	YES	YES

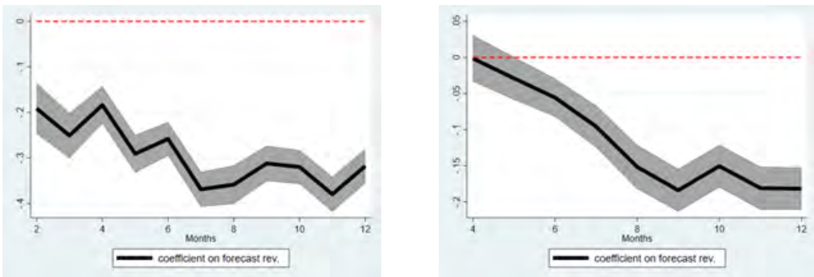
Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Table 2 shows results of regression (5) for the current calendar year inflation forecast errors of individual forecasters from Consensus Forecasts, estimated using revisions of i) previous-month forecast (column 1) and ii) forecasts 3 months ago (column 2).

statistically significant. Interestingly, the size of the overreaction does not decline at horizons closer to the end of the calendar year, but in fact increases.

Figure (9) *Responses of individual inflation forecast errors to forecast revisions*

1-month revision 3-month revision



Note: The figure plots coefficients β_1^p from equation (5) for the current calendar year inflation forecast errors of individual forecasters from Consensus Forecasts, estimated month by month using revisions of i) previous-month forecast (left panel) and ii) forecasts 3 months ago (right panel). Shaded areas correspond tot 90% confidence intervals.

The estimation results of equation (5) bring us to the first stylized fact about the expectation formation process that we document for the euro area countries:

Stylized fact 1: *Individual inflation forecasts overreact to news about inflation.*

This is consistent with recent evidence for the U.S. Using individual forecasts of a broad range of macroeconomic variables in the Survey of Professional Forecasters (SPF) and Blue Chip Survey, Bordalo et al. (2020) find that forecasters mostly overreact to news, with the coefficient β_1^p negative and significant in 14 out of 22 regressions (including for CPI inflation). Using the same SPF Survey, Angeletos et al. (2020) find evidence of overreaction of individual inflation forecasts to forecast revisions, but no such evidence for forecasts of unemployment in the post-1984 period.

6 Behavior of average expectations

6.1 Average forecast errors and forecast revisions

Next, we look at the behavior of average expectations from surveys. We conduct two exercises. First, we re-estimate equation (5) but this time using average forecasts for current-year inflation from Consensus Economics:

$$\underbrace{\pi^j_{t+k,t} - \bar{\pi}^j_{t+k,t|t+l}}_{\text{average forecast error in country } j} = \beta_0 + \beta_1 \underbrace{(\bar{\pi}^j_{t+k,t|t+l} - \bar{\pi}^j_{t+k,t|t+l-m})}_{\text{average forecast revision in country } j} + \varepsilon^j_{t+k}, \qquad (6)$$

where $\bar{\pi}^j_{t+k,t|t+l}$ and $\bar{\pi}^j_{t+k,t|t+l-m}$ correspond to average forecasts for inflation between months t and $t+k$ in country j made in months $t+l$ and $t+l-m$. Table 3 shows estimation results for the full sample (with month dummies and country fixed effects), while Figure 10 plots coefficients β_1 obtained from the regression (6) estimated month by month (controlling for country fixed effects). The sample covers 10 countries, between 1996m01–2019m06. The results hold also when we focus on the 2004m01–2019m06 sample, consistent with the next exercise we perform in this section.

Table (3) *Average inflation forecast error on forecast revision regression results*

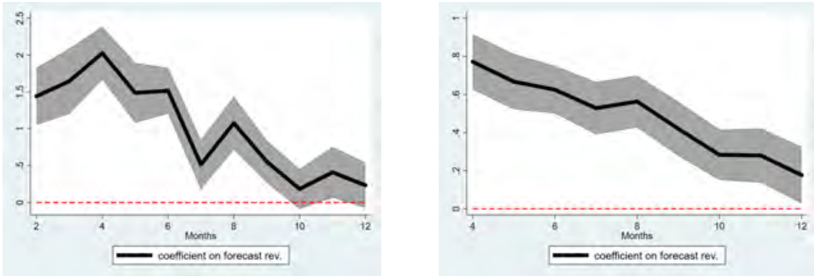
	(1)	(2)
1-month revision	1.189***	
	(0.125)	
3-month revision		0.557***
		(0.066)
Observations	2,629	2,151
Country FE	YES	YES
Month FE	YES	YES

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Table 3 shows results of regression (6) for the current calendar year average inflation forecast errors from Consensus Forecasts, estimated using revisions of i) previous-month forecast (column 1) and ii) forecasts 3 months ago (column 2).

Figure (10) *Responses of inflation forecast errors from Consensus Forecasts to forecast revisions*

1-month revision 3-month revision



Note: The figure plots coefficients β from equation (6) for the current calendar year forecast errors from Consensus Forecasts, estimated using revisions of i) previous-month forecast (left panel) and ii) forecasts 3 months ago (right panel). Shaded areas correspond to 90% confidence intervals.

Consistent with CG (2015) and Angeletos et al. (2020) we also find evidence of underreaction of *average* inflation forecasts to news about inflation: the coefficient β_1 is positive and statistically significant across different specifications. As Figure 10 makes clear, the size of underreaction to revisions declines over time (coefficient β_1 becomes smaller).

6.2 Responses of inflation expectations to macroeconomic shocks

Methodology. In the second exercise, we study how average survey expectations responds to news over longer horizons than the next few months. For this purpose we use the average expectations of 12-months ahead inflation and unemployment available on monthly frequency from the EC Consumer Survey, as well as 12-months ahead average inflation expectations of professional forecasters from Consensus Economics, computed as the weighted average of current and next calendar year inflation forecasts.[17]

The methodology that we apply is in the spirit of CG (2012) who proposed a simple empirical test of the models of expectations formation based on a following ARMA specification:

$$\pi_{t,t-4} - \bar{\pi}_{t,t-4|t-4} = \alpha + \sum_{k=1}^{K} \beta_k (\pi_{t-k,t-4-k} - \bar{\pi}_{t-k,t-4-k|t-4-k}) + \sum_{l=0}^{L} \gamma_l \epsilon_{t-l}^s + \xi_t^s, \tag{7}$$

where ϵ_t^s stands for an externally identified macroeconomic shock in quarter t and where $\pi_{t,t-4} - \bar{\pi}_{t,t-4|t-4}$ is the (ex-post) inflation forecast error in quarter t ($\pi_{t,t-4}$ and $\bar{\pi}_{t,t-4|t-4}$ stand for realized inflation between quarters $t-4$ and t, and for the inflation expected, on average, in quarter $t-4$).

Under FIRE, inflation forecasts should respond to shocks by the same amount as future inflation. Thus, forecast errors should not respond to shocks, with $\gamma_0 = 0$ in Equation (7). Conversely, if expectations underreact to inflationary shocks we should see $\gamma_0 > 0$, and $\gamma_0 < 0$ if expectations overreact.

[17]The expectation series used in this exercise are characterized by a constant 12-month horizon, which allows us to look at the dynamic response over time. In comparison, the forecast horizon in the current calendar year forecasts in Consensus Economics changes each month by design.

Most recently, however, Angeletos et al. (2020) show that an ARMA specification with a low number of lags may impose important constraints on the estimated dynamic response of forecast errors to shocks. To mitigate these concerns, we thus apply the local projections of Jordà (2005) that allow for more flexibility in the estimated responses to shocks over time:

$$\underbrace{\pi^j_{t+h,t+h-12} - \bar{\pi}^j_{t+h,t+h-12|t+h-12}}_{\text{average forecast error in country } j} = \alpha^{j,h} + \sum_{k=1}^{K} \beta^h_k (\pi^j_{t-k,t-k-12} - \bar{\pi}^j_{t-k,t-k-12|t-k-12}) \\ + \sum_{k=1}^{K} \delta^h_k \pi^j_{t-k,t-k-12} + \sum_{l=0}^{L} \gamma^h_l \epsilon^s_{t-l} + \xi^{j,s}_{t+h}, \quad (8)$$

where ϵ^s_t stands for a (global) shock s in month t, and j is again the country index. We also control for lags of realized inflation. In all regressions, we set $K = 6$ and $L = 2$, and consider horizons $h = 1, 2.., 24$. Again, a positive value of the coefficient γ^h_0 indicates an underreaction of expectations to a positive (inflationary) shock h months after, and a negative value–an overreaction. We start the analysis with expectations of inflation; we use forecast errors of consumers' unemployment expectations in section 6.4.

Finally, we also report results of regression (8) for actual year-on-year inflation and average expectations of year-on-year inflation:

$$y^j_{t+h,t+h-12} = \alpha^{j,h} + \sum_{k=1}^{K} \beta^h_k \bar{\pi}^j_{t-k,t-k-12|t-k-12} + \sum_{k=1}^{K} \delta^h_k \pi^j_{t-k,t-k-12} + \sum_{l=0}^{L} \gamma^h_l \epsilon^s_{t-l} + \xi^{j,s}_{t+h}, \quad (9)$$

where $y^j_{t+h,t+h-12}$ stands for $\pi^j_{t-k,t-k-12}$ or for $\bar{\pi}^j_{i,t-k,t-k-12|t-k-12}$.

When presenting the results, we use the following timing convention:

- For the responses of actual inflation and mean inflation expectations in regression (9), we will analyze next 24 months after the shock, i.e., $h = 1, 2, ..24$.
- For the forecast errors in equation (8), we will consider only responses in the second year, i.e., $h = 13, ..24$. This is because any biases in forecast errors in the first 11 months after the shock would simply reflect the fact that expectations were made *before* the shock materialized. For this reason, we can only consider forecast errors for the further horizons.

Identification of shocks. We consider a range of externally identified shocks. Table 4 provides information on all structural shocks used in the analysis, their average contribution to inflation dynamics across countries in the sample, and availability in the period for which we have data on household expectations from the EC Consumer Survey.[18] All shocks we consider are either global or, in the case of monetary shocks, common to all countries in the sample. By keeping the coefficients γ country-invariant, we implicitly assume that the behavior of inflation and inflation expectations in response to a given shock is the same in all countries.

[18] We use time series of shocks as made available by Jarociński and Karadi (2020) and Kanzig (2021). For the rest of shocks, we re-estimate the models after extending the sample until 2019m6.

When discussing the main results in section 6.3, we focus on shocks available at monthly frequency, i.e. Kanzig (2021) oil supply shock, Kilian (2009) global demand shock, and two Eurozone monetary shocks from Jarociński and Karadi (2020). In section 6.5 we show that results carry through to global demand and global oil supply shocks from Bobeica and Jarociński (2019) that are available at *quarterly* frequency but account for a larger share of total variation in inflation in our sample.

Table (4) Structural shocks and contribution to inflation volatility

shock	frequency	sample	avg. share of inflation volatility (in %)
Kanzig (2021) oil supply news	monthly	2004m01–2017m12	15.8
Kilian (2009) global demand	monthly	2004m01–2019m06	3.8
Jarociński and Karadi (2020) monetary policy	monthly	2004m01–2016m12	2.2
Jarociński and Karadi (2020) monetary information	monthly	2004m01–2016m12	1.1
Bobeica and Jarociński (2019) global demand	quarterly	2004Q1–2019Q2	34.3
Bobeica and Jarociński (2019) global oil supply	quarterly	2004Q1–2019Q2	21.9

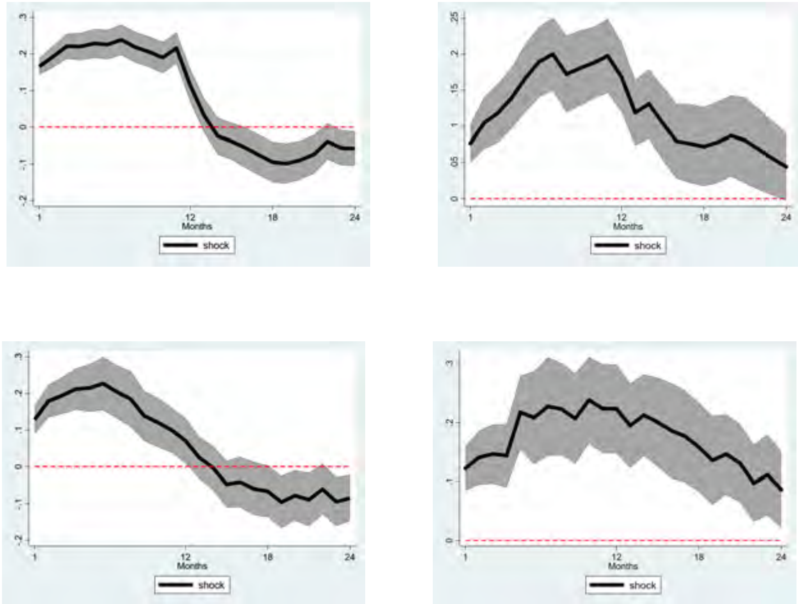
Note: for the description of individual shocks, see Section 4.3. Inflation variance decomposition is based on country-specific VAR(2) models, estimated on a sample 2004m01–2019m06. The reported contribution is the average contribution across countries.

6.3 Results for inflation expectations

Expectations of consumers. We consider regressions (8) and (9) with one shock at a time, and begin with expectations of consumers from the EU Consumer Survey. Figure 11 shows responses of actual inflation and inflation expected in 12 months time to an adverse Kanzig (2021) global oil supply shock and to a positive Kilian (2009) global demand shock. Both actual and expected inflation increase in response to the two inflationary shocks and remain elevated for a prolonged period of time (of 15 to 24 months).

Figure (11) *Impulse responses of actual inflation and of average inflation expectations from EC Consumer Survey: global shocks*

Oil supply shock Global demand shock

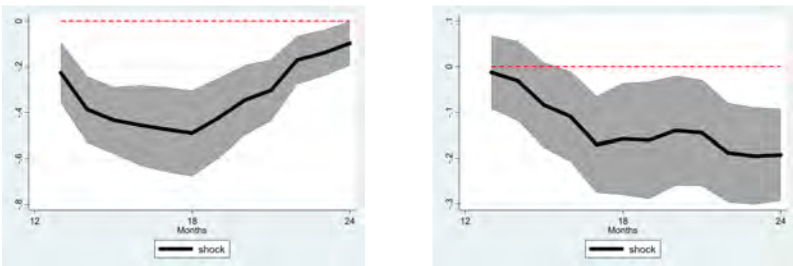


Note: The figure plots coefficients on the i) global oil supply shock (left panel) and ii) global demand shock (right panel) from regression (9) where the dependent variable is realized y-on-y inflation (top panel) and average inflation expectations from EC Consumer Survey (bottom panel). Grey areas denote 90% confidence intervals.

Figure 12 plots responses of forecast errors at months 13-24 after the shock. For both oil and demand shocks, forecast errors exhibit a statistically significant downward bias over most of the horizon considered. In other words, EC Survey respondents overestimate the medium-term impact of those shocks on inflation.

Figure (12) *Impulse responses of average inflation forecast errors from EC Consumer Survey: global shocks*

Oil supply shock Global demand shock

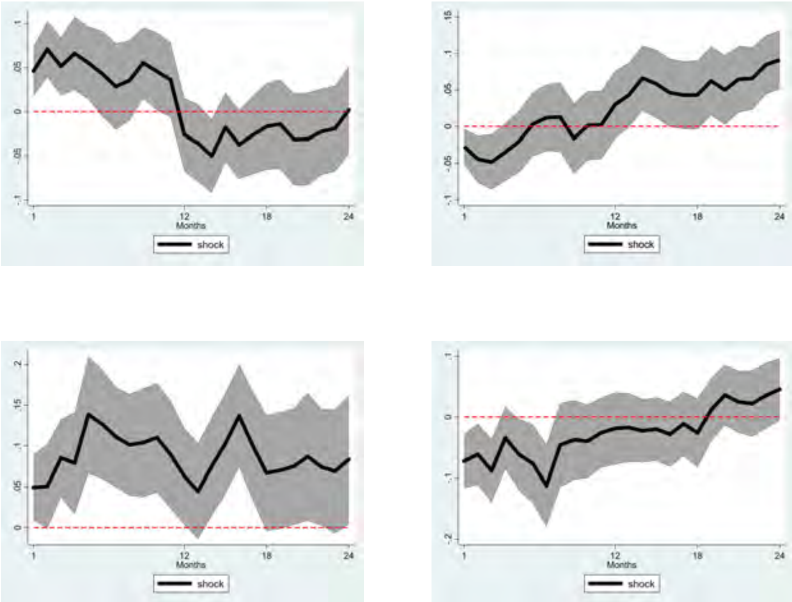


Note: The figure plots coefficients on the i) global oil supply shock (left panel) and ii) global demand shock (right panel) from regression (8). Grey areas denote 90% confidence intervals.

Next, we consider responses of inflation and expectations to the monetary policy and monetary information shocks of Jarociński and Karadi (2020). The monetary policy shock impacts inflation through the standard transmission channels of interest rates. The monetary information shock is a complementary shock, which works through the information about central bank's assessment of the economy that is revealed by the policy action. For example, a surprise policy easing increases inflation, while the complementary monetary information shock leads to a negative correction of agents' views on the economic outlook, leading to a downward price pressure.

Figure (13) *Impulse responses of actual inflation and average inflation expectations from EC Consumer Survey: monetary shocks*

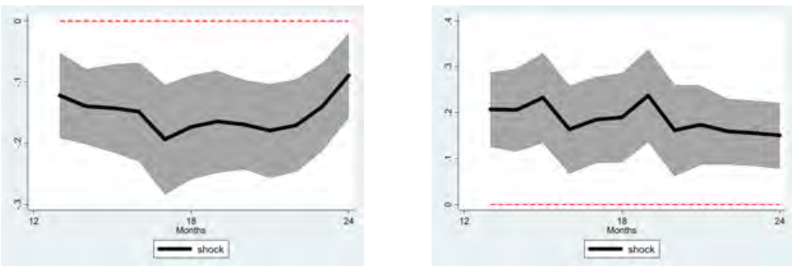
Monetary policy shock | Monetary information shock



Note: The figure plots coefficients on the i) monetary policy (left panel) and ii) monetary information shock (right panel) from regression (9) when the dependent variable is y-on-y inflation (top panel) and and average inflation expectations from EC Consumer Survey (bottom panel). Grey areas denote 90% confidence intervals.

Figure (14) *Impulse responses of average inflation forecast errors from EC Consumer Survey: monetary shocks*

Monetary policy shock | Monetary policy information shock



Note: The figure plots coefficients on the i) euro area monetary policy (left panel) and ii) euro area monetary information shock (right panel) from regression (8). Grey areas denote 90% confidence intervals.

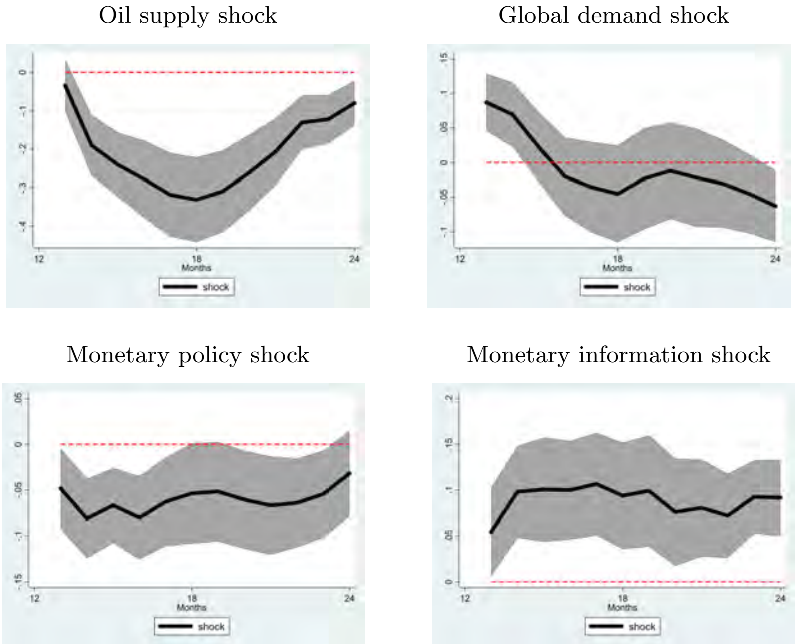
As Figure 13 shows, an easing monetary policy shock and a complementary negative monetary information shock have respectively inflationary and deflationary effects on realized inflation and on inflation expectations, on impact. The response of actual inflation to the information shock is, however, only significant initially and flips sign after 10 months. Both shocks seem to have a more significant and persistent impact on inflation expectations compared with actual inflation.

This is confirmed when looking at the impact of the two monetary shocks on inflation forecast errors (Figure 14). Forecast errors show a statistically significant *negative* bias for the inflationary monetary policy shock, and a *positive* bias for the deflationary information shock. Both reactions are consistent with an overreaction of inflation expectations.

Expectations of professional forecasters. Figure 15 shows responses of average forecast errors for one-year ahead inflation expectations of professional forecasters from Consensus Economics. We do not show responses of average expectations of professionals, but those are very similar to responses shown in Figures 11 and 13 for expectations of consumers.

The forecast errors show overreaction for three out of four shocks: the oil supply shock, and two monetary shocks. Forecast errors after the global demand shock are positive 13 to 14 months after the shock (suggesting an underreaction), and then become statistically insignificant, indicating no evidence of overreaction to the shock at longer horizons. Overall, we interpret the evidence from one-year ahead Consensus Forecasts to be consistent with the results for consumers' expectations.

Figure (15) *Impulse responses of average inflation forecast errors from Consensus Forecasts*



Note: The figure plots coefficients on the i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Jarociński and Karadi (2020) euro area monetary policy shock (bottom left panel), and iv) Jarociński and Karadi (2020) euro area monetary information shock (bottom right panel), from regression (8). Grey areas denote 90% confidence intervals.

Overall, our results point to two main takeaways. First, agents' inflation expectations do move in response to macroeconomic shocks, and the reactions are consistent with economic intuition. Second, both professionals and consumers tend to overestimate the medium-term impact of shocks on inflation.

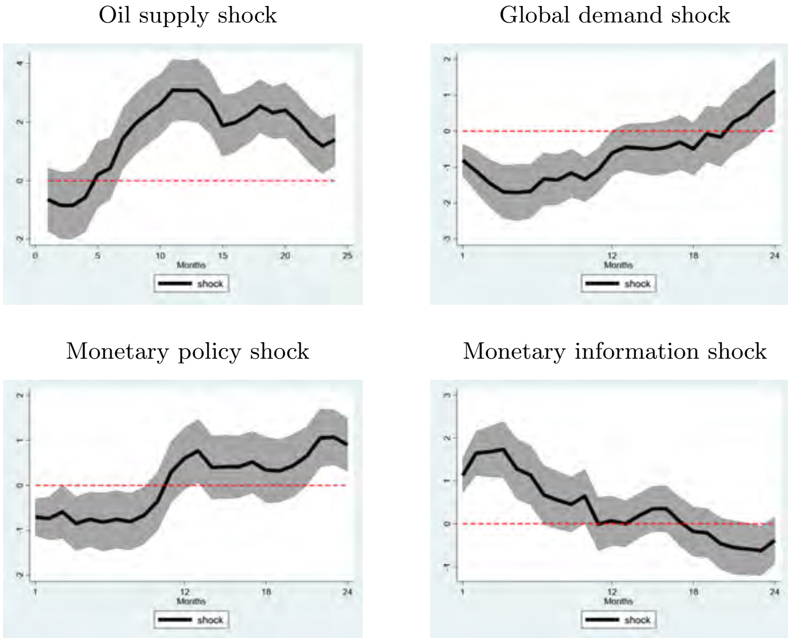
6.4 Results for unemployment expectations

We next look at at consumers' expectations of unemployment. Figure 16 shows responses of unemployment expectations to the four monthly shocks we considered before. In line with intuition, an adverse oil supply shock increases the expected unemployment. A positive global demand shock and an easing monetary policy shock both reduce unemployment expectations, while a deflationary monetary information shock increases the expected unemployment rate.

To investigate if expectations under- or overreact to the shocks, we turn to the analysis of forecast errors, which are calculated as the difference between actual unemployment rate and expected unemployment rate for the same period.[19]

Figure 17 plots responses of forecast errors at months 13-24 after the shocks. For the global demand and the two monetary policy shocks, the behavior of forecast errors suggests an overreaction to the shocks starting already in month 13, while for the oil supply shock the overreaction of expectations is somewhat delayed and starts after 18 months following a shock.

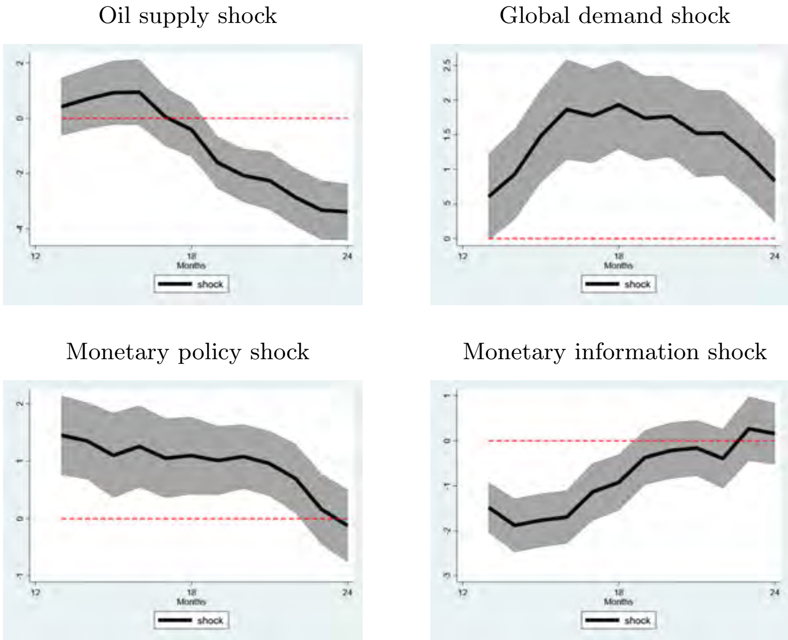
Figure (16) *Impulse responses of average unemployment expectations from EC Consumer Survey*



Note: The figure plots coefficients on the i) global oil supply shock (top left panel), ii) global demand shock (top right panel), iii) monetary policy shock (bottom left panel) and iv) monetary information shock (bottom right panel) from regression (9). Grey areas denote 90% confidence intervals.

[19]The expected unemployment rate is proxied by the balance of qualitative answers from question Q7 in the EU Consumer Survey. See Section 4.1 for details. The constant terms in local projection regressions absorb the average difference in the levels of the balance variable and the actual unemployment rate, which emerges due to the design of the balance variable.

Figure (17) *Impulse responses of average unemployment forecast errors from EC Consumer Survey*



Note: The figure plots coefficients on the i) global oil supply shock (top left panel), ii) global demand shock (top right panel), iii) monetary policy shock (bottom left panel) and iv) monetary information shock (bottom right panel) from regression (8). Grey areas denote 90% confidence intervals.

Again, the results suggest consumers' unemployment expectations respond to shocks in the direction suggested by standard economic theory. Moreover, households tend to overestimate the impact of shocks on unemployment over the medium term.

This allows us to document the second fact about expectations formation in the euro area countries.

Stylized fact 2: *Average expectations underreact to news initially, but overreact in the medium term.*

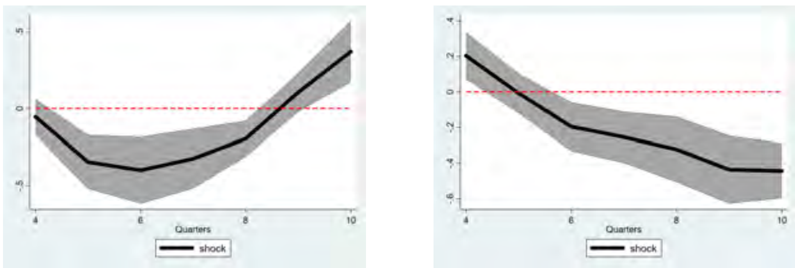
This fact is consistent with evidence presented recently in Angeletos et al. (2020) for inflation and unemployment expectations in the U.S.. However, also for the U.S., CG (2012) find evidence of continuous underreaction of average inflation expectations to shocks over time. That is, their results do not indicate overreaction of expectations in the medium term. Angeletos et al. (2020) argue that this might be due to the strict restrictions imposed on the impulse responses by the ARMA specification used in CG (2012). Nevertheless, in the rest of the section we test robustness of our results and try to reconcile them with the CG (2012) analysis.

6.5 Robustness

Alternative macroeconomic shocks. First, we verify that the overreaction of medium-term inflation expectations to shocks holds also if we consider alternative shocks. We also show results from country-specific regressions and discuss evidence from the U.S.. For brevity, we focus on the responses of inflation forecast errors. Figure 18 shows impulse responses of average inflation forecast errors from the EC Consumer Survey to two (inflationary) shocks identified in Bobeica and Jarociński (2019): a global oil supply shock and an aggregate demand shock. The frequency of the two shocks is quarterly, in each case we control for 4 lags of the dependent variable and of realized inflation, and focus on responses of forecast errors in 4–10 quarters after the shock. Consistent with the results in the previous sections, average expectations of a year-ahead inflation overreact to the two inflationary shocks, leading to a statistically significant negative bias in average forecast errors for most of the horizon considered. The responses to shocks are very similar if we use average inflation forecast errors of professional forecasters from Consensus Economics instead.

Figure (18) *Impulse responses of average inflation forecast errors from EC Consumer Survey: quarterly shocks*

BJ (2019) oil supply shock BJ (2019) demand shock



Note: The figure plots coefficients on the i) global oil supply (left panel) and ii) global demand shocks (right panel) identified in Bobeica and Jarociński (2019), from regression (8). Grey areas denote 90% confidence intervals.

Next, we verify that the results also hold in country-specific regressions. Figure 28 in the Appendix A shows responses of average forecast errors from the EC Consumer Survey to Kanzig (2021) oil and Kilian (2009) global demand shocks for the largest four countries in our sample: Germany, France, Italy and Spain. Although in few instances less significant that in the panel regressions, the results again point to the overreaction of expectations. Finally, our results are robust to controlling for the global financial crisis (GFC) and adding a post-GFC time dummy.

Evidence from the U.S. We run regressions (8) and (9) using U.S. inflation expectations from the Michigan Consumer Survey and the Survey of Professional Forecasters. For that purpose, we use two shocks that the literature has found to account for a large variation of inflation in the U.S.: the Gali (1999) technology shock and the Hamilton (1996) oil supply shock, as well as the Kanzig (2021) oil news shock. The sample is quarterly, between 1990Q1-2020Q1. Figure 29 in the Appendix A shows responses of average forecast errors for the two surveys. Similar to the results for the euro area, we find evidence of overreaction to shocks, particularly for the expectations of consumers (although the estimates are characterized by larger standard errors).

To reconcile our results for the U.S. with CG (2012), we conduct the following exercise. First, we estimate regressions (8) and (9) using the same sample (1976Q1-2007Q3) and shock series as CG (2012) did. Consistent with their findings based on an ARMA specification, we too find that expectations underreact to shocks also at medium-term horizons. However, when in the next step we run the two regressions with the CG (2012) data but on a shorter sample that excludes the period of very high inflation in late 1970s and early 1980s (i.e. starting in 1985), the results change (Figure 30 in the Appendix). First, although the impulse responses are again less statistically significant compared to our euro area analysis, when the impulse responses are significantly different from zero their sign is consistent with overreaction to shocks in 5 out of 6 cases (only for the SPF survey and the Hamilton (1996) shock the impulse response is consistent with underreaction).

7 Disagreement about future inflation

Another dimension which the models of expectations formation offer predictions for, is disagreement among forecasters. For example, in the simple models of noisy information (Woodford 2003), disagreement about future inflation should be invariant to to macroeconomic shocks, whereas the sticky information model of Mankiw and Reis (2004) as well as a version of the noisy information model with heterogenous signal precision imply that disagreement should rise after any shock.

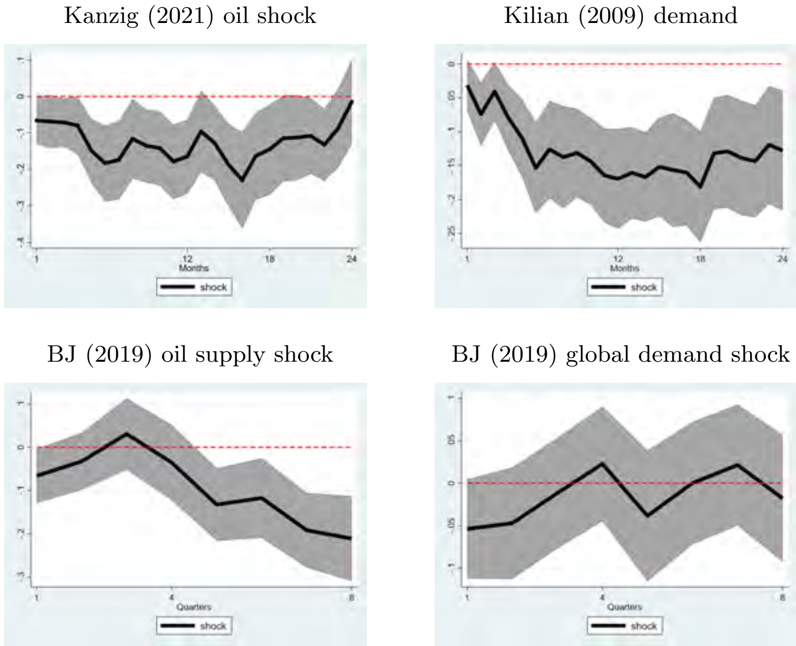
To assess whether disagreement about future inflation responds to shocks, we estimate the following regression, proposed by CG (2012):

$$\begin{aligned}\sigma(\pi^j_{t+h,t+h-12|t+h-12}) = \alpha^{j,h} &+ \sum_{k=1}^{K} \beta^h_k \sigma(\pi^j_{t-k,t-k-12|t-k-12}) \\ &+ \sum_{k=1}^{K} \delta^h_k \pi^j_{t-k,t-k-12} + \sum_{l=0}^{L} \gamma^h_l |\epsilon^s_{t-l}| + \xi^{j,s}_{t+h},\end{aligned} \tag{10}$$

where $\sigma(\pi^j_{t+h,t+h-12|t+h-12})$ is the cross-sectional standard deviation of forecasts of 12-month ahead inflation. Following GC (2012) we use the absolute value of shocks because predictions for the dynamics of disagreement of both the sticky information and the noisy information models apply symmetrically to inflationary and deflationary shocks. Again, we set $K = 6$ and $L = 2$.

Figure 19 shows the impulse responses of disagreement about future inflation from the EU Consumer Survey to four macroeconomic shocks. To show the results hold also for shocks accounting for a large variation in the euro area inflation, we focus on two out of four shocks available at monthly frequency: Kanzig (2021) oil supply shock and the global demand shock of Kilian (2009) and the two quarterly shocks in Bobeica and Jarocinski (2019).

Figure (19) *Impulse responses of disagreement about future inflation from EU Consumer Survey*



Note: The figure plots impulse responses of cross-sectional standard deviation of inflation expectations from the EU Consumer Survey in (10) to i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Bobeica and Jarocinski (2019) global oil shock (bottom left panel), and iv) Bobeica and Jarocinski (2019) global demand shock (bottom right panel). Grey areas denote 90% confidence intervals.

Surprisingly, the results are broadly consistent with a decline in disagreement following macroeconomic shocks. Disagreement about future inflation clearly declines among consumers following the Kanzig (2021) oil supply shock and the global demand shock of Kilian (2009).[20] When looking at the quarterly shocks in Bobeica and Jarocinski (2019), that account for larger share of inflation variation, the picture is somewhat more mixed. In particular, there is no evidence that disagreement responds in a statistically significant manner to the global demand shock, but for the global oil supply shock, the disagreement starts to decline after one year.

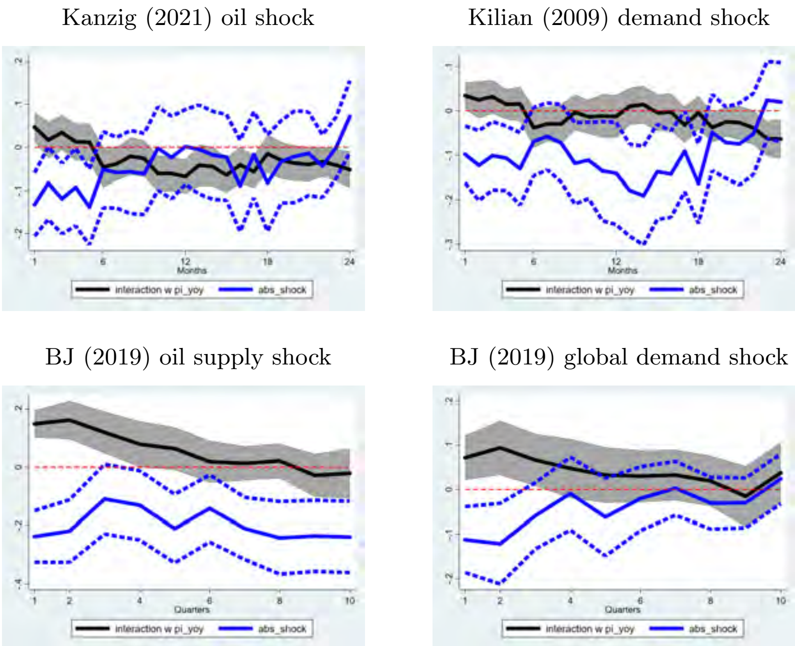
Empirically both CG (2015) and Angeletos et al. (2020) find no evidence of disagreement responding to inflationary or deflationary shocks in the U.S., consistent with the simple noisy information models (that do not allow for heterogeneity in signal-to-noise ratios among agents). However, our finding that after some shocks disagreement declines is at odds with the main theories of information formation. Thus, in the next step we verify whether the results are driven by a nonlinear character of the relationship between disagreement, shocks and current inflation not captured by (10). Formally, we consider the following specification:

[20] The impulse responses to the two monetary shocks also indicate a decline in disagreement among consumers.

$$
\begin{aligned}
\sigma(\pi^j_{t+h,t+h-12|t+h-12}) &= \alpha^{j,h} + \sum_{k=1}^{K} \beta^h_k \sigma(\pi^j_{t-k,t-k-12|t-k-12}) \\
&+ \sum_{k=1}^{K} \delta^h_k \pi^j_{t-k,t-k-12} + \sum_{l=0}^{L} \gamma^h_l |\epsilon^s_{t-l}| + \sum_{l=0}^{L} \eta^h_l (|\epsilon^s_{t-l}| \times \pi^j_{t-l,t-l-12}) + \xi^{j,s}_{t+h},
\end{aligned}
\tag{11}
$$

where η_0 is the coefficient on the interaction term between the shock and the current period inflation. Figure 20 shows coefficients on the standalone shock term (blue lines) and the coefficient on the interaction term with the current period inflation (black lines) at horizons $h = 1...24$ after the same four shocks as before. While the impact of each standalone shock (in absolute terms) remains negative, the interaction term is positive and statistically significant immediately after each of the shocks. In other words, consumers' disagreement about future inflation continues to increases in response to both inflationary and deflationary shocks when the current inflation is sufficiently high, but declines when the current inflation is low.

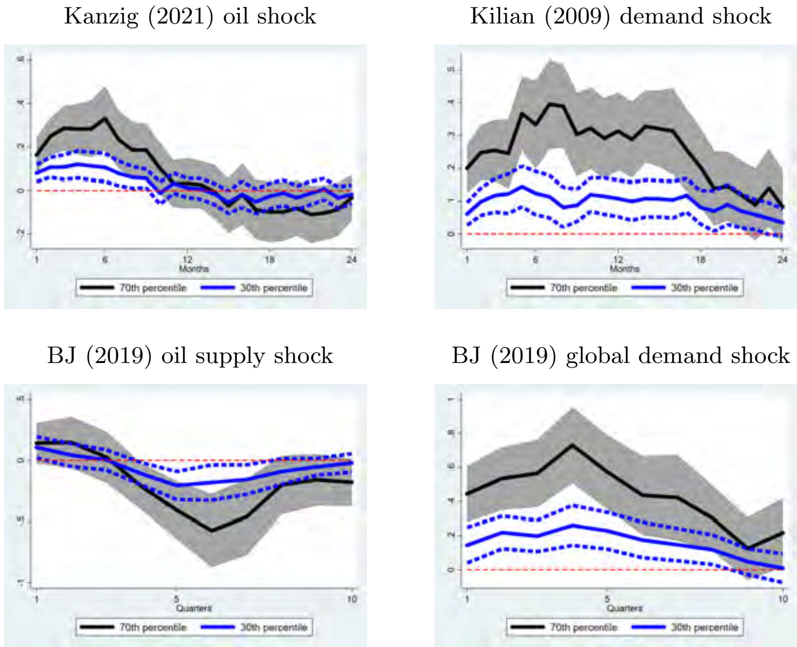
Figure (20) *Impulse responses of disagreement: a nonlinear specification*



Note: The figure plots impulse responses of cross-sectional standard deviation of inflation expectations from the EU Consumer Survey in (11) to i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Bobeica and Jarocinski (2019) global oil supply shock (bottom left panel), and iv) Bobeica and Jarocinski (2019) global demand shock (bottom right panel). Black lines show the coefficient on the interaction term between the shock and current period inflation, and blue lines–the coefficient on the standalone shock term. Grey areas and blue dotted lines denote 90% confidence intervals.

To understand better this differential dynamics of disagreement depending on the level of inflation, we looked at the behavior of different percentiles of inflation expectations in the EC Consumer Survey. First, we observe that if they fall to zero, lower (20th, 30th) percentiles stay at the zero level, i.e. they do not fall further. Such dynamics are very robust across countries and over time. Second, across all the countries, we see that lower percentiles of the expectations distribution are much less responsive to shocks, compared to upper (70th, 80th) percentiles of expectations distribution, when we reestimate (9) with percentiles of expectations distribution rather than the mean expectations as the dependent variable: Figure 21 shows the results for 30th and 70th percentiles. Overall, we interpret this evidence as suggestive of a zero lower bound of inflation expectations, which could be consistent e.g. with the presence downward price rigidities.[21]

Figure (21) *Impulse responses of lower and upper percentiles of the households' expectations distribution.*



Note: The figure plots impulse responses of lower and upper percentiles of inflation expectations responses from the EU Consumer Survey in (8) to i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Bobeica and Jarocinski (2019) global oil supply shock (bottom left panel), and iv) Bobeica and Jarocinski (2019) global demand shock (bottom right panel). Black lines show the coefficient on the shock variable for the 70th percentile, and blue lines–for the 30th percentile. Grey areas and blue dotted lines denote 90% confidence intervals.

This brings us to the third fact about inflation expectations.

Stylized fact 3: *Consumers' disagreement about future inflation increases in response to both inflationary and deflationary shocks when the current inflation is high, and declines when current inflation is low. Lower percentiles of the expectations distribution are less responsive to news about inflation compared to upper percentiles, suggesting presence of a zero lower bound of expectations.*

[21] More details on the shape and movements of the entire distribution of inflation expectations, including results from the percentile regressions can be found in accompanying forthcoming ECFIN working paper under the same title.

8 Expectations post-GFC

In this section, we consider whether the overreaction of inflation expectations has changed over time. Given the time period covered in our sample, a natural candidate for generating such state-dependency is when monetary policy rate is close to or at the ZLB, prevalent in the euro area for most of the post-GFC period. The presence of the ZLB can affect agents expectations of inflation and other macroeconomic variables through multiple channels: such as perceptions of no or less effective policy response to future deflationary shocks, signalling of persistently weaker economic environment, or loss of attention to inflation developments if inflation remains persistently low (like in rational inattention models).

To study the impact of the ZLB on the responsiveness of inflation expectations to shocks, we augment regressions (5), (6), (8) and (9) with a ZLB dummy. For example, for the regression of average forecast errors in (6), we consider:

$$\begin{aligned} \pi^j_{t+k,t} - \bar{\pi}^j_{t+k,t|t+l} &= \beta_0 + \beta_1(\bar{\pi}^j_{t+k,t|t+l} - \bar{\pi}^j_{t+k,t|t+l-p}) \\ +\beta_2 \left((\bar{\pi}^j_{t+k,t|t+l} - \bar{\pi}^j_{t+k,t|t+l-p}) \times \mathbf{I}_{ZLB,t+l} \right) &+ \beta_3 \mathbf{I}_{ZLB,t+l} + \varepsilon^j_{t+k}, \end{aligned} \tag{12}$$

and for regression of average forecast errors in (8),

$$\begin{aligned} \pi^j_{t+h,t+h-12} - \bar{\pi}^j_{t+h,t+h-12|t+h-12} &= \alpha^{j,h} + \sum_{k=1}^{K} \beta^h_k (\pi^j_{t-k,t-k-12} - \bar{\pi}^j_{t-k,t-k-12|t-k-12}) \\ + \sum_{k=1}^{K} \delta^h_k \pi^j_{t-k,t-k-12} &+ \sum_{l=0}^{L} \gamma^h_l \epsilon^s_{t-l} + \eta^h (\epsilon^s_t \times \mathbf{I}_{ZLB,t}) + \rho^h \mathbf{I}_{ZLB,t} + \xi^{j,s}_{t+h}, \end{aligned} \tag{13}$$

where $\mathbf{I}_{ZLB}$ takes the value of 1 when the ECB policy rate is close to or at the ZLB and zero otherwise. Following Ehrman et al. (2019), we consider monetary policy to be at the ZLB when the policy rate is below 1 percent. For the euro area, this is between May 2009 and April 2011, and since January 2012 onward. An important caveat applies: while we focus our analysis on the interactions with the ZLB dummy, we recognize that the ZLB period covers a majority of the post-GFC part of the sample, thus our dummy might be capturing other effects as well.

8.1 Individual inflation expectations post-GFC

We begin by looking at the behavior of individual inflation forecast errors of professionals from Consensus Economics. Table 5 shows the results.

The coefficient on the interaction term between forecast revisions and the ZLB is negative and statistically significant for both revision horizons we consider. In other words, presence of the ZLB is associated with a larger overreaction of individual inflation expectations to news. Regressions month by month (not shown for brevity) show that this amplification impact is driven by forecasts made in the first six months of the calendar year.

Stylized fact 4: *Overreaction of individual forecasts to news increased after the global* *financial crisis.*

Table (5) *Individual inflation forecast error on forecast revision regression results: ZLB interaction*

	(1)	(2)
1-month revision	-0.221***	
	(0.010)	
1-month revision-ZLB interaction	-0.092***	
	(0.020)	
ZLB	-0.067***	-0.045***
	(0.010)	(0.010)
3-month revision		-0.044***
		(0.013)
3-month revision-ZLB interaction		-0.097***
		(0.017)
Observations	30,471	24,625
Country-forecaster FE	YES	YES
Month FE	YES	YES

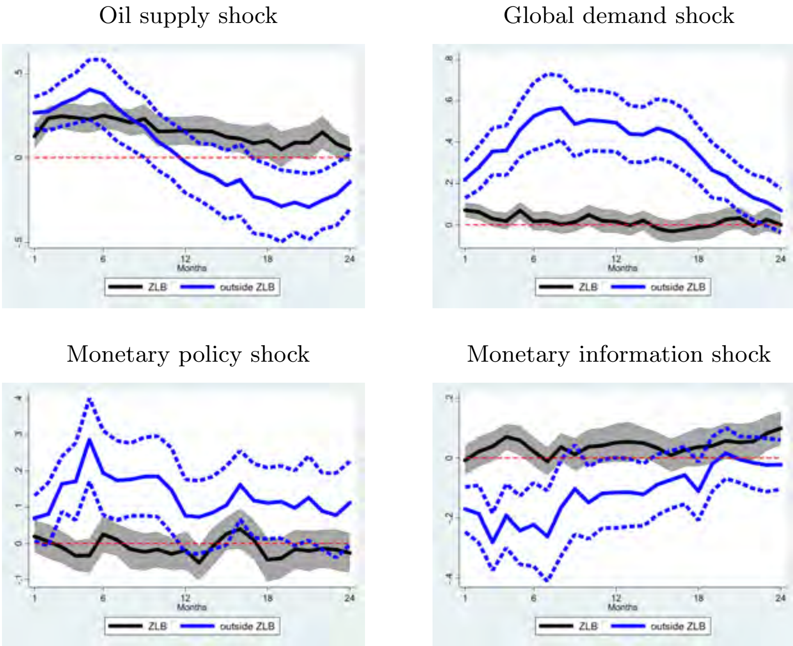
Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Table 5 shows results of regression (5) augmented with an interaction term of forecast revision with the ZLB dummy for the current calendar year inflation forecast errors of individual forecasters from Consensus Forecasts, estimated using revisions of i) previous-month forecast (column 1) and ii) forecasts 3 months ago (column 2).

8.2 Average inflation and unemployment expectations post-GFC

Actual inflation and average inflation expectations. We then look at how responsiveness of *actual inflation* and average *expectations* changed after the GFC. Figure 22 shows responses of average year-on-year inflation expectations from the EU Consumer Survey to four monthly shocks when the policy rate is outside the ZLB and at the ZLB.

Figure (22) *Impulse responses of average inflation expectations from the EU Consumer Survey at the ZLB*

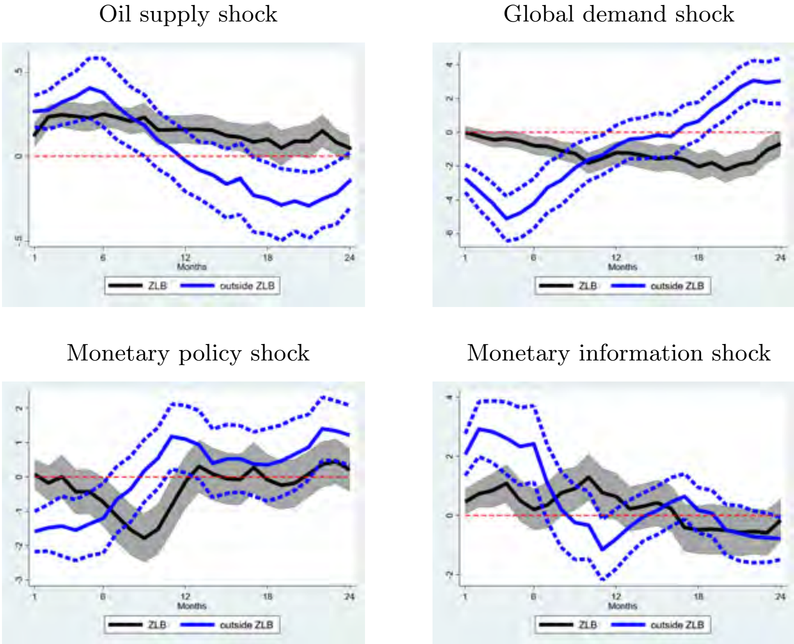


Note: The figure plots impulse responses of average inflation expectations from EU Consumer Survey to i) Kanzig (2021) global oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Jarociński and Karadi (2020) euro area monetary policy shock (bottom left panel), and iv) Jarociński and Karadi (2020) euro area monetary information shock (bottom right panel) at the ZLB (black line) and outside the ZLB (blue line). Grey areas and dotted blue lines denote 90% confidence intervals.

In the case of two monetary shocks and the global demand shock, the response of expectations is more muted at the ZLB, compared to the responses during the period when monetary policy is outside the ZLB. For the oil supply shock, the impulse response chart shows an initially more muted, but also more prolonged impact of the shock on expectations at the ZLB. We find very similar patterns when looking at average inflation expectations of professionals from the Consensus Forecasts. The impulse responses of actual inflation present very similar patterns as for the average inflation expectations (not shown).

Figure 23 shows responses of average unemployment expectations to four monthly shocks. In general, the impact on unemployment expectations is initially more muted at the ZLB, but also more persistent at times, for example in the case of the oil supply and aggregate demand shocks.

Figure (23) *Impulse responses of average unemployment expectations from the EU Consumer Survey at the ZLB*



Note: The figure plots impulse responses of average unemployment expectations from EU Consumer Survey to i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Jarociński and Karadi (2020) euro area monetary policy shock (bottom left panel), and iv) Jarociński and Karadi (2020) euro area monetary information shock (bottom right panel) at the ZLB (black line) and outside the ZLB (blue line). Grey areas and dotted blue lines denote 90% confidence intervals.

Overall, we take the above evidence as suggestive of more *muted* responsiveness of actual inflation and average inflation expectations to a range of economic shocks when monetary policy rate is close or at the ZLB. However, the evidence for unemployment expectations is more mixed.

Stylized fact 5: *Reaction of both average inflation expectations and actual inflation to news is (much) more muted post-GFC.*

Inflation forecast errors. Finally, we turn to the behavior of average forecast errors post-GFC. This will tell us whether the decline in responsiveness to news post-GFC was the same for expectations and for inflation or whether the expectations adjusted in a distinct manner.

Table 6 shows estimation results when regressing average forecast errors from Consensus Economics on forecast revisions when including an interaction term with the ZLB dummy (equation 12).

Table (6) *Average inflation forecast error on average forecast revision regression results: ZLB interaction*

	(1)	(2)
1-month revision	1.385***	
	(0.12)	
1-month revision-ZLB interaction	-0.409**	
	(0.16)	
ZLB	0.015	0.042
	(0.03)	(0.4)
3-month revision		0.570***
		(0.08)
3-month revision-ZLB interaction		0.002
		(0.05)
Observations	2,629	2,151
Country FE	YES	YES
Month FE	YES	YES

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

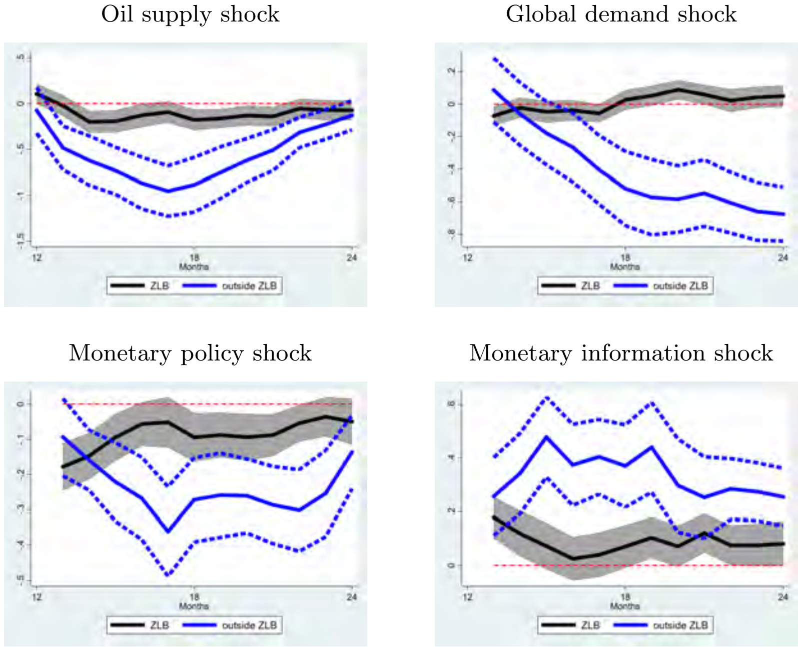
Note: Table 6 shows results of regression (12) for the current calendar year average inflation forecast errors from Consensus Forecasts, estimated using average forecast revisions of i) previous-month forecast (column 1) and ii) forecasts 3 months ago (column 2).

The results show some evidence of the ZLB reducing the magnitude of the short-term underreaction of average inflation forecasts to news, which is consistent with larger overreaction at the individual forecast level. In particular, in the specification with 1-month forecast revision, the interaction with the ZLB is negative and statistically significant. However, this is not the case for the 3-month revisions, where the interaction term is not statistically different from zero.

Figure 24 shows impulse responses of average forecast errors from the EU Consumer Survey based on estimation of equation (13). Consumers' inflation forecast errors are smaller in the medium term for all four shocks when monetary policy is at the ZLB, and frequently the forecast errors are not statistically different from zero.[22] We find a similar pattern of smaller forecast errors when instead of the EU Consumer Survey, we use professional forecasts from the Consensus Economics. The average forecast errors continue to show overreaction to most of the shocks as well, with the exception of the Bobeica and Jarocinski (2019) global demand shock, to which the forecast errors of professionals underreact at the ZLB in the medium term.

[22]We also estimate equation (13) using the U.S. data. In the U.S. we define the ZLB as periods with the Fed funds rate below 0.25 percent, which broadly covers the years 2008-2016. Interestingly, we do not find evidence of more muted responses of forecast errors in this case.

Figure (24) *Impulse responses of average inflation forecast errors from the EU Consumer Survey at the ZLB*



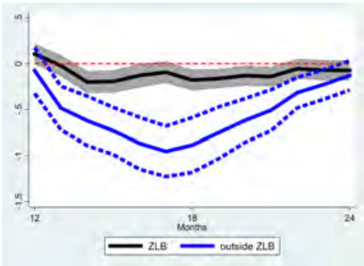
Note: The figure plots impulse responses of average forecast errors of consumers from the EU Consumer Survey to i) Kanzig (2021) global oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Jarociński and Karadi (2020) euro area monetary policy shock (bottom left panel), and iv) Jarociński and Karadi (2020) euro area monetary information shock (bottom right panel) at the ZLB (black line) and outside the ZLB (blue line). Grey areas and dotted blue lines denote 90% confidence intervals.

Unemployment forecast errors. Consistent with the results for inflation expectations, Figure 25 shows that average forecast errors for unemployment expectations from the EU Consumer Survey become smaller in absolute terms, although continue to show overreaction to shocks when the ZLB constraint binds.

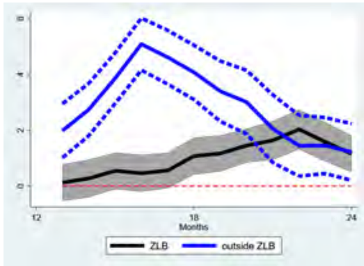
Overall, we find the results for forecast errors consistent with the general decline in responsiveness of actual inflation and inflation expectations to news. Finally, since the responses of inflation and expectations are frequently statistically not different from zero, we interpret the results for the forecast errors with some caution.

Figure (25) *Impulse responses of unemployment forecast errors at the ZLB*

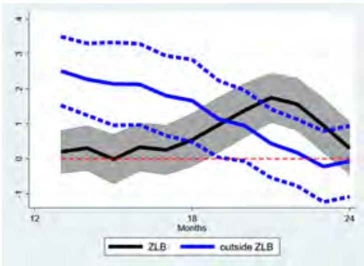
Oil supply shock



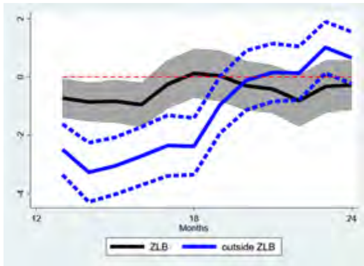
Global demand shock



Monetary policy shock



Monetary information shock



Note: The figure plots impulse responses of forecast errors for expectations from the EU Consumer Survey to i) Kanzig (2021) oil supply shock (top left panel), ii) Kilian (2009) global demand shock (top right panel), iii) Jarociński and Karadi (2020) euro area monetary policy shock (bottom left panel), and iv) Jarociński and Karadi (2020) euro area monetary information shock (bottom right panel) at the ZLB (black line) and outside the ZLB (blue line). Grey areas and dotted blue lines denote 90% confidence intervals.

9 What explains the stylized facts?

In this section, we explore factors that can account for the changes in dynamics of actual and expected inflation after GFC within the same framework set out in Section 3. We first illustrate that a combination of two mechanisms, imperfect information and over-extrapolation, can generate the initial underreaction and medium-term overreaction of average expectations as well as overreaction at the individual forecaster level (stylized facts 1 and 2). Imperfect information implies that although individual agents overreact to news, the *average* expectations initially underreact due to the noise associated with the information that agents obtain. Yet, as time passes, this friction fades out and over-extrapolation starts to dominate, guaranteeing that average forecasts overreact in the medium term.

We use equations (1) and (4) to simulate path for inflation (x_t) and 200 individual inflation expectations ($E_{i,t}[x_{t+1}]$). We then compute average inflation expectations by averaging across individual expectations. The parameter calibration is shown in Table 7.

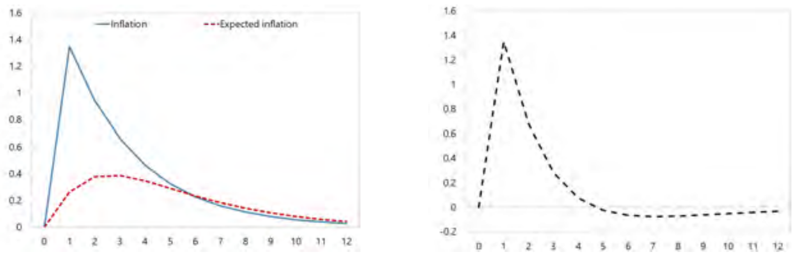
In Figure 26, we show impulse responses of actual inflation, average expectations and average forecast errors to an inflationary shock. The simulation results are qualitatively consistent with the stylized facts 1 and 2. In particular, we observe that agents, on average, overreact to the inflationary shock initially, but underreact over the medium term. Note that, by design, at the individual level, agents overreact to news, since $\hat{\rho} > \rho$.

Table (7) *Parameter Calibration*

Parameter	Description	Value
ρ	AR(1) coef. in inflation dynamic	0.7
r	standard deviation of error term	1
$\hat{\tau}$	perceived precision	0.15
$\hat{\rho}$	perceived AR(1) coef. in inflation dynamic	0.82
σ_u	standard deviation of error term	0.01

Figure (26) *Simulated inflation, average inflation expectations and average forecast errors*

Inflation and expected inflation Forecast errors



Note: The figure plots simulated inflation, expected inflation and inflation forecast errors. The simulations are based on equation (1) and (4) using parameters in Table 7.

We then explore what changes in the parameter values in this simple model could account for our empirical findings regarding expectations and inflation dynamics post-GFC. We consider several hypotheses:

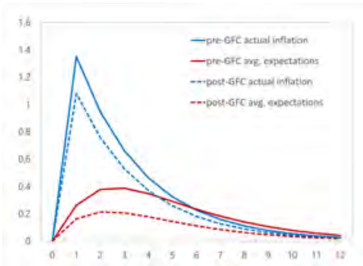
1. The individual perceptions of persistence of shocks, $\hat{\rho}$, have increased.
2. Transparency about shocks has increased (e.g. thanks to better central bank communication) thus lowering the noise around signals (higher τ).
3. Persistence of shocks has declined (lower ρ).
4. Impact of shocks on inflation has declined (lower r).

The hypothesis 1 can account for larger individual overreaction we find in the post-GFC period, but it is not consistent with the more muted response of both average expectations and actual inflation to news. In turn, more transparency under hypothesis 2 cannot generate larger individual overreaction (nor more muted response of actual inflation).

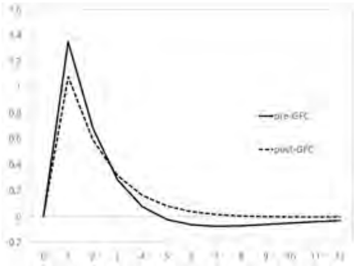
We find that the larger individual-level overreaction post-GFC (stylized fact 4), more muted reaction of both average inflation expectations and actual inflation to shocks (stylized fact 5) and smaller initial underreaction and medium term overreaction of average expectations can all be generated by lowering the values of parameters ρ and $\hat{\rho}$, but in such a way that the difference between $\hat{\rho}$ and ρ actually increases. The larger overreaction to shocks at the individual level follows directly from the higher discrepancy between $\hat{\rho}$ and ρ. At the same time, lower values of both ρ and $\hat{\rho}$ reduce the responsiveness of actual inflation and inflation expectations to news. Additionally, for a lower responsiveness of actual inflation and inflation expectations to news *on* *impact*, the parameter r needs to decline too. Figure 27 shows changes in the impulse responses of inflation, average expectations, and forecast errors in on our simulation exercise, when we set $\hat{\rho} = 0.73$, $\rho = 0.6$ and $r = 0.8$.

Figure (27) *Simulated inflation, average inflation expectations and average forecast errors after parameter changes*

Inflation and expected inflation



Forecast errors



Note: The figure plots simulated inflation, expected inflation and inflation forecast errors. The simulations are based on equation (1) and (4) using parameters in Table 26, but with $r = 0.8$, $\rho = 0.6$ and $\hat{\rho} = 0.73$.

While the simple model presented above provides a useful framework to think about the potential explanations of the observed stylized facts, several caveats and open questions remain. For example, it is not straightforward to see why post-GFC the responsiveness of actual inflation to shocks would decline by more than responsiveness of individual expectations, resulting in larger individual forecast overshoots. Second, we are not taking into account general equilibrium effects that could be potentially important. Finally, the simple framework does not allow us to investigate the dynamics of standard deviation in a satisfactory way. In particular, in the simulations the standard deviation of expectations always increases after a shock, although by less for our "post-GFC" calibration.

To conclude, we find that the partial equilibrium framework in Angeletos et al. (2020) can account for some of the empirical findings presented in this paper. Specifically, noisy information as well as over-extrapolation at the individual level can account for stylized facts 1-2, while a decline in responsiveness to shocks as well as in persistence of inflation and inflation expectation dynamics can account for the more muted reaction of both inflation and inflation expectations (stylized fact 5) post-GFC. However, a more sophisticated theory is needed to fully rationalize all five stylized facts including on the state-contingent dynamics of dispersion of inflation expectations (stylized fact 3) and on the changes in the strength of over-extrapolation bias at the individual level (stylized fact 4).

10 Conclusions

In this paper, we document five novel facts about inflation expectations in the euro area. First, individual inflation forecasts overreact to news about inflation. Second, the average expectations underreact to news initially, but overreact in the medium term. The same pattern is present for the average expectations of unemployment. Third, disagreement about future inflation increases in response to news when the current inflation is high, and declines when current inflation is low, suggesting a zero lower bound of expectations. Fourth, overreaction of individual forecasts to news increases after the global financial crisis. Fifth, post-GFC the reaction of both average expectations and *actual inflation* to news is (much) more muted post-GFC. The first two facts are not new to the literature, but this is the first paper providing evidence based on the euro area data which re-enforces the evidence revealed based on the US data in the literature. But to our best knowledge, facts 3 - 5 are new to the literature.

We then use the simple analytical framework proposed by Angeletos et al. (2020) to rationalize some of the empirical findings. The combination of imperfect information and over-extrapolation can account for the dynamics of expectations we document outside the ZLB (stylized facts 1 and 2): The former implies that although individual agents overreact to news, the *average* expectations initially underreact to the news due to the noise associated with the information that agents obtain. Yet, as time passes, this friction fades out and over-extrapolation starts to dominate, guaranteeing that average forecasts overreact in the medium term.

Finally, we show that within the same analytical framework, a decline in responsiveness to shocks can account for the more muted reaction of both inflation and inflation expectations (stylized fact 5) post-GFC. However, a more sophisticated theory is needed to fully rationalize all five of stylized facts including on the state-contingent dynamics of dispersion of inflation expectations (stylized fact 3) and on the changes in the strength of over-extrapolation bias at the individual level (stylized fact 4).

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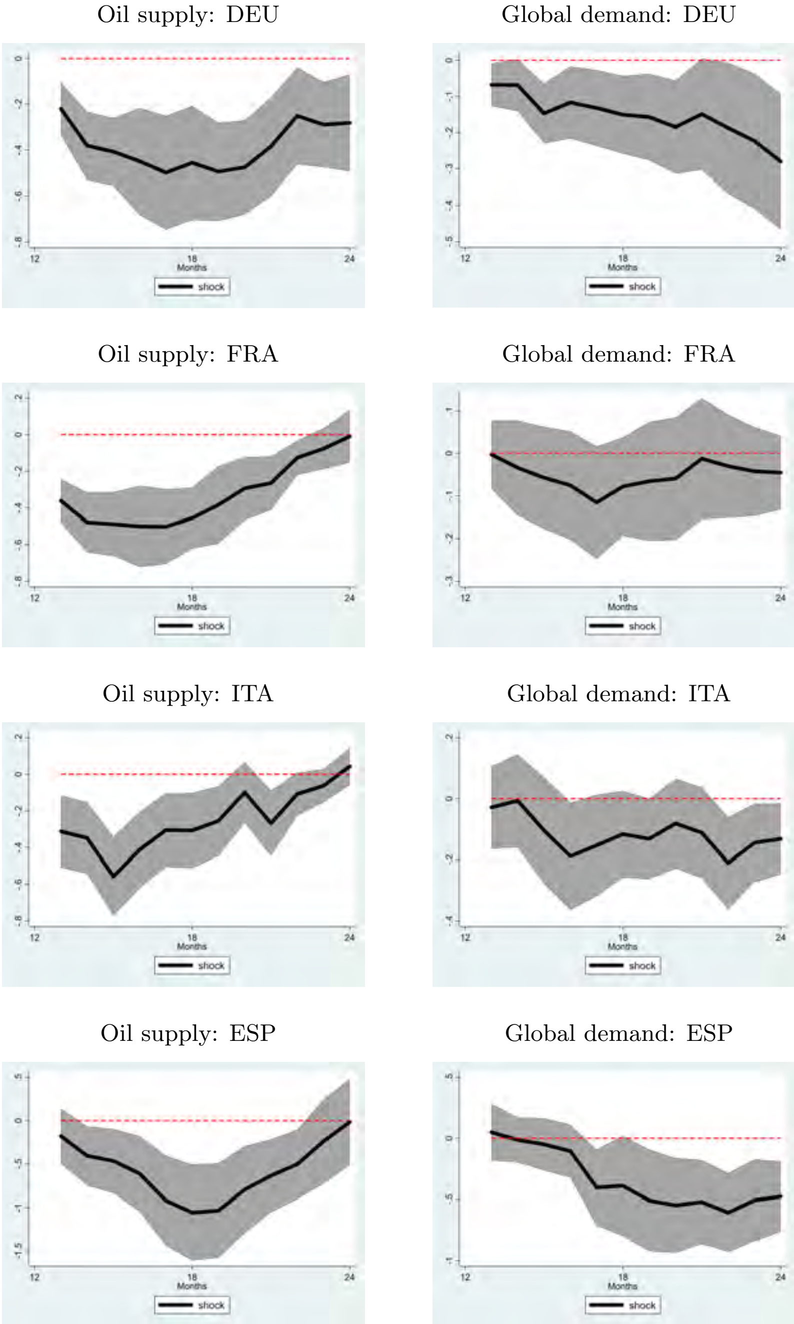
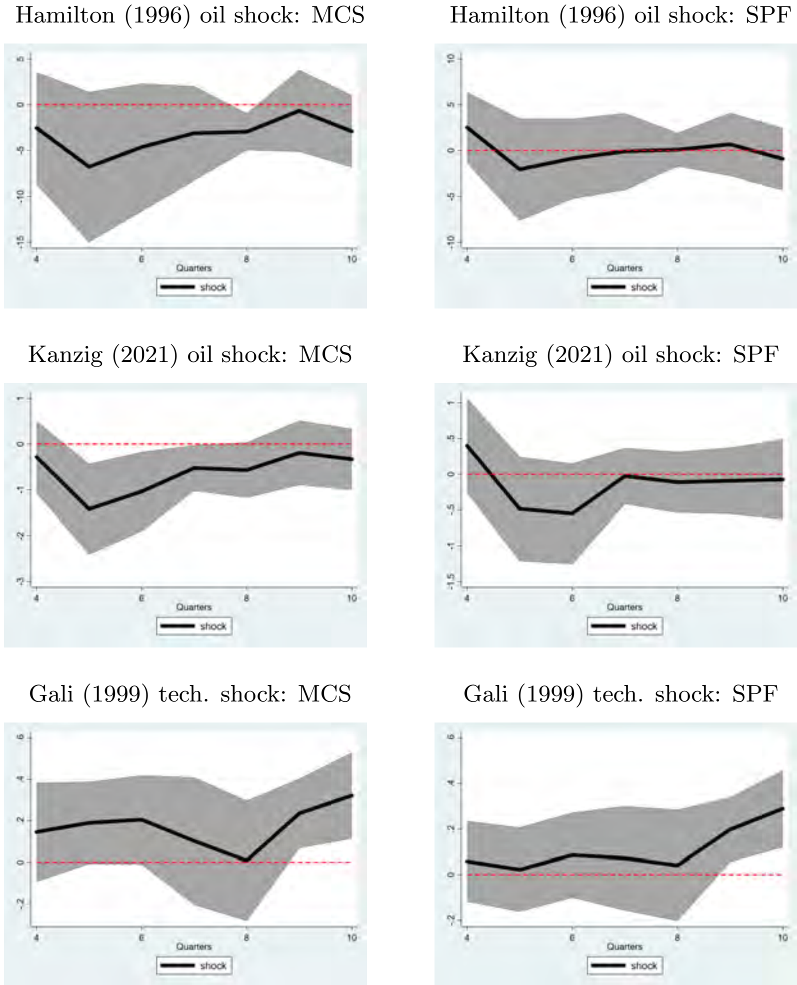
A Appendix

Figure (28) *Impulse responses of inflation forecast errors: country-level regressions*



Note: The figure plots coefficients on the i) oil supply shock (left panel) and ii) global demand shock (right panel) from regression (8) estimated at the country-level. Grey areas denote 90% confidence intervals.

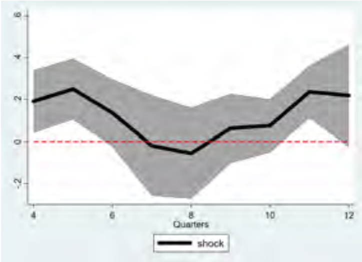
Figure (29) *Impulse responses of average inflation forecast errors: evidence from the U.S.*



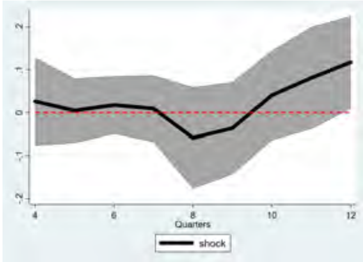
Note: The figure plots impulse responses of average inflation forecast errors for the U.S. in the Michigan Consumer Survey (left column) and the Survey of Professional Forecasters (right column) to i) Hamilton (1996) inflationary oil shock (top row), ii) Kanzig (2021) inflationary oil supply shock (middle row), and iii) Gali (1999) deflationary technology shock (bottom row). A positive impulse response denotes overreaction to deflationary shocks and underreaction to inflationary shocks. Grey areas denote 90% confidence intervals.

Figure (30) *Impulse responses of average inflation forecast errors: evidence from the U.S. using CG(2012) data*

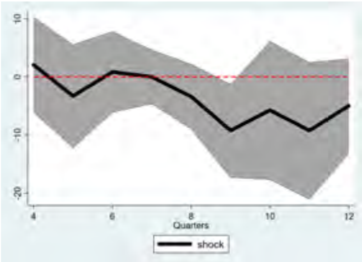
Barsky Sims (2011) news shock: MCS



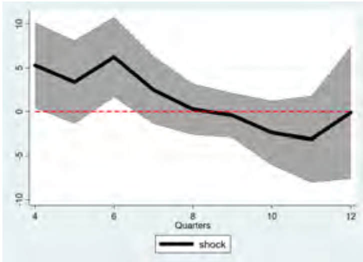
Barsky Sims (2011) news shock: SPF



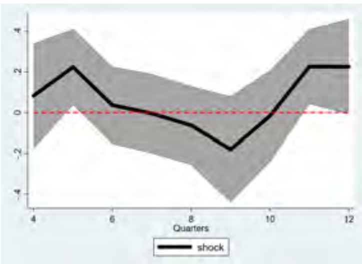
Hamilton (1996) oil shock: MCS



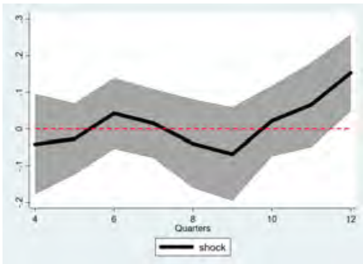
Hamilton (1996) oil shock: SPF



Gali (1999) tech. shock: MCS



Gali (1999) tech. shock: SPF



Note: The figure plots impulse responses of average inflation forecast errors for the U.S. in the Michigan Consumer Survey (left column) and the Survey of Professional Forecasters (right column) to externally identified shocks used in Coibion and Gorodnichenko (2012) (CG, 2012) i) Barsky and Sims (2011) deflationary news shocks (top row) ii) Hamilton (1996) inflationary oil shock (middle row), and iii) Gali (1999) deflationary technology shock (bottom row). A positive impulse response denotes overreaction to deflationary shocks and underreaction to inflationary shocks. Grey areas denote 90% confidence intervals. The sample is 1985Q1–2007Q3.

EC Consumer expectations – summary statistics

Table (8) Inflation expectations of consumers – the entire ample

Number of countries	Min. obs. per country	Max. obs per country	Earliest obs.	Latest obs.	Total obs.
11	85469	316712	2004m01	2019m04	3247947

Note: Statistics are based on winsorised country samples (5%) for the question (Q61) in the Survey. Min/Max observations per country are based on the entire sample (January 2004 – May 2019).

Table (9) Inflation expectations of consumers – summary statistics

Full sample						
	mean	median	stand.dev.	skewness	kurtosis	obs.
EA	6.09	3.00	8.11	1.65	4.93	3247947

Inflation (HICP) $< 0\%$						
	mean	median	stand.dev.	skewness	kurtosis	obs.
EA	3.97	0.00	6.86	2.35	8.27	227492

Inflation (HICP) $\geq 0\%$						
	mean	median	stand.dev.	skewness	kurtosis	obs.
EA	6.25	3.00	8.17	1.61	4.78	3020455

Note: Statistics are based on winsorized country samples (5%) for the question (Q61) in the Survey over the entire sample (January 2004 – May 2019). Characteristics calculated across the entire sample are conditional upon Y-on-Y %-change in the headline inflation (HICP) in the particular month.

Consensus Economics forecasts – summary statistics

Table (10) Inflation expectations of professionals – sample

Number of countries	Min. obs. per country	Max. obs per country	Earliest obs.	Latest obs.	Total obs.
10	4	33	1996m1	2020m12	35228

Note: Minimum and maximum number of observations per country refers to the number of forecasters in a single month.

Table (11) Inflation expectations of professionals – summary statistics

Full sample					
mean	median	stand.dev.	skewness	kurtosis	obs.
1.53	1.6	0.97	0.05	3.58	35228

Inflation (HICP) $< 0\%$: Four largest counries					
mean	median	stand.dev.	skewness	kurtosis	obs.
0.08	0.1	0.42	-0.07	3.51	1224

Inflation (HICP) $\geq 0\%$: Four largest counries					
mean	median	stand.dev.	skewness	kurtosis	obs.
1.65	1.7	0.84	0.25	3.53	14128

Note: Characteristics for the periods with the headline Y-o-Y inflation (HICP) above and below zero are calculated across the same sample as for consumer forecasts (January 2004 – June 2019).

PUBLICATIONS

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