

Economics School of Louvain - ESL

Title: The nonlinear transmission of monetary policy

Subtitle: How disagreement among forecasters affect the transmission of the monetary policy shocks in the Euro Area.

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ABSTRACT:

Using a local projection estimation method coupled with a logit function to model a regime switching from high to low disagreement, I found an evidence of the “puzzling” increase of inflation and output during periods of high disagreement that the literature calls “the signalling channel” from the response of a pure contractionary monetary policy shock in the Euro area. In times of low disagreement, inflation and output respond normally from the same shock, by decreasing. I also consider a central bank information shock and find that the effect of the shock, that conveys positive economic outlook, depends on the nature of the disagreement and on the level of the disagreement in the economy. The central bank should monitor carefully the nature of the information they release and the source of the disagreement between the agents.

1 Introduction

The efficiency of a monetary policy relies on several factors such as the instrument used, the transmission mechanism, the financial market condition or the expectations formed by the agents about the economic activities. Decisions related to saving, consumption, investment or price-setting impact the macroeconomic activities of a country through future expectations. Since Keynes’ General Theory, the importance of this channel for efficient policy-making has been stressed. The main assumption under which expectation was modelled was under full-information rational expectations (FIRE). But increasingly available high-quality survey data on inflation expectations show that agents’ expectations deviate from the FIRE (Coibion and al., 2017). The full-information assumption does not hold with survey data. As a result, there are periods where agents face higher and lower disagreement and there is evidence of a lot of heterogeneity. It is important to analyse the implication of these situations on monetary policy efficiency. Jarociński et al., (2020), retrieved two separated central bank shocks: a pure monetary policy shock and a central bank information shock. Our baseline question is to analyse whether these two disentangled monetary policy shocks have a sizable impact on inflation expectations, on inflation and on output under 2 different regimes in the Euro area: low and high disagreement regime across agents.

To analyse the impulse responses of a monetary policy shock we use a local projection estimation method by Jordà (2005) coupled with a logit function to account for the high and low disagreement regime or the nonlinearity in this area. The local projection logit method integrates a smooth probability function and is considered an appropriate method to analyse state-dependent impulse responses (Ramey and Zubairy ,2018). This approach is related to the method used by Falck et al. (2021) where they found

that in the United States, the effects of a contractionary monetary policy on inflation and output are significant but differ in direction depending on whether there is low or high disagreement about inflation expectations. Miranda et al. (2021) found that the puzzling responses of output and inflation can be attributed to the signalling channel. In this scenario, firms form their expectations based on incorrect signal perception due to information asymmetry. Our contributions are twofold:

- 1- Analysing the occurrence and effect of the signalling channel in Europe.
- 2- Evaluating whether an active communication from the central bank mitigates the “puzzling” increase in price and output as argued by Miranda et al. (2021)

In fact, Miranda et al. (2021) argued that an active communication from the central bank should mitigate this “puzzling” increase of price and output. However, Jarociński et al. (2020), documented that a tightening monetary policy shock increases interest rate and decreases stock prices while the information shock increases both. In this case, central bank information’s effects, that the authors attribute to behave like a positive demand shock, does not align with the pure monetary policy shock, as suggested by Miranda et al., (2021). On the contrary, the information shock mitigates the efficiency of the pure monetary policy. We will try to reconcile these findings by adding additional assumptions around this matter.

In section two, we will provide a literature review. Section three will describe the data and methodology used in our analysis. Section four will present the results. In section five, we will use available literature and economic theory to map our findings using a New Keynesian framework and try to explain the potential mechanisms behind our results. Finally, section six will conclude.

2 Literature review

According to the European Central Bank (ECB, n.d), the effects of the monetary policy are subject to long, variable, and uncertain lags. While the interest rate channel has traditionally been emphasized as the primary mechanism of monetary policy, the expectations channel is increasingly gaining recognition for its role in influencing economic outcomes.

Several factors can influence the transmission mechanism of monetary policy, including financial conditions, external shocks beyond the central bank's control, the state of the banking system, economic policies, the overall economic conditions of the country, and expectations. Firms and households make forward-looking decisions about future consumption, investment, or production based on real interest rates. These decisions form agents' expectations and impact prices and wages. This process is referred to by the ECB as the expectations channel (ECB, n.d).

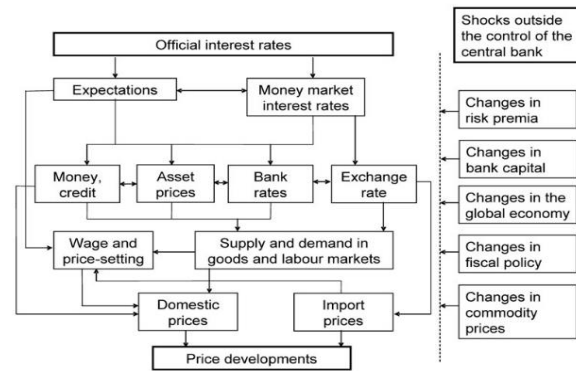


Figure 1: The main transmission channels of monetary policy decisions. Reproduced from European Central Bank, n.d., *Transmission mechanism of monetary policy*, Retrieved May 23, 2024, from <https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html>

Therefore, the determinants or the drivers of this channel can significantly impact policy making and its effectiveness. One main driver of inflation expectations in Europe is the oil price (Bauman et al., 2021). Furthermore, using the survey of professional forecasters dataset and a cross-country panel estimation among 34 OECD economies, Moessner (2021), found that core CPI inflation, the output gap and the depreciations of the domestic exchange rate significantly and positively influence inflation expectations. Additionally, the study revealed that among the various types of CPI inflation, country-specific food CPI inflation has a more substantial impact compared to energy CPI inflation and global food and oil prices.

In Europe, there are two main types of expectation indicators: survey-based expectations and market-based expectations. Survey-based expectations, which include responses from households and firms, are often considered subjective and may exhibit systematic biases (Bauman et al., 2021). Firms form their expectations based on a variety of factors, including past levels of inflation, wages, and prices, as well as economic and non-economic news and monetary policy (Galati, 2011; Bauman et al., 2021). Professional forecasters, despite not representing a specific category of economic agents, can significantly influence expectations in an economy (Bauman et al., 2021, figure 1). More research relies on survey-based professional forecasters to gauge economic expectations (see among others, Falck et al, 2021; Bauman et al., 2021; Binder et al; 2022). These surveys are particularly valuable for economic analysis because they provide quantitative point forecasts over short and longer horizons, unlike the qualitative nature of surveys directed at households and firms (Bauman et al., 2021).

Assumptions used to model expectations have different implications on the estimation results. The full information rational expectations assumption is argued to be too restrictive to represent reality (Galati et al. 2011).

The presence of information asymmetry between economic agents and the central bank can lead to varied outcomes. Esady (2022) found that during periods of elevated disagreement, the effect of a

tightening monetary policy on inflation is weaker than its effect on output in the United Kingdom. This underscores the importance of effective central bank communication to reduce disagreements among agents. Improved communication can help align expectations and enhance the overall effectiveness of monetary policy. Several studies have documented the presence of the "signalling channel" in the United States (Romer and Romer, 2000; Melosi, 2017; Miranda et al., 2021; Falck et al., 2021). When the central bank releases its interest rate decisions, the market may have a different information set compared to the central bank. This discrepancy can lead the market to revise its views about the state of the economy rather than treating the policy change as a policy shock. Essentially, the central bank is pursuing the same policy, but the market interprets the policy actions based on its own information and adjusts its expectations accordingly. As a result, firms can misinterpret the signals conveyed by the central bank, leading to "puzzling" impacts on key economic variables such as output and inflation. Miranda et al. (2021) advised that an active communication policy by the central bank can reduce information asymmetry and address the "puzzling" issues documented in the literature. Based on a model with learning, Orphanides and Williams (2005) found that when the central bank effectively communicates its policy to economic agents, it enhances the anchoring mechanism of inflation expectations to the price level. However, some academics argued that the effect of news on agents' expectations is not straightforward. Using market-based expectation indicator, Bauman et al. (2021) found that a pure tightening monetary policy shock significantly affects inflation expectations in Europe. However, the impact of an information shock(an unforeseen shift in the central bank's information release related to macroeconomic outlook) on the same variable remains unclear. Deconstructing monetary policy in US and in Europe into two different shocks: a pure monetary policy shock and an information shock, Jarociński et al. (2020), documented that a pure contractionary monetary policy increases interest rate and lowers stock prices in both regions. In contrast, these variables respond in an opposite direction from an information shock. The authors also emphasize that their Central Bank Information shock has the same effect as an impending financial demand shock or news related to the good state of the economy, which the central bank wants to partially mitigate.

It is also important to note that the nature of the news can lead to different outcomes on inflation expectations as documented by Beechey and Wright (2008) in the United States. They documented that the effect of news related to prices, real economy or monetary policy, have different implications on real interest rates and inflation compensation.

Finally, Falck et al., (2021), argued that information asymmetry and disagreement are related concepts. Economic agents are more likely to disagree between each other when information is not precise (Coibion and Gorodnichenko, 2012).

The most common measure of disagreement in the literature is the standard deviation of point forecasts in the professional forecast surveys (see among others : Romer and Romer, 2000;, Bauman et al., 2021;

Falck et al., 2021). Some academics argue that due to the high correlation between disagreement measure and measures of uncertainty, disagreement among forecasters can serve as a proxy for uncertainty (Himounet, 2022). But more research tend to refute this approach (see among many Falck et al., 2021; Binder et al., 2022).

Our interest is to measure the nonlinear effects of two distinct shocks: pure tightening monetary policy shock and the central bank information shock on expected inflation, price levels, and output in the Euro area. Various econometric techniques have been employed in the literature to estimate impulse response functions.

Miranda et al. (2021) compared three estimation methods: vector autoregression (VAR), local projection (LP), and Bayesian local projection (BLP). They argued that VAR estimates are likely to be biased, with these biases compounding at each horizon. Consistent with Jordà (2015), Miranda et al. (2021) added that local projection estimates are robust to misspecification, but the robustness of impulse responses can be questionable with small sample sizes. They recommended using Bayesian local projection to address both misspecification issues associated with VAR and small sample problems.

Falck et al. (2021) also advocated for local projection, emphasizing that it does not require the complex process of shock identification and variable ordering needed in VAR, making it a favourable method. Esady (2022) proposed using non-linear local projections and narrative monetary policy shocks to estimate non-linearity, which requires a clear threshold to distinguish between high and low disagreement regimes.

In this research, we will use local projection estimated with OLS coupled with a logit function to model the switch between two different regimes. Additionally, we will ensure that our sample size is large enough to be robust to misspecification.

3 Data description and Methodology

3.1 Data description

3.1.1 Survey of Professional Forecasters (SPF)

The Survey of Professional Forecasters (SPF) is a quarterly survey conducted by the European Central Bank (ECB) that has been ongoing since 1999. Each quarter, the ECB sends questionnaires to approximately 60 professional forecasters, asking their expectations and probability distribution regarding three key macroeconomic variables: inflation rate(HICP), GDP growth, and unemployment: These expectations are collected for up to six different forecast horizons: the current calendar year, one

year ahead, two years ahead, a longer-term horizon, and a "rolling horizon" which is defined as 12 months ahead from the latest available observation (ECB, 2022). In addition to these primary variables, some surveys include information on forecasters' assumptions about other relevant economic factors, such as the ECB's interest rate, oil prices, the USD/EUR exchange rate, and labour costs (ECB, 2022).

- Measure of disagreement : Following the approach of Falck et al. (2021), disagreement data is computed as the cross-sectional standard deviation of individual forecasts about one year ahead of the variable of interest in the Survey of Professional Forecasters (SPF). Simply put, the disagreement at time t is the standard deviation of all forecasters' point forecasts for variable x for the 12-months-ahead horizon forecast. Using two variables in the SPF—inflation, GDP growth, and unemployment—we compute two measures of disagreement:
 - 1- Disagreement Related to Inflation Expectations: This measures the standard deviation of forecasters' one-year-ahead inflation expectations.
 - 2- Disagreement Related to GDP growth Expectations: This measures the standard deviation of forecasters' one-year-ahead GDP growth expectations.
- Expectations: The expectation data was computed as the cross-sectional average of individual forecasts about one-year-ahead inflation in the Survey of Professional Forecasters (SPF). Simply put, the expectation at time t is the average of all forecasters' point forecasts for inflation expectations for the 12-months-ahead horizon forecast..

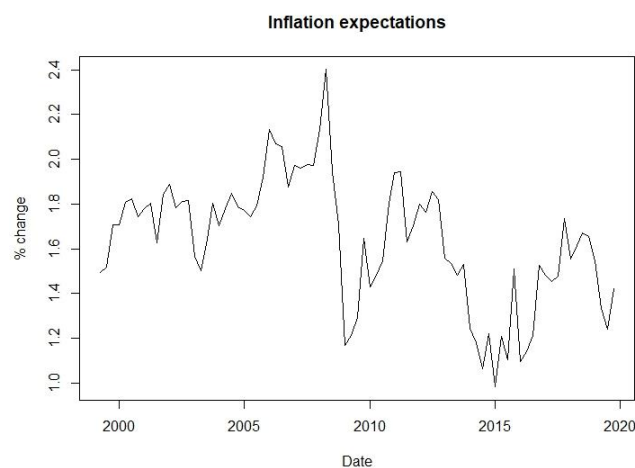


Figure 2: Inflation expectations, (percentage change)

3.1.2 Other variables

Our dataset comprises seven quarterly variables that go from 1999Q1 to 2019Q4: real GDP, HICP, Inflation expectations, the EURO STOXX 50 equity index, ECB interest rate, the pure monetary policy shock (MP) and the central bank information shock (CBI). We removed the COVID-19 period from our analysis since it can change the direction of our results from its outlier nature. Below the description and the transformation applied to each data.

Real GDP:

The real GDP data was downloaded from the ECB data portal and represents the GDP of 20 European countries. It is measured in millions of euros, with 2015 as the base year. The dataset is quarterly, calendar-adjusted, and seasonally adjusted. We took the logarithm and first difference of real GDP for our analysis. Finally, we annualized our growth rate by multiplying it by 400. This is to ensure that our data is stationary to avoid biases.

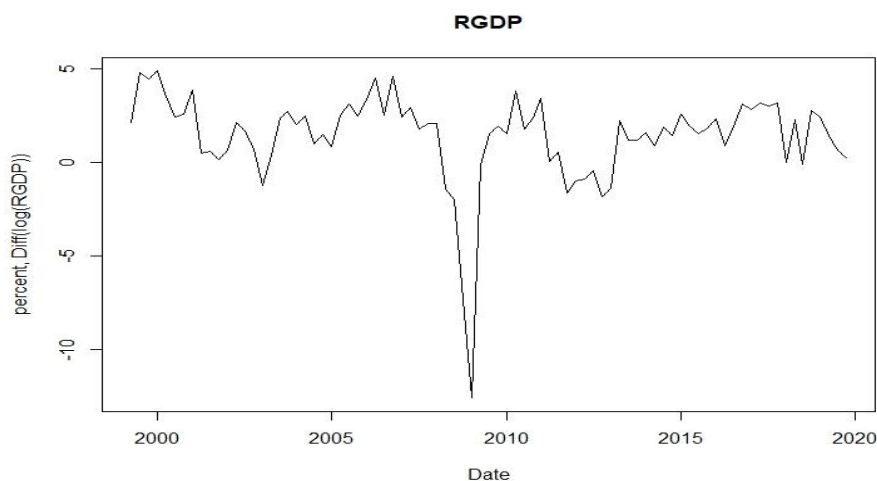


Figure 3: Real GDP, annualized growth rate

The Harmonized Index for Consumer Prices (HICP):

As a measure of the price level in the economy, we use the Harmonized Index of Consumer Prices (HICP) for the Euro area, which includes 20 out of the 27 EU member countries that use the Euro as their official currency. The HICP is a monthly index with a base year of 2015 and was downloaded from the ECB data portal. The data is seasonally and calendar adjusted. For our analysis, we converted the monthly data to quarterly and then took the log difference to ensure that our data is stationary. Finally we annualized our rate by multiplying it by 400.

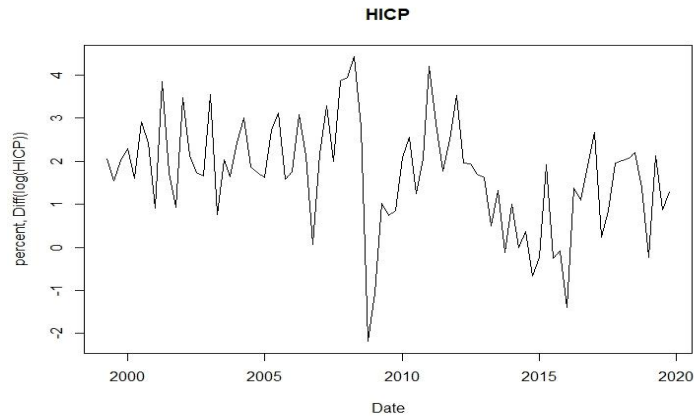


Figure 4: HICP , annualized rate

STOXX 50:

The Euro STOXX 50 equity index represents the performance of 50 of the largest firms in Europe. We downloaded this indicator from the ECB data portal. The data was already in quarterly format, and no further transformations were applied.

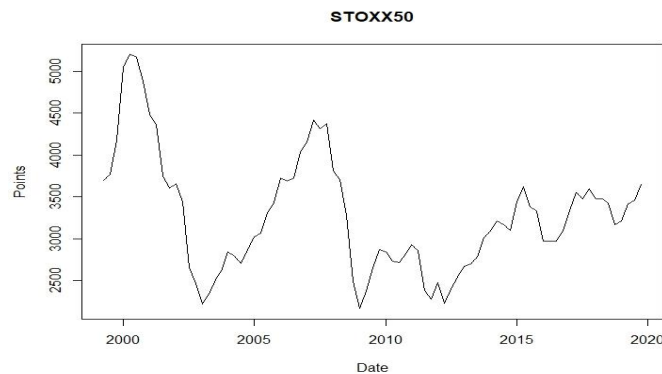


Figure 5: Euro STOXX 50 equity index (Index)

Shocks:

Jarociński et al. (2021) disentangle the two components of a monetary policy: a pure monetary policy shock (a surprise increase or decrease in the interest rate) and an information shock (a surprise information release related to the economic outlook). The author provides two different versions on his website. One version is estimated with “Poor man’s” sign restriction, and another one is obtained with the median rotation that implements the sign restrictions.

The first set, estimated with Poor man’s sign restriction, has a more strict assumption: the two shocks do not occur simultaneously. We use this set of shocks (Poor man’s) because we want to differentiate the effects of the two shocks on our variables of interest. We transform the data from daily to quarterly frequency for our analysis..

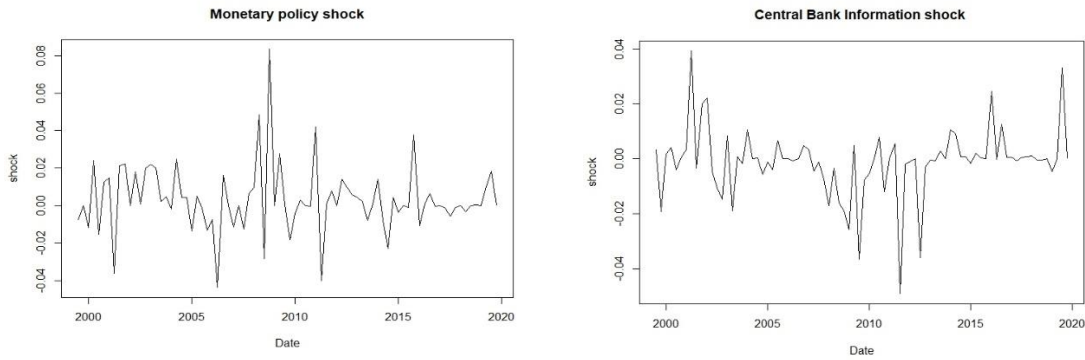


Figure 6: Pure monetary policy shock and Central Bank Information shock estimated with "Poor Man's" sign restriction, data retrieved from

[Marek Jarocinski | Personal webpage](#)

EONIA:

EONIA was the official interest rate released by the ECB until it was replaced by ESTER in 2021. Since our analysis does not include the covid -period, we use this rate. We downloaded EONIA data from the ECB data portal from Q2 1999 up to Q4 2019. The dataset was transformed from daily to quarterly frequency for our analysis.

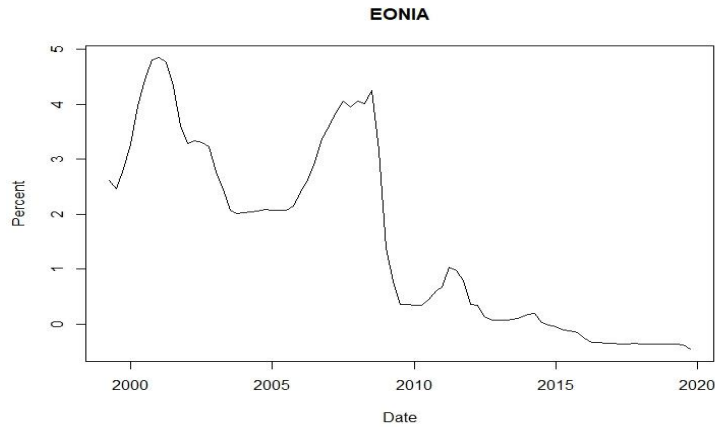


Figure 7: EONIA: official ECB interest rate(percent)

3.2 Methodology

We use the local projection method by Jordà (2005), incorporating a probability function related to the two regimes of low and high disagreement as suggested by Falck et al. (2021).

$$y_{t+i} = (\alpha_i^H + \beta_i^{H,MP} \varepsilon_t^{MP} + \gamma_i^H x_{t-1})F(z_{t-1}^\omega) + (\alpha_i^L + \beta_i^{L,MP} \varepsilon_t^{MP} + \gamma_i^L x_{t-1})(1 - F(z_{t-1}^\omega)) + u_{t+i} \quad (3.1)$$

$$y_{t+i} = (\alpha_i^H + \beta_i^{H,CBI} \varepsilon_t^{CBI} + \gamma_i^H x_{t-1})F(z_{t-1}^\omega) + (\alpha_i^L + \beta_i^{L,CBI} \varepsilon_t^{CBI} + \gamma_i^L x_{t-1})(1 - F(z_{t-1}^\omega)) + u_{t+i} \quad (3.2)$$

$t \in \{1, I\}$ indicates the period of occurrence of the shock and $i \in \{0, I\}$ indicates the rolling horizon from which the shock occurred.

y_{t+i} represents the variables of interest: HICP, Real GDP and Inflation expectations at time $t+i$.

z_{t-1}^ω represents the variable of disagreement, where the superscript $w \in \{1, 2\}$ indicates the source of the disagreement. 1= disagreement around inflation expectations. 2= disagreement around GDP growth expectations.

ε_t represents the shocks: either the pure monetary policy shock ε_t^{MP} or the central bank information shock ε_t^{CBI}

x_{t-1} represents the control variables: HICP, real GDP, ECB interest rate (EONIA), STOXX50, inflation expectations, at time $t-1$.

All the coefficients with superscript H represent the high disagreement regime and those with superscript L represent the low disagreement regime.

$\beta_i^{H,MP}$ and $\beta_i^{L,MP}$ represent the impulse responses of our variables of interest from a pure monetary policy shock at time t .

$\beta_i^{H,CBI}$ and $\beta_i^{L,CBI}$ are the impulse responses of the variables we study from a central bank information shock at time t .

The feature of the model implies that when the shock occurs at time t it is not conditioned to a specific economic situation, hence the controls are lagged by one period. The probability is also lagged by one period to prevent potential endogeneity bias (Falck et al., 2021).

We compute the probability function by taking $\Theta = 5$, where c and σ_t represent the median and the standard deviation of the disagreement measure, respectively (Falck et al., 2021). Thus, the function $F(z_{t-1})$ has a logit shape of the form:

$$F(z_{t-1}) = \frac{\exp\left(\theta \frac{z_{t-1} - c}{\sigma_t}\right)}{1 + \exp\left(\theta \frac{z_{t-1} - c}{\sigma_t}\right)} \quad (3.3)$$

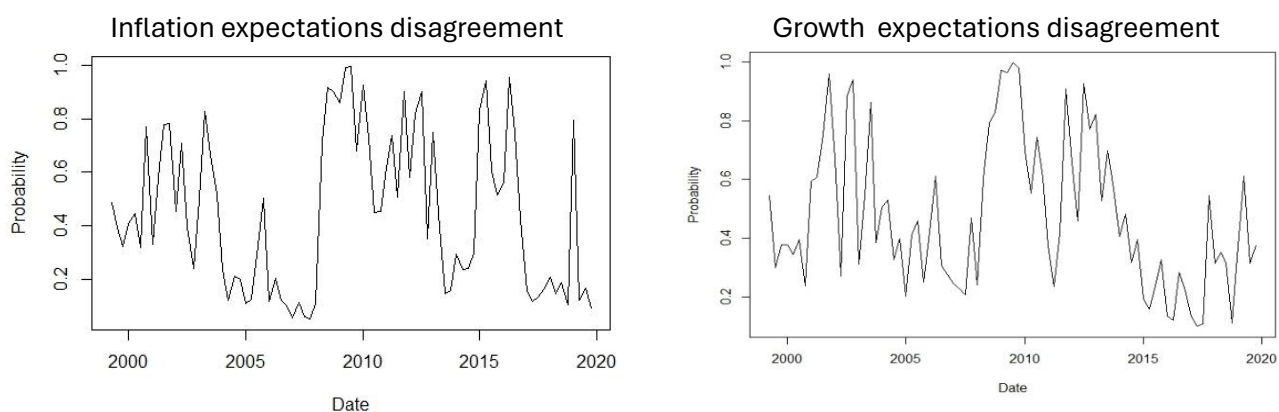


Figure 8: Probability of occurrence in high disagreement regime

The two figures highlight potential periods of high disagreement during the financial crisis from 2008 to 2010. The probability to be in high disagreement is higher for growth expectations than for inflation expectation between the year 2000 and 2003.

4 Results

In this section, we present the impulse response functions (IRFs) of our variables of interest: the inflation rate, inflation expectations, real GDP growth in response to two types of shocks—pure monetary policy shock and central bank information shock. Given that our model is state-dependent, we differentiate the responses between high disagreement and low disagreement regimes. We choose lag 2 for our graphs such that we avoid the problem of small sample size even though our results hold in shape by adding more lags.

The source of disagreement has significant implications for our results. Therefore, each graph includes two panels: the right panel shows the IRFs related to GDP growth expectations disagreement, and the left panel displays the IRFs related to inflation expectations disagreement.

The final subsection provides a robustness check. The only smoothing applied to our variables was the transformation from high-frequency data to quarterly data. Our goal was to preserve as much information as possible from the original data. Consequently, although our IRFs may not appear very smooth, their true shapes are preserved.

4.1 Monetary policy shock

This subsection focuses on the effect of a tightening monetary shock on our variables of interest in high and low disagreement regime, respectively.

4.1.1 High disagreement regime

First, we notice that all of our impulse responses are significant. The responses of inflation expectations and HICP when the disagreement is around inflation expectations (see left panel, first and last rows) are very low but this low responses are consistent as in the literature (see Bauman et al., 2021, Chart 20; Jarociński et al., 2021, figure8b Panel C)

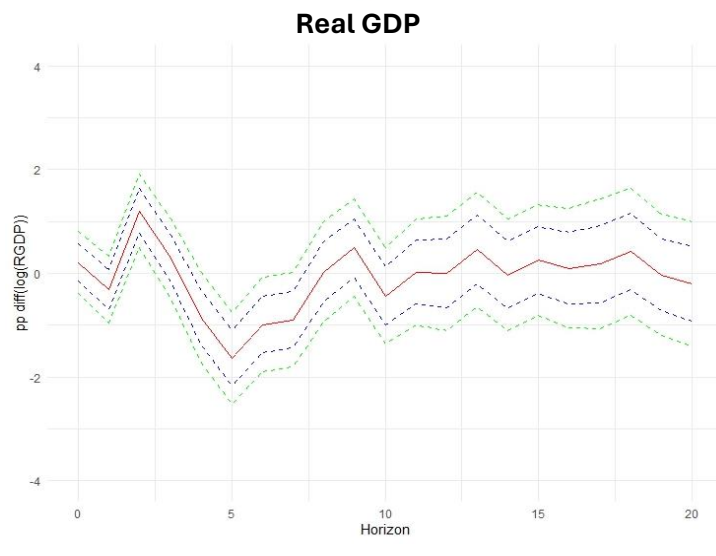
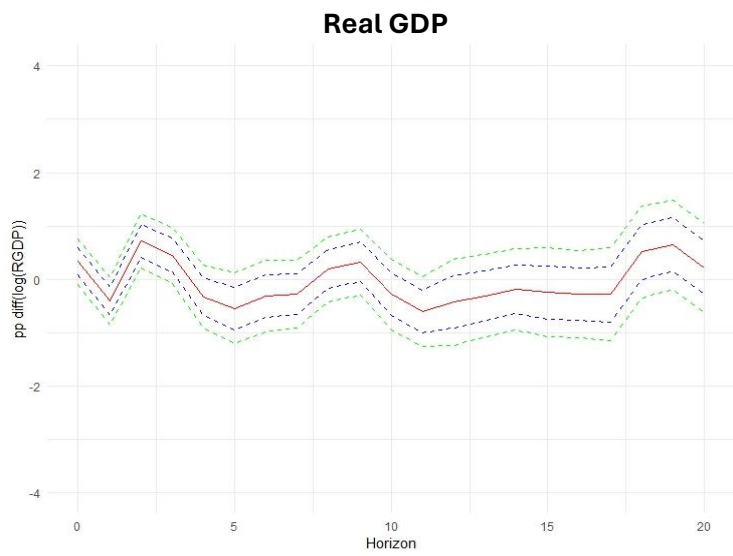
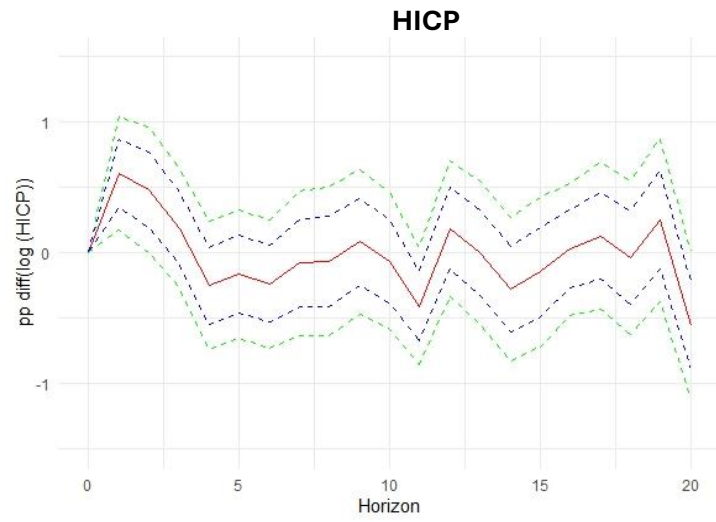
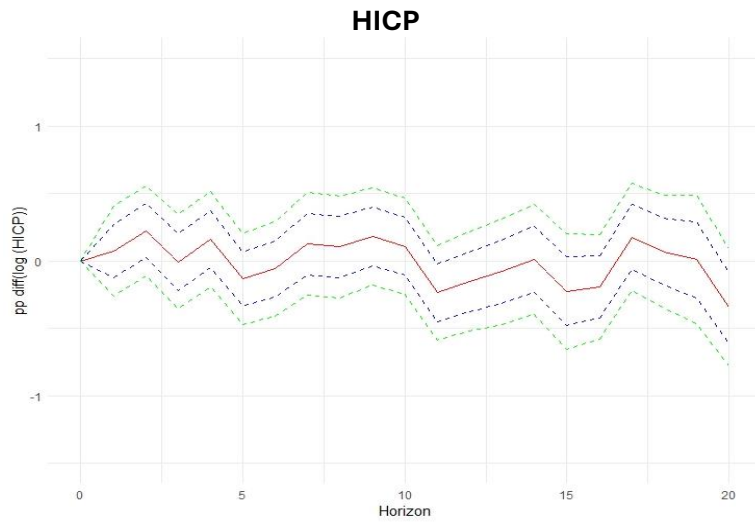
Secondly, comparing the graphs related to disagreement around inflation expectations (left panel) to the graphs related to disagreement around growth expectations (right panel) shows that their shape is similar especially in the short-run, but the IRFs related to growth expectations disagreement display stronger responses. The similarity between the graphs right and left panel also suggests that the effect of the monetary policy shock does not depend on the source of the disagreement.

Finally, in the short run with elevated disagreement, we observe an increase in inflation expectations, the price level, and real GDP in response to a tightening monetary policy. Indeed, despite not being very high for some variables, we observe positive responses for all of our dependent variables. This situation is counterintuitive and is referred to as the "signalling channel" (Romer and Romer, 2000; Miranda et al., 2021).

MONETARY POLICY SHOCK WITH HIGH DISAGREEMENT

Disagreement around inflation expectations

Disagreement around growth expectations



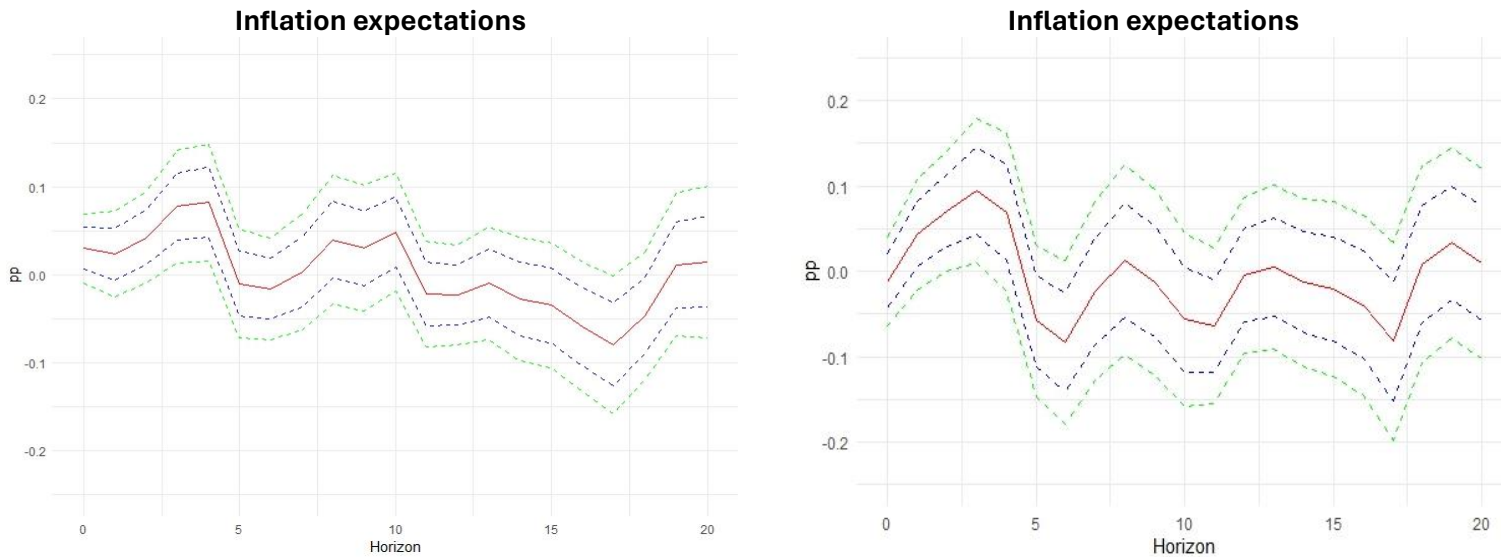


Figure 9: IRFs in high uncertainty regime, to one standard deviation tightening pure monetary policy shock

Notes: the green dashed and blue dashed lines represent 90% and 68% confidence intervals, respectively. Our impact variables are HICP (diff(log)), Real GDP(diff(log)) and inflation expectations. Our sample goes from 1999Q2 to 2019Q4. We use annualized rates for HICP and Real GDP.

4.1.2 Low disagreement regime

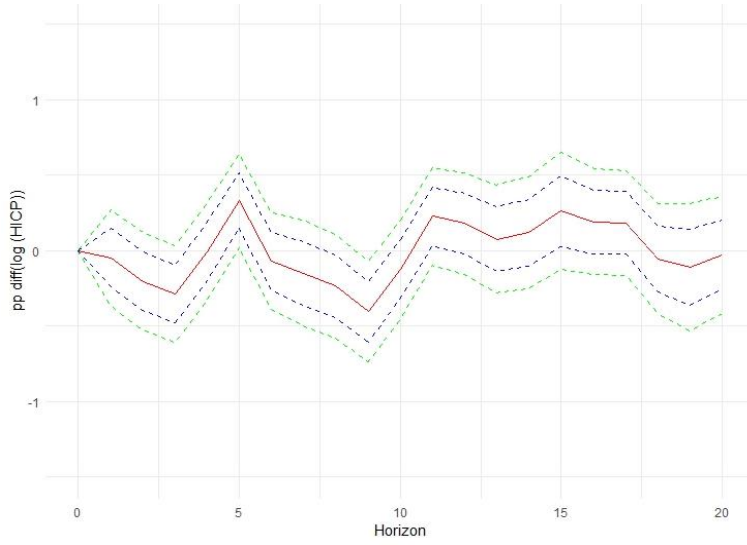
First, all the responses are significant. In line with our earlier findings, the shapes of the graphs (left and right panels) are similar, suggesting that whether agents disagree about inflation expectations or GDP growth expectations, a pure contractionary monetary policy has the same effects on our dependent variables. However, the intensity of the responses differs slightly.

During period of low disagreement, the responses of inflation expectations, inflation rate and GDP growth from a contractionary monetary policy follows the empirical conventional view. In the short-run, inflation decreases due to price stickiness but in the long-run, the variable increases reaching their long-run equilibrium. The same pattern is observed for real GDP especially in the short-run. This is consistent with the findings of Falck et al. (2021).

MONETARY POLICY SHOCK WITH LOW DISAGREEMENT

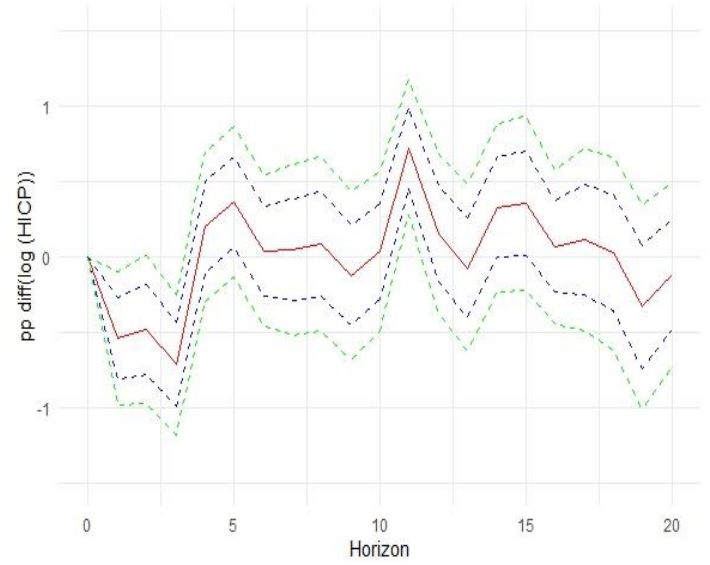
Disagreement around inflation expectations

HICP

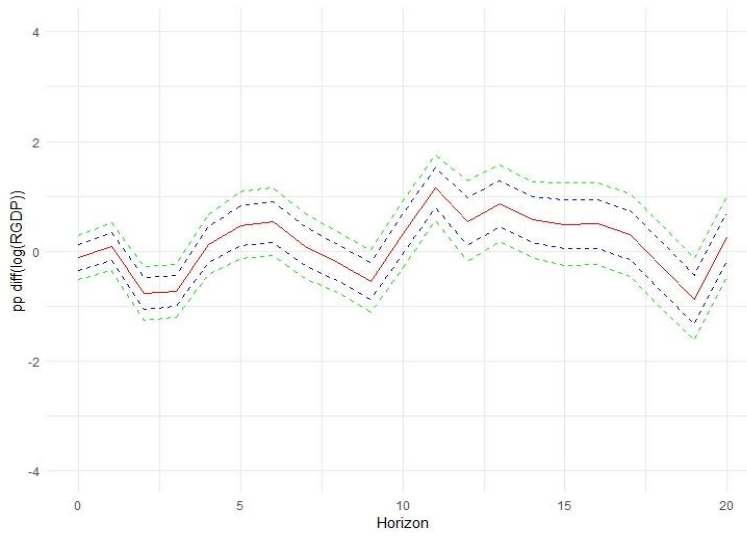


Disagreement around growth expectations

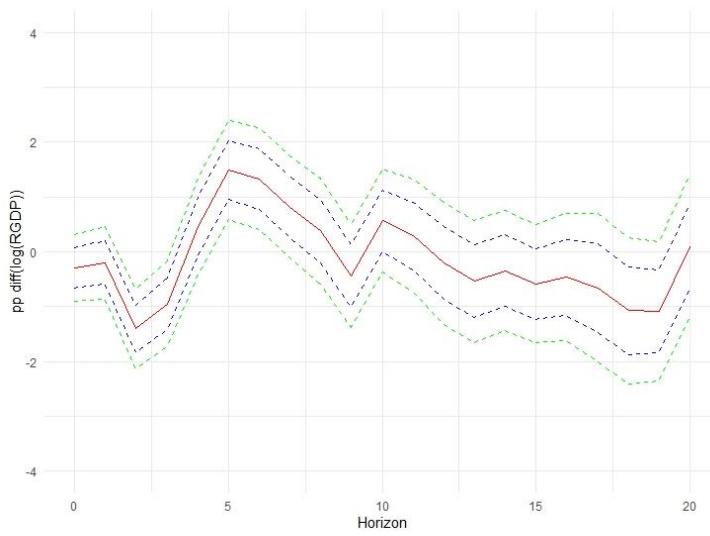
HICP



Real GDP



Real GDP



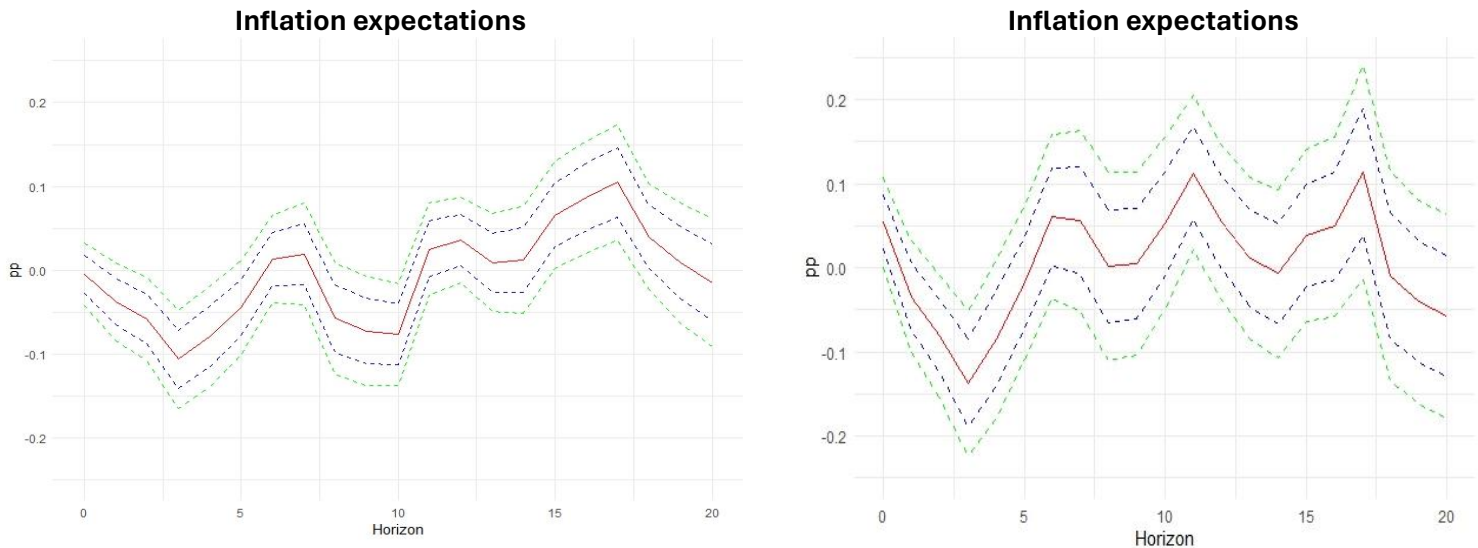


Figure 10: IRFs in low uncertainty regime, to one standard deviation tightening pure monetary policy shock

Notes: the green dashed and blue dashed lines represent 90% and 68% confidence intervals, respectively. Our impact variables are HICP (diff(log)), Real GDP(diff(log)), inflation expectations. Our sample goes from 1999Q2 to 2019Q4. We use annualized rates for HICP and Real GDP.

4.2 Central Bank Information shock

This subsection focuses on the effect of a positive information shock on our variables of interest in both high and low disagreement regimes. According to Jarociński et al. (2021), this shock is akin to a positive demand shock. In principle, a positive demand shock increases prices in the short run since firms, unable to immediately adjust production, respond by raising prices. Demand, being a component of GDP, also boosts GDP in the short run. The long-term effects depend on additional factors. We will find that incorporating more assumptions may reveal different outcomes.

4.2.1 High disagreement regime

The central bank information's effect should reduce the asymmetry of information between agents and the central bank, thereby decreasing disagreement among economic agents. This reduction in disagreement helps agents perceive the true signals conveyed by the pure monetary policy shock.

In our study, the source of the disagreement has different implications (see that the IRFs are different in left and right panels).

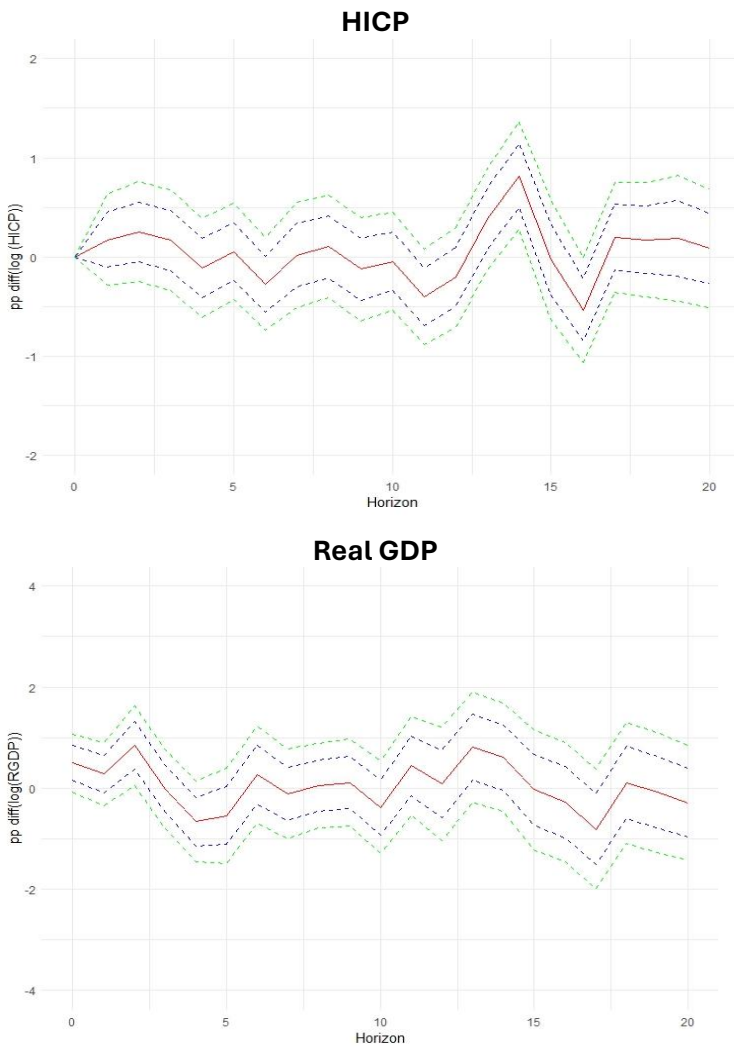
Firstly, when agents strongly disagree about inflation expectations, releasing a positive surprise about the economic situation has no significant effect on prices and inflation expectations in the short-run. Inflation expectations seem to fluctuate around zero without a clear pattern. However, Real GDP shows a certain pattern, being positive in the short run (horizon 1), then decreasing, and evolving around zero in the long run. This is intuitive because providing information related to the economic outlook does

not substantially impact the expectations around inflation expectations but has a small effect on real GDP.

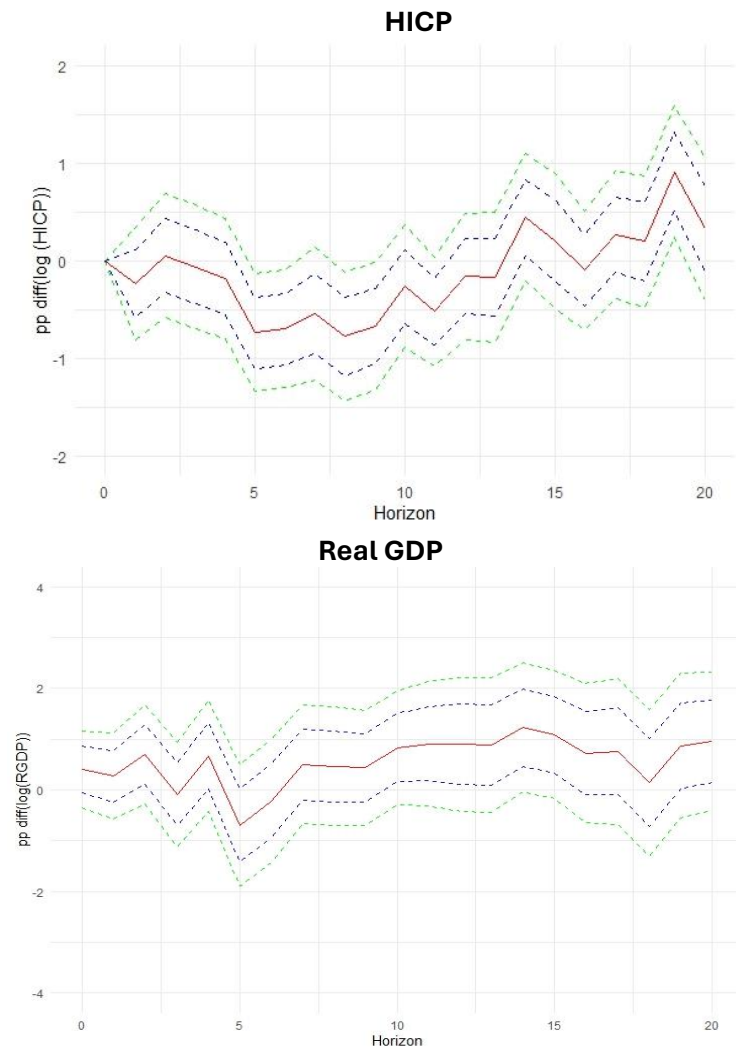
Secondly, when the disagreement is around growth expectations (see right panel), HICP and inflation expectations initially decrease in the short run and then increase. The real GDP receives a slight decrease in the short-run but not as pronounced as the responses of the other two variables mentioned before. These responses align with the effect of a tightening monetary policy shock. It appears that providing surprise information about the economic outlook helps correct the misperceptions firms have when the disagreement is about growth expectations.

CENTRAL BANK INFORMATION SHOCK WITH HIGH DISAGREEMENT

Disagreement around inflation expectations



Disagreement around growth expectations



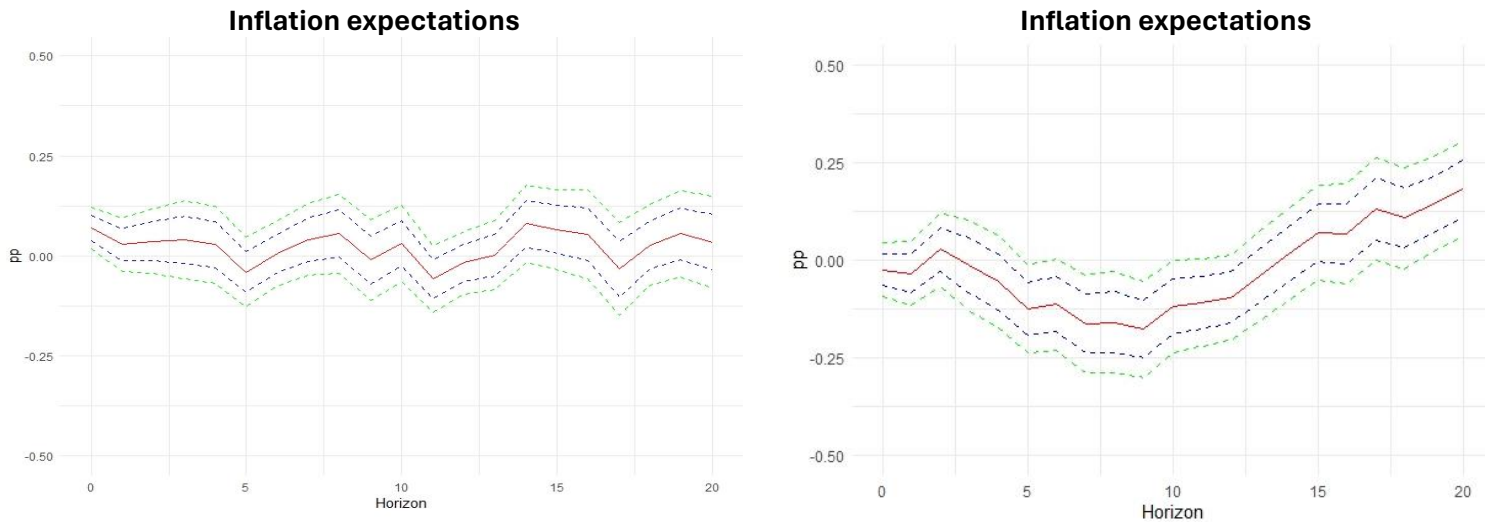


Figure 11: IRFs in high uncertainty regime, to one standard deviation central bank information shock

Notes: the green dashed and blue dashed lines represent 90% and 68% confidence intervals, respectively. Our impact variables are HICP (diff(log)), Real GDP(diff(log)), inflation expectations. The sample goes from 1999Q2 to 2019Q4. We use annualized rates For HICP and Real GDP

4.2.2 Low disagreement regime

The graphs in the left and right panels display different shapes in response to an information shock, indicating that the nature of the disagreement impacts agents' expectations differently.

Since almost all the responses seem significant, this situation seems puzzling since we document that during times of low disagreement, economic agents should perceive with more accuracy the information given by the central bank. So in principle, we should see more homogenous responses from the same shock. We can hypothesize that, giving more information even in times of low disagreement can backfire since it can change the expectations of the agents.

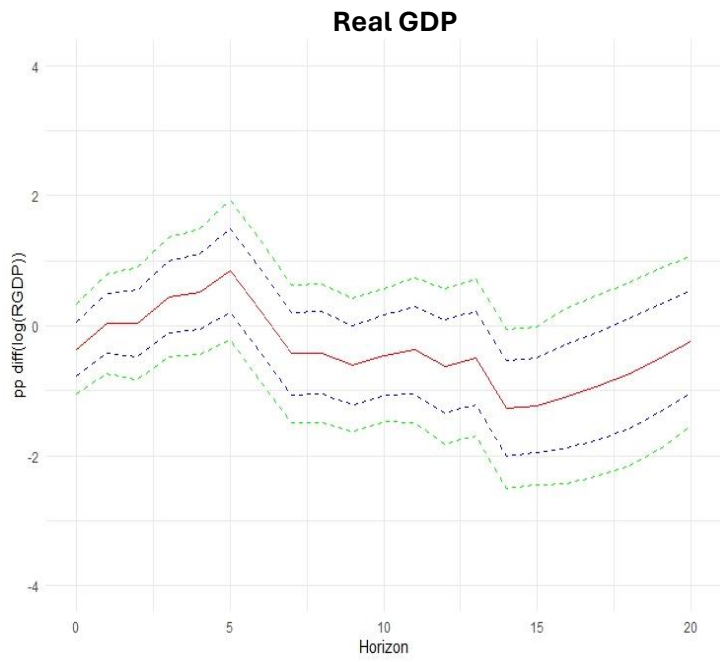
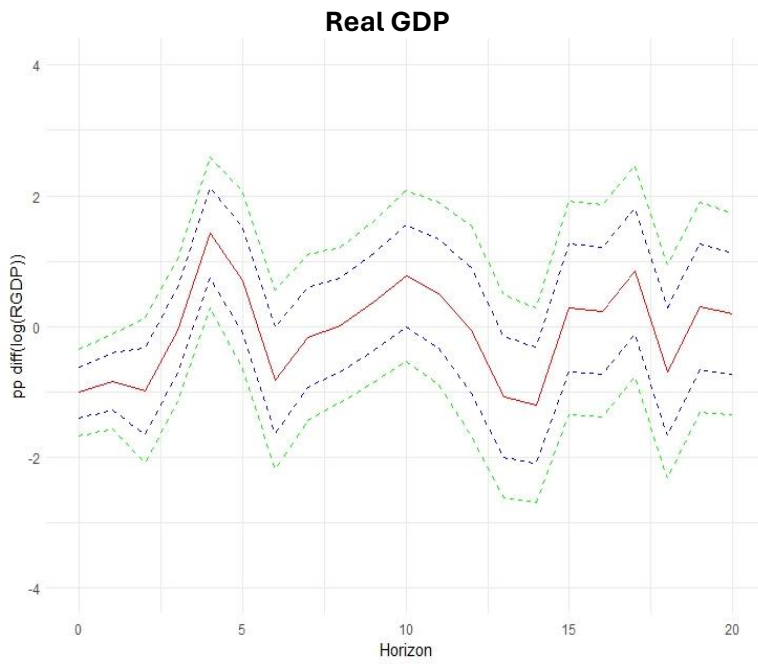
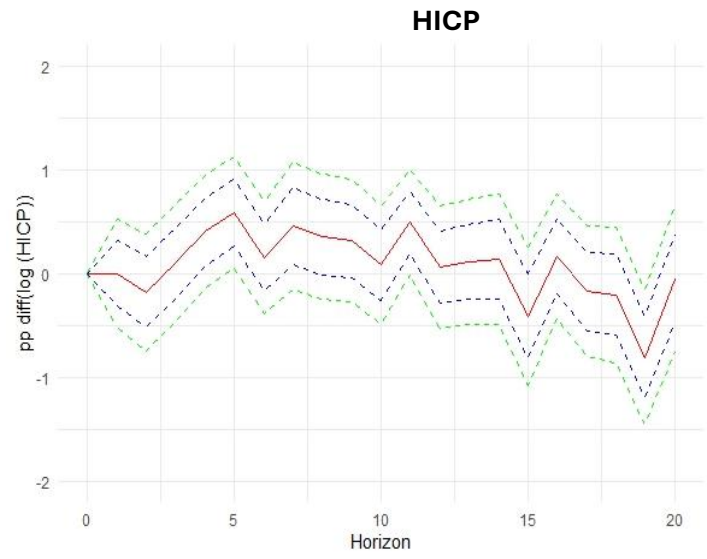
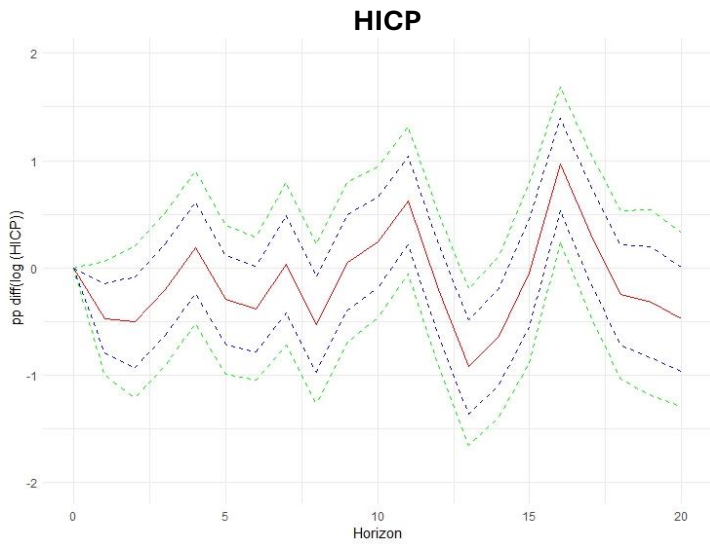
When disagreement is around inflation expectations (right panel), responses show considerable spikes, making it difficult to assess the real impact of the shock and understand long-term effects.

On the other hand, when disagreement is around growth expectations, a positive surprise in information related to the economy, increases all our explained variables. This result is consistent with Jarociński et al. (2020), where they found that interest rate and prices increase after a CBI shock. We suggest that a positive surprise central bank information can alter agents' expectations, causing them to misinterpret policymakers' true intentions.

CENTRAL BANK INFORMATION SHOCK WITH LOW DISAGREEMENT

Disagreement around inflation expectations

Disagreement around growth expectations



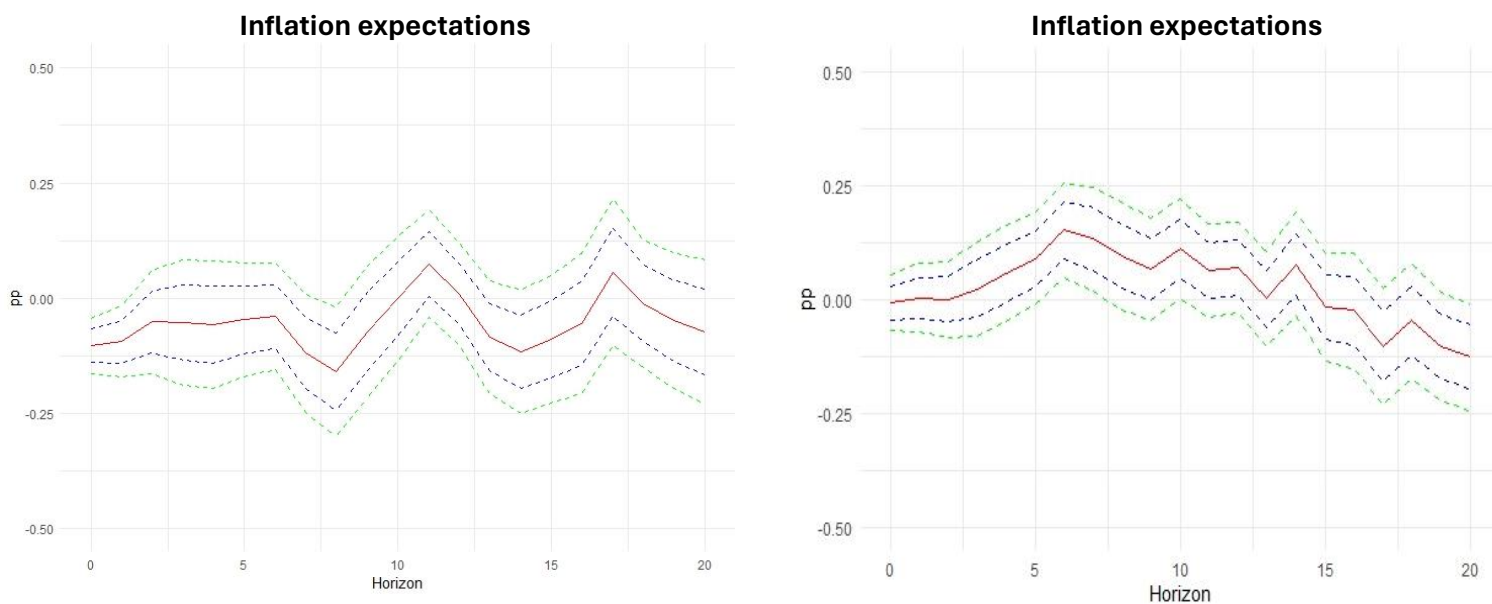


Figure 12: IRFs in low uncertainty regime, to one standard deviation central bank information shock

Notes: the green dashed and blue dashed lines represent 90% and 68% confidence intervals, respectively. Our impact variables are HICP (diff(log)), Real GDP(diff(log)), inflation expectations. Our sample goes from 1999Q2 to 2019Q4. We use annualized rates for HICP and the real GDP

4.3 Robustness check

We tried to increase the number of lags until lag 4 and found that our IRFs are robust to an increasing number of lags. The shape of the impulse responses remain similar.

We tried to use GDP deflator instead of HICP as a measure of the level of price in Europe. We found very low responses from our variable of interests compared to the models using HICP, we think that the transmission of monetary policy is more effective through prices directly related to consumers. Despite these low responses, we still document that the dependent variable was increasing in period of high disagreement and decreasing in period of low disagreement from a tightening monetary policy shock. The effect of the central bank information shock remains conditional on the source of the disagreement.

5 New Keynesian framework

In this section, we will begin to map our results using a New Keynesian framework, to explain the possible mechanism behind our results. We simplify some assumptions and mainly focus on explanations.

Building on Melosi, (2017) and Miranda et al., (2021), we use a New Keynesian model with imperfect information and dispersion.

5.1 Households

Households have perfect information: they can see with accuracy the true state of the economy, therefore there is no disagreement between them. They can maximise their current and future consumption and saving with respect to their incomes: wage from working and past saving that is in function of past interest rate.

5.2 Firms

Firms' production function is linear: $Y_{j,t} = a_{j,t}N_{j,t}$. (5.1)

$Y_{j,t}$: is the total output for firm j at time t

$a_{j,t}$: is the productivity factor for firm j at time t

$N_{j,t}$. represent the number of labour that firm j needs for production at time t

Each firm has its own production function that we model with the subscript j.

Firms want to maximise their profit in two stages.

In the first stage, they decide their production with respect to the number of available labour that they need: $N_{j,t}$.

At stage 2, since there is disagreement between the firms, some firms update their belief based on information related to: the demand by the households, their productivity, the monetary policy and the price. As a result, parts of the firms change their benchmark price based on their updated expectations.

5.3 Central bank

We assume that the central bank has perfect information: the policy makers can see the true state of the economy. Therefore, they can set their policy with accuracy, no error of measure. The interest rate i_t at time t is based on their own forecast (denoted $E_{cb,t}(x_t)$) of the macroeconomic variables x_t and the monetary policy shock (Mirand et al. , (2021)). Since we have two different shocks (a pure monetary policy shock: MPt and an information shock: CBIt) that do not happen at the same time, we can write our interest rate as follow:

$$i_t^{MP} = \phi_0 + \phi'_x E_{cb,t}(x_t) + MP_t \quad (5.2)$$

$$i_t^{CBI} = \phi_0 + \phi'_x E_{cb,t}(x_t) + CBI_t \quad (5.3)$$

5.4 Explanations

To model this disagreement between the firms, we assume that each firm specific macroeconomic variables diverge from the aggregate macroeconomic variable (aggregate demand, aggregate productivity and the price) by an idiosyncratic component $\mathcal{E}_{j,t}^x$

$$x_{j,t} = x_t + \mathcal{E}_{j,t}^x. \text{ where } \mathcal{E}_{j,t}^x \sim N(0, \sigma_x^2). \quad (5.4)$$

The total information set for each firms at time t is denoted:

$$I_{j,t} = [a_{j,t}; d_{j,t}; p_{j,t}; i_t^{MP}] \text{ or } I_{j,t} = [a_{j,t}; d_{j,t}; p_{j,t}; i_t^{CBI}] \quad (5.5)$$

$$a_{j,t} = a_t + \mathcal{E}_{j,t}^a. \text{ where } \mathcal{E}_{j,t}^a \sim N(0, \sigma_a^2). \quad (5.6)$$

Where $a_{j,t}$ is Firm j's productivity at time t, that deviates from the aggregate productivity a_t by the idiosyncratic error $\mathcal{E}_{j,t}^a$.

$$d_{j,t} = d_t + \mathcal{E}_{j,t}^d. \text{ where } \mathcal{E}_{j,t}^d \sim N(0, \sigma_d^2). \quad (5.7)$$

Where $d_{j,t}$ is the volume of demand, firm j perceives from households. It deviates from the aggregate demand d_t by an idiosyncratic error $\mathcal{E}_{j,t}^d$

$$p_{j,t} = p_t + \mathcal{E}_{j,t}^p. \text{ where } \mathcal{E}_{j,t}^p \sim N(0, \sigma_p^2). \quad (5.8)$$

Where $p_{j,t}$ is the price level perceived by firm j. It deviates from the level of price p_t by $\mathcal{E}_{j,t}^p$

- Pure monetary policy shock

When disagreement is elevated, (*ie, high variance: σ_a^2, σ_d^2 or σ_p^2*), firms do not perceive the accurate signal conveyed by the increase of the interest rate. Consequently, instead of decreasing, firms' inflation expectations rise, leading to a puzzling increase in price levels and output

In times of low disagreement, (*i. e., low variance: σ_a^2, σ_d^2 or σ_p^2*), firms accurately observe the central bank's intentions when policy makers increase the interest rate. As a result, inflation expectations decrease and this translate to a decrease in price levels and output.

- Central bank information shock

This shock aims to reduce the asymmetry of information between the central bank and firms by lowering the disagreement between the agents (lowering *variances: σ_a^2, σ_d^2 or σ_p^2* during times of high disagreement). During times of low disagreement, since the information asymmetry is minimal, a positive information shock should not alter inflation expectations if they are well anchored.

However, we observed that during times of high disagreement around inflation expectations, a positive information shock did not significantly affect inflation expectations and the price level. Conversely, the same shock significantly decreased these variables during times of high disagreement around growth expectations. This suggests that both the nature of the disagreement and the type of information are crucial for the effectiveness of the central bank's information shock.

In times of low disagreement, additional guidance from the central bank can backfire, blurring firms' perceptions and leading to an increase in inflation expectations, price level, and output. These mechanisms remain hypotheses that should be tested using empirical analysis.

6 Conclusion

We use the local projection method coupled with a logit function to estimate non-linear impulse responses from two different shocks: a pure monetary policy shock and a central bank information shock. Our findings provide evidence of the signalling channel in Euro area. Specifically, in times of high disagreement about inflation expectations or growth expectations: inflation expectations, price levels, and output increase following a tightening monetary policy shock. Conversely, in periods of low disagreement, regardless of the source of the disagreement, our dependent variables decrease, which aligns with the conventional responses documented in the literature. Falck et al. (2021) attribute this situation to an asymmetry of information between the central bank and economic agents. When disagreement is high, firms do not perceive the correct signal conveyed by the central bank, leading to puzzling agents' expectations increase that translate into an increase in price levels and output.

On the other hand, the effect of a positive central bank information shock depends on the source of the disagreement and the nature of the news. Positive information about the economy does not substantially affect inflation expectations and price levels when agents highly disagree about inflation expectations. However, in times of elevated disagreement about GDP growth expectations, a surprise information from the central bank related to the economic outlook significantly decreases inflation expectations, price levels, and output. We hypothesize that, in times of high disagreement, providing information to agents about the subject of their disagreement can reduce the asymmetry of information between the central bank and firms. During times of low disagreement, additional information from the central bank seems to alter economic agents' expectations, as all our explained variables either increase or fluctuate without a clear pattern. In this case, we hypothesize that additional information from the central bank can backfire, especially when agents' expectations are not well-anchored.

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ChatGPT was used to correct orthograph and grammatical mistakes in this thesis.