The Fed Response to News vs. Information: Occam's Razor and the Empirical Evidence

PRELIMINARY DRAFT, DO NOT CIRCULATE

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Abstract

Two explanations exist for the output and price puzzles arising from the identification of monetary policy shocks with high-frequency monetary surprises: the 'information channel' and the 'Fed response to news' hypothesis. We argue that the information channel better explains these anomalies, aligns more closely with empirical evidence, and relies on fewer assumptions. Using a model of imperfect information incorporating both monetary policy shocks and policy rule deviations, we derive testable implications to distinguish the two hypotheses. Our findings show that policy rule deviations have minimal impact, while information effects drive the observed puzzles, resolving key inconsistencies in the literature.

JEL classification: E32, E52, E58

Keywords: Monetary Policy, information effects

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1 Introduction

The analysis of high-frequency market reactions to monetary policy decisions, pioneered by Kuttner (2001) and Gürkaynak et al. (2005a), has provided researchers with instrumental variables (IVs) for identifying policy shocks in reduced-form macroeconomic settings, such as vector autoregressions (VARs) and local projections (LPs). This approach, first proposed by Gertler and Karadi (2015a), allows for identification without relying on assumptions about the sign or timing of macroeconomic responses. However, the use of monetary policy surprises as IVs to identify structural monetary policy shocks often leads to puzzling results (see Ramey, 2016).

The literature has converged on two key 'puzzling' stylised facts, which escape a simple full information rational expectation framework. First, high-frequency monetary policy surprises often produce unexpected results, such as rising inflation and output following a policy tightening, known as price and output puzzles. Second, these surprises can be predicted by past data, violating the assumption of full-information rational expectations.

Two competing explanations attempt to account for these anomalies: one focussing on imperfect information, the other on deviations from perfect rationality. The 'information channel of monetary policy,' proposed among others by Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021), assumes that economic agents have imperfect information about the economy's state. Conversely, the 'Fed response to news' hypothesis of Bauer and Swanson (2023a,b), which suggests that agents misestimate the Fed's reaction to inflation due to incorrect parameter assumptions. Both explanations likely capture elements of the truth, but the question remains as to which one better explains the observed data.

The information argument posits that both the central bank and market participants operate with imperfect information, leading to differences in economic forecasts. These discrepancies cause policy surprises to be partially endogenous. In fact, when market participants are surprised by an interest rate change, they may attribute it to an actual policy

shock, or conversely to the central bank's anticipation of higher inflation. These two different types of shocks – i.e. the monetary policy shock and the structural shocks to which the central bank responds – both generate in the market asset price revisions triggered by the policy announcement. The contamination of the high-frequency monetary policy surprises by the endogenous policy response generates price and output puzzles. Furthermore, since agents continuously update their beliefs based on new information, policy surprises exhibit autocorrelation and are somewhat predictable, supporting the idea that imperfect information is a primary driver of these anomalies.

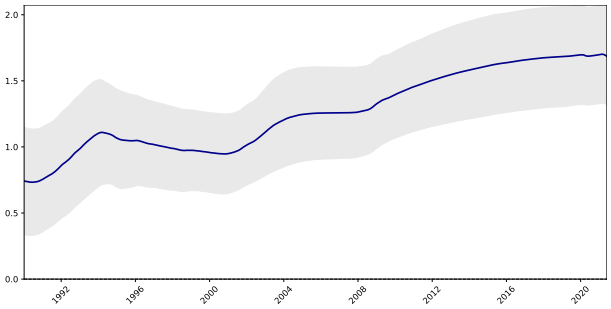
The 'Fed response to news' hypothesis, on the other hand, attributes these puzzles to agents' systematic underestimation of the Fed's inflation response. If market participants consistently use incorrect parameters for the Fed's policy rule – particularly underestimating its responsiveness to inflation – monetary policy surprises will appear to be driven by errors in expectation rather than genuine policy shifts. However, for this explanation to hold, agents must repeatedly make the same mistake due to a stochastic drift in the parameter, or never updating their estimates despite available data, as suggested by Bauer and Swanson (2023a,b). To explain the persistent predictability of forecast revisions, this hypothesis also needs to appeal to the existence of informational rigidities, thus overlapping with the information hypothesis (see discussion in Bauer and Swanson, 2023a).

To a large extent the two hypotheses explain the same facts and hence are generally regarded as two plausible interpretations of the same empirical evidence. This paper tries to move beyond this observation and provides an assessment of the two hypotheses in two steps.

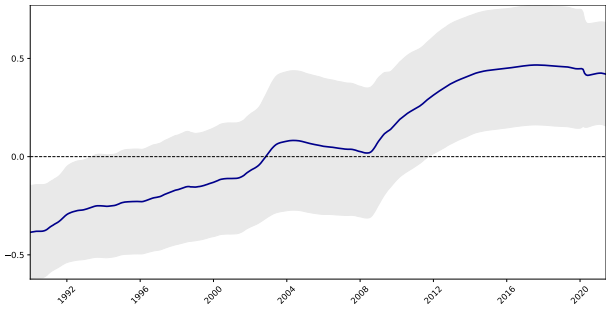
In our first step, in Sections 2 and 3, we provide an exposition of the hypotheses and focus on the stylised facts that the two arguments try to explain. We then provide an appraisal of both the logical consistency of the arguments, and of the robustness of the empirical evidence available.

We argue that a simple application of the Occam's razor, which favours the simpler and more powerful theories able to rationalise a large set of facts with a smaller number of

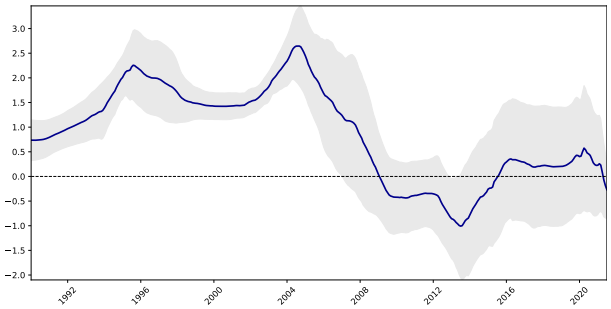
Figure 1: Recursive and rolling estimates of monetary policy rule



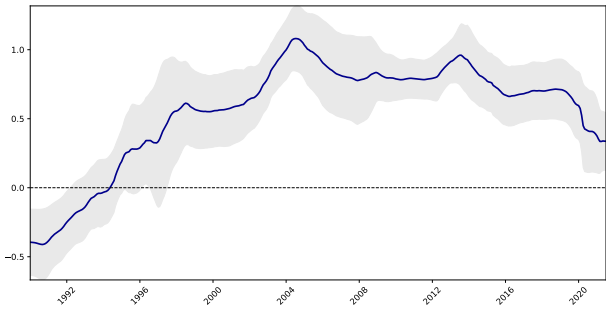
(a) Expanding window inflation coefficient



(b) Expanding window output gap coefficient



(c) Rolling window inflation coefficient



(d) Rolling window output gap coefficient

Notes: The figure presents estimates of the monetary policy rule coefficients from recursive and rolling regressions. The first row shows estimates from an expanding window regression with exponential down-weighting of older observations (as in Bauer and Swanson, 2023b), while the second row presents results from a rolling-window estimation. The first column represents the response to inflation, while the second column shows the response to the output gap. The blue solid line represents the estimated coefficient, while the shaded grey area represents the 95% confidence interval based on Newey-West standard errors. The dependent variable is the market yield on U.S. Treasury securities at a 2-year constant maturity (DGS2). The independent variables include the 1-year growth in Personal Consumption Expenditure (PCEPILFE) as a measure of inflation, and the output gap (OUTGAP), defined as the difference between real GDP (GDPC1) and potential GDP (GDPPOT), expressed as a percentage of potential GDP. All regressions include a constant term.

assumptions, would favour the information argument. Indeed, it naturally accounts for the same stylised facts while requiring fewer additional assumptions than the Fed response to news argument. Furthermore, the latter is a U.S.-centric explanation, yet similar monetary policy puzzles have been observed across various central banks, including the ECB, the Bank of Japan, and the Bank of England. If markets worldwide consistently underestimated policy responses, it would require an unlikely global pattern of miscalculation.

Our reassessment of the evidence also casts doubt on the claims of the 'Fed response

to news' hypothesis. In order: (i) the Fed has an information advantage over individual forecasters; (ii) the forecasters update after the central bank's announcements as shown by the survey run by Bauer and Swanson, 2023a, and in line with the empirical evidence of the literature on information effects; there is no drift in the coefficients of the policy rule (see Figure 1), as also shown in Bauer et al. (2024);[1] (iv) market participants are not constantly wrong in their forecasts of the policy rate; (v) there is substantial disagreement in the market to force biased forecasters out of it. We also point to some logical inconsistencies in the argument and misinterpretation of the information hypothesis.

In the second step, in Section 4, we discuss a model that incorporates both monetary policy shocks and shocks to the parameter of the Taylor rule in a model with imperfect information. The model expands the framework of Miranda-Agrippino and Ricco (2021) by incorporating an affine term structure model, of the type discussed in Smith and Taylor (2009), into a model in which agents receive noisy signals about the state of the economy and the policy rule's parameter. This framework allows for a formalisation of the argument of Bauer and Swanson (2023a) and delivers testable implication to disentangle monetary policy shocks, shocks to the rule's parameter, and information. In particular the model shows that shocks to the rule move the short and the long end of the yield curve, and differently from monetary policy shocks. This result chimes with the model-based results of Smith and Taylor (2009) and Ellingsen and Soderstrom (2001).

Finally, in Section 5, using the results provided by the model, we construct empirical high frequency IVs to identify the different types of shocks of interests and to assess their role in the observed puzzles. We adopt these IVs in Section 6 to study the macroeconomic propagation of monetary policy shocks, shocks to the rule's parameter, and information in a VAR setting.

Our results indicate shocks to the policy rule play a small role in the propagation of

[1]The recursive estimates show how the Fed's response has evolved over time, with later periods indicating a more hawkish Fed. The rolling estimates do not confirm the results, as the coefficient for both the output gap and inflation tend to decline at the onset of the great financial crisis.

monetary policy, for the sample of interest, and play close to no role in creating the puzzles reported in the literature. Conversely, the information channel appears to be the cause of the inconsistent response observed when raw surprises are used to identify monetary policy shocks. After correcting for information effects, no puzzle is visible in the dynamic responses to identified shocks either in the full sample or in subsamples.

Related literature. This paper contributes to the literature on puzzles in the responses obtained using the high-frequency monetary policy surprises to identify monetary policy shocks. The foundational paper of the literature on the central bank information channel is Romer and Romer (2000), which led to the development of the narrative identification of monetary policy shocks Romer and Romer (2004).

A key paper in this literature is Nakamura and Steinsson (2018), which reports puzzles in the response of professional forecasts to monetary policy shocks and argues that monetary actions may reveal information about the natural rate of interest. Differently from this stronger informational hypothesis, Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021) argue that policy decisions disclose information about the state of the economy and fluctuations at business cycle frequency.

The approach proposed by Jarociński and Karadi (2020) disentangles monetary policy shocks from central bank information by looking at the positive or negative correlation of the surprises to interest rates and the stock market. A similar approach is also suggested by Cieslak and Schrimpf (2019) and Cieslak and Pang (2020). Several other papers have followed this idea.

A different methodology has been proposed by Miranda-Agrippino and Ricco (2021), who build an informationally robust instrument for monetary policy shocks by regressing the high-frequency surprises on the Greenbook forecasts, a measure of the Fed's expectations. The idea follows from the approach of Romer and Romer (2004), and more recently Campbell et al. (2012). This approach has also been applied to the euro area (see Ricco et al., 2024) and South Africa (see Pirozhkova et al., 2024).

Finally, Bu et al. (2021) separate monetary and non-monetary policy shocks using Fama-MacBeth cross-sectional regressions. Melosi (2016) identifies the information component in monetary policy announcements through a DSGE model. Holtemöller et al. (2024) adopts a strategy based on the heteroscedasticity of the changes in short-term and long-term interest rates, as well as exchange rates around the FOMC announcement, to identify a monetary policy shock, an information shock, and an unconventional monetary shock.

Bauer and Swanson (2023a) and Bauer and Swanson (2023b) have criticised the idea of an information channel of monetary policy, and propose a Fed response to news explanation of the observed puzzles. They also offer a correction of the monetary policy surprises that project on financial indicators to remove the endogenous component of monetary policy.

This paper provides an appraisal of the different proposed arguments. Jarociński and Karadi (2025) offers a different and complementary approach to the ideas presented in this paper, delivering similar conclusions.

2 The hypotheses and Occam's razor

The literature on monetary policy shocks has broadly agreed on two well-documented stylised facts. First, when high-frequency monetary policy surprises are used to identify policy shocks, they can produce puzzling results, such as price and output puzzles, where a tightening of the policy stance appears to cause inflationary pressure and economic expansion. Second, policy surprises can be Granger-caused by lagged variables – whether private or central bank forecasts, financial variables, or macroeconomic indicators – and exhibit some autocorrelation. These facts clearly violate the assumption of full-information rational expectations.

Broadly speaking, the 'information channel of monetary policy' argument attributes these facts to deviations from full information, whereas the 'Fed response to news' explanation focuses on deviations from perfect rationality. The first assumes that model parameters are known while the state of the economy is unobserved; the second assumes that agents agree on

the state of the economy but may use incorrect parameters to forecast economic developments. It is reasonable to assume that both arguments capture aspects of the problem to some degree. Yet, which one holds more explanatory power for the stylised facts?

Let us start by presenting a stylised framework – which we expand into a model of imperfect information in the next section – to illustrate the argument and weigh its different components. To focus ideas, consider a standard monetary policy rule of the form:

$$r_t = r^* + (\phi + \widehat{\phi}_t)\pi_t, \tag{1}$$

where the central bank follows a Taylor rule by reacting to inflation, with $\widehat{\phi}_t$ representing a shift in the response parameter. If inflation is not directly observed, the policymaker must form expectations (denoted by F_t^{cb}) to enact policy, i.e.,

$$r_t = r^* + (\phi + \widehat{\phi}_t)F_t^{cb}\pi_t + \sigma^{mp}u_t^{mp}, \tag{2}$$

where monetary policy may be too tight or too loose due to exogenous factors, which we call monetary policy shocks, u_t^{mp}. These shocks have received significant attention, as they are crucial for identifying the causal effects of monetary policy on the economy. If not perfectly informed, each market participant i must form expectations about inflation and the policy rule, leading to the expectation:

$$F_{\underline{t}}^i r_t = r^* + (\phi + F_{\underline{t}}^i\widehat{\phi}_t)F_{\underline{t}}^i\pi_t, \tag{3}$$

where $F_{\underline{t}}^i\pi_t$ represents the market participant's nowcast for inflation at time t before the rate announcement, and $F_{\underline{t}}^i\widehat{\phi}_t$ is the assumed shift in the policy coefficient. When the rate is announced, market participants experience a forecast error:

$$r_t - F_{\underline{t}}^i r_t = \underbrace{(\widehat{\phi}_t - F_{\underline{t}}^i\widehat{\phi}_t)F_t^{cb}\pi_t}_{\text{Rule Misspecification}} + \underbrace{(\phi + \widehat{\phi}_t)(F_t^{cb}\pi_t - F_{\underline{t}}^i\pi_t)}_{\text{Information Effect}} + \sigma^{mp}u_t^{mp}. \tag{4}$$

Aggregating across market participants, we can interpret this monetary surprise as incorporating price revisions across bonds of different maturities. Equation (4) captures both sides of the argument: monetary surprises, which are typically used to identify policy shocks, may be contaminated by two distinct effects.

The 'information argument' suggests that central banks and markets may disagree on the state of the economy due to imperfect information. Thus, surprises will be influenced by forecast differences, which correlate with the endogenous component of monetary policy. Market participants who observe higher-than-expected interest rates might conclude that either a policy shock has occurred or that the policymaker anticipates higher inflation than they had forecasted. The latter case, depending on the model's specifics, may lead agents to update their expectations toward the central bank's forecast, anticipating higher rates and lower future inflation. Identifying policy shocks using surprises that are contaminated by endogenous responses could explain the observed puzzles in impulse response functions, while the continual updating of expectations over time introduces the autocorrelation and forecastability of surprises (see Coibion and Gorodnichenko, 2012, 2015).

Now consider the 'Fed response to news' hypothesis of Bauer and Swanson (2023a,b). If agents and the central bank share the same information but agents use an incorrect policy response parameter, monetary policy surprises will be contaminated by a term depending on the difference in parameter assumptions. This term alone cannot explain the stylised facts. If parameter errors were symmetrically distributed, their misspecification effects would cancel out on average. To induce puzzles, the misspecification term must be systematically biased – implying that agents consistently underestimate the Fed's response to inflation. How could this happen? Bauer and Swanson (2023b) propose that agents never update the Taylor rule parameter due to strong bounded rationality. Alternatively, Bauer and Swanson (2023a) argue that the Fed's response to inflation has drifted over time, becoming increasingly hawkish, leading to systematic misestimation by market participants. However, this is a small-sample argument that would vanish in large samples. Moreover, it cannot explain the forecastability

of SPF or Greenbook revisions, which Bauer and Swanson (2023a) ultimately attribute to imperfect information:

> [...] we also note that old economic news, released before the beginning-of-month Blue Chip forecast, can also be relevant if some of the Blue Chip forecasters do not update their forecasts immediately following the release of that news. The evidence in Coibion and Gorodnichenko (2012, 2015) on informational rigidities in the Blue Chip forecasts suggests that this is the case [...].

To summarise, the 'Fed response to news' argument involves three elements: (i) a mis-specified policy rule, (ii) a persistent underestimation of the Fed's inflation response, and (iii) informational rigidities. However, this argument still relies on informational rigidities – the key mechanism in the information hypothesis – while also requiring additional assumptions. Furthermore, the 'Fed response' explanation fails to account for persistent disagreement among agents, which naturally arises from information frictions. By Occam's razor, the simpler explanation – imperfect information – should be preferred.

A further issue with the 'Fed response to news' argument is its U.S.-centric focus. Similar stylised facts have been documented for virtually all central banks with high-frequency surprise data, including the UK, Japan (Cieslak and Schrimpf, 2019), the euro area (Jarociński and Karadi, 2020; Ricco et al., 2024), and South Africa (Pirozhkova et al., 2024). If the Fed became more hawkish over time, how can we explain why all markets across different economies seem to make the same dovish error?

3 The Fed response to news and some facts

Overall, the argument about the Fed response to news is not fully formalise in a model, and requires the simultaneous presence of multiple moving parts. However, it roughly proceeds in the following steps. First, all the information upon which the economic forecasts are based is public and equally available to both the Fed and market participants. Second, the Fed does

not possess an information advantage concerning the state of the economy and the future economic outlook. Third, the private forecasters do not update their forecasts upon observing the Fed's decision. Hence, information effects are unlikely. Furthermore, and fifth, both the market's forecasts and the monetary policy surprises are predictable using lagged and public economic news. Hence, those apparent information effects are due to the information gap between the stale forecasts and the policy decisions. Sixth, there has been a drift in the policy parameter of the response to inflation. Therefore, the argument goes, one can safely conclude that there is no information effect but market participants keep using a misspecified Taylor rule to forecast rates. Let's have a look at these points.

Does the Fed have access to more data? One key observation against the idea of imperfect information is that the Fed does not have access to specific information unavailable to market participants – all macroeconomic and financial data are public – aside from information on its own reaction function (and, crucially, some detailed information about the balance sheets of financial institutions). From this perspective, public forecasts should be as accurate as the Fed's, except for differences in knowledge of the coefficients of the Taylor rule. The hypothesis that the Fed responds to news is thus a natural one.

However, this holds only if agents have unlimited capacity to process information. When agents cannot process all available information, as in models of rational inattention, access to the same expansive set of public data does not necessarily change the situation. Indeed, rationally inattentive agents behave as if they face exogenously given noise, even though this noise is endogenous and arises from information-processing constraints (see Sims, 2003; Fulton, 2017; Maćkowiak et al., 2023). In light of this, models of exogenously imperfect information can be viewed as stylised representations of a reality in which agents are bounded in their ability to process information.[2]

In the light of this observation, it doesn't matter whether the monetary surprises are

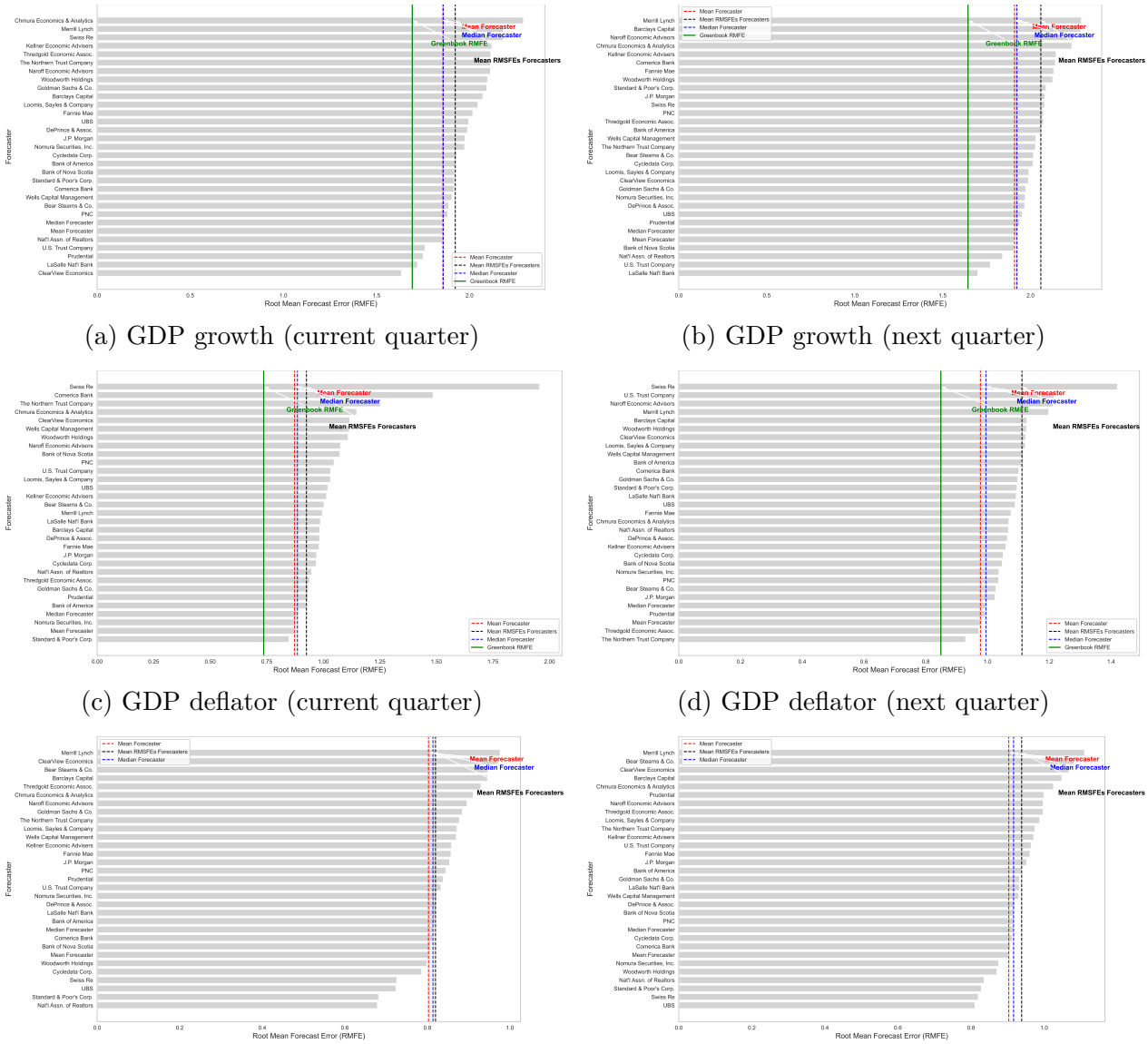
[2]In the linear-quadratic-Gaussian rational inattention framework, agents optimally choose signals about the variables of interest with Gaussian noise, similar to the model presented in the next section.

Granger caused by financial variables, private forecasts or the policymaker's forecast. As long as the lagged variables capture the relevant states, which in real time are not observed by the agents, they will have forecasting power on the market's expectation revisions. A regression on those variables will reduce the issue of endogeneity of the surprises. Hence, the approach of Bauer and Swanson (2023a), that corrects with financial variables, is equivalent to what proposed in Miranda-Agrippino and Ricco (2021), and in line with the predictions of a model of imperfect information. We develop this point more formally in the next section.

Does the Fed have an information advantage? Another key argument in Bauer and Swanson (2023a) and Bauer and Swanson (2023b) is that the Fed does not possess an information advantage concerning the state of the economy and the future economic outlook. The observation that the Fed possesses superior information was first made in the influential paper by Romer and Romer (2000). This hypothesis has been foundational in the literature on information effects, albeit as discussed in the next section, a superior information is not necessary to generate information effects but only determines the strength of those.

Let's have a look at the data, in Figure 2, which reports the root mean square forecast errors (RMSFEs) on the sample 1992 to 2016 for individual Blue Chip forecasters, the average across them, as well as the mean and median forecaster forecaster error, and compares these measure with the Greenbook's precision. A few remarks are in order. First, it is clear that the Greenbook's forecasts (dashed green line) are competitive with the respect to the professional forecasters, they basically outperform all the forecasters. While this advantage may appear larger or smaller, depending on the subsamples it is generally there (see also Hoesch et al., 2023, for a recent appraisal). Second, and how it is well know in the forecasting literature the mean (median) forecaster, that is obtained by averaging (taking the median across) forecasts is more competitive than the individual forecasters. This is evident in the difference between individual RMSFEs or their average (dashed black line) and the mean or median forecaster (red and blue dashed lines). In the literature that assess the Fed's information advantage often the average forecaster is compared to the Fed, as a comparison of the central bank with the

Figure 2: Market's and Greenbook's RMFEs



(a) GDP growth (current quarter)

(b) GDP growth (next quarter)

(c) GDP deflator (current quarter)

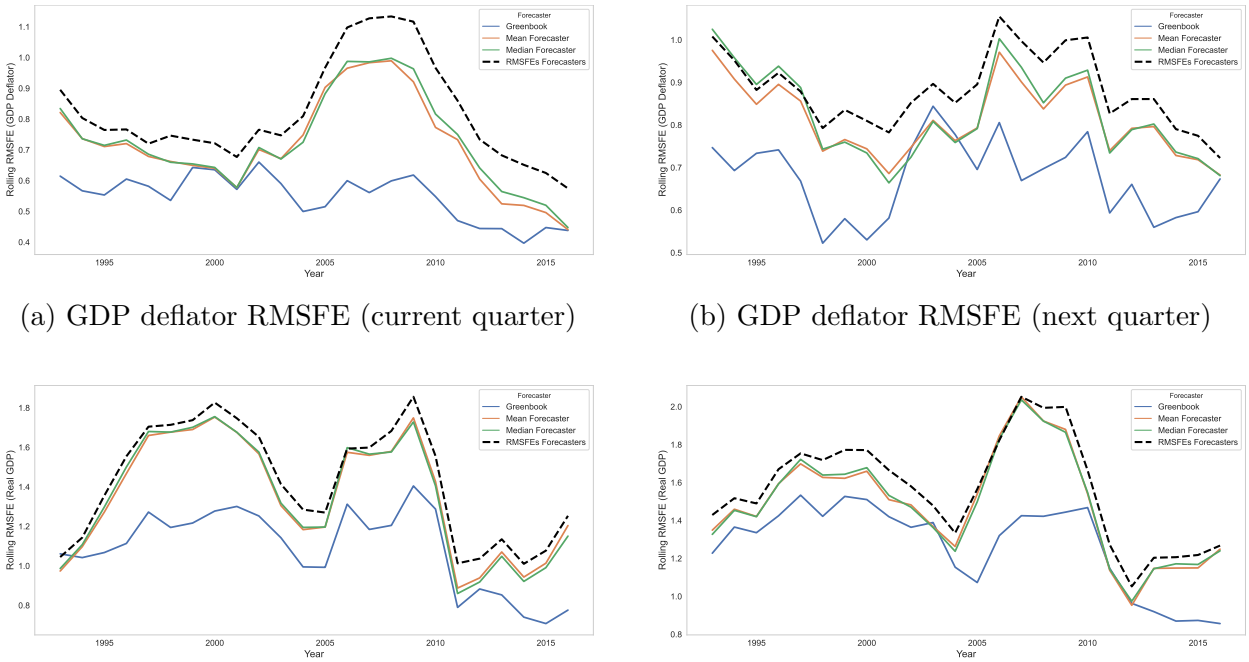
(d) GDP deflator (next quarter)

(e) FFR (current quarter)

(f) FFR (next quarter)

Notes: The figure displays the Root Mean Forecast Error (RMFE) for forecasts of (a) real GDP growth for the current quarter ($h = 0$), (b) real GDP growth one-quarter-ahead ($h = 1$), (c) inflation for the current quarter, (d) inflation for the next quarter, (d) FFR for the current quarter, (e) FFR for the next quarter made by individual market forecasters and the Federal Reserve's Greenbook. Each bar represents the RMFE of an individual forecaster, excluding the Greenbook. The black dashed vertical lines indicates the average forecast error across forecasters. The red dashed vertical line instead indicates the RMFE of the mean forecasters, while the blue dashed vertical line represents the median forecaster's RMFE. The solid green vertical line corresponds to the Greenbook RMFE. The RMFE is computed as the square root of the mean squared forecast error over the available sample.

Figure 3: Rolling RMSFE



(a) GDP deflator RMSFE (current quarter)

(b) GDP deflator RMSFE (next quarter)

(c) Real GDP RMSFE (current quarter)

(d) Real GDP RMSFE (next quarter)

Notes: The figure presents rolling RMSFEs for GDP deflator and real GDP forecasts. The RMSFEs are computed over a rolling 5-year window for each forecast horizon. The Greenbook forecasts are compared against the mean and median forecasters.

aggregate market. This is also the case Bauer and Swanson (2023a) (which look at media as the market 'consensus'). However, this is misleading in the context of the information channel, since each forecaster and market participants have their own forecast (which disagree), and the signals they get from the central bank are signals with respect to their information set. The charts show that the signals of the Fed are obviously informative. Third, while there is time variation in the relative performances, a time-varying analysis with 5-year rolling window confirms the overall picture (reported in Figure 3).

Do forecasters updated after the central bank's announcements? They do. An important piece of evidence is reported in Bauer and Swanson (2023a), who in July 2019 run a small one-off survey of the Chief Economists of each member institution in the Blue Chip panel and asked them directly how they revise their unemployment, real GDP, and inflation

Table 1: RMSFEs Comparison

Forecaster	Horizon	FFR	GDPdefl (growth)	Real GDP (growth)
Mean Forecaster	current quarter	0.803	0.871	1.862
Mean Forecaster	next quarter	0.903	0.972	1.906
Median Forecaster	current quarter	0.814	0.884	1.865
Median Forecaster	next quarter	0.917	0.990	1.919
Greenbook	current quarter	–	0.735	1.735
Greenbook	next quarter	–	0.845	1.644
Mean RMSFEs	current quarter	0.844	1.061	1.983
Mean RMSFEs	next quarter	0.948	1.091	2.039

Notes: This table reports the RMSFEs for different forecasters: Blue Chip Financial Forecast (BCFF) and the Greenbook. Forecast errors are calculated as the difference between forecasted and realised values. For real GDP and GDP deflator, we use the Philadelphia Fed's 'Real-Time Data Set for Macroeconomists': Real GNP/GDP Q/Q growth (for Real GDP) and price index for GNP/GDP Q/Q annual (for GDP deflator), as in Hoesch et al. (2023). FFR refers to the effective federal fund rate. We restrict the computation of RMSFEs to quarterly target dates (March, June, September, and December), as in Hoesch et al. (2023), and take the most recent available forecasts for every quarter from 1993 to 2016. Mean RMSFEs refer to the mean of the RMSFEs of every forecaster, while the mean (or median) forecaster are the error of a hypothetical forecaster whose predictions are the average (or median) of all forecasts. Sample goes from 1993 to 2016.

forecasts in response to FOMC announcements. Out of the 52 forecasters in the survey, 36 responded.

The paper reports the responses on the revisions to GDP forecasts, conditional on the policy decision. They show that 13 (i.e. 36%) do not revise their forecasts in response to changes in the funds rate, and 16 (44%) do not revise in response to the FOMC statement. The authors observe that this is a surprising fact, since standard macroeconomic models and VARs imply that, for example, a tighter monetary policy stance should cause GDP to fall. Of the remaining forecasters, 18 (50%) after a change in the funds rate and 15 (42%) in response to FOMC announcements revise their GDP forecast downward, following a tightening. Finally 5 (14%) revise their forecasts in a direction depends on other factors. Bauer and Swanson (2023a) conclude against the presence of information effects.

The conclusions are however surprising. While the findings may cast doubts on stronger form of an information channel, as in Nakamura and Steinsson (2018), they provide strong support to the empirical findings of Miranda-Agrippino and Ricco (2021) – quite surprisingly

so. First, the reported information effects account for a small part of the surprises, less then 10%. Hence the survey results are strikingly in line with the order of magnitude reported, even too strong. Second, in the presence of information frictions, the direction of the update has to be conditional on three things: (i) the market participants being surprised by the change; (ii) the pre-decision baseline forecasts of the individual forecaster; (iii) the balance between the perceived monetary policy shock and the information disclosure, i.e. the bundle of the shocks that lead the update. We conclude that this is strong evidence in favour of the information channel and against the proposed Fed response to news hypothesis. Yet, let us caution our enthusiasm: clearly one datapoint doesn't make for much statistics.

Let us also remark that the survey results are the more surprising given that even a small degree of rational inattention (or just being busy otherwise) would let any reasonable forecaster that does not have to deliver a new projection soon, to hold on to revise the GDP forecast until more informative signals are released by the statistical offices and the markets. Obviously, the behaviour of a market trader in a liquid market is very different and more reactive.

A natural question to ask is: how can a low degree of information contamination create puzzles? The explanation is provided in Miranda-Agrippino and Ricco (2023) who derive an analytical expression of the bias to the IRFs derived employing a contaminated IV. The size of the bias depends essentially on two things: the strength of the contamination in the instrument and, crucially, how pervasive are the shocks in the economy, i.e. the explained variance by the contaminant shocks in the variables of interests. This provides an interpretation: even in the presence of a small contamination from pervasive shocks – i.e. demand shocks – puzzles can be observed.

Is there a drift in the coefficients of the policy rule? Not at all. Figure 1 shows the coefficients of a Taylor rule, which includes inflation and output gap, that are obtained by regressing the market yield on U.S. Treasury Securities at 2-year onto 1-year growth in Personal Consumption Expenditure and GDP growth, as in Bauer and Swanson (2023b).

The first row shows estimates from an expanding window regression with exponential down-weighting of older observations, as done by Bauer and Swanson (2023b), while the second row presents results from a rolling-window estimation.

The top left chart replicates the results in Bauer and Swanson (2023b) and show the presence of a drift. Yet, as the other charts indicates, this is not a robust finding. A rolling window exercise, which is more appropriate to appraise the presence of time variation, shows that there is no trend and if any the coefficient on inflation is zero, puzzling. At the same time, the coefficient on output gap appears to have been drifting, indicating an increasingly dovish stance of the Fed.

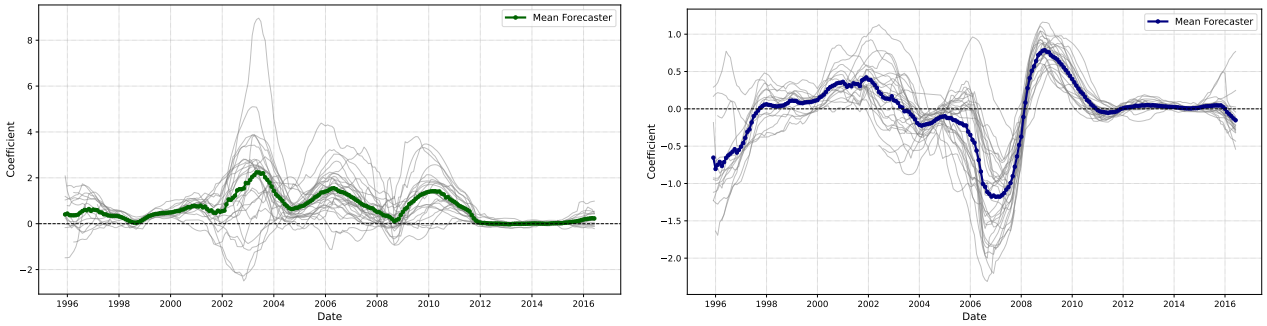
A similar exercise with survey data is reported in Figure 4. The figure shows for the individual forecasters and the mean forecaster in the Blue Chip dataset the coefficients of a Taylor rule that are obtained from rolling regressions the forecasts for the effective federal funds rate onto the forecasts for GDP growth and inflation, with a rolling window of 36 months. It is worth observing that our results, chime with the ones reported by Bauer et al. (2024), who estimate perceptions of the Fed's monetary policy rule from the BCFF survey.

Are all market participants always wrong about the policy rate forecast? No. Figure 5 complements Figure 1 and plots the realised FFR along with the range between the 5th and 95th in the dispersion of Blue Chip forecasts. Together the two charts indicate that not all of the forecasters expect a substantially more dovish policy rate. If any, there is, on average, more mass above the realised rate, showing that forecasters are more hawkish than the policymaker.

It is important to observe that in such a situation if a market participant were to constantly trade based on a forecast underestimating the inflation parameter of the Taylor rule, the rest of the market would rapidly drive them out of the market.

A related and important question is: how is it possible that market forecasts are as good as the Fed's at forecasting any variable, a part from the policy rates? After all, the latter is an essential input in forecasting both inflation and GDP growth. Here the inconsistency of

Figure 4: Market perception of Taylor Rule parameters

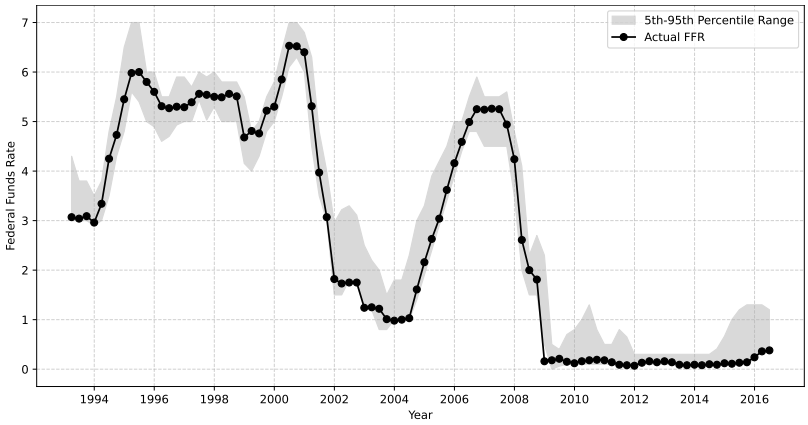


(a) GDP deflator coefficient

(b) GDP growth coefficient

Notes: The figure displays the dispersion of forecasters' estimated sensitivity to (a) inflation and (b) GDP growth, in a Taylor Rule specification. The coefficients are obtained from rolling regressions of the effective federal funds rate (FFR) on GDP growth and inflation, with a rolling window of 36 months. Each grey line represents an individual forecaster's estimated coefficient on GDP growth, while the navy blue (GDP growth) and the dark green (inflation) lines represents the cross-sectional average of these coefficients at each point in time. The data includes professional forecasters from the Blue Chip Financial Forecasts (BCFF) survey, covering the period from 1992 to 2016. Forecasters included in the sample meet a minimum consistency criterion of 15 years of participation with at least 6 monthly observations per year. The sample is restricted to those reporting forecasts at a horizon of zero (h=0).

Figure 5: Dispersion of market forecasts for federal funds rate



Notes: The figure illustrates the dispersion of market forecasts for the FFR alongside the actual realised rate at the end of each quarter. The grey shaded area represents the range between the 5th and 95th percentiles of forecasts collected from professional forecasters in each quarter. The black line corresponds to the realised FFR at the end of each quarter. This figure highlights the degree of heterogeneity in expectations among forecasters, with the widening or narrowing of the percentile band reflecting periods of high or low forecast uncertainty.

the reasoning is obvious.

Do forecasts agree on the Taylor rule? No. Figure 4 also reports the dispersion in the estimated Taylor rule coefficients for GDP growth and inflation, across forecasters. It is important to notice that some forecasters consistently overestimate the sensitivity of monetary policy to economic conditions relative to the mean forecaster, while others systematically underestimate it (and no drift is apparent). This dispersion suggests that perceptions about the monetary policy rule are not homogeneous but vary substantially across market participants.

The presence of substantial dispersion in forecasts contradicts one of the key tenets of the Fed response to news channel, which cannot accommodate disagreement. If agents persistently disagree on their interpretation of the policy rule (or equivalently on the type of shocks to which the Fed has to respond) and have a large span of beliefs, they will tend to drive out of the market traders with large (negative) biases.

It is worth stressing that the results cannot be interpreted literally as the perceived Taylor rule, since the Fed and hence the forecasters are unlikely to employ a simple Taylor rule of the form estimated, and there are well know issues econometric issues of endogeneity with this type of estimates (see Carvalho et al., 2021).

4 A model of imperfect information and policy shifts

The previous section showed some of the potential inconsistencies of the idea that the reported information effects can be in fact due to a misspecification of the policy rule used by agents to forecast the policy rate, possibly due to unexpected changes to the parameters of the Taylor rule. We also observed that to a large extent the Fed response to news hypothesis explains the same facts of the information effects argument and hence it does not seem to allow for a direct falsification.

We now provide a formalisation to the problem discussed in Section 2, and show that there are testable implications that allow to distinguish the role of information from the effects of unexpected changes to the policy rule in the monetary policy surprise. To do this we

proceed in steps. We start by discussing how to frame the problem of a Taylor rule with time changing parameters in the context of a standard linearised policy rule. This is of interest for two reasons. First, in the standard approach to linearisation, a shift to the Taylor rule ends up being a monetary policy shock. Second, because it allows to think about first and second order terms in the policy rule.

The next step is to embed the Taylor rule with shifts to the policy parameter into an affine term structure model, of the type discussed in Smith and Taylor (2009). This allows to formalise the effects of shocks and shifts to the policy parameters onto the entire yield curve.

We then consider the implication of such a setting for agent that are imperfectly informed about the state of the economy and receive both private noisy signals about the fundamentals of the economy, and observe the policy rate which constitute a noisy public signal. In doing this we expand the stylised model with imperfect information of Miranda-Agrippino and Ricco (2021), and similarly to what is done in Pirozhkova et al. (2024).

Finally, we derive the structure of the monetary policy surprises, i.e. the price revisions of bonds of different maturities triggered by a policy announcement. This provides us with predictions and testable implication to assess whether information effects or shift to the coefficients of the policy rule account for the observed puzzles. In the rest of the paper we assess these predictions.[3]

4.1 Nonlinear and linear (time-varying) policy rule

Let us consider a generic nonlinear Taylor rule, following Woodford (2003):

$$R_t = \phi\left(\frac{\Pi_t}{\Pi_t^*}; \nu_t\right), \tag{5}$$

where R_t is the gross nominal interest rate, and the function ϕ indicates the rule used by the central bank to set its operating target (i.e. R_t^*). $\phi(\cdot; \nu_t)$ is a bounded-below, non-decreasing

[3]All the derivations are reported in Section A of the Online Appendix.

function for each possible value of the shifter ν_t, while $\Pi_t \equiv P_t/P_{t-1}$ is the gross inflation rate and Π_t^* is a possibly time-varying target rate.[4] ν_t captures shifts in the central bank's rule – i.e. variations in policy, or in its implementation –, as distinct from changes in the target inflation itself.

A standard first order log-linear Taylor expansion of the rule with respect to the point $(\Pi_t = \Pi^*; \nu_t = 0)$, as discussed in Woodford (2003), delivers a fixed coefficient Taylor rule, i.e.

$$r_t = r^* + \phi(\pi_t - \pi^*) + \sigma^{mp}\nu_t + \mathcal{O}(2), \tag{6}$$

where r^* can be thought of as the nominal equilibrium rate, and ϕ is the elasticity of the policy rule with respect to deviations of inflation from the target. Interestingly the policy rule shifter, ν_t is the monetary policy shock itself. Which implies that all the residual variation is hidden in the (assumed) sub-leading term of second order and beyond, which are indicated as $\mathcal{O}(2)$.

To obtain a time varying rule with a drift we need to go back to the linearisation. Let us assume that ν_t is stable around a possibly time-varying steady state $\bar{\nu}_t$, i.e

$$\nu_t = \bar{\nu}_t + \nu_t^{mp},$$

where $\bar{\nu}_t$, will become the point of expansion which we assume to undergo permanent shifts, similarly to a random walk, and ν_t^{mp} will be assumed to be a small and transitory process. We can now linearise with respect to the point $(\Pi_t = \Pi_t^*; \nu_t = \bar{\nu}_t)$ to obtain the standard linear Taylor rule, but with time-varying coefficients, i.e.[5]

$$r_t = r_t^* + \phi_t(\pi_t - \pi_t^*) + \sigma_t^{mp}\nu_t^{mp} + \mathcal{O}(2). \tag{7}$$

[4] In general, ϕ is a function capturing the nonlinear behaviour of the policy away from the steady state where a small perturbations approximation is not accurate, or around the zero or effective lower bound where its non negative-valued (or bounded below) nature is visible.

[5] The time-variation that has been captured through ν_t does not need to occur simultaneously in all the parameters of the Taylor rule and will depend on the nature of ϕ and the dimension of ν_t.

Let us remark that for this log-linear expansion to be valid it has to be that the rule is relatively stable and the changes are not 'too large' otherwise the linear expansion around a time-varying point could be not valid and second order terms could be as large as or larger than first order terms.

The object $\bar{\nu}_t$ has to be thought of as the persistent part of the parameter characterising the variations in the policy or its implementation. Given the relative stability of the US monetary policy, we can think of it as a stochastic parameter evolving as a bounded random walk (see, for example, Nicolau, 2002). This allows for a formalisation of the problem where the policy rule is broadly stable over time but small changes of its parameters can appear as shocks to a random walk process to the agents in the model.

This observation allows us to consider a further expansion in ν_t around what we can think of the central point of the bounded random walk. If the area in which the process behaves like a random walk is not 'too large', then a Taylor expansion can provide an approximation to the policy rule. Let us focus on the inflation parameter of the Taylor rule and consider an expansion at the centre of the area of the bounded random walk process, $\bar{\nu}$, i.e.

$$\phi_t = \frac{\partial \phi\left(\Pi_t/\Pi_t^*;\nu_t\right)}{\partial\left(\Pi_t/\Pi_t^*\right)}\bigg|_{1;\bar{\nu}} + \frac{\partial^2 \phi\left(\Pi_t/\Pi_t^*;\nu_t\right)}{\partial\left(\Pi_t/\Pi_t^*\right)\partial\bar{\nu}_t}\bigg|_{1;\bar{\nu}} \bar{\nu}_t + \mathcal{O}(2) \equiv \phi + \widehat{\phi}_t + \mathcal{O}(2) \tag{8}$$

The expansion shows that we are now considering terms of the second order, and going beyond a first order expansion. For the sake of the exposition, let us focus on the ϕ parameter only and absorb all the other exogenous shift in the central bank's reaction function into the monetary policy shock ν_t^{mp}. We obtain:

$$r_t = r^* + (\phi + \widehat{\phi}_t)(\pi_t - \pi^*) + \sigma^{mp}\nu_t^{mp} + \mathcal{O}(2), \tag{9}$$

where $\mathcal{O}(2)$ stays for the remainder term which still contains second order terms, i.e. $\sim u_t^{mp,2}$, $(\pi_t - \pi_t^*)^2$, and $(\pi_t - \pi_t^*)\nu_t^{mp}$, albeit the expansion now features some terms beyond the first oder, i.e. $\widehat{\phi}_t(\pi_t - \pi)$.

Let us summarise. Starting from a general nonlinear policy rule we derived a linearised Taylor with an inflation coefficient varying trough time, and with a shift behaving like a random walk, but effectively covering a bounded space (and hence being a stationary and ergodic process). It is important to stress that in doing so we have to consider second order terms beyond the standard first oder log-linearisation Taylor expansion. Other second oder terms, of the same magnitude, may have been (erroneously) dropped in the expansion.

4.2 A term structure with policy shocks and rule changes

Let us now embed the policy rule discussed in the previous section into an affine term structure model, of the type discussed in Smith and Taylor (2009). All the variables are considered now in deviation from their steady state:

$$r_t = (\phi + \widehat{\phi}_t)\pi_t + \sigma_{mp}\nu_t^{mp}, \tag{10}$$

$$\nu_t^{mp} = \zeta\nu_{t-1}^{mp} + u_t^{mp} \tag{11}$$

$$\widehat{\phi}_t = \widehat{\phi}_{t-1} + \sigma_\phi u_t^\phi \tag{12}$$

$$i_t^{(n)} = -\frac{1}{n}\log P_t^{(n)}, \tag{13}$$

$$P_t^{(n+1)} = \mathbb{E}_t\left[m_{t+1}P_{t+1}^{(n)}\right], \tag{14}$$

$$m_{t+1} = e^{-r_t - \frac{1}{2}\lambda_t^2 - \lambda_t u_{t+1}^\pi}, \tag{15}$$

$$\lambda_t = -\gamma - \psi\pi_t, \tag{16}$$

$$\pi_t = \alpha\pi_{t-1} - \delta(r_{t-1} - \pi_{t-1}) + \sigma_\pi u_t^\pi, \tag{17}$$

As discussed, Eq. (10) is the (linearised) monetary policy rule in which the short-term nominal interest rate r_t depends on the inflation rate with a policy response coefficient $\phi > 0$. Eq. 11 models the transitory policy shock as an AR(1) process, with coefficient $0 \leq \zeta < 1$. In the rest of this section, we will focus on the simplest case, where $\zeta = 0$ and $\nu_t^{mp} = u_t^{mp}$. Eq. (13) gives the yield to maturity of a zero-coupon bond with face value of one, that matures in n

periods, where $P_t^{(n)}$ is the price of the bond at time t. Eq. (14) is a no-arbitrage condition showing that the price of an $n+1$ period bond at time t must equal the expected present discounted value of the price of an n-period bond at time $t+1$, where m_t is the stochastic discount factor. Eq. (15) describes this stochastic discount factor, whose functional form is borrowed from the affine term structure literature. Eq. (16) models the risk factor as depending on a constant risk premium, γ, and a time-varying risk premium, ψ, connected to changes in inflation. Finally, in Eq. (17) the dynamics of inflation is function of the lagged real interest rate and past inflation. The three shocks in the model – an inflation shock, a conventional monetary policy shock, and a shifter of the policy rule – are independent and identically distributed normal white noise processes, $u_t^i \sim iidN(0,1)$ for $i \in (\pi, mp, \phi)$.

Although we will consider shifts in Taylor rule parameter, we assume that the central bank and the private agents at any time view it as certain and constant. Any changes in the Taylor rule parameters are thus fully unanticipated, and seen as permanent. This is in line with the intuition proposed by Bauer and Swanson (2023a).

This model implies the affine structure of the yield curve, which is described by the following Lemma.

Lemma 1. *The yield curve described by the model in Eq.s (10-17) is*

$$i_t^{(n)} = a_n + b_n \pi_t + c_n u_t^{mp} \tag{18}$$

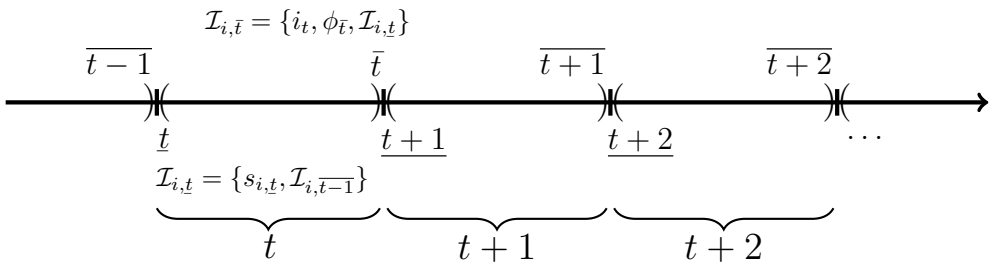
with coefficients of the disturbances given by

$$b_n = \frac{\phi \sum_{i=1}^{n-1} \kappa^i}{n}, \quad c_n = \frac{\sigma_{mp} \left(1 - \delta\phi \sum_{i=0}^{n-2} \kappa^i\right)}{n}, \tag{19}$$

for $\kappa = \alpha + \delta(1-\phi) + \sigma_\pi \psi$.[6]

[6] We assume $|\kappa| < 1$.

Figure 6: **The information flow.**



4.3 Imperfect information and policy signals

We now embed the term structure model in an environment characterised by imperfect information, following Miranda-Agrippino and Ricco (2021) and Pirozhkova et al. (2024).

Each agent i in the economy does not directly observe π_t, but receives a private noisy signal of π_t at the beginning of the time period $t = [\underline{t}, \bar{t}]$ (see Figure 6):

$$s_{i,\underline{t}} = \pi_t + \nu_{i,\underline{t}} \ , \qquad \nu_{i,\underline{t}} \sim \mathcal{N}(0, \sigma_{n,\nu}) \ . \tag{20}$$

Agents also form beliefs about the Taylor rule parameter, i.e. $\phi + \widehat{\phi}_{t-1}$, by assuming that it is equal to last period, i.e.

$$\phi_{\underline{t}} = \phi_{\overline{t-1}} = F_{\overline{t-1}} \left(\phi + \widehat{\phi}_{t-1} \right)$$

Given the signal and conditional on their information set $\mathcal{I}_{\underline{t}} = \{s_{i,\underline{t}}, \phi_{\underline{t}}, \mathcal{I}_{\overline{t-1}}\}$, agents update their expectations from closing time of the previous period, $F_{i,\overline{t-1}}\pi_t$, and form expectations $F_{i,\underline{t}}\pi_t$ given their information set via the Kalman filter

$$F_{i,\underline{t}}\pi_t = K_1 s_{i,\underline{t}} + (1 - K_1) F_{i,\overline{t-1}}\pi_t \ , \tag{21}$$

$$F_{i,\underline{t}}\pi_{t+h} = (\alpha - \delta(\phi_{\underline{t}} - 1))^h F_{i,\underline{t}}\pi_t \qquad \forall h > 0 \ , \tag{22}$$

where K_1 is the Kalman gain which represents the relative weight placed on new information relative to previous forecasts. When the signal is perfectly revealing $K_1 = 1$, while in the

presence of noise $K_1 < 1$. Thus $(1 - K_1)$ is the degree of information rigidity faced by the agents.

Given their forecasts, at $\underline{t}$, agents trade bonds of different maturities with the following interest rates

$$i_{\underline{t}}^{(n)} = a_n + b_n F_{i,\underline{t}} \pi_t \ . \tag{23}$$

At opening time $\underline{t}$ the central bank observes a private noisy signal of the state of the economy in period t

$$s_{cb,\underline{t}} = \pi_t + \nu_{cb,\underline{t}} \ , \qquad \nu_{cb,\underline{t}} \sim \mathcal{N}(0, \sigma_{cb,\nu}) \ . \tag{24}$$

We can assume without loss of generality that the signal observed by the central bank is more precise than the one observed by agents: $\sigma_{cb,\nu} < \sigma_{n,\nu}$. Given the signal, the central bank updates its expectations from closing time of the previous period given its information set via the Kalman filter

$$F_{cb,\underline{t}} \pi_t = K_{cb} s_{cb,\underline{t}} + (1 - K_{cb}) F_{cb,\overline{t-1}} \pi_t \ , \tag{25}$$

$$F_{cb,\underline{t}} \pi_{t+h} = (\alpha - \delta(\phi + \widehat{\phi}_t - 1))^h F_{cb,\underline{t}} \pi_t \qquad \forall h > 0 \ , \tag{26}$$

where K_{cb} is the bank's Kalman gain. Given its nowcast for inflation, the central bank sets and announces the interest rate, by following its policy rule:

$$i_t^{(1)} = r_t = (\phi + \widehat{\phi}_t) F_{cb,\underline{t}} \pi_t + \sigma_{mp} u_t^{mp} \tag{27}$$

At closing time $\bar{t}$, agents observe the new interest rate r_t and receive a noisy signal about the Taylor rule parameter of the central bank, i.e.

$$\phi_{\bar{t}} = \phi + \widehat{\phi}_t + \zeta_t \ , \qquad \zeta_t \sim \mathcal{N}(0, \sigma_\zeta) \ .$$

Given these two signals they update their expectations and trade bonds at different maturities.

Agents observe the interest rate r_t at closing time $\bar{t}$ and update their expectations and trade bonds at different maturities. The policy rate is a public signal about the state of the economy to the agents. In fact, conditionally, on observing r_t and r_{t-1} (and knowing K_{cb}), agents extract a public signal on π_t, i.e. $\tilde{s}_{cb,t} = \pi_t + \widetilde{\nu}_{cb,\underline{t}}$.[7]

At $\bar{t}$, conditional on this public signal, agents update their information set, $\mathcal{I}_{\bar{t}} = \{i_t, p_t, \mathcal{I}_{\underline{t}}\}$, and their forecasts

$$F_{i,\bar{t}}\pi_t = K_2\tilde{s}_{cb,\bar{t}} + (1-K_2)F_{i,\underline{t}}\pi_t \ , \tag{28}$$

$$F_{i,\bar{t}}\pi_{t+1} = (\alpha+\delta)F_{i,\bar{t}}\pi_t - \delta r_t \ , \tag{29}$$

$$F_{i,\bar{t}}\pi_{t+h} = (\alpha - \delta(\phi_{\underline{t}}^{-1}-1))^{h-1}F_{i,\bar{t}}\pi_{t+1} \qquad \forall h>1 \ , \tag{30}$$

where K_2 is the Kalman gain, as given by the noise in the public signal $\tilde{\nu}_{cb,\underline{t}}$.

The solution of the model delivers a set of interesting results. Let us start from the revisions of expectation on the state of the economy, which are captured by the following result.

Lemma 2 (**Expectation revisions**). *A policy announcement triggers revision a market revision of expectations, i.e. the information effects, of the form*

$$\begin{aligned} F_{\bar{t}}\pi_t - F_{\underline{t}}\pi_t = {} & (1-K_1)(1-K_2)(F_{\overline{t-1}}\pi_t - F_{\underline{t-1}}\pi_t) \\ & + (1-K_1)(1-K_2)\delta(r_{t-1} - F_{\underline{t-1}}r_{t-1}) \\ & + K_2\left[(1-K_1)\sigma_\pi u_t^\pi - (1-K_1)(\alpha+\delta)\tilde{\nu}_{cb,\overline{t-1}} + \tilde{\nu}_{cb,\bar{t}}\right]. \end{aligned} \tag{31}$$

The lemma generalises what found in Miranda-Agrippino and Ricco (2021). Two remarks are in order. First, the expectation revisions triggered by a policy announcement are autocorrelated, due to the slow absorption of information and the fact that agents keep revising their

[7] The noise in the signal $\tilde{s}_t$ is coloured, and not orthogonal to the state. Hence, it does not fulfill the standard conditions under which the Kalman filter is derived. Unmodelled dynamics can degrade the filter performance. We abstract here from these consideration that would require robust control methods.

backcasts. This the trademark of models of imperfect information, as discussed in Coibion and Gorodnichenko (2012, 2015). Second, they blend current and past shocks and hence are predictable by past information such as past macro and financial variables. Third, the term that feature the current shock to inflation, i.e. u_t^π can be thought of as the direct information effects of the announcement that reveal information about the current state of the economy. The strength of these information effects depends on $K_2(1-K_1)$ which increases with the noise in the private signal and decreases with the noise of the public signal. This indicates that, while the presence of information effects does not depend on the central bank having superior information, yet the strength of the information channel is a function of the relative precision of the policy signal as compared to the signals received by private agents.

We can derive the structure of the monetary policy surprise. Observing that from the point of view of the agents, it has to be true that $i_t^{(0)} = r_t = \delta F_{i,\bar{t}}\pi_t + \sigma^{mp} F_{i,\bar{t}} u_t^{mp}$, we obtain the following results.

Lemma 3 (**Policy rate surprise**). *The average market forecast error on the policy rate is*

$$\begin{aligned} r_t - F_{\underline{t}} r_t = & \underbrace{(1-K_1)(1-K_2)\,(\alpha+\delta)\,(r_{t-1} - F_{\underline{t-1}} r_{t-1})}_{autocorrelation} \\ & + \underbrace{(1-K_1)(1-K_2)\,(\alpha+\delta)\,\phi^{-1}\sigma_\phi u_{t-1}^\phi (r_{t-1} - F_{\underline{t-1}} r_{t-1})}_{rule\ parameter\ change} \\ & + \underbrace{\sigma_\phi u_t^\phi F_{\bar{t}}\pi_t - \sigma_\phi u_{t-1}^\phi (\alpha+\delta) F_{\overline{t-1}}\pi_{t-1} + \widehat{\phi}_{t-1} K_2(1-K_1)\sigma_\pi u_t^\pi}_{rule\ parameter\ change} \\ & + \underbrace{\phi K_2(1-K_1)\sigma_\pi u_t^\pi}_{info\ effect} + \underbrace{\sigma^{mp} F_{\bar{t}} u_t^{mp}}_{mp\ shock} + \upsilon_t, \end{aligned} \tag{32}$$

where υ_t is convolution of past and current shocks.

The expression in Eq. (32) shows how the average market forecast errors on the realised policy rate are function of (i) the shift to the policy rule, (ii) the information effects, and (iii) the monetary policy shocks. The presence of imperfect information also delivers the autocorrelation in the forecast errors. This expression provides a model-based counterpart to,

and solidifies the intuition provided by Eq. (4) in Section 2.

We can now discuss the effect of a policy announcement on the yield curve.

Lemma 4 (**Monetary policy surprises**). *The price revisions, i.e., the monetary policy surprises, for bonds at longer maturities are*

$$i_t^{(n)} - F_{\underline{t}} i_t^{(n)} = \underbrace{b_n(F_{\bar{t}}\pi_t - F_{\underline{t}}\pi_t)}_{\textit{info effect}} + \underbrace{\frac{\partial b_n}{\partial u_t^{\phi}}(\phi_{\bar{t}} - \phi_{\underline{t}})(F_{\bar{t}}\pi_t - F_{\underline{t}}\pi_t)}_{\textit{rule parameter change}} + \underbrace{c_n F_{\bar{t}} u_t^{mp}}_{\textit{mp shock}}, \tag{33}$$

where the derivative of b_n with respect to u_t^{ϕ}, captures the shift in the policy parameter, and hence its effect on yield at different maturities.

Lemma 4 shows that the yield curve reacts to the policy announcement, as due to (i) the market updated expectations about the state of the economy, (ii) the updated understanding of the policy rule, (iii) the monetary policy shock. These three terms potentially affect the yields in different ways, as summarised by the following results.

Lemma 5 (**Policy parameter shift**). *The effect of a change in the policy parameter on the yield curve is*

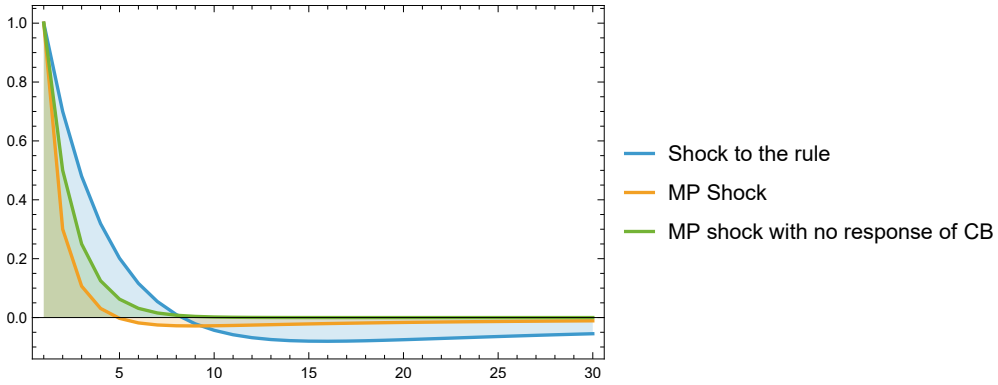
$$\frac{\partial b_n}{\partial u_t^{\phi}} = \frac{\sigma_{\phi}}{n}\frac{1}{(1-\kappa^2)}[n\delta\phi\kappa^{n-1}(1-\kappa) - (1-\kappa^n)(\delta\phi + \kappa - 1)], \tag{34}$$

which for $\alpha + \delta + \sigma_{\pi} > 1$ is such that there exists a unique n^* such that

$$\frac{\partial b_n}{\partial u_t^{\phi}} = \begin{cases} > 0 & \text{if } n < n^* \\ < 0 & \text{if } n > n^* \end{cases}$$

This result shows that the impact of a shock to the parameter of the Taylor rule onto the yield curve is positive for small values of n, and negative for large values of n, since the term including k^{n-1} approaches zero for large values of n. If a central bank becomes more responsive to inflation yields at short maturities increase whereas those at longer maturities

Figure 7: Policy Parameter Shift and Policy Rate Surprise



Notes: The figure compares the impact on the term structure of interest rates of a shift in the perceived policy rule (blue) versus a standard policy rate surprise (yellow). The calibration follows Smith and Taylor (2009), where the policy parameter is altered from 1.2 (pre-shift) to 1.6 (post-shift). Over longer maturities, the standard policy rate surprise converges to nearly zero, while the effect of the perceived rule shift remains more persistent. In green, we report the reaction of the term structure under the assumption that the central bank does not adjust its policy, with the policy rate surprise following an AR(1) process with an autocorrelation coefficient of 0.5.

decrease. Its prediction is in line with results reported by Smith and Taylor (2009) and Ellingsen and Soderstrom (2001), but in a model with imperfect information.

Lemma 6 (**Response to inflation**). *The derivative of* b_n *in* n *is*

$$\frac{\partial b_n}{\partial n} = \frac{\partial}{\partial n}\left(\frac{\phi}{n}\frac{1-\kappa^n}{1-\kappa}\right) = -\frac{1}{n}\frac{\phi}{1-\kappa}\left(\frac{1-\kappa^n}{n} + \kappa^n \log \kappa\right) < 0,$$

hence the response coefficient to inflation decreases over the horizons.

This result indicates that updated expectations about inflation, due to information effects, will lead to higher interest rates at all maturities, with a decreasing effects over the horizons.

The behaviour of the last term, that relates to monetary policy shocks, will critically depend on two aspects of the model: (i) he degree of autocorrelation of the shock, which will shape its persistence, and (ii) whether the central bank responds to the effects of its own shocks or not. However, its effects will dissipate ad business cycle frequency and will be close to zero at long maturities.

4.4 A few takeaways

Let us summarise our results and add a few remarks. First, the presence of imperfect information implies the predictability of the surprise by past information, be it policymakers or private forecasts, or financial and macroeconomic variables. The use of policymaker's pre-meeting forecast to control for information effects, as done in Miranda-Agrippino and Ricco (2021), is potentially more effective since (i) it aligns the econometric information set to the one upon which the decision was based, a (ii) employs non-stale forecasts potentially capturing current shocks and not only past shocks.

Second, the presence of information effects does not depend on the central bank having superior information in the stronger sense of Romer and Romer (2000). However, the strength of the information channel is a function of the relative precision of the policy signal as compared to the signals obtained by the individual agents and not the aggregate market.

Third, information effects shift the entire yield curve in the same direction, with decreasing weights. Shocks to the rule impose a rotation to the yield curve with its long end moving in opposite direction to shorter maturities. The effects monetary policy shocks depends on their persistence and whether the central bank reacts to the macroeconomic effects caused by its own shocks. However, their effects are close to zero at longer maturities. In the next section, we will adopt this last predictions of the model to disentangle monetary policy shocks, shocks to the rule, and information effects.

5 Measures of policy changes and policy shocks

The results presented in the previous section provide an empirical strategy to identify policy shocks, and disentangle the role of information from shocks to the policy rule by studying the response of the entire yield curve to policy announcements.

Table 2: Variance decomposition

	FF1	FF2	FF3	FF4	FF5	FF6	ED1	ED2	ED3
Conventional	65.22	81.61	81.61	76.10	65.64	56.57	81.67	78.75	71.53
Shock to rule	10.71	2.31	0.92	0.31	0.13	0.34	0.69	0.81	5.33
FG	0.00	4.70	8.08	13.41	22.30	26.36	0.94	0.00	0.21
QE	0.00	0.20	1.87	3.13	6.22	6.57	6.59	12.54	15.05
Res	24.05	11.15	7.50	7.03	5.69	10.14	10.09	7.89	7.85
	ED4	TRE3M	TRE6M	TRE2	TRE5	TRE10	TRE30	SP500	
Conventional	60.95	81.22	84.57	61.65	29.36	6.50	0.00	17.99	
Shock to rule	9.97	0.07	1.33	13.67	23.46	23.04	27.18	33.75	
FG	0.88	2.01	3.13	0.81	2.06	1.35	0.00	2.01	
QE	17.76	0.21	2.36	16.81	37.93	61.78	54.60	43.13	
Res	10.42	16.46	8.58	7.04	7.17	7.31	18.21	3.10	

Notes: The table reports the variance of the prices revisions for federal funds futures (FF), eurodollar future (ED), on-the-run treasuries (TRE), and the stock market (SP500) triggered by policy announcements explained by the identified factors. Values are in percentage.

5.1 The dimensions of monetary policy

To extract measures of monetary policy surprises, we rely on an extended version of the dataset of high-frequency price revisions compiled by Gurkaynak et al. (2005b), which captures the high-frequency responses of financial markets to monetary policy announcements. The dataset records price changes for a range of assets in the minutes surrounding FOMC announcements, isolating the policy surprise from other economic news. Our methodology builds on Gurkaynak et al. (2005b), but introduces an additional restriction to distinguish between conventional monetary policy shock and a shock to the monetary policy rule.

In particular, we consider the following assets:

- Federal funds futures contracts with maturities from 1 to 6 months (FF1–FF6),
- Eurodollar futures with maturities up to 1 year (ED1–ED4),
- On-the-run U.S. Treasury securities with maturities of 3 months, 6 months, 2 years, 5 years, 10 years, and 30 years,

- S&P 500 stock index.

We employ principal component analysis (PCA) to extract factors capturing the relevant commonalities in asset price movements following FOMC announcements, with the estimated factor model taking the form:

$$Y = F\Lambda + \epsilon, \tag{35}$$

where Y is a $T \times 17$ matrix of intraday surprises, F is a $T \times 4$ matrix of principal components, Λ is the 4×17 loading matrix, and ϵ represents the idiosyncratic components.

The principal components are unique up to an orthonormal rotation. To obtain an economically meaningful decomposition, and following Gurkaynak et al. (2005b), we need to impose a set of identification restrictions. Specifically, we apply the following assumptions:

- The first (F1) and second factor (F2) are the only factors affecting the shortest-term interest rate (FF1).

- Following the predictions of the model presented in Section 4, to distinguish between a factor capturing conventional monetary policy (F1) and a factor that encapsulates the shocks to the rule (F2), we impose that the second factor (F2) is the only one with maximal effect on the long end of the yield curve (30-year Treasury yield).

- The third factor (F3) is restricted to minimise its variance before August 2008 and to have zero effect on FF1, isolating quantitative easing/tightening (QE/QT) shocks, as suggested by Swanson (2021).

- The fourth factor (F4) is left as residual factor in the rotation with one constraint ensuring that it has zero impact on FF1. This is the factor that captures forward guidance.

It is worth stressing that the restrictions identifying the last two factors are not strictly speaking needed for this study, since by imposing that only two factors have non-zero effect on the short end of the yield curve, we identify an orthogonal subspace.

Figure 8 presents the time series of the two identified factors: monetary policy shocks and shocks to the perceived policy rule. Two remarks. First, the time series for F1 is remarkably similar to the FF4 series generally used to identify monetary policy shocks, following the work of Gertler and Karadi (2015b). Second, the time series for F2 shows a rather symmetric pattern around zero, and does not show one sided errors, as it would be the case if the policy parameters had been drifting to higher values over the years.

The inclusion of the S&P 500 surprises delivers factors with a given correlation with the market and incorporate the intuition of the approach of Jarociński and Karadi (2020), which distinguishes monetary policy shocks from information using the positive or negative correlation with the stock market.

The first factor (F1/conventional) explains the largest share of the variance of the assets spanning the yield curve at shortest maturities (Table 2). The second factor (F2/shock to rule) explains a smaller share at shorter maturities but a larger share at the end of the curve and of the stock market. Figure 9 displays their loadings on different asset price movements. It shows that F1 has a loading pattern that decreases over the maturities which is compatible with standard monetary policy shocks (and information). It also has a negative impact on the stock market. The loadings for the second factor decline more rapidly over the maturities and turn negative after the two year mark, with a stronger negative effect on the stock market.

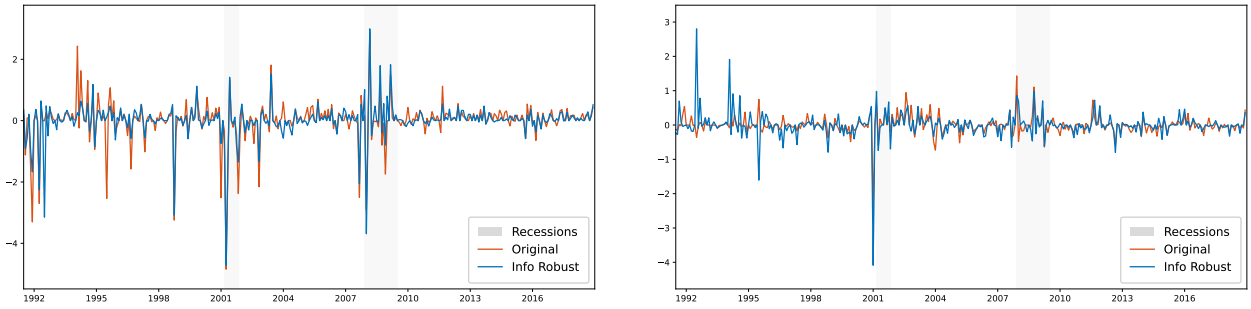
5.2 Information effects

To isolate the true policy surprises, following the intuition provided by the model, we estimate an information regression of the type proposed by Miranda-Agrippino and Ricco (2021)

$$ms_t^i = \beta_0 + \sum_{j=0}^{J} \theta_j^i F_t x_{q+J} + \sum_{j=0}^{J-1} \eta_j \Delta F_t x_{q+j} + \widetilde{ms}_t^i, \tag{36}$$

where ms_t^i represents the monetary surprise for asset i at time t. The regressors include the Greenbook forecasts about unemployment, inflation and GDP growth ($F_t x_{q+J}$) and

Figure 8: Identified and informationally corrected factors

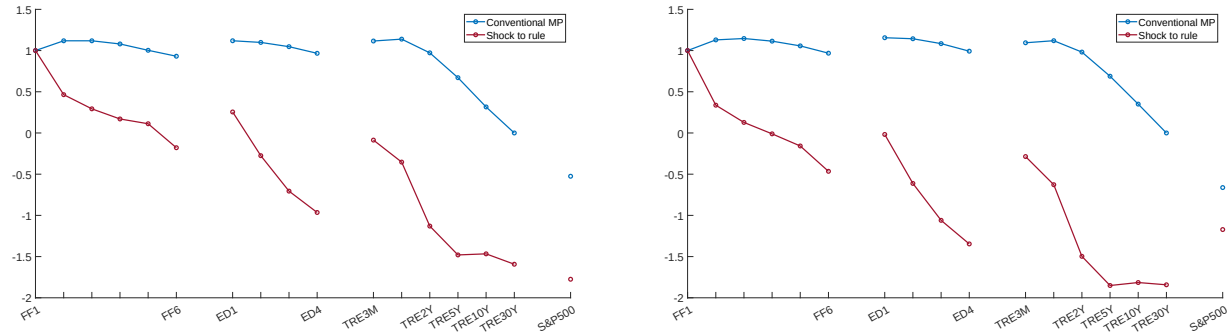


(a) F1 (conventional monetary policy)

(b) F2 (shift to the policy rule)

Notes: The figure presents the time series of the identified monetary policy shock (first panel) and the shock to the perceived policy rule (second panel) distinguishes between original instruments without information correction (in orange) and info corrected instruments (in blue). Recessions bands are in light grey.

Figure 9: Identified and informationally corrected factors



(a) Loadings on raw surprises

(b) Loadings on surprises corrected for info

Notes: The figure reports the loadings of (a) the identified factors on asset price revisions, and (b) the the identified factors corrected for information effects. F1 (blue) captures conventional monetary policy shocks, while F2 (red) absorbs changes to the parameters of the policy rule.

their forecast revisions ($\Delta F_t x_{q+j} = F_t x_{q+j} - F_{t-1} x_{q+j}$). We include backcasts, nowcasts and forecasts up to three quarters ahead. The set of regressors follows the suggestion of Romer and Romer (2000). The residual $\widetilde{ms}_t^i$ are thought to be the informationally robust IVs for monetary policy shocks.

Differently from Miranda-Agrippino and Ricco (2021), we first select the relevant regressors using Lasso, followed by a post-estimation OLS on the regressors selected by Lasso. This approach allows for a cleaner extraction of the information component avoiding issues of collinearity among the regressors.

Table 3: Information effects on market surprises I

	FF1	FF2	FF3	FF4	FF5	FF6	ED1	ED2	ED3	ED4
$\text{RGDP}_{h=0}$	0.008***	0.005	0.004	0.007*	0.007***	0.010***	0.006	0.010**	0.009*	0.008*
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
$\text{RGDP}_{h=3}$	-0.005									
	(0.004)									
$\text{PGDP}_{h=1}$	-0.006	-0.009								
	(0.004)	(0.006)								
$\text{UNEMP}_{h=0}$	0.003*									
	(0.002)									
$\Delta\text{UNEMP}_{h=2}$	0.026									
	(0.017)									
$\text{RGDP}_{h=1}$		0.003	0.006	0.002			0.007	0.002	0.005	0.005
		(0.005)	(0.005)	(0.005)			(0.006)	(0.006)	(0.007)	(0.007)
$\text{PGDP}_{h=3}$				-0.010	-0.011					
				(0.008)	(0.008)					
$\Delta\text{RGDP}_{h=-1}$				-0.005*						
				(0.003)						
$\Delta\text{RGDP}_{h=1}$				0.008	0.007		0.012	0.010	0.011	
				(0.007)	(0.007)		(0.008)	(0.009)	(0.009)	
$\Delta\text{PGDP}_{h=0}$							0.010			
							(0.008)			
$\Delta\text{RGDP}_{h=0}$								0.005	0.007	
								(0.006)	(0.006)	
Constant	-0.018	-0.012	-0.032***	-0.010	-0.006	-0.037***	-0.040***	-0.040***	-0.044***	-0.041***
	(0.015)	(0.017)	(0.011)	(0.018)	(0.017)	(0.009)	(0.014)	(0.014)	(0.014)	(0.014)
$\mathcal{R}^2$	0.079	0.059	0.060	0.086	0.067	0.071	0.089	0.135	0.147	0.129
F	2.712	2.953	4.246	3.208	3.562	13.422	4.575	4.626	5.536	4.681
$P-value$	0.021	0.033	0.015	0.008	0.015	0.000	0.011	0.001	0.000	0.001
N	239	239	239	239	239	239	239	239	239	239

Notes: This table presents the results of the information effect regressions for short-term interest rates (FF1-FF6) and Eurodollar futures (ED1-ED4). The dependent variables are the monetary surprises, while the explanatory variables include Greenbook forecasts and revisions of key macroeconomic indicators. Sample goes from 1991m7 to 2018m12.

Tables 3 and 4 report the information effects regressions for different market surprises. Table 3 reports information effects on short-term rates and eurodollar futures. The $\mathcal{R}^2$ values indicate that short-term interest rates (FF1-FF6) exhibit significant predictability based on Greenbook forecasts, with values ranging between $7-12\%$, and in line with the results of Miranda-Agrippino and Ricco (2021) who only consider FF4 surprises. Eurodollar futures (ED1-ED4) display even stronger predictability, with $\mathcal{R}^2$ values in the $10-15\%$ range. Similarly, table 4 reports information effects on long-term yields and the stock market surprises. For longer-term yields (on-the-run 3M - on-the-run 30), the $\mathcal{R}^2$ values increase, averaging 10%. This pattern of information is in line with the intuition that monetary policy decisions disclose information about developments in the economy at business cycle frequency.

Table 4: Information effects on market surprises II

	TRE3M	TRE6M	TRE2	TRE5	TRE10	TRE30	SP500
$\text{gRGDP}_{h=0}$	0.005**	0.006***	0.008**	0.008*	0.007*	0.004	
	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	
$\text{gPGDP}_{h=1}$	-0.004						
	(0.005)						
$\text{UNEMP}_{h=0}$	0.002*						
	(0.001)						
$\Delta\text{UNEMP}_{h=2}$	0.033*			0.047			
	(0.017)			(0.040)			
$\text{gRGDP}_{h=1}$			0.002	0.001			
			(0.005)	(0.005)			
$\Delta\text{gRGDP}_{h=1}$			0.011	0.008			
			(0.007)	(0.008)			
$\text{gRGDP}_{h=-1}$				0.002	0.002	0.001	
				(0.002)	(0.002)	(0.002)	
$\text{gPGDP}_{h=-1}$				0.008**	0.007*	0.005	
				(0.004)	(0.004)	(0.003)	
$\text{gPGDP}_{h=0}$				0.008**			
				(0.004)			
$\text{gPGDP}_{h=3}$				-0.014*			
				(0.008)			
$\Delta\text{gRGDP}_{h=0}$				0.008*			
				(0.005)			
$\Delta\text{gRGDP}_{h=2}$				0.023**	0.031**	0.026***	
				(0.011)	(0.013)	(0.009)	
$\Delta\text{gPGDP}_{h=2}$				0.026	0.017		
				(0.016)	(0.013)		
$\Delta\text{UNEMP}_{h=0}$				-0.001		0.026*	
				(0.038)		(0.014)	
$\text{gRGDP}_{h=3}$					0.003	0.004	
					(0.004)	(0.003)	
$\Delta\text{gRGDP}_{h=-1}$						0.004	
						(0.003)	
Constant	-0.026	-0.022***	-0.027**	-0.030**	-0.043**	-0.030*	0.007
	(0.018)	(0.007)	(0.011)	(0.015)	(0.022)	(0.016)	(0.038)
$\mathcal{R}^2$	0.051	0.040	0.098	0.182	0.235	0.194	0.000
F	2.560	7.885	7.228	3.459	1.406	2.270	0.000
P-value	0.039	0.005	0.000	0.000	0.213	0.030	
N	239	239	239	239	239	239	239

Notes: This table reports the impact of Greenbook forecasts and revisions on on-the-run longer-term bond yields (TRE) and the S&P 500 index. Sample goes from 1991m7 to 2018m12.

6 Policy shocks and information

This section discusses the macroeconomic propagation of the two monetary shocks – a conventional monetary policy shock and a shock to the rule – and an 'information shock' that is identified by the IVs we have constructed in the previous section.

6.1 The relevance of the IVs

Table 5: F-STAT (MEAN OVER BVAR DRAWS) FOR DIFFERENT SAMPLES

Factor	**Information Type**	**Sample**	
		1980-2019	
		Normalisation on:	
		Treasury 1Y	**FFR**
Conventional MP	Raw	10.76	19.75
	Info robust (surprises)	7.31	18.58
	Info robust (assets)	8.12	18.98
Shock to Rule	Raw	0.30	0.30
	Info robust (surprises)	2.18	2.19
	Info robust (assets)	0.34	0.30

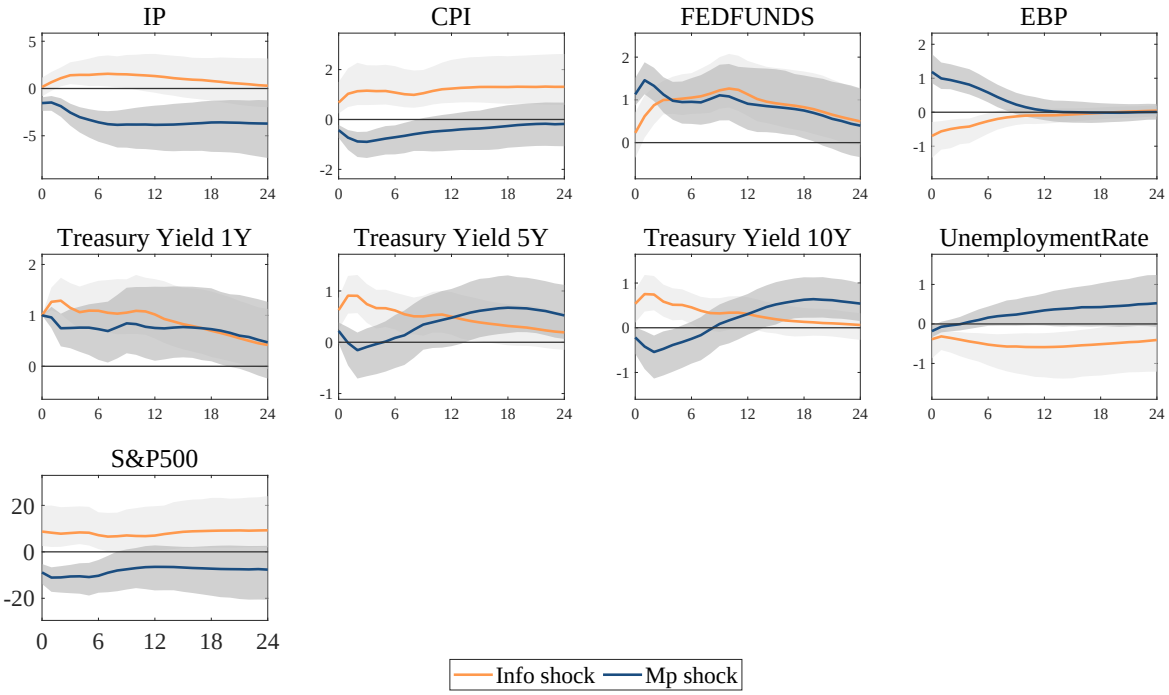
Notes: This table reports the mean F-statistic from the first-stage regression in a Proxy-SVAR of residuals on the selected factors. 'Conventional MP' refers to standard monetary policy shocks, while 'Shock to Rule' captures shocks to the policy rule. Info robust instruments are constructed either by regressing market surprises on Greenbook forecasts (surprises) or the raw factors on Greenbook forecasts (assets). Monetary policy factors are extracted from 1991m7 to 2018 (latest date in which Greenbook forecasts are available).

To assess the relevance of the instruments, Table 5 reports the mean F-statistics in the regression of the VAR residuals of the policy rate on the identified factors. Higher statistics indicate stronger instrument relevance, with values above ten generally considered acceptable for reliable identification.

The results confirm that conventional monetary policy shocks are well-identified, particularly when normalising on the federal funds rate. The F-statistics for these shocks are consistently above ten, reaching values as high as 19.75 in the full sample. Information-robust instruments tend to reduce the F-statistics slightly, but they remain within an acceptable range.

In contrast, the identification of rule-based monetary policy shocks is much weaker. The raw instruments produce F-statistics below one in most cases, suggesting severe weak instrument problems. The information-corrected instruments improve the identification somewhat, with F-statistics increasing to around four in the 1991m7-2019 sample. However, even after correction, the identification remains less robust than for conventional monetary policy shocks. These results indicate that shocks to the policy rule are not particularly important in the

Figure 10: Conventional monetary policy shock and information shock



Notes: This figure presents the IRFs to a conventional monetary policy shock (blue) and the information shock obtained as the first principal component of the information regression (orange). Both shocks are normalised to induce a 100 basis point increase in the one-year Treasury rate.

sample considered and cannot be the explanation for the observed puzzles.

6.2 Monetary policy shocks and shocks to the rule

We identify these structural shocks in a rich VAR model with the external IV approach of Stock and Watson (2012) and Mertens and Ravn (2013), which is valid under mild conditions of relevance and exogeneity, and the invertibility of the shocks of interest for the model adopted (see Miranda-Agrippino and Ricco, 2023). For each shock, we estimate a monthly Bayesian VAR with 12 lags and standard Minnesota priors, on the sample 1980 to 2019. The informativeness of the priors is set following Giannone et al. (2015). Our baseline specification includes a rich set of real, nominal, and financial variables. The monetary policy factors are for the sample 1991m7 - 2018m12.

Let us start by looking at the propagation of a conventional monetary policy shock (Figure

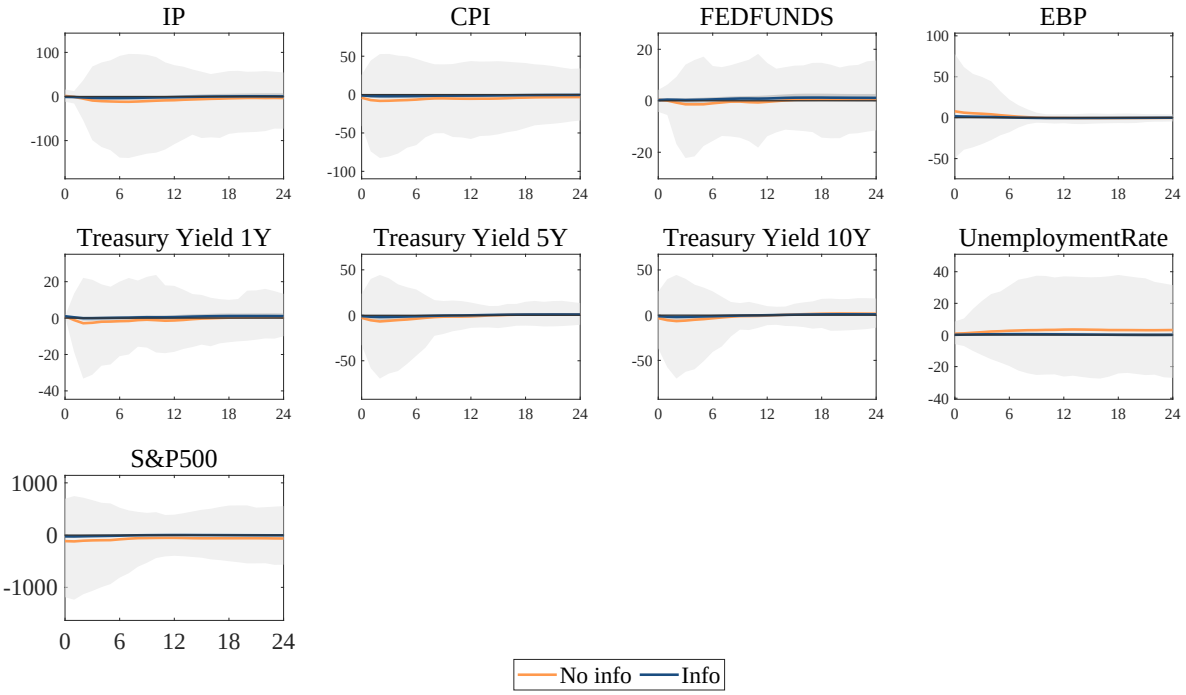
10). An exogenous tightening, identified with the informationally robust IV for monetary policy shocks, causes a standard economy-wide contractionary response, with economic activity and inflation decreasing after the shock and unemployment increasing. These results are in line with the findings in Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021).

The information shock is identified using as an IV the first principal component of the fitted components of the Greenbook-based information regressions. While the monetary policy shock leads to a decline in economic activity, the information shock produces the opposite effect, increasing both output and inflation in line with the effects of a demand shock and the results in Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021).

It is important to stress that the information component cannot be interpreted as a structural shock or an information shock delivered by the central bank. The correct interpretation of this component, in line with the model in Section 4, is that it represents a bundle of different structural shocks to which the Fed responds via its systematic reaction function. The presence of imperfect information delivers contamination of the market surprises by these shocks. While the policy decision and communication inform the market participants of the view of the central bank, they cannot be seen as 'delivering' the shocks but only as being part of their transmission through the economy. Hence, the IRFs to the information component in Figure 10 should be seen as informative of the reaction function of the Fed and not as structural response functions to a given shock.

We can now try to identify the effects of a shock to the rule. Without information correction (Figure 11), the IV is too weak to identify any shock, as seen in the large confidence bands of impulse responses and in line with the F-stat reported. After correcting for information effects (Figure 12), the estimated responses become slightly more stable, though the identification remains relatively weak compared to the conventional monetary policy shock. The effects of the shocks are overall contractionary and do not seem able to directly account for the puzzle in high-frequency surprises.

Figure 11: Rule-based monetary policy shock



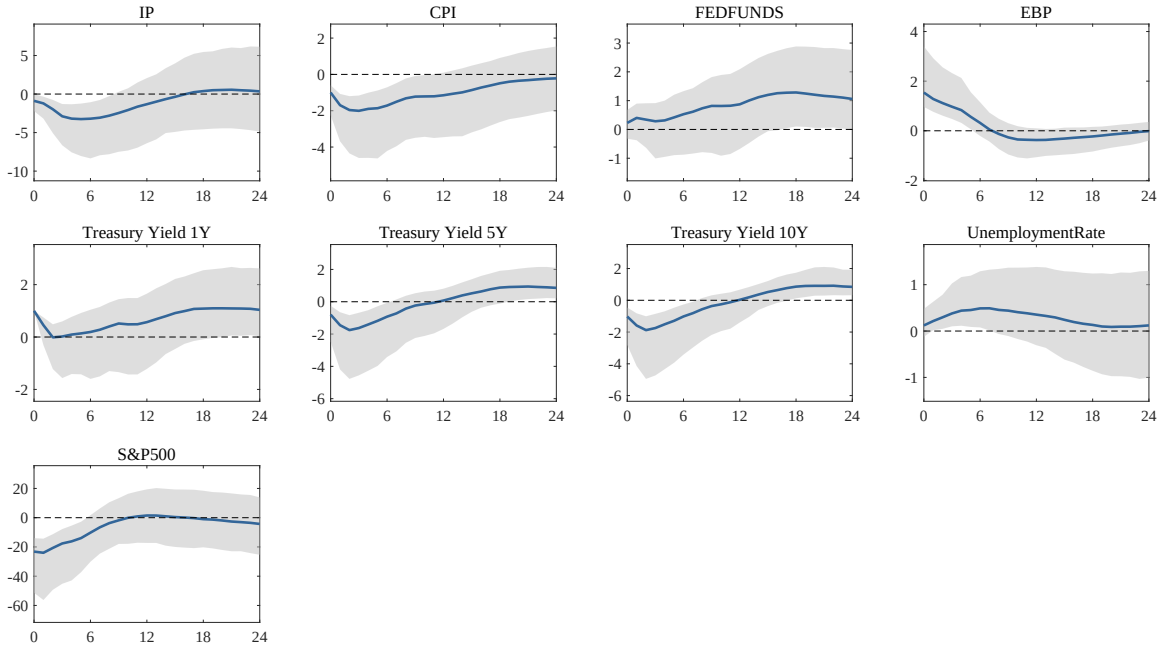
Notes: The figure presents the IRFs to a rule-based monetary policy shock, comparing the raw factor without information effects (orange) with the informationally robust factor (blue). The shock is identified as a deviation from a standard policy rule and is normalised to induce a 100 basis point increase in the one-year Treasury rate.

6.3 Robustness of the IRFs over different samples

The rolling estimates of the IRFs, in Figure 13, confirm that the effects of monetary policy shocks are generally stable across different time periods. For conventional monetary policy, the responses show a contractionary effect on industrial production and inflation, with financial markets also reacting negatively. The effects vary slightly in magnitude across different rolling windows, and the overall direction remains unchanged.

After applying the information correction, we also report robust IRFs across subsample for the shock to rule (see Figure 14).

Figure 12: Rule-based monetary policy shock (with information correction)

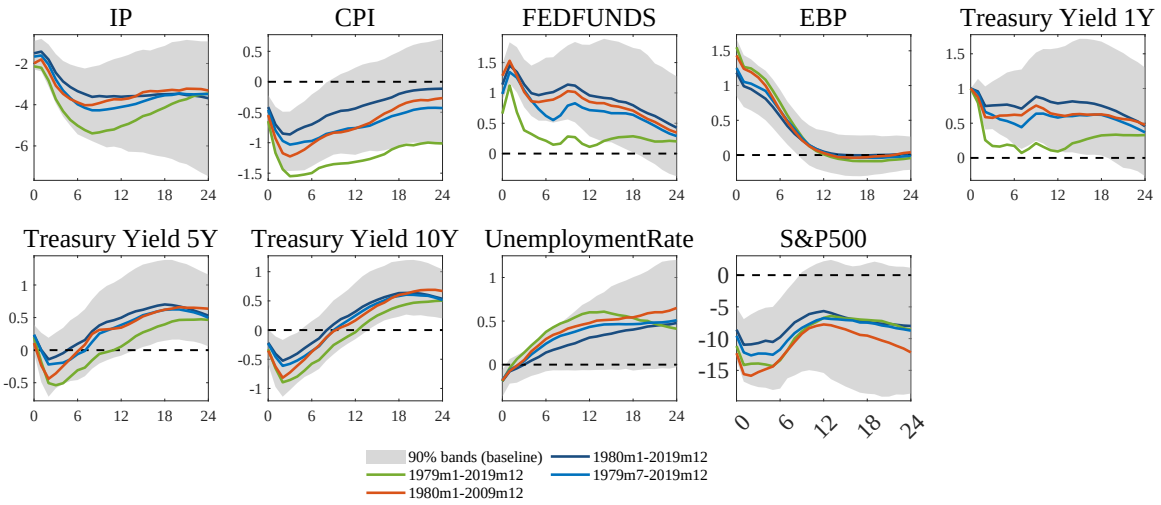


Notes: This figure presents the IRFs to a rule-based monetary policy shock, identified using only the information-corrected instrument (blue). The shock is normalised to induce a 100 basis point increase in the one-year Treasury rate.

6.4 Comparison of different information corrections

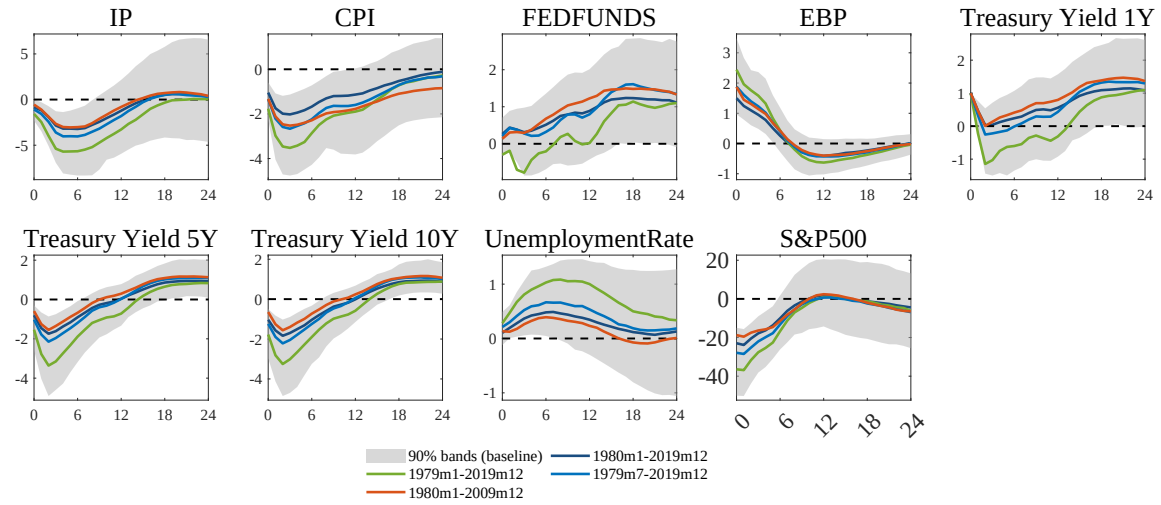
The results in Figures (15) and (16) show that correcting for information effects leads to similar responses, regardless of whether the correction is applied to market surprises or to the extracted factors.

Figure 13: Conventional monetary policy – rolling samples



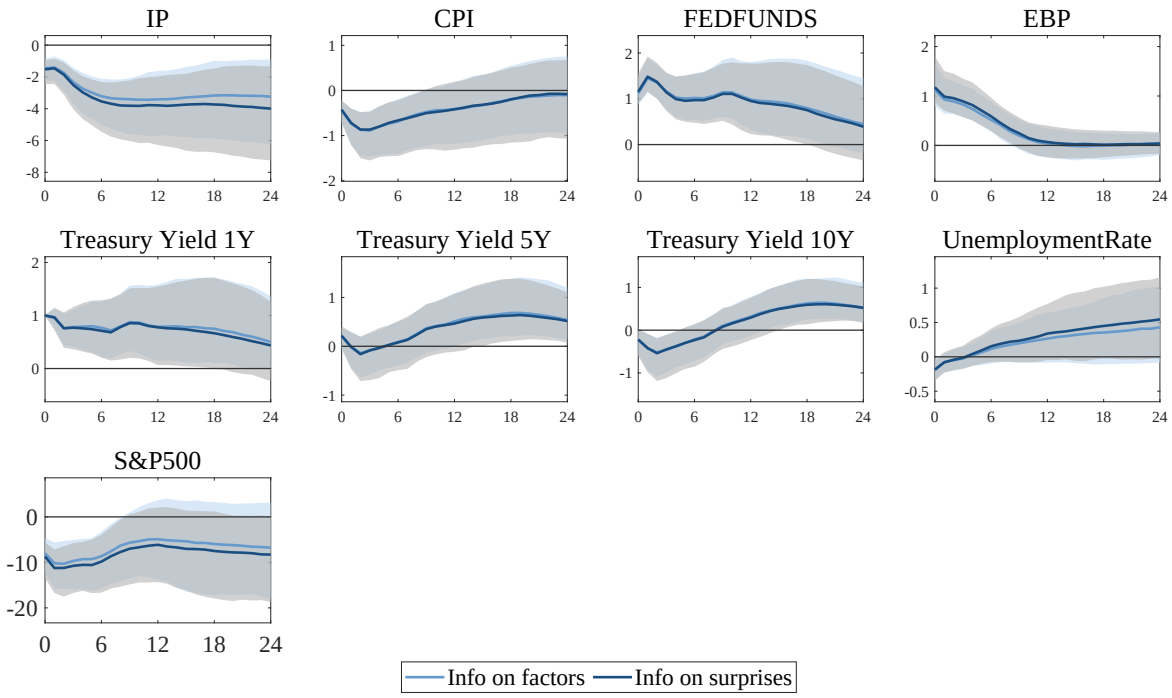
Notes: The figure reports the impulse response functions (IRFs) to a conventional monetary policy shock estimated over different rolling subsamples. The shock is identified with an informationally robust factor, accounting for information effects in monetary policy surprises, and normalized to induce a 100 basis point increase in the 1-Year Treasury rate. The grey shaded areas represent the 90 percent coverage bands from the baseline specification.

Figure 14: Shock to rule – rolling samples (information correction)



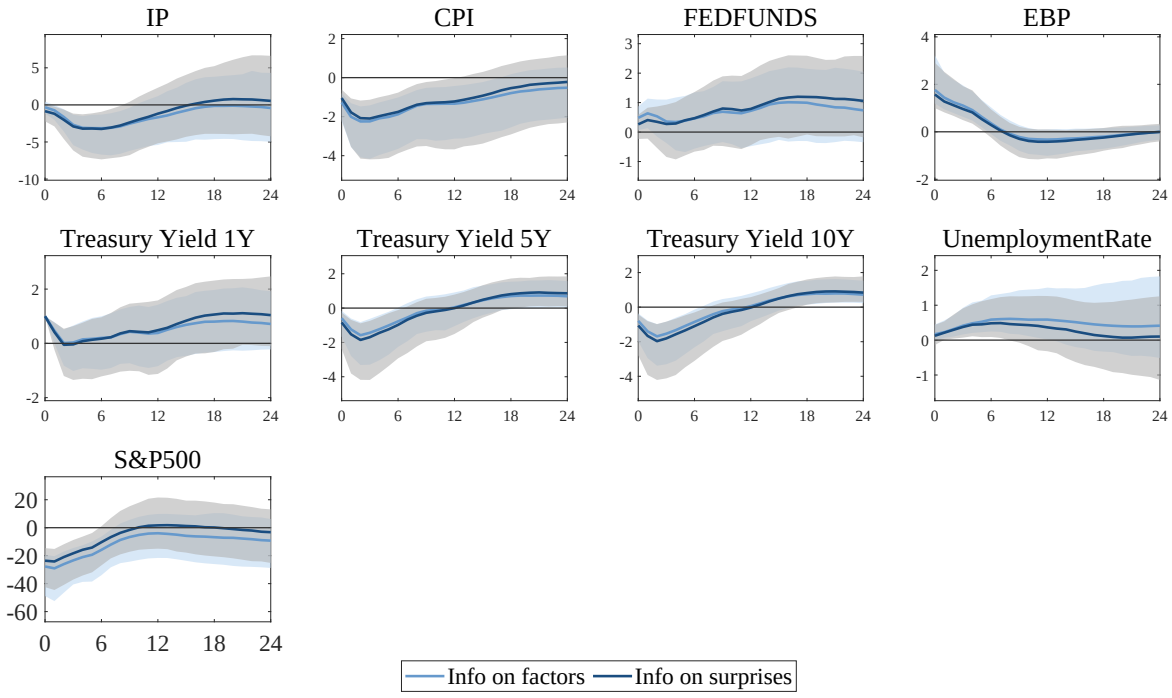
Notes: This figure presents the IRFs for a monetary policy shock identified as a deviation from a policy rule, estimated over rolling subsamples. The identification accounts for information effects in the instrument. The shock is normalised to induce a 100 basis point increase in the 1-Year Treasury rate. Grey shaded areas indicate 90 percent coverage bands from the baseline specification. The results show that the shock to rule is weakly identified without controlling for information effects, but improves after correction.

Figure 15: Comparison of information corrections MP shocks



Notes: The figure compares the IRFs for a conventional monetary policy shock using two different methods for information correction. The dark blue line corresponds to the correction applied to market surprises, while the light blue line represents the correction applied directly to the extracted factors. The results show that both methods produce similar impulse responses.

Figure 16: Comparison of information corrections policy shift



Notes: The figure compares the IRFs for a rule-based monetary policy shock using two different information correction methods. The dark blue line represents the correction applied to market surprises, while the light blue line represents the correction applied to the extracted factors. The responses are nearly identical.

7 Conclusions

Our analysis reassesses the causes of the puzzling macroeconomic responses to monetary policy shocks identified with the high-frequency monetary policy surprises of Gürkaynak et al. (2005a). In particular, we evaluate two competing explanations: the information channel of monetary policy and the 'Fed response to news' hypothesis. By incorporating both monetary policy shocks and shocks to the parameter of the policy rule in a framework of imperfect information, equipped with an affine term structure model, we derive empirical implications to disentangle the two hypotheses.

Our empirical findings reveal that the anomalies observed in traditional identification approaches stem from market participants' belief revisions triggered by the policy announcements, rather than systematic misestimation of the Fed's reaction function. Once information effects are accounted for, the so-called price and output puzzles disappear.

These results challenge the 'Fed response to news' hypothesis, which requires persistent forecasting errors by market participants and struggles to explain similar puzzles across multiple central banks. Our framework provides a clearer interpretation of monetary policy transmission and highlights the need to account for central bank information effects when using high-frequency identification strategies.

References

Bauer, Michael D. and Eric T. Swanson, "An Alternative Explanation for the 'Fed Information Effect'," *American Economic Review*, March 2023, *113* (3), 664–700.

_ and _ , "A Reassessment of Monetary Policy Surprises and High-Frequency Identification," *NBER Macroeconomics Annual*, 2023, *37* (1), 87–155.

_ , Carolin E. Pflueger, and Adi Sunderam, "Perceptions about Monetary Policy," *Quarterly Journal of Economics*, November 2024, *139* (4).

Bu, Chunya, John Rogers, and Wenbin Wu, "A unified measure of Fed monetary policy shocks," *Journal of Monetary Economics*, 2021, *118*, 331–349.

Campbell, Jeffrey R, Charles L Evans, Jonas DM Fisher, Alejandro Justiniano, Charles W Calomiris, and Michael Woodford, "Macroeconomic effects of federal reserve forward guidance [with comments and discussion]," *Brookings papers on economic activity*, 2012, pp. 1–80.

Carvalho, Carlos, Fernanda Nechio, and Tiago Tristão, "Taylor rule estimation by OLS," *Journal of Monetary Economics*, 2021, *124*, 140–154.

Cieslak, Anna and Andreas Schrimpf, "Non-monetary news in central bank communication," *Journal of International Economics*, 2019, *118* (C), 293–315.

_ **and Hao Pang**, "Common shocks in stocks and bonds," CEPR Discussion Papers 14708, C.E.P.R. Discussion Papers May 2020.

Coibion, Olivier and Yuriy Gorodnichenko, "What Can Survey Forecasts Tell Us about Information Rigidities?," *Journal of Political Economy*, 2012, *120* (1), 116–159.

_ **and** _ , "Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts," *American Economic Review*, August 2015, *105* (8), 2644?78.

Ellingsen, Tore and Ulf Soderstrom, "Monetary Policy and Market Interest Rates," *American Economic Review*, December 2001, *91* (5), 1594?1607.

Fulton, Chad, "Mechanics of Linear Quadratic Gaussian Rational Inattention Tracking Problems," Finance and Economics Discussion Series 2017-109, Board of Governors of the Federal Reserve System (U.S.) November 2017.

Gertler, Mark and Peter Karadi, "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 44–76.

_ **and** _ , "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, January 2015, *7* (1), 44–76.

Giannone, Domenico, Michele Lenza, and Giorgio E. Primiceri, "Prior Selection for Vector Autoregressions," *The Review of Economics and Statistics*, 2015, *97* (2), 436–451.

Gürkaynak, Refet S, Brian Sack, and Eric Swanson, "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 2005, *1* (1).

Gurkaynak, Refet S, Brian Sack, and Eric T Swanson, "Do actions speak louder than words? The response of asset prices to monetary policy actions and statements," 2005.

Hoesch, Lukas, Barbara Rossi, and Tatevik Sekhposyan, "Has the Information Channel of Monetary Policy Disappeared? Revisiting the Empirical Evidence," *American Economic Journal: Macroeconomics*, July 2023, *15* (3), 355–387.

Holtemöller, Oliver, Alexander Kriwoluzky, and Boreum Kwak, "Is There an Information Channel of Monetary Policy?," DIW Berlin Discussion Papers 2084, DIW Berlin Discussion Papers May 2024.

Jarociński, Marek and Peter Karadi, "Deconstructing Monetary Policy Surprises—The Role of Information Shocks," *American Economic Journal: Macroeconomics*, April 2020, *12* (2), 1–43.

_ **and** _ , "Disentangling Monetary Policy, Central Bank Information, and Fed Response to News Shocks," CEPR Discussion Papers 19923, C.E.P.R. Discussion Papers 2025.

Kuttner, Kenneth N, "Monetary policy surprises and interest rates: Evidence from the Fed funds futures market," *Journal of Monetary Economics*, 2001, *47* (3), 523–544.

Maćkowiak, Bartosz, Filip Matějka, and Mirko Wiederholt, "Rational Inattention: A Review," *Journal of Economic Literature*, March 2023, *61* (1), 226?73.

Melosi, Leonardo, "Signalling Effects of Monetary Policy," *The Review of Economic Studies*, 09 2016, *84* (2), 853–884.

Mertens, Karel and Morten O. Ravn, "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States," *American Economic Review*, 2013, *103* (4), 1212–47.

Miranda-Agrippino, Silvia and Giovanni Ricco, "The Transmission of Monetary Policy Shocks," *American Economic Journal: Macroeconomics*, July 2021, *13* (3), 74–107.

_ **and** _ , "Identification with External Instruments in Structural VARs," *Journal of Monetary Economics*, 2023, *135*, 1–19.

Nakamura, Emi and Jón Steinsson, "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect," *The Quarterly Journal of Economics*, 2018, *133* (3), 1283–1330.

Nicolau, João, "Stationary Processes That Look like Random Walks: The Bounded Random Walk Process in Discrete and Continuous Time," *Econometric Theory*, 2002, *18* (1), 99–118.

Pirozhkova, Ekaterina, Giovanni Ricco, and Nicola Viegi, "Trouble Every Day: Monetary Policy in an Open Emerging Economy," CEPR Discussion Papers 19094, C.E.P.R. Discussion Papers May 2024.

Ramey, V.A., "Chapter 2 - Macroeconomic Shocks and Their Propagation," in John B. Taylor and Harald Uhlig, eds., *John B. Taylor and Harald Uhlig, eds.*, Vol. 2 of *Handbook of Macroeconomics*, Elsevier, 2016, pp. 71–162.

Ricco, Giovanni, Anshumaan Tuteja, and Emanuele Savini, "Monetary Policy, Information and Country Risk Shocks in the Euro Area," CEPR Discussion Papers 19679, C.E.P.R. Discussion Papers 2024.

Romer, Christina D. and David H. Romer, "Federal Reserve Information and the Behavior of Interest Rates," *American Economic Review*, June 2000, *90* (3), 429?457.

_ **and** _ , "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review*, September 2004, *94* (4), 1055?1084.

Sims, Christopher A., "Implications of rational inattention," *Journal of Monetary Economics*, 2003, *50* (3), 665–690. Swiss National Bank/Study Center Gerzensee Conference on Monetary Policy under Incomplete Information.

Smith, Josephine M. and John B. Taylor, "The term structure of policy rules," *Journal of Monetary Economics*, October 2009, *56* (7), 907–917.

Stock, James H. and Mark Watson, "Disentangling the Channels of the 2007-09 Recession," *Brookings Papers on Economic Activity*, 2012, *43* (1 (Spring)), 81–156.

Swanson, Eric T, "Measuring the effects of federal reserve forward guidance and asset purchases on financial markets," *Journal of Monetary Economics*, 2021, *118*, 32–53.

Woodford, Michael, *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, 2003.