Impact of FED Forward Guidance Announcements on Interest Rates and Inflation Expectations

Evidence from the US Treasury Bonds' Market

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Forward guidance is an unconventional monetary policy tool that has been used intensively during and after the 2008 financial crisis by many central banks (including but not limited to Federal Reserve, European Central Bank, Bank of England and Bank of Japan). When the central bankers use this policy, they announce the likely future path of the rates' level. This tool is particularly useful when the level of rates is at its lowest, namely at the Zero Lower Bound. Indeed, the bank can use this sort of announcement to influence markets' expectations on future short-term rates and, as a result, to reduce the current level of long-term rates. In this work, I explain the concept of Forward Guidance and its use by the Federal Reserve from the 2008 Financial Crisis to the first quarter of 2022. I use the FED Policy Statements from 2007 to 2022 to observe when and with which level of commitment this tool has been adopted by the Federal Open Market Committee. Then, I estimate the effect that the announcements about the future path of rates' levels have on Treasury bonds' yields, market-based inflation expectations, and market-based inflation risk premia. In particular, I try to disentangle the different components of the Policy Statements to understand which parts have a significant effect on the market and which have not. I observe that Forward Guidance announcements have a significant impact on Treasury yields at certain maturities (mainly 3 and 5 years). The impact on inflation expectations is statistically significant, but very small.

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Contents

1 Introduction

During and after the financial crisis some unconventional monetary policy tools have been widely employed by central banks all over the world. The two most used are quantitative easing and forward guidance.

A central bank uses the tool of Forward Guidance when it announces the future likely stance of its monetary policy. This tool has been widely used during the financial crisis by all the major central banks in the world, to continue providing monetary stimulus even when the policy rates were already at the effective lower bound. However, the effect is still not completely clear and largely depends on how the market perceives the central bank statement.

In this work, I focus on the use of forward guidance by the Federal Reserve Board from 2007 to the first quarter of 2022. This work could contribute to the understanding of the Forward Guidance effectiveness both with and without rates at the lower bound.

After exposing the theoretical roots of this unconventional monetary policy tool in Section 2, in Section 3 I present the methodology of this work, building on Moessner (2015b) and Moessner (2015a), in Section 4 I present the results, and in Section 5 I conclude.

2 The Tool

In this section, I focus on the definition of this tool and its use in the context of the Federal Reserve Monetary Policy.

A central bank uses the tool of Forward Guidance (FG) when it makes some statements about the future stance of its monetary policy. In other words, as in Woodford (2012), FG is defined as "explicit statements by a central bank about the outlook for future policy, in addition to its announcements about the immediate policy actions that it is undertaking" (page 2).

For example, the Policy Statement released after the FOMC Meeting on December 16th, 2008, said that "the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time". Thus, not only the Committee had said what the Federal Reserve was going to implement immediately after the meeting, but also what was probably going to be done in the future.

While particularly used as an accommodative monetary policy tool in the aftermaths of the financial crisis, Forward Guidance can be used in both directions: the statement can be both about future increasing or decreasing short-term interest rates.

Andrade et al. (2019)[1] briefly illustrates the history of FG employment by the FED, also compared with other major central banks. In particular, he observes that also before the crisis, at the end of the "Greenspan Era", the FOMC publicly forecasted to keep rates low "for a considerable period"[2] (De-

1. This paper is the main source for this paragraph.
2. FED Press Release, December 9th, 2003

cember 2003). The same did the Bank of Japan, that employed FG since 1999 (Shirai (2013)), committing to keep interest rates at zero until given conditions occur.

Bernanke observes that the same qualitative tone has been kept by the FED immediately after the 2008 financial crisis (e.g. "for some time"[3] (December 16, 2008), "for an extended period"[4] (March 18th, 2009)). However, the tone then became more precise, in particular with calendar and state-contingent FG that began to be employed, respectively, in August 2011 and December 2012. This has probably been due to the fact that policymakers were worried about the possible implications of the new tools and thus less effective in their use.

The same process (from qualitative to state-contingent FG) has been followed by the Bank of England and Bank of Japan (that employed calendar FG as well).

Lastly, Bernanke observes that FG announcements could result even more effective in a future economic downturn if systematically included in policy and communication frameworks of the central banks.

For the sake of completeness, Yellen (2014) provides a clear definition of the objective of Forward Guidance that I do not use in this work since it specifically refers to the accommodative use of the tool when the rates are at the effective lower bound, while I try to assess the impact of FG announcements also when the policy rate is still employable as a monetary policy tool and the central bank wants to raise interest-rate expectations.

In this analysis, indeed, I categorize as "hawkish FG" the announcements of future increases in rates and "dovish FG" the announcements of future decreases or lower-for-longer interest rates.

In the same paper cited above, Bernanke (2020) proposed a definition of FG that includes statements about the future economic outlook. However, in this work, I take into account only explicit references to future movements of rates.

2.1 Odyssean and Delphic Forward Guidance

The literature distinguishes between two kinds of forward guidance, Odyssean and Delphic. In this work, I use the definition provided by Campbell et al. (2012).

In particular, using Delphic forward guidance, the central bank does not commit itself to a specific monetary policy in the future, but simply makes statements about the likely future macroeconomic conditions and likely monetary policy reaction. This kind of announcement is based on the assumption that the central bank has more information than the general public. Delphic FG can improve macroeconomic outcomes by reducing uncertainty. This channel is the focus of the empirical analysis done by Hansen, McMahon, and Tong (2019) using UK data. They believe that this effect is under-appreciated

3. Press Release: "FOMC statement", December 16 2008
4. Press Release: "FOMC statement", March 18, 2009

in the literature, which usually explains the long-term yields' reaction to FG announcements with changing expectations.

On the other hand, Odyssean FG announcements contain a clear commitment that the central bank will adopt a certain monetary policy in the future. This tool aims at impacting on long-term yields by changing expectations about future short-term rate likely path. The Odyssean announcements do not require the general public to assume the central bank has more forecasting capacity or precision. In other words, it is a *de facto* commitment to deviate, at least temporarily, from the monetary policy rule that has been followed until that moment.

Campbell et al. (2012) provide a clear explanation of the rationale behind the Odyssean forward guidance. If the central bank has committed in t_0 to implement a certain monetary policy action in t_1, when t_1 comes, what matters is simply the state of the economy at that moment and thus the central banker could regret the announcement that she or he made in t_0. This is known both by the central bank itself and by the public. Thus, the reputation of the policymakers plays a central role in the perceived level of commitment. For example, Woodford (2012) (page 191) recognizes that the "the most logical way to make such commitment achievable and credible is by publicly stating the commitment, in a way that is sufficiently unambiguous to make it embarrassing for policymakers to simply ignore the existence of the commitment".

Sutherland (2023) finds that central banks rarely issue Odyssean statements. In particular, he finds that the Federal Reserve has never committed itself to specific monetary policy actions in the period of his sample (1990-2020): the announcement always states the likely future monetary policy as a consequence of likely economic conditions.

However, the theoretical literature on this topic is largely focused on Odyssean unconditional commitments by central bankers.

This trend could be explained saying that even though the commitment is not intended, it could be perceived by the public (Sutherland (2023)). This outlines a limit of the approach that I use in this work, which identifies the announcements looking at the wording of the statements and not at markets' reaction.

For example, Andrade et al. (2019) study the effect of FG announcements with the hypothesis that the agents do not agree on whether the announcements are Delphic or Odyssean: they observe that this heterogeneity puts at risk FG effectiveness, because some of the agents (those who perceive FG as Delphic) behave anticipating a recession. If the proportion of this kind of agents is high enough, the announcements about future interest rates can even be detrimental.

Woodford (2012) notices that if the central bank does not succeed in communicating its commitment and the announcement is perceived as Delphic, the effect on the economy is contractionary and "forward guidance of this kind would have a perverse effect" (page 223).

2.2 The Impact of Forward Guidance on Interest Rates and Macroeconomic Outcomes

As said above, the objective of this tool is to lower future short-term rate expectations in order to lower the current level of long-term rates.

Thus, to evaluate the effectiveness of this tool, it is important to look at the reactions of the market and of the expectations about macroeconomic outcomes.

Del Negro, Giannoni, and Patterson (2023) introduce Forward Guidance announcements in a standard Dynamic Stochastic General Equilibrium (DSGE) model and find a positive response of inflation and output.

However, they also find that its magnitude is excessive and unrealistic when compared to the empirical results. They solve what they call the "Forward Guidance Puzzle" by correcting the DSGE model (a) introducing the fact that unborn cohorts cannot adjust their consumption choices to FG announcements immediately (since they are not born yet) and (b) adjusting the probability of death of each cohort. Their paper includes an empirical part that will be illustrated below.

De Graeve, Wouters, and Ilbas (2014) notice that FG could have ambiguous effects on long-term interest rates: if a dovish announcement raises inflation expectations, the public could expect the central bank to increase rates. The authors observe that, then, the results found by Del Negro, Giannoni, and Patterson (2023) could actually be model-dependent. Lastly, the authors notice that the empirical results about FG impact on interest rates should be analysed with caution, since those studies cannot disentangle the effects of FG from other announcements (e.g., state of the economy, quantitative easing. . .). I am aware that this is a limitation of my analysis as well.

From the empirical point of view, one of the main contributions about the impact of FOMC announcements on interest rates is provided by Gürkaynak, Sack, and Swanson (2018). They perform a Principal Component Analysis to explain asset prices changes with federal funds futures changes few minutes before and after each FOMC announcement (from July 1991 to December 2014). They reject the hypothesis that movements in asset prices are explained by one common factor, and they do not reject the hypothesis that it is explained by two factors. In particular, they arrange the factors so that the first one can be structurally interpreted as the target factor (i.e., monetary policy surprises) and the second one as all the other components of FOMC announcements that influence asset prices (the so-called "path factor").

They find that the second factor explains more than 75% of the variations in 5- and 10-year US Treasury bonds' rates and the coefficients are larger than the one related to the monetary policy surprise (respectively 36.9 bps vs 27.6 bps and 28.3 bps vs 12.8 bps).

Their paper is not about Forward Guidance announcements, but about the general (also implicit) information that FOMC statements give about the future monetary policy. However, the authors notice that the analysis provides evidence that the central bank can deeply affect asset prices just by changing the statements, that is an important premise for Forward Guidance.

Campbell et al. (2012) apply the same methodology to a sample that includes FOMC statements since the beginning of the financial crisis (2007 – 2011) and they find results consistent with Gürkaynak, Sack, and Swanson (2018). In particular, they find that, in their sample, the coefficient of the path factor is larger even for 2-year Treasuries (0.716 vs 0.592 for the target factor).

Moreover, they regress survey forecasts of inflation and output (from the Blue Chip survey) against the two factors and they find that the path factor is correlated in an unexpected way with the expectations (but they use a larger sample (1990 – 2007) in order to obtain significant estimates): the sign of the reaction is positive for the output and negative for inflation, suggesting that the FOMC policy surprises include a Delphic component[5].

Lastly, they introduce an interest rate rule that includes exogenous shocks, among which there are FG announcements as well. The difference from conventional rules is that public gets to know some of the policy shocks before the implementation.

What they find with this last analysis is that FG shocks impact asset prices (and in particular bonds' rates) more than current policy shocks. The authors notice that this suggests that FG not only affects future short-term rates expectations, but risk premia as well.

Hansen, McMahon, and Tong (2019) stress the risk premium channel of Forward Guidance, but focusing on Delphic announcements.

Woodford (2012) analyses the impact of forward guidance announcements looking at overnight rates in some countries (United States, Canada, Sweden, New Zealand and Norway). While his analysis does not allow to infer general conclusions (since it examines only specific cases), it stresses the importance of the choice of words and of the level of commitment in the FG speech. For example, referring to the reaction of US dollar OIS rates to the January 25th, 2012, announcement, he notices that the 2- and 3-year rates did not fall to the level anticipated by the FOMC. This could be due to the fact that, while market participants received the information, they did not perceive it as a full commitment.

Del Negro, Giannoni, and Patterson (2023) provide an interesting empirical contribution (beyond the theoretical one, exposed above) to the understanding of the effectiveness of FG announcements. In particular, they analyse the reaction of some asset prices to three FOMC FG announcements (August 9th, 2011, January 25th, 2012 and September 13th, 2012) and find significant impact on Treasury bonds' yields. Moreover, they run a regression using Blue Chip survey forecasts and they find that the August 2011 announcement has been perceived as "Delphic", while the September 2012 as "Odyssean", applying the definition as in Campbell et al. (2012). The authors stress how the wording could affect markets' reaction (e.g., the August 2011 announcement

5. The authors define the target factor as "GSS (Gurkaynak, Sack and Swanson) forward guidance" but it is not Forward Guidance as defined by Woodford (2012) and as intended in this work, since the GSS FG includes aspects of FOMC Statements that are not explicit guidance about the future policy rate.

has been perceived as Delphic because it "emphasized negative news about economic activity" (page 19)).

Moessner (2015b) and Moessner (2015a) performs an analysis that this work tries to extend, using dummy variables to understand the impact of FG announcements on bonds' yields, real yields (using TIPS), inflation compensation and term spread (his sample goes from 2004 to 2014). Moreover, he distinguishes between forward guidance associated or not with announcements of quantitative easing. He finds negative (consistently with FG premises) significant reactions of real forward rates of about 15 bps for maturities from 2- to 4-year. He also finds that repeated announcements of FG do not have effect on real yields, whereas reactions to FG associated with asset purchases are more robust than to non-asset-purchase-related FG (the magnitude is not larger, but the level of significance is higher at all maturities up to 10 years). The same happens with nominal bonds' rates. He runs the regressions distinguishing between the different kinds of FG (open-ended, date-based and state-dependent): the open-ended seems to be the most impactful. Lastly, he finds negative reactions of the term spread to FG announcements.

Sutherland (2023) applies a similar model to private forecasters' revisions of estimates of future bonds' rate. His analysis (from 1990 to 2020) involves many countries but provides isolated results for FED FG as well. In particular, he adopts a narrative approach to distinguish between hawkish and dovish announcements and finds that interest rates move up (down) by 5 bps on average in case of a hawkish (dovish) change in the FG tone. He notices that FG announcements are less effective on short-term rates (e.g., six-month Treasury yield) when the central bank is operating near or at the lower bound. However, this does not apply to longer-term maturities (Swanson (2021)). Lastly, the author does not find evidence of differences in the reactions to different kinds of FG (i.e., time-contingent, data-contingent and qualitative).

Swanson (2021) extends the analysis of Gürkaynak, Sack, and Swanson (2018) to a sample that goes from July 1991 to June 2019. He studies the reaction of asset prices to FG and large asset purchases announcements. He finds that forward guidance has a hump-shaped effect on the yield curve, with a peak at the 2- to 5- year maturity, but the effectiveness of the tool on short-term yields (6-months) was reduced while the rates were at the effective lower bound.

Lastly, he finds that FG is more effective than LSAPs with respect to the impact on stock prices and shorter-term Treasury yields. On the other hand, LSAPs are more impactful on longer-term Treasury and corporate bonds.

3 The event-study

In this work, I use an event study methodology to assess the impact that the Forward Guidance announcements made by the Federal Reserve Open Market Committee (FOMC) have had on the US government bonds' and TIPS' market from 2007 (January 31st) to 2022 (March 30th). The analysis builds on the approach of Moessner (2015a and b) in the choice of the model and its variables, but includes the distinction between hawkish and dovish announcements and a larger sample.

In particular, the model investigates the effect on the bond market in order to assess the Forward Guidance effectiveness in influencing long-term rates, term spread and inflation expectations. Indeed, the question that I am trying to answer is whether Forward Guidance affects the markets in the desired direction and whether the announcements reduce or, on the opposite, increase uncertainty among markets' agents.

The question about long-term yields is about the central bank credibility and the functioning of its transmission channels: the rationale and the theoretical premises, on the other hand, are uncontroversial (the announcements of lower (higher) interest rates in the future lead to lower (higher) current long-term government bonds' yields).

On the contrary, the question about term spreads and inflation expectations regards the intrinsic rationale of this tool as well.

Indeed, looking at the effect of Forward Guidance on the term spread we could infer possible conclusions or hints on whether or not these announcements impact interest-rate risk premia. For example, if, following an FG communication, the term spread ($5y - 1y$) decreases, there could be two explanations: rates' expectations 5 years into the future fell more than expectations 1 year into the future or the risk-premium associated with future short-term rates decreased.

Lastly, the breakeven inflation rate is, as I am going to explain, a proxy for inflation expectations. As a result, when I assess the impact that FG announcements have on market-based inflation expectations, I could say something about how the announcements are perceived by the public. Indeed, as it has been said before, if the announcement of lower (higher) future short-term rates is perceived as Delphic, I expect inflation expectations to go down (up).

While analysis with the same objective have already been conducted by others (Moessner (2015b), Moessner (2015a), Del Negro, Giannoni, and Patterson (2023), Campbell et al. (2012)), they have always been mainly focused on the effect of Forward Guidance while the policy rate was at the Effective Lower Bound

However, given that the rates in the US have abandoned the lower bound in 2015, I have a wide enough sample to analyse the effectiveness of Forward Guidance while the policy-rate tool is still available (i.e., the central bank is not operating near the lower bound).

Moreover, I can observe market's reactions to FG announcements during the slowdown due to the COVID-related restrictions on economic activity.

3.1 How to Classify Forward Guidance

To identify Forward Guidance announcements, I have analyzed the Policy Statements that the Federal Reserve issued after each meeting of the Open Market Committee (from 2007 to the first quarter of 2022).

The Federal Reserve employs two different communication tools after each meeting. The first one is the Policy Statement, which is issued during the last day of the meeting, and the second one is a minute, which is currently published three weeks after the meeting.

While the Policy Statements are voted by the majority of the FOMC members and outline the decisions that have been taken about monetary policy, the minutes give an overview of the discussion (Nechio and Wilson (2016)).

Gürkaynak, Sack, and Swanson (2018) look at the markets' reaction to the January 4th, 2005, minute's release (the first that has been published 3 weeks and not 6 weeks after the meeting). They find results similar to Policy Statements' releases. In this analysis, minutes' releases are not taken into account.

The first Policy Statement was issued in February 1994 and starting in February 1995 it was released after all monetary policy changes. In January 2000, the Federal Reserve began issuing the Policy Statement after each scheduled meeting.

My sample includes two unscheduled FOMC meetings at the beginning of the COVID outbreak in the US after which two Policy Statements have been released (March, 3rd and 16th, 2020).

On March 13th, 2013, the FED has announced changes in the timing of the Policy Statements' releases, in order to "facilitate the release of information in conjunction with the Chairman's quarterly news conferences" [6] . Indeed, they reduced the time between the news conferences (at 2.30 p.m. Eastern Time) and the release (now at 2 p.m. Eastern time). Before March 2013, the news conference was at 2.15, with the Policy Statement being published at 12.30 pm8 (or, in case of non-news conference meetings, at 2.15). The change in timing could affect market reactions, but I check the robustness of the results by looking at 3-day windows around the FG event. These estimates should not be affected by such changes[7].

All the policy statements have a similar structure, even though the details that are being provided increased over time.

Firstly, the current economic situation is compared with the once that has been exposed in the previous policy statement. In particular, the variables that are more often analysed are economic growth, housing sector, labor market, employment, inflation, inflation expectations, financial markets, credit conditions, business investments, household spending and sometimes exports and global economy.

Then, there is an evaluation of the distance between the current inflation and employment levels and the objectives of the Federal Reserve and the projection about the path the FOMC expects to be followed to reach the objectives (e.g. "the Committee expects that, with gradual adjustments in the stance of monetary policy, economic activity will expand at a moderate pace, labor market conditions will strengthen somewhat further, and inflation will stabilize

6. Press Release: "Federal reserve announces time changes for FOMC statements and news conferences", March 13th, 2013.

7. This information has been found on the Reuters Website: `\UPDATE 1-Fed changes time of FOMC statement release to 2 p.m. ET"`, by Reuters Staff, March 13th, 2013. accessed on August 28th, 2022

around 2 percent over the medium term"[8]). This section includes the risks to the economic outlook. Then comes the monetary policy decision that has been taken during the meeting and comments about it. Lastly, when employed, the FOMC provides details about the evolution of the balance sheet activities (Large Scale Asset Purchase (LSAP)).

Obviously, the order of these contents could change.

The Policy Statement includes the names of the FOMC members that have voted for the policy action and the names of the members that have voted against (with their reason to do so). For example: "Voting against the action was Neel Kashkari, who preferred at this meeting to maintain the existing target range for the federal funds rate"[9] . It could be interesting to understand whether the presence of FOMC members that have voted against affects the effectiveness of, for example, Forward Guidance announcements. However, this analysis is beyond the scope of this work.

Sutherland (2023) evaluates the impact that information provided by central banks about inflation projections have on private forecasters' expectations of interest rates and he finds that the effect is more significant when the central banker does not send other monetary policy signals, such as FG and quantitative easing. Growth projections, on the other hand, are never found to be significantly impactful.

I have used the Policy Statements that are published on the Federal Reserve website to build the dummy variables that are among the inputs of my models. I have not considered repeated announcements in this analysis, but only changes in FG speech. The first dummy variable (CFG_t^d) has value 1 on the days (or larger time spans) in which a Statement has been issued and the guidance that is expressed is more dovish compared to the previous announcement (otherwise, it has value 0). On the other hand, the second variable (CFG_t^h) has value 1 when the guidance that is expressed in the Statement is more hawkish compared to the previous announcement (otherwise, it has value 0).

In particular, it is dovish each announcement that forecasts an accommodative (or accommodative-for-longer) monetary policy in the future. On the opposite, a hawkish announcement forecasts a tighter monetary policy in the future.

While the majority of Forward Guidance changes indicate a clear direction of future monetary policy, for some of them I could not be certain whether to classify them as dovish or hawkish. Moreover, some of the changes in guidance are extremely subtle. For example, on December 19th, 2018, the FED changed the previous FG speech that said "further gradual increases in the target range for the federal funds will be consistent with sustained expansion of economic activity"[10] by simply adding "**some** further gradual increases..."[11]. I decided to classify this change as hawkish because it strengthens the possibility of more than one further increase in the rates.

8. Press Release: Federal Reserve issues FOMC Statement, March 15th , 2017.
9. *idem*
10. Press Release: Federal Reserve issues FOMC Statement, September 26th, 2018.
11. Press Release: Federal Reserve issues FOMC Statement, December 19th, 2018.

3.2 The Variables

As Moessner (2015b) and Moessner (2015a) does, I apply the event-study to the following dependent variables: US Treasury bonds' yields, term spread (short and long), TIPS' yields, and inflation compensation.

Moreover, I add two variables, that are components of inflation compensation: inflation expectations and inflation risk premium.

3.2.1 US Treasury Bonds

The first model regards the impact that the FED Forward Guidance has on Treasury Bonds. In particular, as in the Moessner analysis, I use zero-coupon and instantaneous forward interest rates.

Analysing the impact that Forward Guidance announcements have on US Treasury bonds' yields, allows to understand the effectiveness of this monetary policy tool in its transmission to the economy. Indeed, US Treasury bonds are not only relevant to understand the financing cost of the government but are also a key-determinant of the corporate financing cost: other things being equal (and first of all the credit spread), the higher the government's financing cost, the higher the corporates' one.

However, I am aware that these variables could not be the most significant to assess how the FG announcements are perceived by the markets. In order to do that, Federal funds futures or overnight interest rates (used, respectively, in Gürkaynak, Sack, and Swanson (2018)) could be more useful and precise.

3.2.2 Term Spread

The bonds' yields time series allows to compute the term spread time series. The term spread is defined as the difference, in a given moment, between the long- and short- term rates of a given yield curve.

In this work, I will consider two term spreads given by the difference between the 10-year and the 1-year and between the 5-year and the 1- year US Treasury bonds (Moessner uses only the "short" term spread, that is, $5y$–$1y$).

$$\mathrm{TSS}_t = y_t^{5y} - y_t^{1y} \tag{1}$$

$$\mathrm{TSL}_t = y_t^{10y} - y_t^{1y} \tag{2}$$

This metrics is significant for different reasons. First, it is an approximation of the magnitude of the long-term interest rate risk premium: assuming that interest rate shocks are persistent (that is, the shocks affect each maturity with the same magnitude), a variation of the term spread is caused by a variation in the risk premium (i.e., in the uncertainty perceived by the market).

Moreover, term spread dynamics has shown to be accurate in forecasting output growth and recessions. While there is a wide empirical literature (documented in Wheelock and Wohar (2009)), there is not a consensus about the theoretical founding of this phenomenon: it is defined as a "stylized fact in search of a theory" (Benati and Goodhart (2008)).

While some explain[12] it with the intertemporal consumption theory, what interests me are the monetary policy explanations. Indeed, if the central bank implements a tight (loose) monetary policy, but the market expects the inflation to decline (rise), and thus the output growth to decline (rise) at a certain maturity, the expected future monetary policy will be less tight (loose). As a result, the expected future short-term and the current long-term interest rate will be lower (higher) and the term spread will decrease (increase).

3.2.3 Treasury Inflation Protected Security (TIPS)

While the US Treasury bonds are significant in analysing the macroeconomic determinants of nominal yields, other securities are needed to analyze the real yields. As in Moessner (2015b), in this work, I use TIPS' yields[13]

The US Treasury issues Treasury Inflation Protected Securities (TIPS) since 1997. These are securities that pay semi-annual coupons and the principal at maturity. Unlike the nominal bonds, the principal is adjusted to the inflation level, so that the investor receives inflation-adjusted cash-flows.

In particular, the inflation level is the non-seasonally adjusted US City Average All Items Consumer Price Index, and, as explained in Gürkaynak, Sack, and Wright (2010), the reference index at a certain maturity t is the following (in a month with n days):

$$\text{Reference Index} = \text{CPI}_{-2}\frac{d_t - 1}{d_n} + \text{CPI}_{-3}\frac{d_n - d_t + 1}{d_n} \tag{3}$$

where CPI_{-2} and CPI_{-3} are, respectively, the CPI levels during the second and the third month before the current one. In other words, the reference index is a weighted average between the two levels and the closer the maturity is to the beginning of the month (the higher $d_n - d_t$), the higher the weight on CPI_{-3}.

Gürkaynak, Sack, and Wright (2010) also notice that, as a result, there is an indexation lag of about 2.5 months.

3.2.4 Inflation Compensation

A metrics of particular interest to this kind of analysis is inflation compensation, that is the difference, at a given time t, between the yield of a bond with maturity n and a TIPS with the same maturity

$$\pi_{t,n}^{\text{Comp}} = y_{t,n}^{\text{nom}} - y_{t,n}^{\text{real}} \tag{4}$$

In other words, it is the higher remuneration that a bond holder requires for detaining a security that is not adjusted to the inflation level. Given that

12. For a detailed literature review about term spread dynamics, Wheelock and Wohar (2009), that is the source that I have used for this paragraph.

13. As explained better below, TIPS rates and real rates are different because TIPS rates are affected by inflation and liquidity risk premia. For this reason, in my results I do not speak about real rates, but only about TIPS rates.

the bond remuneration is fixed (if the bond is kept until the maturity), the bondholder is betting on the inflation rate when buying the security: she bets that the inflation expectations that are taken into account into the pricing will be realized. Thus, inflation compensation has actually two components: inflation expectations and inflation risk premium.

In other words, the inflation risk premium is an additional remuneration that a risk-adverse agent requires in order to be indifferent between buying a bond and a TIPS.

Gürkaynak, Sack, and Wright (2010) analyse the ten-year forward rate of inflation compensation $\pi_{t,10}^{\text{Comp}}$, and conclude that it is too volatile at high frequency to represent inflation expectations alone (the conclusion is reached by rejecting the hypothesis of $\pi_{t,10}^{\text{Comp}}$ being a martingale).

For the sake of completeness, inflation compensation includes a liquidity premium as well. Indeed, the bonds' market is more liquid than the TIPS' one (Fleming and Krishnan (2012)). Given that the risk, in this case, is borne by TIPS holders, its direction is opposite compared to the inflation risk premium.

As a result,

$$\pi_{t,n}^{\text{Comp}} = \pi_{t,n}^{e} - \text{IRP}_{t,n} - \text{LRP}_{t.n}^{\text{TIPS}} \tag{5}$$

where $\pi_{t,n}^{e}$ is inflation expectation, $\text{IRP}_{t,n}$ the inflation risk premium, and $\text{LRP}_{t.n}^{\text{TIPS}}$ the liquidity premium.

One could notice that in the difference between the two yields, the credit risk premium is not included. That is because the issuer is the same institution (US Treasury) and thus the probability of default is the same.

In this work, I also use a decomposition of inflation compensation which is provided by the Federal Reserve staff on their website: details are explained in the Section about data.

The same risk premia are found in the TIPS' yields as well and represent the difference between the level of real and TIPS' rates. For this reason, in this work I avoid speaking directly about real rates, but always about TIPS' rates.

3.2.5 Zero Coupon Constant Maturity and Instantaneous Forward Rates

The data that are provided by the FED's staff include the zero-coupon constant-maturity rates, the par yields and the instantaneous forward rates.

The zero-coupon constant-maturity (n) continuously compounded yield is defined as following[14] Gurkaynak, Sack, and Wrigt (2007):

$$y_t^{\text{ZC}} = \frac{1}{n} \ln \frac{1}{d_t(n)} \tag{6}$$

where $d_t(n)$ is the discount function, namely the value in t of 1\$ available in $t+n$.

14. In this part I am using the definitions and the equations from Gurkaynak, Sack, and Wrigt (2007).

Even though available in the FED dataset, in this work par yields are not considered, since they do not have a significant meaning in the context of this analysis.

Lastly, the instantaneous forward rate is the instantaneous return that an investor requires today (time t) in order to invest at time n in a security with infinitesimal maturity.

Given the forward rate observed in t that begins in n with maturity h:

$$f_t(n,h) = -\frac{1}{m}\ln\frac{d_t(n+m)}{d_t(n)} \tag{7}$$

the instantaneous forward rate is defined as follows:

$$f_t(n,0) = \lim_{h\to 0} f_t(n,h) = \lim_{h\to 0}\left(-\frac{1}{m}\ln\frac{d_t(n+m)}{d_t(n)}\right) = y_t(n)+ny_t'(n) = \frac{\partial \ln d_t(n)}{\partial n} \tag{8}$$

As a result, given (8) and (6):

$$y_t^{\mathrm{ZC}}(n) = f_t(t,n) = \frac{1}{n}\int_0^n f_t(x,0)\,dx \tag{9}$$

Thus, the continuously compounded zero-coupon constant-maturity yield is the average of instantaneous forward rates.

In this analysis I will follow Moessner in using both: zero-coupon rates are a good proxy for the US Treasury cost of financing and instantaneous forward rates allow to understand at which maturities FG announcements have effect, without being influenced by shorter maturities dynamics (as, on the other hand, happens for zero-coupon rates).

For this reason, I will use both zero-coupon and instantaneous forward rates for the bonds' yields, but only instantaneous forward rates for TIPS, given that, in the case of indexed securities, the zero-coupon yield does not directly represent a cost of financing. The breakeven inflation rate and the term spreads that I use in this work are based on zero-coupon constant-maturity yields.

Instantaneous forward rates are still conceptually different from future short-term rates' expectations: the former combine the expectations with an interest rate risk premium that the investor requires since she is fixing at time t a rate that begins in $n > t$, while the latter does not include the interest rate risk premium.

3.3 The Model

In this work, I use a model with two dummy variables, in order to distinguish between hawkish and dovish forward guidance.

Thus, the general model is the following:

$$a_t - a_{t-k} = \beta_0 + \beta_d \mathrm{CFG}_t^d + \beta_h \mathrm{CFG}_t^h + \sum_{i=1}^{12}\gamma_i C_i + \varepsilon_t \tag{10}$$

where a is the variable for which I assess the reaction to FG announcements, CFG_t^d (CFG_t^h) is the dummy variable that takes value 1 on the day (or larger time span, e.g., 3-day window) in which a dovish (hawkish) change in the FG speech occurs. ε_t is the error term and β_0, β_d, and β_h are the coefficients of the regression. $\hat{\beta}_d$ and $\hat{\beta}_h$ estimates are the estimates of the magnitude of the dependent variable's reaction to FG announcements. For this reason, I often express their value in basis points.

I consider only changes in Forward Guidance: CFG_t^h and CFG_t^d do not include repetitions of the same FG speech: I have tried to assess the impact of the repetitions, but I have not found significant results (consistently with Moessner (2015b)).

Lastly, $\sum_{i=1}^{12} \gamma_i C_i$ contains all the control variables that I use times their regression coefficients. Details about the variables are provided below.

Three are the main original innovations to the original Moessner model.

- I update his results to the first quarter of 2022, assessing the use of Forward Guidance by the FED while the rates are not at the lower bound.
- I apply the model to two variables that are not included in his analysis (inflation risk premium and inflation expectations).
- I use two distinct dummies for hawkish and dovish announcements. Indeed, most of the empirical analysis of this kind are focused on the tool employment when the policy rate cannot be lowered: in this case most of the announcements are dovish. The absence of much literature is probably due to the fact that a large enough sample with hawkish announcements became available only recently (given that the FED abandoned the ELB in 2015).

Sutherland (2023) distinguishes between dovish and hawkish announcements, but his analysis is done using survey forecasts, and not market-based metrics: in the section about Results I will compare my conclusions with his.

$a_t - a_{t-k}$ is the variation in the dependent variable. In this work I will use $k = 1$day, but I will also repeat the analysis with $k = 3$days (Moessner (2015b) and Moessner (2015a) use 1- and 5-day windows), to understand whether the FG is priced in the markets within the same day of the announcement or it takes more. This model does not allow to take into account the expectations about FG that are already incorporated in the prices before the announcement is made. This limitation is due to the fact that I use daily data: using monthly data (as in Sutherland (2023), that uses monthly forecasters' expectations) would reduce this problem on one hand, but on the other would not allow to disentangle the reaction to FG from reactions to other announcements.

In the following table, there are the variables I apply this model to and their symbols.

3.4 Control Variables

Bonds' yields and inflation expectations are not subjected to monetary announcements only and react to many announcements and economic shocks.

Variable	**Notation**
Zero Coupon Constant-Maturity US Treasury Bonds' Yields	$y_{t,n}^{\text{nom}}$
Instantaneous Forward Bonds' Yields	$y_{t,\text{IF}}^{\text{nom}}$
Instantaneous Forward TIPS' Yields	$y_{t,\text{IF}}^{\text{TIPS}}$
Inflation Compensation	$\pi_{t,n}^{\text{Comp}}$
Market-Based Inflation Expectation	$\pi_{t,n}^{e}$
Market-Based Inflation Risk Premium	$\text{IRP}_{t,n}$

Table 1: Summary of Variables

For this reason, in this model I use many control variables in order to take into account those other key determinants and to make my estimation more reliable. The choice of the control variables follows Moessner (2015a), with some adjustments (explained below).

Gürkaynak, Sack, and Swanson (2018) find that macroeconomic releases and monetary policy announcements have a significant impact on long-term forward rates. However, the news could be already expected by the public and priced in the market. Thus, what could move asset prices in the day of the announcement are the surprise components of each news. In order to assess the magnitude of the surprise for each announcement, I use the survey forecasts provided by Bloomberg.

Bloomberg provides the median of the estimates, their standard deviation and computes the surprise component as follows:

$$r_t^{\text{surprise}} = \frac{r_t^{\text{rel}} - \text{median}(\underline{r}_t^s)}{\sigma(\underline{r}_t^s)} \tag{11}$$

In other words, the surprise component is computed as the difference between the actual value of the release in t (r_t^{rel}) and the median median$(\underline{r}_t^s)$ of the estimates (that are collected in vector $\underline{r}_t^s$), divided by their standard deviation.

Swanson and Williams (2014) notice that "an important feature of these surveys is that they are conducted just a few days prior to each announcement" (page 14). In particular, the economists that contribute to the Bloomberg survey can change their expectations until the night before the release. This makes this survey particularly accurate and the surprise component computation very reliable.

While both Gürkaynak, Sack, and Swanson (2018) and Swanson and Williams (2014) normalize the difference $r_t^{\text{rel}} - \text{median}(\underline{r}_t^s)$ by the historical standard deviation of the releases, Bloomberg uses the standard deviations of the estimates' panel. This means that the lower the uncertainty on the market about the announcement, the higher the surprise component, being equal the difference between the actual value and the median of the estimates.

Most of the variables that I use are the ones used by Swanson and Williams (2014), Moessner (2015b), and Moessner (2015a): Capacity Utilization, Consumer Confidence, Core CPI, GDP (advance), Initial Claims, ISM Manufacturing, New Home Sales, Nonfarm Payrolls, Core PPI, Leading Indicators Index, Retail Sales ex. autos and Unemployment Rate.

Moreover, I have added the surprise components deriving from the FOMC policy-rate setting. In this way, I try to avoid that FOMC decisions about immediate changes in the policy rate (i.e., non-forward announcements) impact the assessment of FG effectiveness.

One could also control for monetary policy surprises using the movements in Federal Funds Rate futures (as Gurkaynak, Sack and Swanson, 2005).

3.5 Choice of the Sample and Temporal Decomposition

The sample that is used in this work begins at the beginning of 2007 (January 31st) and ends at the beginning of 2022 (March 30th).

Even though this work is focused on forward guidance announcements after the 2008 financial crisis (the first in December 2008), I have collected data since 2007 in order to include periods in which monetary policy was in standard conditions.

The end of the sample is not justified by economic reasons: I have tried to use data as recent as possible. This choice allows to have the COVID-19 crisis and its aftermaths included in the analysis.

In this work, I run the regressions that are presented above multiple times, to assess whether FG effectiveness and markets' reactions depends on particular economic conditions. For this reason, I create the following subsamples:

- **December 16th, 2008 - October 27th, 2015**: Rates at the Lower Bound
- **October 28th, 2015 - March 14th, 2020**: Non-lower-bound rates
- **March 15th, 2020 - March 31st, 2022**: Rates at the Lower Bound and COVID crisis. Aftermaths of the COVID crisis.

3.6 Data

The following are the sources that I have used to build the dataset for this work:

- the Press Releases page of the Federal Reserve website for the FOMC Policy Statements (from which I have created the dummy variables CFG_t^d and CFG_t^h).
- Bloomberg Financial Services for the economic releases calendar, the survey forecasts, and the surprise component of each announcement.
- The time series provided by the FED's staff for bonds' and TIPS' yields, inflation compensation, and inflation compensation decomposition.

I will now provide some details about the methodology that has been followed by FED's staff in building the time series. Indeed, yields are not directly observable on the market, since what is observable are only the prices of bonds and TIPS.

3.6.1 Interest-Rates Time Series

The nominal yields, the TIPS yields and the inflation compensation decomposition time series are built and updated by FED staff following the methodology exposed in, respectively, Gurkaynak, Sack, and Wrigt (2007), Gürkaynak, Sack, and Wright (2010), and D'Amico, Kim, and Wei (2018). I have used the same sources of data as Moessner (2015b), but, obviously, considering an updated sample.

Gurkaynak, Sack, and Wrigt (2007) and Gürkaynak, Sack, and Wright (2010) use a model originally proposed by Nelson and Siegel (1989) and extended by Svennson (1994). In particular, they use a parametric yield curve specification for the instantaneous forward rates. As the authors notice, this choice makes the estimation of the yield curve suitable for macroeconomic analysis of the time series (as I do in this work), while could be less precise in capturing brief dips due to particular market conditions.

The methodology is used both for Treasury Bonds and TIPS, but the authors made some adjustments to better fit the model to the TIPS specificities. For example, they excluded securities with maturities shorter than 2 years, since the movements in their prices could be deeply affected by the indexation lag.

The main limitation of the Svennson methodology is an instability issue that affects the reliability of the estimates of rates at short-term maturities (mainly less than 2 years). This issue is described in Anderson and Sleath (1999) and Gurkaynak, Sack, and Wrigt (2007).

Lastly, D'Amico, Kim, and Wei (2018) use a four-factor affine-Gaussian model through which they decompose inflation compensation into inflation expectations, inflation risk premium and liquidity premium. In particular, using their model, FED staff provides estimates at 5-, 10- and 5-to-10-year maturities.

They find a significant and non-negligible liquidity risk premium that, if not taken into account, would deeply affect the results of this analysis.

3.7 Methodology

The model is an OLS regression. As said above, the explanatory variables are dummies (FG announcements) or variables that assume values different from zero in few days (economic releases).

For this reason, I do not expect the regressions to have a high adjusted R square, given that the model does not try to explain the movements of the dependent variables, but only their reactions to the announcements. As a result, I will principally focus on the level of significance of the coefficients.

The robustness of the estimates is checked in two ways.

First, I use heteroskedasticity-and-autocorrelation consistent Newey West standard errors as Moessner does. I use a truncation lags of 8 for the entire sample, 7 for the first subsample and 6 for the second and the third. Actually, I do not find autocorrelation and heteroskedasticity in all 32 the regressions, but I use the HAC SEs for all the models anyway. As explained in Fomby and Murfin (2005), this could be a limitation in a model with dummy variables, since the HAC SEs could be less conservative then the OLS SEs, when applied to a large sample and where the errors are actually i.i.d. Anyway, most of the results (and the general conclusion) are statistically significant both using standard OLS and HAC standard errors.

Secondly, I temporally decompose the sample in subsamples. The main aim of this experiment is to understand whether there are differences in the reactions depending on the economic circumstances or announcements' timing. However, observing that the reactions are significant and consistent in their directions in all the subsamples, makes more likely that the significance of the results is not due to few outliers, but to structural markets' behaviour. The fact that models of this kind could be biased by few outliers is noticed in Swanson and Williams (2014).

4 Results

I find rates' reactions that are consistent with the existing literature (Del Negro, Giannoni, and Patterson (2023), Moessner (2015b), Moessner (2015a), Sutherland (2023), Swanson (2021)). On the other hand, the evidence about inflation expectations and breakeven inflation rate is partially ambiguous.

4.1 Interest Rates

First, I analyse the reaction of the zero-coupon Treasury bonds rates. I find a significant and persistent reaction to changes in FG announcements by the FED. The direction of the reactions is consistent with the announcements: when the FED announced that rates in the future were going to be lower (higher), the long-term bonds' yields decreased (increase). The largest effect is found at the maturity of 6 and 7 years for dovish announcements and 3 years for hawkish announcements. However, this does not mean that the announcements have been perceived by the markets as regarding in particular rates up to 7 years in the future (or 3 years for hawkish announcements): the zero-coupon constant maturity yields are the averages of instantaneous forward rates.

The same-day reaction has been less than 10 bps at all maturities, from the smallest of -2.5 bps (1-year) to the largest of -9.1 (7-year) for dovish announcements and from a minimum of 2.3 bps (10-year) to a maximum of 5.7 bps (3-year) for hawkish announcements.

Decomposing the sample in the three phases, I observe consistency in the direction and magnitude of the reactions. However, the statistical significance of the reactions' estimates is lower for both hawkish and dovish announcements in the second subset. In the third subset, no estimate of the reactions to dovish announcements is significant.

Even though the values of the coefficients are different in the three periods, the magnitude of the reactions is not statistically different (even at a confidence level of 90%).

Now, I am going to analyze the reaction of instantaneous forward rates.

While the relationship between them and the ZC constant-maturity rates is purely mathematical, their analysis allows to understand more clearly at which maturities the FG announcements are effective (i.e., affect interest rates) (Moessner (2015b)).

The direction of the reactions is obviously still consistent with the aim of this monetary policy tool (negative (positive) for dovish (hawkish) announcements). The magnitude is larger, it goes from -5.2 bps (9-year) to -11.5 bps (4-year) for dovish announcements and from 3.4 bps (4-year) to 7.6 bps (2-year) for hawkish announcements.

The shape of the coefficient curve is consistent with the shape of the coefficients curve for the ZC yields, given the fact that the latter are the averages of the former.

In particular, the hump-shaped effect that I find is consistent with what Moessner (2015b), Moessner (2015a), and Swanson (2021) find, with different methodologies (respectively, event-study and principal component analysis).

Not much can be said about the symmetry of the reactions, that is, whether the increase in rates following a hawkish announcement is bigger or smaller (in absolute value) than the decrease following a dovish announcement. Indeed, even though the absolute value of β_d is persistently higher than the value of β_h, the differences are not statistically significant (even at a level of significance of 90%). As a result, one cannot reject the symmetry hypothesis at a confidence level of 90%.

Even though the statistical result does not provide strong evidence, the difference in the coefficients could be explained by the impact that FG has on the interest rate risk premium: if FG announcements (hawkish and dovish) decrease uncertainty, they contribute to decrease the risk premium as well. However, this effect emphasizes the downward reaction in case of dovish announcements but dampens the upward reaction in case of hawkish announcements, leading to $|\beta_d| > \beta_h$ This explanation of such asymmetry would be consistent with what Sutherland (2023) finds: he observes that reactions are symmetric when risk premia are not involved (his analysis is about survey forecasts of interest rates, that do not include risk premia).

In any case, I am aware that mine is not a rigorous proof, and the statistical significance of this result does not allow to infer general conclusions.

The temporal decomposition of the sample provides the same conclusions and results that have been found with the ZC constant-maturity interest rate.

Moessner (2015a) does not find significant results performing a similar analysis with a sample that goes from 2004 to 2014 (but considering after-2008 FG announcements only) and using instantaneous forward nominal interest rates23. The fact that he does not find significant coefficients could be due to

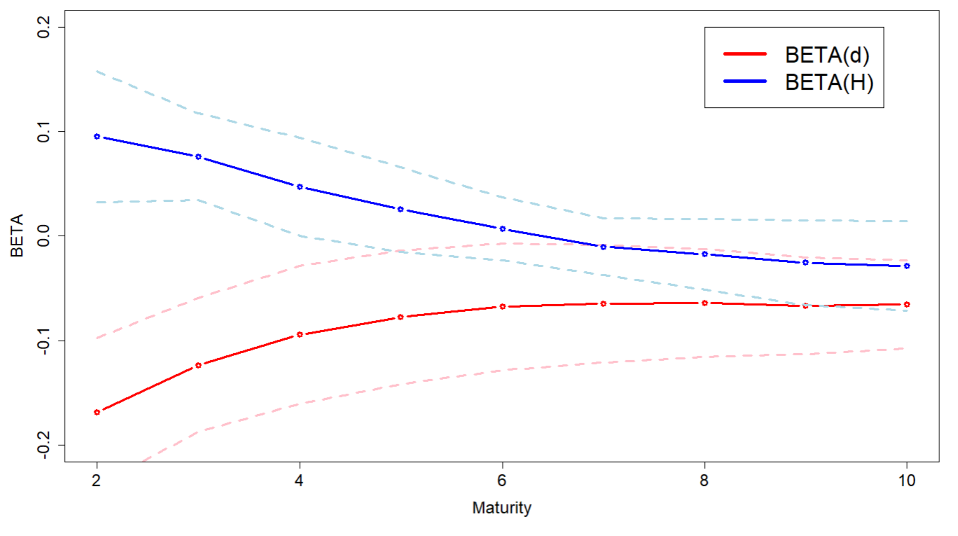

Figure 1: Reaction of TIPS' yields to Forward Guidance Announcements. The Standard Errors are HAC, and the confidence interval of 90%. One of the most significant results is the shape of each line: the hump is found for each dependent variable in this and other works (Moessner (2015b), Swanson (2021)

the different samples that he uses.

I will now analyze the reactions of TIPS instantaneous forward rates.

Firstly, the reactions for TIPS with maturity of 1 year are not observable, since the Gurkaynak, Sack, and Wrigt (2007) methodology does not allow to have accurate estimates of the rates at short maturities.

I find reactions to FG announcements that are significant and larger than the ones found for nominal rates. Indeed, for dovish announcements the largest (when considered in absolute value) significant reaction has been -16.8 bps (1-year) and the smallest -6.4 bps (7-year). For hawkish announcements, the largest has been 9.5 bps (1-year) and the smallest (significant) upward reaction 4.7 bps (3-year).

With respect to the symmetry of the reaction, we cannot reject the symmetry hypothesis for maturities up to 8 years (we can for 9- and 10- year, but then the coefficients are not significantly different from zero) at a confidence level of 90%. Moreover, the economic interpretation in this case could be more complex, since there are many risk premia (interest rate, inflation and liquidity) and also because of the lack of significance in the long-maturities coefficients.

Comparing the magnitude of the TIPS' yields reactions with what is found by Moessner (2015b) and Moessner (2015a), the differences are not large (even though, given that the author does not provide SEs, I cannot test whether they are significant) and probably mainly due to the different samples that are taken into account.

4.2 Inflation Compensation

Running the model using the spread between nominal bonds' and TIPS' rates as dependent variable gives some insights about the effectiveness of Forward Guidance on inflation expectations and risk premium.

I observe a significant effect only for dovish announcements and only for 2-, 3- and 4-year maturities. Moreover, the adjusted R^2 for these regressions is particularly low (0.008, 0.010 and 0.010 for the same maturities). While this does not weaken the significance of the coefficients, it could mean that there are other control variables that could be used, in order to better explain BEIR dynamics.

The sign of the three statistical coefficients is positive (+10 bps, +8.4 bps and +6.6 bps), meaning that dovish FG announcements increased the spread between bonds' and TIPS' rates (at least at 2-, 3- and 4- year maturities).

One of the interesting results of this analysis is that I do not find significant reactions to hawkish announcements.

Moessner (2015b) finds different results for his sample: he finds negative and significant reactions at 6- to 8-year maturities (-6, -7 and -7 bps) in the 1-day window, while he finds positive reactions for 2- to 4- year maturities (+13, +16 and +13 bps) in the 5-day window. However, he recognizes that, given the absence of significance in the 1-day window, this result could be the consequence of other news occurred in the 5-day horizon.

The temporal decomposition of the model is particularly interesting in this case, since the significance and the magnitude of the results vary a lot depending on the subsets.

In the following table, I report the values that the estimate $\hat{\beta}_d$ assumes in each regression for each subset. in the first and in the second subset the reactions are significant and positive, while in the third one, they are not significant.

Subset	**BE02**	**BE03**	**BE04**	**BE05**	**BE06**	**BE07**	**BE08**	**BE09**	**BE10**
2008-2015	0.10^{**}	0.08^{**}	0.07^{**}	0.05^{**}	0.04^{*}	0.03^{*}	0.03^{*}	0.03^{*}	0.03^{*}
2015-2020	0.08^{***}	0.06^{***}	0.05^{***}	0.05^{***}	0.04^{**}	0.05^{*}	0.05^{*}	0.05^{*}	0.04.
2020-2022	-0.07	-0.04	-0.05	-0.07	-0.08	-0.09	-0.09	-0.08	-0.07

Table 2: Inflation Compensation Reaction to Dovish Announcements. Significance Levels: *** 0.001, ** 0.01, * 0.05, . 0.1

Even though inflation compensation (or Breakeven Inflation Rate, BEIR) is often used as a real-time proxy for inflation expectations (Kim, Walsh, and Wei (2019)), I would not consider these results as indicative of the impact of FG announcements on inflation expectations. Indeed, as it is explained below, they are deeply affected by movements in the risk premia that are priced into the spread between TIPS' and bonds' yields. For this reason, I now use the BEIR decomposition provided by FED staff.

Unfortunately, inflation expectations estimates are not available for all the maturities from 1- to 10-year. In fact, FED's staff provides estimates only for

5- and 10-year maturities. In the following table, I report the results of my analysis of inflation expectations and inflation risk premium reactions to FG announcements. Newey-West Standard Errors are reported within brackets.

	EI(5)	**RP(5)**	**EI(10)**	**RP(10)**
$\hat{\beta}_d$	-0.021*	-0.009**	-0.020**	-0.010**
	(0.008)	(0.003)	(0.007)	(0.004)
$\hat{\beta}_h$	0.008*	0.007***	0.001*	0.006
	(0.003)	(0.002)	(0.002)	(0.002)

Table 3: Inflation Expectations and Inflation Risk Premia. Significance Levels: *** 0.001, ** 0.01, * 0.05, . 0.1

It can be noticed that the impact on inflation expectations is opposite to what one would expect from the aim of Forward Guidance tool: the inflation expectations increase (decrease) when there is a hawkish (dovish) announcement. This result cannot be compared with the one obtained for BEIR, since in that case the estimates at 5- and 10-year maturity is not significant. However, comparing the estimates using the subsamples could be useful.

For the first two subsamples, the reactions of BEIR on one hand and inflation expectations and inflation risk premium on the other seem to be inconsistent, since the former is brought up by dovish FG announcements, while the latter are brought down. Given that

$$\pi^{\mathrm{Comp}_{t,n}} = \pi^e_{t,n} + \mathrm{IRP}_{t,n} - \mathrm{LRP}^{\mathrm{TIPS}}_{t,n}$$

I check whether the TIPS liquidity premium affect the sign of the BEIR reaction largely enough to change it. The other possible explanation for this phenomenon would be the errors in the BEIR decomposition, i.e., the difference between raw and fitted inflation compensation. The fitted inflation compensation is the sum of inflation expectations, inflation risk premium minus liquidity premium.

I run two regressions using respectively the liquidity premium and the model errors and I find that liquidity premium reacts significantly to dovish FG announcements, bringing up the BEIR reaction and biasing the inflation compensation metrics: the day of the announcement, the liquidity premium decreases by 4.8 bps). On the other hand, the model errors do not react significantly to dovish announcements.

The same is found for inflation and liquidity premia at 10-year maturity (the liquidity premium decreases by 0.9 bps in case of dovish announcements and 0.46 bps in case of hawkish announcements), but the results are not comparable since the 10-year BEIR does not react significantly to FG announcements.

Once the inconsistency between the two models with movements in the liquidity premium is explained, it seems that the inflation expectations at 5 years decrease (increase) when the FED announces a loose (restrictive) monetary policy. However, I would not take this result as evidence of Delphic-perceived forward guidance announcements since (a) we are analyzing inflation expectations at 5- and 10-year maturities only, (b) the decomposition of inflation compensation could be inconsistent with other market-based inflation metrics and the estimates of the liquidity premium could be excessively high (Christensen and Gillan (2011)) and (c) the magnitude of the reaction is particularly small (the biggest coefficient (in absolute value) is 2.1 bps).

4.3 Term Spread

In this work, I have used a "short" and "long" term spread. the former is the difference between yields at 5 and 1 years, whereas the latter is the difference between yields at 10 and 1 years.

I find a significant reaction of the short term spread to FG announcements. In particular, the reactions are both downward (-5.3 bps for dovish announcements and -4.5 bps for hawkish announcements).

Applying the model to the long term spread, I observe that the only significant coefficient is β_h, and its sign is negative (-7.1 bps). On the other hand, β_d is significant only when considering the second subsample.

The flattening of the yield curve that I observe in reaction to FG announcements could be explained in two ways (Woodford, 2012). First, the market could think that the announcement relates more to rates on long maturities (i.e., the FOMC statement affects short-term rates' expectations five (ten) years in the future more than one year in the future). Secondly, the phenomenon could be due to lower uncertainty. Given that the reaction is in the same direction (the yield curve flattens even after hawkish announcements) and with the same magnitude (for the "short" term spread is about 5 bps), I think that the second explanation is more plausible.

My results are partially consistent with what Moessner (2015a) finds. He finds negative reactions of the term spread (he considers only 5y – 1y spread, that is, what I call the "short" term spread) to FG dovish announcements only when these are not related to asset purchases. However, the magnitude that he finds (-12.3 bps) is larger than mine.

4.4 3-day window

As explained in the paragraph 2.3, I have run the same regressions with a wider window as well. In particular, I have chosen a three-day window. In this way I check whether the information that comes to the market through the FOMC Policy Statement is priced into the bonds' yields in the same day or it takes more than one day. I do not find evidence to reject the same-day hypothesis.

5 Conclusions

Forward Guidance has been largely used by the FOMC during and in the years after the 2008 financial crisis. In that case, the traditional monetary policy tool (the policy rate) was not available to stimulate the economy, since already at the lower bound.

However, Forward Guidance announcements have not only been about future accommodative monetary policies, but, since 2015, they also anticipated future increases in the interest rates.

This allows to assess the effectiveness of FED FG announcements on the US bonds' market distinguishing between hawkish and dovish announcements. In particular, this work builds on the approach of Moessner and finds that the impact on bonds' and TIPS' yields has been persistent, consistent with the theory and significant: when a dovish (hawkish) announcement has been made made, the bonds' rates decreased (increase) at all maturities up to 10 years. The same happened for TIPS' yields. Moreover, FG announcements (independently from their direction) seem to significantly reduce the term spread: this could be consistent with decreasing uncertainty and, consequently, decreasing risk premia.

The other scope of this work was to understand how FG announcements affected inflation expectations. In particular, I find that the inflation compensation increased after dovish announcements (while there is no significant reaction to hawkish announcements). This would be consistent with an Odyssean-perceived FG, but, when using the pure inflation expectations as dependent variable, I find the opposite: inflation expectations (at least at 5- and 10-year maturities) seem to decrease after a dovish announcement. In particular, I show how the result about BEIR is biased by the liquidity premium.

The result on inflation expectations is not strong enough to infer about whether FED FG is perceived as Odyssean or Delphic by the markets, but it neither allows to exclude that FG could have a "perverse effect" (Woodford (2012)) on inflation expectations

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