A Work Project, presented as part of the requirements for the Award of a Master's degree in Economics from the NOVA School of Business and Economics.

THE EFFECT OF ECB FORWARD GUIDANCE ON THE EURO AREA YIELD CURVE

TOMÁS FALUA DUARTE

Work project carried out under the supervision of:

Professor Francesco Franco

15-01-2025

The Effect of ECB Forward Guidance on the Euro Area Yield Curve

Tomás Duarte *

January 15, 2025

Abstract

This paper focuses on the instantaneous and persistent impacts of ECB forward guidance on the euro area term structure of interest rates. A high-frequency event-study method is employed to uncover the response of euro OIS rates to forward guidance through an ARCH model and local projections. Results indicate forward guidance lowers the term structure across all maturities, with a stronger impact on longer horizons. This effect proves to be persistent. Robustness to including ECB and private information sets suggests ECB forward guidance is interpreted as a stance on future monetary policy, rather than a signal of the macroeconomic outlook.

JEL Codes: E43, E52, E58.

Keywords: Term Structure of Interest Rates, Unconventional Monetary Policy, Forward Guidance, High-frequency, Persistence.

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

∗. Nova School of Business and Economics, Universidade Nova de Lisboa. Email: 47195@novasbe.pt. I am extremely grateful for all the invaluable guidance and insightful feedback provided by Professor Francesco Franco. I am also grateful for the insights provided by Nic Kozeniauskas. I also thank Francisco Pinto, João Gomes, Pedro Reis, Tiago Leitão and Vasco Cardoso for their support while writing this thesis and for accompanying me through this Master's degree.

Dedicatória

Ao meu pai e à minha mãe que tanto fizeram por mim, que me educaram e fizeram crescer enquanto pessoa, que sempre que apoiaram e impulsionaram para conquistar todas as oportunidades com que me cruzei no meu caminho, e que tanto carinho me deram. Aos meus avós que sempre me incutiram humildade e seriedade, que nunca me deixaram parar de sonhar e que me mostraram que é possível fazer muito, mesmo quando se começa com tão pouco. Aos Professores Flamino Viola e Luís Lopo, que tanto me ensinaram e que cultivaram em mim uma curiosidade e um interesse em aprender cada vez mais. Por fim, ao meu irmão, o meu grande amor e a minha maior inspiração. O grande ídolo da minha vida que sempre me surpreendeu com a sua força e capacidade de dar a volta a quaisqueres adversidades, sempre a chegar ao fim das suas batalhas com um sorriso no rosto e coberto de sucesso. Um sincero obrigado.

Dedication

To my dad and my mom who have done so much for me, educated me and helped me grow as a person, always supporting me and encouraging me to seize all the opportunities I have encountered along the way, and who gave me so much love. To my grandparents, who instilled in me humility and never allowed me to stop dreaming, showing me it is possible to achieve so much even when starting with so little. To Professors Flamino Viola and Luís Lopo, who taught me so much and cultivated within me a curiosity and interest to never stop learning. Finally, to my brother, my greatest love and my biggest inspiration. The great idol of my life who always left me in awe with his strength and ability to turn things around no matter the obstacles, always reaching the end of his battles with a smile on his face and covered in glory. A sincere thank you.

I. Introduction

In 1996, in his Robbins lectures at the London School of Economics, Alan S. Blinder stated that "*Greater openness might actually improve the efficiency of monetary policy... [because] expectations about future central bank behaviour provide the essential link between short rates and long rates. A more open central bank... naturally conditions expectations by providing the markets with more information about its own view of the fundamental factors guiding monetary policy..., thereby creating a virtuous circle. By making itself more predictable to the markets, the central bank makes market reactions to monetary policy more predictable to itself. And that makes it possible to do a better job of managing the economy.*"

Over time, monetary policy action has evolved beyond conventional monetary policy, with communication strategies and unconventional measures rising in popularity and becoming more prominent. This process accelerated with the global financial crisis, as its aftermath led to major economies facing an effective lower bound. Consequently, managing expectations became king. The European Central Bank (ECB) has not shied away from this trend, employing forward guidance and quantitative easing (QE), among others, as key policies. The use of forward guidance became very explicit when Mario Draghi asserted, on January 9, 2014: "*We firmly reiterate our forward guidance that we continue to expect the key ECB interest rates to remain at present or lower levels for an extended period of time,*" reinforcing a previous forward guidance announcement on July 4, 2013. Unconventional instruments also played a pivotal role in dealing with the COVID-19 crisis, with the use of extended asset purchase programs and refinancing operations, alongside forward guidance and others.

Facing a growing set of monetary policy tools, it is important for policymakers to fully understand the effectiveness of these options. With this in mind, this paper aims to assess the instantaneous and persistent impact of forward guidance on the yield curve, which provides a key reflection of agents' expectations and guides them in investment and consumption decisions.

The yield curve is defined through euro Overnight Interest Swap (OIS) rates at various maturities, and forward guidance is identified through a method I have denominated as Swanson Decomposition. Results show a significant and persistent impact across the yield curve, with a stronger effect on longer horizons. Given the bigger impact at medium-long run maturities, the

risk channel appears as a relevant transmission channel, as forward guidance not only guides expectations regarding the policy path but also reduces uncertainty, thus risk, associated with expectations about the future. This reduction of risk is more relevant in the medium-long term, as OIS rates at longer maturities have a stronger risk premium embedded. These results verify the validity of forward guidance as a policy tool and allow for lower inflation targets by reducing the cost of hitting the zero lower bound. These results hold whether considering only monetary policy announcement dates or a broader range of ECB communication dates, indicating that all statements by monetary authorities hold some relevance in managing expectations. However, considering a broad range of communication dates leads to more conservative estimates, as it consists of a sample including lower-impact moments, whereas a sample restricted to formal monetary policy announcement dates only includes high-impact moments. This is a key contribution highlighting that all information communicated by the central bank is analyzed and interpreted by agents, and even non-monetary decision statements may have an impact. A possible channel for this impact is the reaffirmation of past monetary statements, increasing confidence in the previously signalled policy path. Furthermore, ECB forward guidance is found to be interpreted as a stance on the future monetary policy rule, rather than a signal on the economic outlook.

This paper is organized as follows: Section II provides an overview of related literature, Section III describes the data, Section IV presents the empirical methodology, Section V exhibits the results, and, lastly, Section VI concludes.

II. Literature Review

As the 20^{th} century ended and the 21^{st} century began, the view on monetary policy took a turn. From closed regimes, that gave away little information, the consensus started to shift into more open regimes where information and expectations management are key. As this shift unfolded, monetary authorities' communication strategies became more relevant and unconventional policies started to emerge in importance. Consequently, this gauged interest and led to rising literature regarding the effects of communication strategies and unconventional monetary policies.

Blinder et al. (2008) surveyed the literature on the impact of central banks' communication strategies, where one of the main results was that announcements (e.g., reports, statements, speeches) effectively impact financial markets, both through the levels and volatility of interest rates. Gürkaynak, Sack, and Swanson (2005a) investigated the impact of Federal Open Market Committee (FOMC) communication strategies on asset prices using a high-frequency approach. They found that a significant part of the variation in long-term treasury yields in FOMC announcement dates comes from the FOMC guidance on expected future rates, rather than actual federal funds target rate changes. This highlights the relevance of signals about the future policy path embedded in communications by monetary authorities, which is captured by the "path factor", as denominated by the authors.[1] Moreover, Gürkaynak, Sack, and Swanson (2005b) investigated how the US term structure reacts to macroeconomic and monetary policy shocks, showing that long-term forward rates react significantly to various macroeconomic and monetary surprises.[2] This established a link between monetary policy and the term structure, namely long-term yields.

The macroeconomic impact of forward guidance has been well documented. Ben Zeev, Gunn, and Khan (2020), Bundick and Smith (2020), and D'Amico and King (2023), among others, showed that both real activity and inflation increase after a positive forward guidance shock.[3,4] Koeda and Wei (2023) further proved the efficacy of outcome-based forward guidance on the real economy in an effective lower bound environment during both the global financial crisis and the COVID-19 pandemic.[5]

However, private agents can read forward guidance announcements in different ways. Campbell et al. (2012) coined the distinction between Delphic and Odyssean forward guidance. The Delphic type implies forward guidance announcements are read as the monetary authorities' forecast for the future economic outlook. Thus, news on future macroeconomic conditions for which the central bank will react with its usual policy rule. This type of forward guidance

1. Gürkaynak, Sack, and Swanson (2005a) use a factor approach and identify that 75 to 90 percent of the variation in five-year and ten-year Treasury yields is due to the path factor.
2. Gürkaynak, Sack, and Swanson (2005b) define the term structure with forward rates.
3. Ben Zeev, Gunn, and Khan (2020), Bundick and Smith (2020), and D'Amico and King (2023) use VAR frameworks for estimation.
4. A positive forward guidance shock is defined, in this paper, as a signal of lowering the policy rate.
5. Forward guidance can be time-based (commitment to a monetary policy stance until a certain point in time) or outcome-based (commitment to a monetary policy stance until certain economic conditions are met).

focuses on reducing private agents' uncertainty regarding the future and constitutes a signal of economic expectations. The Odyssean type is read as binding to a future course of action. Therefore, news on a future policy rule change given a future macroeconomic state. This type of forward guidance focuses on a commitment to a future policy stance and constitutes a signal of policy intentions. In short, Odyssean forward guidance shifts expectations by guiding the beliefs about how the central bank will react to future conditions, while Delphic forward guidance shifts expectations by guiding the beliefs about what these future conditions will be. Empirically, Campbell et al. (2012) investigated whether Blue Chip forecasts suffered notable revisions upon FOMC announcements. If forward guidance impacts private agents' forecasts, then its Delphic component is stronger. Campbell et al. (2016) concluded that Delphic, not only Odyssean, interpretations of FOMC's announcements may impact private agent's expectations. For the euro area, Andrade and Ferroni (2021) conclude that ECB shocks shifted from Delphic to Odyssean as the use of explicit forward guidance became more prevalent.

Regarding the literature on the impact of forward guidance on the yield curve, Hubert and Labondance (2018) investigated the impact and persistence of the ECB's forward guidance on the term structure. They used a high-frequency method, employing an ARCH model and local projections. They concluded that a positive forward guidance shock lowers the term structure across various maturities, with a stronger impact on longer maturities, peaking in three and five-year horizons, and with a persistent effect. Goodhead (2024) also contributed to the study of the effects of unconventional monetary policy, such as forward guidance and QE, in the euro area, on the yield curve and asset prices. He concluded that ECB's forward guidance is more effective when accompanied by some form of commitment, with this unconventional instrument becoming more impactful when accompanied by asset purchase programs.

Recently, Swanson (2021) extended the work of Gürkaynak, Sack, and Swanson (2005a) by decomposing FOMC announcements and identifying, separately, the impact of changes in the federal funds rate, forward guidance and large-scale asset purchase programs (LSAPs). This method begins with a matrix with FOMC communication dates as rows and asset price variation as columns - considering assets that reflect short, medium, and long-term expectations - and is based on a factor model and principal component analysis. The idea is that the key

features of FOMC announcements are updates in the policy rate, forward guidance and asset purchase programs. Thus, these will constitute the main aspects of monetary policy and, given an announcement, the impact on financial markets will derive from the unexpected component of the news regarding these three dimensions. This work is particularly relevant because it allows a disentanglement of effects, which is neither clear nor direct, upon communications by monetary authorities. For example, announcements purely regarding asset purchase programs may also have a forward guidance component as agents update their expectations regarding future action or gain more confidence in the policy stance. The channels through which monetary policy can impact the economy have also been studied, in particular the "information channel", as per work from Nakamura and Steinsson (2018) and Miranda-Agrippino and Ricco (2021) that argue that Fed communications play an important role in impacting agents' beliefs and expectations regarding monetary policy and other economic variables.

For the euro area, Altavilla et al. (2019) divided ECB's announcements into two stages - press release and press conference - and, using methods from Gürkaynak (2005) and Swanson (2021), identified four relevant monetary policy factors: Target factor (representing the policy rate target), Timing factor (capturing guidance for the near future), Path factor (capturing guidance for the medium run, thus, forward guidance), and QE factor (representing QE).[6] The authors found that the Target factor only plays a role in the press release moment and is substituted by the Timing factor in the press conference moment. Furthermore, forward guidance and QE surprises both impact long-term yields and have persistent effects.

The work that follows departs from the new developments in this literature and proposes an advancement to the study of the impact of forward guidance on the yield curve, in the euro area, contributing to the rising literature on the effects of unconventional monetary policy. Forward guidance identification follows the method proposed by Swanson (2021) and applied to the euro area by Altavilla et al. (2019), but considers that all ECB communications are relevant in guiding expectations, rather than only considering monetary policy announcement dates. Furthermore, following Hubert and Labondance (2018) and Andrade and Ferroni (2021), ECB

6. ECB policy decisions are announced first with a press release and, afterwards, with a press conference. The press release is brief and simply presents the policy decision with no justification. The press conference contains a justification - the Introductory Statement - and a part for questions and answers.

forward guidance is evaluated in terms of whether it is Delphic or Odyssean.

III. Data

The dependent variable chosen is the euro Overnight Interest Swap (OIS) rate across various maturities from one month to ten years - one month, three months, six months, nine months, one year, two years, three years, five years, and ten years.[7] The euro OIS rate reflects the expected EONIA (Euro Overnight Index Average) - recently replaced by the €STER (Euro Short-Term Rate) - at a given maturity, which is the rate at which banks borrow from each other overnight. Thus, the OIS rate should reflect financial market agents' expectations regarding the future average policy rate at a certain maturity (the maturity of the swap), with an adjustment for risk.

Identification of forward guidance is conducted through the exercise proposed by Swanson (2021), which I will denominate henceforth as Swanson Decomposition, and adapted to the case of the ECB. Data is retrieved on dates of ECB communications, including monetary statements and non-monetary statements (such as speeches), from 2005 to 2024. Given the previous justification, euro OIS rates daily variation is used to capture shifts in short, medium, and long-term expectations on announcement days, similarly to Altavilla et al. (2019). Through a factor model and principal component analysis, it is possible to identify a factor that reflects the forward guidance effect. A detailed description of this method can be found in Section IV.

A vector of variables including Eurostoxx50 daily returns, daily changes in WTI (West Texas Intermediate) oil prices, Composite Indicator of Systematic Stress (CISS) and the Economic Sentiment Indicator (ESI), is used to control for macroeconomic and financial dimensions.

All variables are available at a daily frequency, except for the ESI which is available at monthly frequency. The ESI is constant-interpolated to daily frequency, as done by Hubert and Labondance (2018). The assumption is that, at date t, the best guess of agent's information sets is the last data figure published.

The main data source is Datastream. WTI oil prices are extracted from FRED, while CISS and ESI are made available by the European Commission. Data on the dates of ECB

7. An OIS is an instrument that allows financial institutions to swap the interest rates they are paying. Typically, one party exchanges a floating interest rate, while the other party exchanges a fixed interest rate, implying marginal counterparty risk as no principal amount is exchanged.

communications is made available by the ECB itself and complemented with the EA-MPD dataset, from Altavilla et al. (2019), ensuring all monetary policy decision dates are included. The data ranges from July 2005 to July 2024. However, the specific time span of available data for each variable varies slightly within this range.

IV. Methodology

In order to evaluate the effect of forward guidance on the yield curve, a high-frequency event-study method is deployed, following Favero, Bagliano, and Franco (1999), Kuttner (2001), Cochrane and Piazzesi (2002), Gürkaynak, Sack, and Swanson (2005a), and Hubert and Labondance (2018), among others. The underlying assumption is that the yield curve continually reacts and adjusts to new macroeconomic and financial information and, on days of monetary authorities' announcements, there is no other relevant news that impacts the yield curve besides the central bank's communication. This is fundamental for the identification strategy. The time window used is from the close of business on the day before an ECB announcement to the close of business on the day of the announcement. Intraday data is not used due to the lack of this frequency of data on dates of ECB announcements that are not formal monetary announcements. Furthermore, this higher frequency data is also unavailable for some included variables even on monetary statement days. However, Gürkaynak, Sack, and Swanson (2005a) show similar results when using an intraday window (of 30- or 60-minutes around FOMC statements) and a daily window. Thus, the use of daily data in this paper, instead of within-day data, should not be problematic.

To identify forward guidance, inspiration is taken from Swanson (2021). First, a Txn matrix X is constructed where rows correspond to ECB announcement dates and columns correspond to different assets such that each element x_{ij}, corresponding to entries of the matrix X, represents the response of asset j to the *ith* announcement by the ECB. All types of ECB announcements are included, as any type of communication, whether directly regarding monetary policy or not, may have an impact on expectations. This is supported by conclusions from Ehrmann and Fratzscher (2007), whose results indicate that the ECB shows high consistency between communication and action, thus, agents tend to find all information and communications relevant. This differs

from the approach of other authors that focus only on formal monetary policy announcements.[8] As stated before, the assets used correspond to the daily variation of the euro OIS at different maturities. In the setting of a factor model, this can be represented as:

$$X = F\Lambda + \varepsilon \tag{1}$$

where F is a Txk matrix containing $k \leqslant n$ unobserved factors, Λ is a kxn matrix of loadings of asset price responses on the k factors, and ε is a Txn matrix of white noise residuals that is uncorrelated over time and across assets. In this sense, k informs us of how many dimensions of ECB announcements impact X, besides white noise. Under this setting, interest lies in the estimation of F, in particular the column of F that reflects the forward guidance factor.

Following the Swanson Decomposition framework, three factors - which account for close to 90 percent of cumulative variance - are selected.[9] Swanson (2021) argues that these three factors represent the surprise components of changes in the policy rate, forward guidance and LSAPs.

Afterwards, the first three principal components of X are extracted, which correspond to the three elements with the greatest impact on X across the sample. The Singular Value Decomposition (SVD) method is used, given it is more robust and flexible, which is particularly relevant since the matrix X is non-square.[10] However, this merely provides a statistical decomposition and there is no indication regarding which factor corresponds to the surprise component of changes in policy rate, forward guidance or LSAPs. In fact, the most probable case is that each factor contains correlations between these three. However, for correct identification, the model must be determined in a way such that each factor corresponds to a single monetary policy instrument. In practical terms, this is possible through a rotation matrix U that, when applied to F and Λ, ensures that the rotated factors have the desired interpretation. Algebraically, we have:

8. The sensitivity to this assumption is assessed by estimating an alternative specification with only dates of formal monetary policy announcements in Section V.B.3 and only dates of non-monetary policy announcements in Section V.B.4.

9. Since ECB announcements, as a whole, are considered, and not split into press release and press conference, the four factors by Altavilla et al. (2019) are not considered.

10. The SVD decomposes X into three matrices: left singular values that contain the latent factors; singular values that contain the strength - in terms of contribution to the variation in the data - of each factor; and right singular values that contain factor loadings. By truncation - selecting only the largest singular values (those that capture more variance) - this method simplifies the model while retaining the most significant factors.

$$\widetilde{F} = FU \tag{2}$$

$$\widetilde{\Lambda} = U'\Lambda \tag{3}$$

With three factors, U is a 3x3 orthogonal matrix determined by three parameters. Thus, it is necessary to impose three restrictions for identification. Defining $\tilde{\lambda}_{ij}$ as the elements of $\tilde{\Lambda}$, Swanson (2021) proposes the following restrictions: changes in forward guidance have no impact on the current policy rate, $\tilde{\lambda}_{21} = 0$, changes in LSAPs have no impact on the current policy rate, $\tilde{\lambda}_{31} = 0$, and the LSAPs factor is as small as possible in the pre-Zero Lower Bound (ZLB) period. The last restriction implies computing the sum of squared values of the third factor over the pre-ZLB period (defined as observations previous to 2014) and choosing the elements to minimize this sum of squares. With this process, identification of forward guidance is possible through the factor portrayed in the second column of $\widetilde{F}$. The forward guidance and LSAPs factors were sign normalized such that a positive shock implies a looser monetary stance, thus, a signal of lower rates.[11]

A set of macroeconomic and financial variables are also included as controls. The Eurostoxx50 daily returns are included, due to the potential correlation with the OIS rates, and commodity price impact is controlled for by the inclusion of daily changes in WTI oil prices. Financial stress and private sentiment are also controlled for given the inclusion of the CISS and the ESI.[12]

Since financial variables are used, the variance of the dependent variable will likely be volatile. Therefore, an ARCH model, developed by Engle (1982), is applied and estimated with maximum likelihood at daily frequency. ARCH models capture volatility dynamics, allowing the conditional variance to depend on past values of the error term, and relaxing the assumption that variance is constant. Furthermore, the Huber-White sandwich (HAC) estimator is used to compute robust standard errors to address potential heteroskedasticity and autocorrelation.

11. More details on this procedure can be found in Appendix B.
12. This set of control variables may also react to forward guidance, however, they would cause a downward bias and diminish the significance of the impact of forward guidance on euro OIS rates.

Formally, the baseline static specification can be represented as:

$$\Delta r^{E}_{t,m} = \beta_0 + \beta_1 FG_t + \beta_2 C_t + \varepsilon_t \ , \ \varepsilon_t \sim (0, \sigma^2_t) \tag{4}$$

$$\sigma^2_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i \varepsilon^2_{t-i} \tag{5}$$

Where $\Delta r^{E}_{t,m}$ is the change, between *t* and *t-1*, in euro OIS rates for maturity *m* (comprised of one, three, six and nine months, and one, two, three, five, and ten years), FG_t contains the extracted factor connected to ECB forward guidance, and C_t is the mentioned vector of controls. Equation 4 represents the main model to be estimated (the mean equation) and the key coefficient is β_1. Equation 5 represents the ARCH framework used to model the volatility of the variance (the variance equation). In the baseline setting, the ARCH variance equation is estimated with a single lag (*p=1*).[13] The number of lags is set to one to avoid the decay of degrees of freedom and following the baseline specification of Hubert and Labondance (2018). In Table A1, in Appendix A, Engle's ARCH test for ARCH(1) effects can be found. This is a Lagrange multiplier (LM) test for ARCH(q) effects that departs from an OLS estimation of the model, from which the residuals are squared and regressed on a constant and *q* lagged terms. The test assesses the joint significance of the lagged terms to determine if ARCH effects are present. For five out of the nine maturities of euro OIS rates considered, the test finds ARCH(1) effects.

V. Effects of Forward Guidance

After identifying the forward guidance component from ECB announcements, the focus shifts to analyzing the respective impact on the euro OIS rates with maturities of one, three, six and nine months, and one, two, three, five and ten years.

13. In Section V.B.1, the robustness of this choice is assessed.

V.A. Impact of Forward Guidance in the Euro Area Yield Curve

The starting point is the estimation of the baseline specification presented in Equation 4 and Equation 5, with a single lag ($p=1$). The results can be found in Table 1.

As we can observe, the coefficient associated with forward guidance is negative and very significant across all euro OIS maturity horizons. Furthermore, the magnitude of the coefficient (expressed in basis points per standard deviation) increases up to the two-year maturity and starts decreasing afterwards. However, the impact on maturities above two years is still stronger than the impact on maturities shorter than one year. These conclusions follow those of Hubert and Labondance (2018) and Altavilla et al. (2019), with the latter also detecting a peak of the forward guidance impact in the two-year horizon. Gürkaynak, Sack, and Swanson (2005a) also find that the impact of the path factor has a stronger effect on the long end of the US yield curve.

A key result is that ECB forward guidance has a stronger impact on longer maturities. This indicates that the management of expectations regarding the future policy stance by the ECB is more relevant for medium-long run expectations. This fits the purpose of employing this policy option, validating its effective use by the ECB. A possible explanation is that forward guidance may affect agents' risk aversion and, therefore, impact the risk premium embedded in OIS rates. Through the risk channel, forward guidance impacts market participants by reducing their uncertainty regarding the policy path which, in turn, reduces the risk premium. This reduction of the risk premium is smaller in shorter maturities since the risk factor in itself is smaller. This may also explain the reduction of the impact on euro OIS rates with larger maturities than two years, as the reduction of the risk premium becomes weaker in larger horizons given the higher probability of a policy change - either due to a change in monetary goals or macroeconomic conditions.

The significance of the forward guidance factor identified using a broad definition of ECB communication dates, beyond just monetary policy announcements, indicates that all communications by the ECB may have a relevant component in terms of managing expectations. This finding implies that agents may adjust their expectations based on any type of announcement from monetary authorities, regardless of whether it is a formal policy announcement or not.

Table 1: ARCH(1) Estimates

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
					Mean Equation				
FG	-0.888***	-1.668***	-2.809***	-3.579***	-4.155***	-5.436***	-5.288***	-4.881***	-4.018***
	[0.175]	[0.135]	[0.142]	[0.080]	[0.066]	[0.111]	[0.205]	[0.170]	[0.216]
OilPrice	0.032	-0.023	-0.022	-0.010	-0.029	-0.015	-0.039	0.012	0.071
	[0.066]	[0.047]	[0.048]	[0.033]	[0.025]	[0.038]	[0.081]	[0.079]	[0.081]
EUROSTOXX50	0.001	0.001	0.000	-0.000	-0.001	-0.002	-0.002	0.000	0.003
	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.003]	[0.004]
CISS	-1.191*	-0.690*	-0.363	-0.559**	-0.036	0.134	0.156	1.080**	2.014***
	[0.611]	[0.361]	[0.365]	[0.266]	[0.206]	[0.302]	[0.437]	[0.516]	[0.719]
ESI	0.013**	0.015**	0.008	-0.001	0.003	-0.012***	-0.009	-0.001	0.011
	[0.006]	[0.006]	[0.005]	[0.004]	[0.004]	[0.005]	[0.007]	[0.008]	[0.011]
Constant	-1.065*	-1.443**	-0.734	0.254	-0.304	1.159**	0.921	-0.081	-1.359
	[0.626]	[0.624]	[0.566]	[0.477]	[0.447]	[0.486]	[0.707]	[0.846]	[1.104]
					Variance Equation				
ARCH(1)	0.667***	0.588***	0.336	0.220**	0.122*	0.516***	0.368*	0.348**	0.190*
	[0.231]	[0.178]	[0.251]	[0.112]	[0.065]	[0.112]	[0.223]	[0.155]	[0.105]
Constant	1.935***	1.575***	1.523***	1.300***	1.168***	1.281***	3.260***	3.988***	8.579***
	[0.375]	[0.259]	[0.425]	[0.201]	[0.125]	[0.194]	[0.833]	[0.701]	[1.338]
N	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

V.B. Alternative Static Estimates

V.B.1 Robustness Checks

In order to check the sensitivity of the previously illustrated results, a series of robustness checks is produced.

First, the baseline specification is estimated with no controls (Table A2). Moreover, different specifications are tested. The ARCH variance equation is extended from one lag to two lags (Table A3) and a GJR model is tested (Table A4). GJR models are a type of Threshold ARCH model and take into account asymmetric effects of positive and negative shocks on volatility, capturing a leverage effect where market participants react differently to "good news" and "bad news". Lastly, OLS estimates (Table A5) are also provided. All of the different specifications are estimated with HAC robust standard errors and the results can be found in Appendix A.

The baseline static results appear strongly robust as the sign, magnitude and significance of the forward guidance coefficient are stable among various specifications, and with no controls. Furthermore, the pattern of an increasing magnitude of the coefficient until the euro OIS rate with a maturity of two years, decreasing afterwards, is also repeated across all robustness checks.

V.B.2 Delphic or Odyssean Forward Guidance

Given that forward guidance may be seen as a forecast regarding the future economic outlook (Delphic), ECB's and private agent's information sets are included in the baseline setting (Table 2), retrieved from ECB's macroeconomic projections and ECB's Survey of Professional Forecasters (SPF), respectively.[14] If ECB forward guidance is Delphic, then including information sets should capture part of the effect previously captured by forward guidance, thus reducing the magnitude of the coefficient.

As seen in Hubert and Labondance (2018), the inclusion of information sets does not significantly change the forward guidance coefficient, indicating ECB forward guidance is mainly Odyssean.

14. ECB's macroeconomic projections are produced quarterly, published in March, June, September, and December, and provides forecasts for changes in real GDP and inflation. ECB's SPF is also produced quarterly, published in February, May, August, and November, and collects expectations regarding real GDP, inflation and unemployment. Data on both is made available by the ECB.

Table 2: ARCH(1) Estimates controlling for Information Sets

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
					Mean Equation				
FG	-0.894***	-1.631***	-2.773***	-3.566***	-4.153***	-5.446***	-5.264***	-4.908***	-4.047***
	[0.169]	[0.125]	[0.113]	[0.076]	[0.066]	[0.107]	[0.194]	[0.166]	[0.211]
OilPrice	0.022	-0.026	-0.023	-0.010	-0.028	-0.016	-0.028	0.013	0.075
	[0.061]	[0.044]	[0.044]	[0.033]	[0.025]	[0.039]	[0.069]	[0.078]	[0.080]
EUROSTOXX50	0.001	0.001	0.000	-0.000	-0.001	-0.002	-0.001	0.000	0.003
	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.003]	[0.003]
CISS	-1.756***	-1.367***	-0.768**	-0.742***	-0.139	0.341	0.298	1.672***	2.532***
	[0.506]	[0.367]	[0.322]	[0.275]	[0.224]	[0.310]	[0.612]	[0.516]	[0.757]
ESI	0.002	0.004	-0.002	-0.004	0.005	-0.010**	-0.006	0.011	0.017
	[0.007]	[0.007]	[0.006]	[0.005]	[0.005]	[0.005]	[0.010]	[0.010]	[0.012]
SPFInflation	-1.273**	-1.048	-1.536**	-0.651	0.366	0.157	0.700	1.554*	1.046
	[0.616]	[0.680]	[0.627]	[0.468]	[0.436]	[0.509]	[1.042]	[0.916]	[1.225]
SPFrealGDP	0.462*	0.344	0.242	0.079	0.110	-0.058	0.137	-0.282	-0.223
	[0.238]	[0.222]	[0.220]	[0.157]	[0.150]	[0.183]	[0.584]	[0.372]	[0.438]
SPFUnemployment	0.132*	0.133**	0.124**	0.110**	0.047	-0.115**	-0.195**	-0.143	-0.126
	[0.071]	[0.062]	[0.052]	[0.045]	[0.041]	[0.052]	[0.096]	[0.093]	[0.121]
ECBInflation	0.237***	0.270***	0.226***	0.118***	0.018	-0.118***	-0.212**	-0.262***	-0.213**
	[0.079]	[0.062]	[0.055]	[0.039]	[0.032]	[0.045]	[0.086]	[0.083]	[0.105]
ECBrealGDP	0.034	0.009	0.025*	-0.002	-0.012	-0.022	-0.022	-0.028	0.043
	[0.025]	[0.025]	[0.014]	[0.014]	[0.018]	[0.018]	[0.029]	[0.022]	[0.033]
Constant	0.236	-0.355	1.420	0.535	-1.747*	1.831*	0.969	-2.193	-2.208
	[1.450]	[1.327]	[1.163]	[0.993]	[1.044]	[1.032]	[2.296]	[2.005]	[2.582]
					Variance Equation				
ARCH(1)	0.654***	0.655***	0.395*	0.219**	0.130*	0.499***	0.357	0.398**	0.182*
	[0.248]	[0.181]	[0.201]	[0.108]	[0.073]	[0.121]	[0.234]	[0.156]	[0.102]
Constant	1.937***	1.351***	1.373***	1.287***	1.153***	1.299***	3.244***	3.672***	8.605***
	[0.390]	[0.205]	[0.337]	[0.193]	[0.133]	[0.215]	[0.838]	[0.631]	[1.314]
N	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

V.B.3 Impact of Forward Guidance on Monetary Policy Announcement Days

As stated previously, the identification of the forward guidance factor in the baseline setting considers a matrix with dates of various types of ECB communications, not only monetary policy statement dates. To test the sensitivity of this choice, an OLS regression, with controls, is estimated with a forward guidance factor identified through the Swanson Decomposition using a matrix X with rows corresponding only to monetary decision dates signalled by the EA-MPD dataset by Altavilla et al. (2019). The ARCH baseline specification is not applied due to the sharp sample size reduction. However, robustness checks indicate there is no particular gain in modelling volatility. The results are found below in Table 3.

Results show a stronger impact of forward guidance, although sign, significance and the increasing pattern peaking at the two-year maturity are still verified. It is not surprising that this measure of forward guidance produces bigger estimates, given it is solely focused on monetary decision dates, which are, naturally, high-impact moments. This does not discredit the previous results. It simply implies that, when only considering monetary statement days, the focus is on key decisions with large impacts, whereas when focusing on a broader range of communications the data will include a mixture of high-impact and low-impact moments, which attenuates the impact of forward guidance, on average.

Table 3: OLS Estimates focusing only on MP Statement Days

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
FG	-2.187***	-3.379***	-5.364***	-6.487***	-7.225***	-8.394***	-7.944***	-7.066***	-4.974***
	[0.710]	[0.565]	[0.385]	[0.218]	[0.192]	[0.269]	[0.454]	[0.476]	[0.574]
OilPrice	-0.161	-0.126	-0.083	-0.027	0.063	0.056	-0.134	0.061	0.241
	[0.269]	[0.209]	[0.145]	[0.095]	[0.100]	[0.098]	[0.215]	[0.186]	[0.262]
EUROSTOXX50	0.013	0.010	0.003	0.002	-0.001	-0.005	0.001	-0.008	-0.000
	[0.012]	[0.010]	[0.006]	[0.003]	[0.003]	[0.005]	[0.005]	[0.007]	[0.008]
CISS	-0.408	-2.109	-1.889	-1.793**	0.887	1.348	-0.130	1.674	3.051
	[2.731]	[2.060]	[1.202]	[0.789]	[0.679]	[0.877]	[1.241]	[1.681]	[2.214]
ESI	0.036	0.000	-0.005	-0.010	0.015	-0.002	-0.003	0.005	0.002
	[0.030]	[0.025]	[0.019]	[0.017]	[0.016]	[0.014]	[0.024]	[0.027]	[0.040]
Constant	-3.262	0.527	1.163	1.558	-1.516	0.060	0.331	-0.653	-0.235
	[3.250]	[2.687]	[1.995]	[1.748]	[1.659]	[1.487]	[2.407]	[2.878]	[4.140]
N	180	180	180	180	180	180	180	180	180
$\mathbf{R^2}$	0.223	0.480	0.794	0.905	0.935	0.932	0.832	0.779	0.491

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

V.B.4 Impact of Forward Guidance on Non-Monetary Policy Announcement Days

Similarly to the previous exercise, Table 4, below, presents the results of an OLS estimation, with controls, where the forward guidance factor is identified using a matrix X with rows corresponding only to non-monetary decision dates. Thus, excluding all dates signalled in the EA-MPD dataset by Altavilla et al. (2019). Since this exercise only considers non-monetary policy communications, the Swanson Decomposition cannot be applied, as it no longer makes sense to identify three factors, given that there is no expected or unexpected policy rate shift. Therefore, this identification is conducted through the extraction of a single factor. Given the absence of formal policy actions in these communications, a single factor alone can capture the market reaction and subsequent change in expectations. This single factor will capture this update of expectations as a reinforcement of the path factor, as denominated by Gürkaynak, Sack, and Swanson (2005a).

Results maintain the sign and significance, but the magnitude of the coefficient is smaller versus the estimates with all types of announcements (Table 1) and only monetary policy statements (Table 3). This reduction is smaller for maturities of one and three months and of five and ten years, and the peak of the impact is at the three-year horizon, rather than two years. Nonetheless, forward guidance is still more impactful at longer horizons.

The smaller impact reduction on the short end and long end of the yield curve may provide a key insight into the information agents retrieve from non-monetary policy statements by the ECB. These communications can be interpreted by agents as a reinforcement of the broader policy stance of the ECB, leading to increased security in both shorter-term yields, which are more directly controlled by monetary policy, and in longer-term yields, where a higher degree of uncertainty lies. The forward guidance factor in these announcements could be seen as an added commitment to the forward guidance employed on monetary statement dates. Thus, the smaller impact in the medium run can be due to expectations for this horizon being more driven by policy commitments, or clear policy announcements, rather than reinforcements of a previous stance.

Table 4: OLS Estimates focusing only on Non-MP Statement Days

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
FG	-0.748***	-1.333***	-2.094***	-2.811***	-3.299***	-4.499***	-4.575***	-4.458***	-3.911***
	[0.111]	[0.099]	[0.086]	[0.064]	[0.059]	[0.112]	[0.129]	[0.144]	[0.177]
OilPrice	0.047	-0.016	-0.019	-0.020	-0.052**	0.007	0.021	0.063	0.050
	[0.050]	[0.044]	[0.041]	[0.031]	[0.023]	[0.053]	[0.067]	[0.064]	[0.083]
EUROSTOXX50	0.001	0.001	0.001	-0.001	-0.001	-0.001	-0.002	0.001	0.002
	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.003]	[0.003]	[0.004]
CISS	-1.412***	-0.385	-0.189	-0.314	-0.074	0.138	0.294	1.090*	1.807**
	[0.382]	[0.360]	[0.322]	[0.268]	[0.241]	[0.420]	[0.507]	[0.561]	[0.713]
ESI	0.010*	0.013**	0.008*	-0.003	-0.001	-0.020***	-0.014*	-0.006	0.006
	[0.006]	[0.005]	[0.005]	[0.004]	[0.005]	[0.006]	[0.008]	[0.008]	[0.010]
Constant	-0.727	-1.236**	-0.725	0.365	0.093	1.887***	1.307	0.316	-0.869
	[0.601]	[0.575]	[0.485]	[0.471]	[0.477]	[0.666]	[0.810]	[0.845]	[1.078]
N	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159
$\mathbf{R^2}$	0.174	0.349	0.634	0.768	0.829	0.809	0.727	0.701	0.514

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

V.C. *Persistence of Forward Guidance in the Euro Area Yield Curve*

Static estimations allow us to investigate the immediate impact of forward guidance. However, to better understand the full impact, attention must also be given to the persistence of the shock. For this purpose, dynamic estimates are employed, using the local projections method proposed by Jordà (2005). For an impulse horizon h and a shock of a certain variable at time t, h regressions are estimated from which it is possible to retrieve the impulse response function of the dependent variable, from t to $t+h$, to the aforementioned shock. The advantages of this approach reside in its simplicity, flexibility and robustness to model misspecifications.[15] This method is applied to an OLS model, due to its simplicity and given the robustness checks indicate there is no key gain from explicitly modelling volatility. HAC robust standard errors are still employed. Formally, the dynamic specification can be represented as:

$$\Delta r^{E}_{t+h,m} = \beta_{0,h} + \beta_{1,h} FG_t + \beta_{2,h} C_t + \varepsilon_{t+h} \ , \ \varepsilon_{t+h} \sim (0, \sigma^2) \tag{6}$$

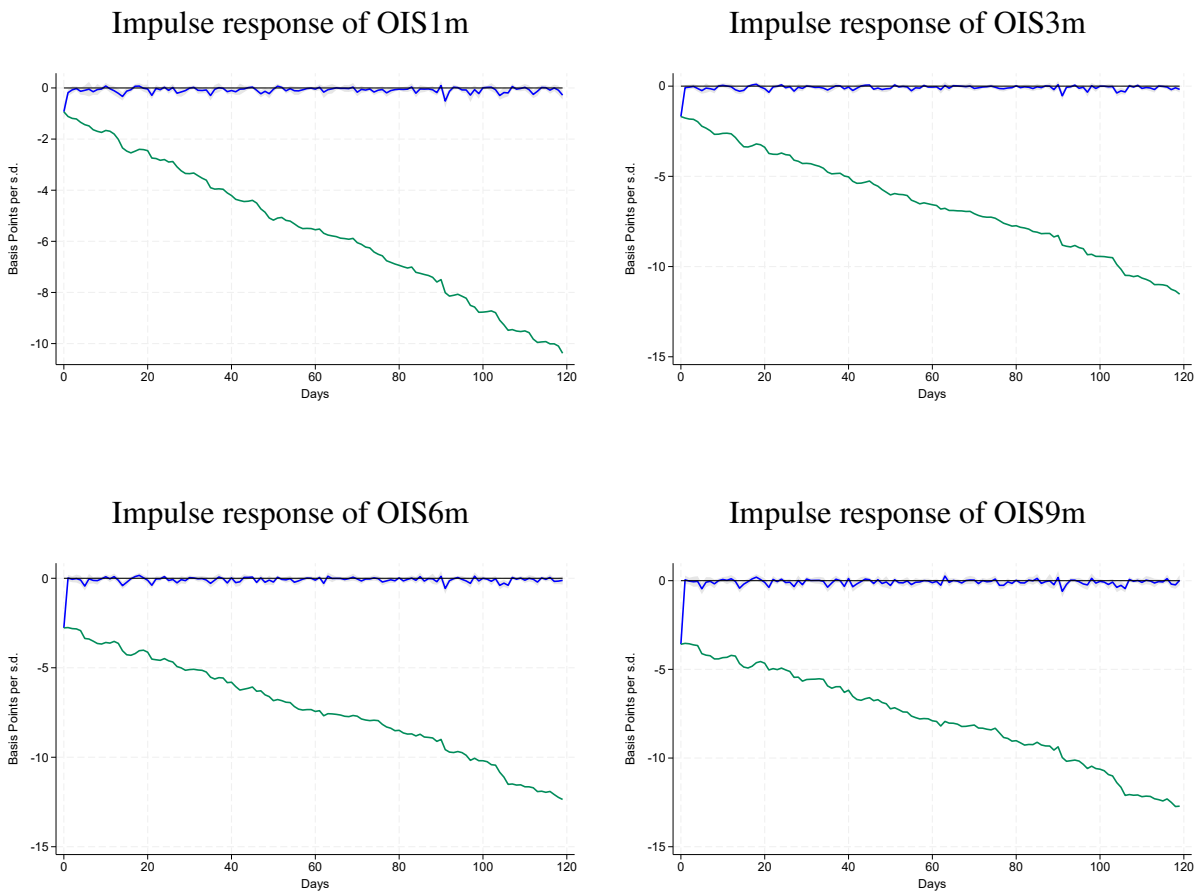
The only difference versus the Jordà approach is that no lagged variables are included, implying a focus on the immediate effect of the unexpected component of forward guidance without cofounding with prior information, as also followed by Hubert and Labondance (2018) and Swanson (2021), among others.[16] Like in the baseline specification, forward guidance is identified using a broad range of ECB announcement dates, not only formal monetary statements. Setting h equal to 120 days, 120 regressions are estimated and the coefficients $\beta_{1,h}$ are collected to plot the impulse response function of euro OIS rates to a forward guidance shock. Results can be found in Figure 1.

Across all maturities, the pattern suggests that the forward guidance shock is persistent, as the negative shock on days of ECB announcements is not offset in the following 120 days, since no following shock can rival the initial negative impact. Furthermore, the cumulative local projections indicate that the impact of the shock tends to increase over the 120-day horizon, especially in shorter maturities. These results imply that market participants immediately react

15. No need for restrictions as in a VAR framework.
16. Campbell et al. (2012) and Nakamura and Steinsson (2018) also prioritize the immediate effect and exclude lagged variables for a more parsimonious model, although they use a VAR framework instead of local projections.

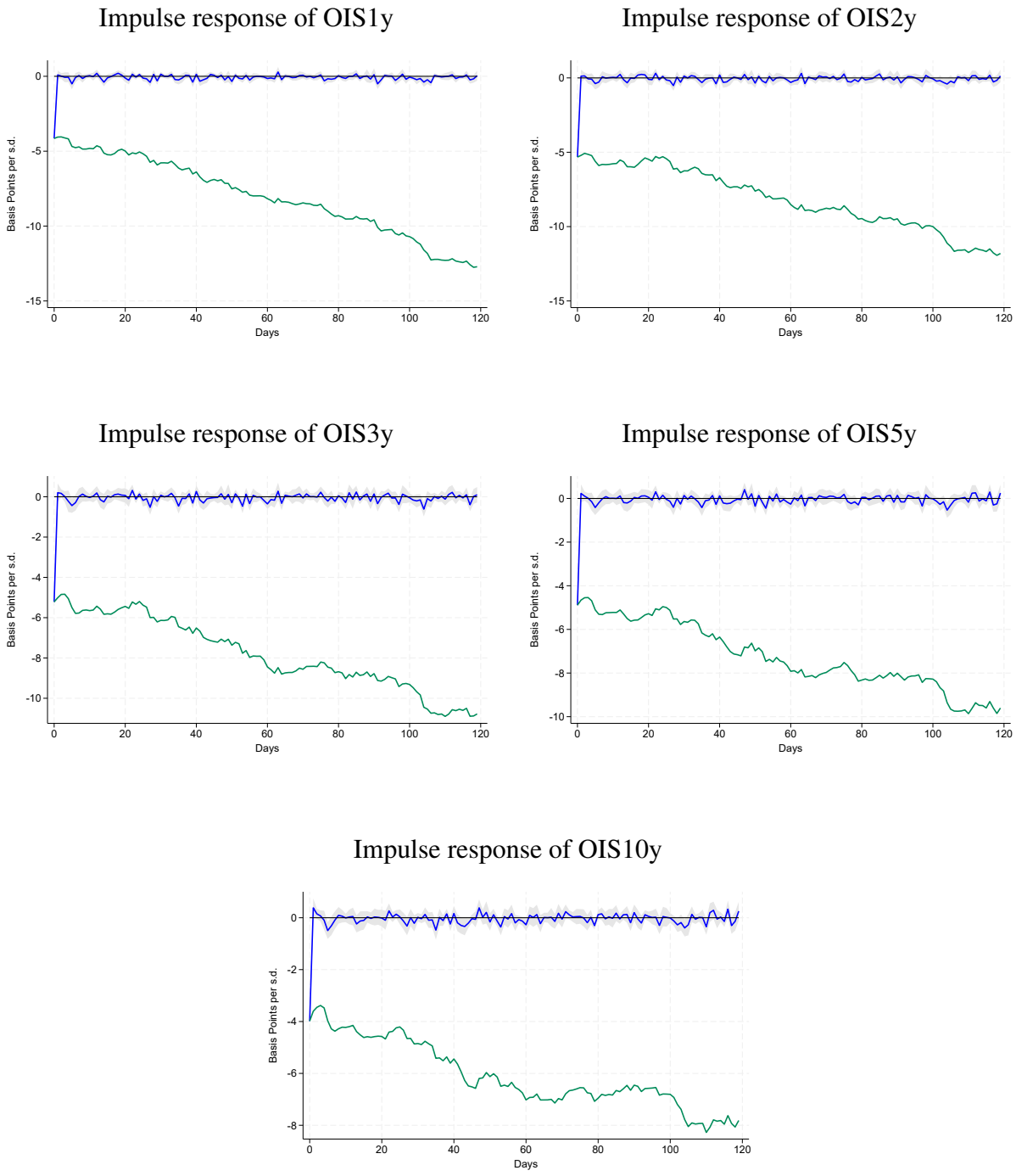
to ECB forward guidance, adjusting their interest rate expectations, and this adjustment is not only persistent but tends to be reinforced, as concluded by Hubert and Labondance (2018).

Figure 1: Impulse response of euro OIS rates to a Forward Guidance shock



Notes: Standard local projections (blue) and cumulative local projections (green) displayed. 90 percent confidence bands presented for standard local projections. Cumulative local projections are provided without confidence bands since they come from different estimations and their standard errors from different variance-covariance matrices.

Figure 1: Impulse response of euro OIS rates to a Forward Guidance shock (continuation)



Notes: Standard local projections (blue) and cumulative local projections (green) displayed. 90 percent confidence bands presented for standard local projections. Cumulative local projections are provided without confidence bands since they come from different estimations and their standard errors from different variance-covariance matrices.

VI. Conclusion

This paper contributes to the analysis of the impact of ECB forward guidance on the term structure of interest rates of the euro area. First, I apply, to data from the ECB, what I have denominated as the Swanson Decomposition (arising from Swanson (2021)), allowing for precise identification of forward guidance. Afterwards, a high-frequency event-study methodology is applied, with an ARCH model and local projections. The term structure is defined as euro OIS rates at various maturities to reflect the expected future average policy rate.

Estimates indicate that a positive forward guidance shock has a significant and negative impact across all maturities, with an increasing effect peaking at the two-year maturity. Thus, forward guidance lowers the yield curve with a more pronounced effect in the medium-long run. An argument arises that this lowering of the term structure comes from a fall in the policy rate signalled by the ECB and a drop in risk premium, attaching relevance to the risk channel. Results are shown to be persistent, with the impact increasing over time. These results deepen our knowledge of the effects of ECB unconventional monetary policy and suggest that forward guidance is a viable policy tool, constituting a substitute for conventional monetary policy with the added benefit of being effective in a ZLB environment. The effectiveness of unconventional policies indicates a lower cost of hitting the ZLB, allowing for lower inflation targets.

These results are found to be robust among various specifications and with the inclusion of ECB and private agents' information sets. This implies that market participants interpret ECB forward guidance mainly as a stance on future monetary policy actions (Odyssean), rather than a signal of ECB's macroeconomic forecast (Delphic).

Lastly, the relevance of all ECB communications is highlighted, as agents continuously react and adjust expectations given their interpretation of any relevant information stated by the ECB. Using a broader sample of communications leads to more conservative estimates of the impact of forward guidance, as it includes high-impact and low-impact moments, whereas monetary policy statements are typically high-impact, but the significance of results is maintained. Furthermore, these lower-impact moments are significant and impact the term structure through a reinforcement of the forward guidance employed on formal monetary policy announcements.

References

Altavilla, Carlo, Luca Brugnolini, Refet S. Gürkaynak, Roberto Motto, and Giuseppe Ragusa. 2019. "Measuring Euro Area Monetary Policy." *Journal of Monetary Economics* 108 (1): 162–179.

Andrade, Phillipe, and Filippo Ferroni. 2021. "Delphic and Odyssean Monetary Policy Shocks: Evidence from the Euro Area." *Journal of Monetary Economics* 117:816–832.

Ben Zeev, Nadav, Christopher Gunn, and Hashmat Khan. 2020. "Monetary News Shocks." *Journal of Money, Credit and Banking* 52 (7): 1793–1820.

Blinder, Alan S., Michael Ehrmann, Marcel Fratzscher, Jakob De Haan, and David-Jan Jansen. 2008. "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence." *Journal of Economic Literature* 46 (4): 910–945.

Bundick, Brent, and A. Lee Smith. 2020. "The Dynamic Effects of Forward Guidance Shocks." *The Review of Economics and Statistics* 102 (5): 946–965.

Campbell, Jeffrey R., Jonas D. M. Fisher, Alejandro Justiano, and Charles L. Evans. 2012. "Macroeconomic Effects of FOMC Forward Guidance." *Brookings Papers on Economic Activity* 164:1–80.

Campbell, Jeffrey R., Jonas D. M. Fisher, Alejandro Justiniano, and Leonardo Melosi. 2016. "Forward Guidance and Macroeconomic Outcomes Since the Financial Crisis." In *NBER Macroeconomics Annual 2016, Volume 31,* by Martin Eichenbaum and Jonathan A. Parker, 283–357. University of Chicago Press, October.

Cochrane, John H., and Monika Piazzesi. 2002. "The Fed and Interest Rates - A High-Frequency Identification." *American Economic Review* 92 (2): 90–95.

D'Amico, Stefania, and Thomas B. King. 2023. "What Does Anticipated Monetary Policy Do?." *Journal of Monetary Economics* 138:123–139.

Ehrmann, Michael, and Marcel Fratzscher. 2007. "Communication by Central Bank Committee Members: Different Strategies, Same Effectiveness?." *Journal of Money, Credit and Banking* 39 (2-3): 509–541.

Engle, Robert F. 1982. "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation." *Econometrica* 50 (4): 987–1007.

Favero, Carlo A., Fabio-Cesare Bagliano, and Francesco Franco. 1999. "Measuring Monetary Policy in Open Economies." *CEPR Discussion Papers,* no. 2079.

Goodhead, Robert. 2024. "The Economic Impact of Yield Curve Compression: Evidence from Euro Area Forward Guidance and Unconventional Monetary Policy." *European Economic Review* 164.

Gürkaynak, Refet S. 2005. "Using Federal Funds Futures Contracts for Monetary Policy Analysis." *FEDS Working Paper No. 2005-29.*

Gürkaynak, Refet S., Brian Sack, and Eric Swanson. 2005a. "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements." *International Journal of Central Banking* 1 (1): 55–95.

———. 2005b. "The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models." *American Economic Review* 95 (1): 425–436.

Hubert, Paul, and Fabien Labondance. 2018. "The Effect of ECB Forward Guidance on the Term Structure of Interest Rates." *International Journal of Central Banking* 14 (5): 193–223.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95 (1): 161–182.

Koeda, Junko, and Bin Wei. 2023. "Forward Guidance and Its Effectiveness: A Macro-Finance Shadow-Rate Framework." *Working Paper 2023-16, Federal Reserve Bank of Atlanta.*

Kuttner, Kenneth N. 2001. "Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market." *Journal of Monetary Economics* 47 (3): 523–544.

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

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

Swanson, Eric T. 2021. "Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets." *Journal of Monetary Economics* 118 (4): 32–53.

Appendix

Appendix A: Tables

Table A1: Engle's LM test for ARCH(1) effects

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
t-statistic	2.174	6.953	1.082	12.773	4.214	18.952	0.593	1.347	11.008
p-value	0.140	0.008	0.298	<0.001	0.040	<0.001	0.441	0.246	0.001

Notes: H_0: No ARCH effects in the residuals vs H_1: ARCH effects in the residuals. Statistical significance at the 1%, 5%, and 10% levels indicates the presence of ARCH effects.

Table A2: ARCH(1) Estimates with No Controls

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
					Mean Equation				
FG	-0.753***	-1.701***	-2.819***	-3.578***	-4.132***	-5.411***	-5.211***	-4.883***	-4.072***
	[0.151]	[0.158]	[0.153]	[0.084]	[0.067]	[0.130]	[0.203]	[0.177]	[0.225]
Constant	0.106**	-0.035	0.035	0.024	-0.001	-0.033	0.013	0.009	0.108
	[0.049]	[0.046]	[0.039]	[0.034]	[0.031]	[0.038]	[0.066]	[0.074]	[0.091]
					Variance Equation				
ARCH(1)	0.827***	0.521***	0.331	0.230**	0.131**	0.506***	0.315*	0.349**	0.203*
	[0.257]	[0.190]	[0.242]	[0.115]	[0.063]	[0.117]	[0.183]	[0.147]	[0.122]
Constant	1.502***	1.779***	1.544***	1.291***	1.166***	1.313***	3.483***	4.020***	8.569***
	[0.310]	[0.354]	[0.377]	[0.197]	[0.121]	[0.209]	[0.770]	[0.696]	[1.495]
N	1,345	1,345	1,345	1,345	1,345	1,345	1,345	1,345	1,345

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A3: ARCH(2) Estimates

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
					Mean Equation				
FG	-0.966***	-1.673***	-2.752***	-3.580***	-4.152***	-5.349***	-5.203***	-4.846***	-3.997***
	[0.152]	[0.143]	[0.122]	[0.079]	[0.065]	[0.094]	[0.213]	[0.195]	[0.216]
OilPrice	-0.021	-0.048	-0.059	-0.023	-0.032	0.025	0.018	0.106*	0.106
	[0.052]	[0.040]	[0.037]	[0.027]	[0.024]	[0.033]	[0.077]	[0.059]	[0.073]
EUROSTOXX50	0.001	0.001	-0.000	-0.001	-0.001	-0.001	-0.001	0.002	0.005
	[0.003]	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.003]	[0.003]	[0.003]
CISS	-0.412	-0.540	-0.398	-0.510**	-0.062	0.113	0.056	0.956*	1.703**
	[0.940]	[0.417]	[0.309]	[0.245]	[0.216]	[0.298]	[0.549]	[0.536]	[0.668]
ESI	0.007	0.010*	0.005	-0.004	0.002	-0.015***	-0.008	0.001	0.010
	[0.007]	[0.006]	[0.005]	[0.004]	[0.004]	[0.005]	[0.007]	[0.008]	[0.010]
Constant	-0.519	-0.926	-0.384	0.543	-0.179	1.416***	0.698	-0.315	-1.197
	[0.705]	[0.605]	[0.493]	[0.468]	[0.448]	[0.518]	[0.779]	[0.825]	[1.095]
					Variance Equation				
ARCH(2)	0.637**	0.341	0.359**	0.251**	0.016	0.508***	0.151	0.279	0.161
	[0.288]	[0.224]	[0.167]	[0.121]	[0.049]	[0.129]	[0.205]	[0.252]	[0.105]
Constant	1.647**	2.084***	1.294***	1.214***	1.312***	1.182***	4.136***	4.258***	8.707***
	[0.819]	[0.540]	[0.323]	[0.188]	[0.112]	[0.270]	[1.122]	[1.190]	[1.266]
N	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A4: GJR Estimates

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
					Mean Equation				
FG	-0.905***	-1.693***	-2.794***	-3.577***	-4.149***	-5.451***	-5.391***	-4.876***	-4.018***
	[0.175]	[0.139]	[0.169]	[0.079]	[0.065]	[0.146]	[0.168]	[0.171]	[0.212]
OilPrice	0.019	-0.018	-0.024	-0.010	-0.028	-0.021	-0.041	0.009	0.069
	[0.064]	[0.047]	[0.086]	[0.033]	[0.026]	[0.045]	[0.067]	[0.075]	[0.079]
EUROSTOXX50	0.002	0.001	0.000	-0.000	-0.001	-0.002	-0.002	0.000	0.003
	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.007]	[0.002]	[0.003]	[0.003]
CISS	-1.112**	-0.645*	-0.422	-0.537**	-0.060	0.174	0.401	1.099**	1.983***
	[0.540]	[0.357]	[0.345]	[0.263]	[0.208]	[0.995]	[0.426]	[0.527]	[0.714]
ESI	0.011*	0.016***	0.009	-0.001	0.003	-0.013***	-0.006	-0.001	0.011
	[0.007]	[0.006]	[0.006]	[0.004]	[0.004]	[0.001]	[0.007]	[0.008]	[0.010]
Constant	-0.825	-1.504**	-0.743	0.198	-0.292	1.216	0.489	-0.144	-1.314
	[0.649]	[0.631]	[0.634]	[0.477]	[0.449]	[0.000]	[0.751]	[0.893]	[1.100]
					Variance Equation				
ARCH	0.443*	0.327**	0.186	0.168**	0.118	0.548	1.230	0.482	0.164*
	[0.261]	[0.140]	[0.383]	[0.085]	[0.079]	[0.560]	[0.953]	[0.449]	[0.093]
TARCH	0.192	0.309	0.184	0.074	0.020	-0.021	-0.843	-0.164	0.035
	[0.352]	[0.251]	[0.609]	[0.104]	[0.065]	[0.000]	[0.864]	[0.450]	[0.102]
GARCH	0.506**	0.261	0.190	-0.177	-0.376*	-0.226	0.393	-0.025	-0.395
	[0.237]	[0.360]	[1.775]	[0.156]	[0.202]	[0.662]	[0.402]	[0.059]	[0.351]
Constant	-0.144	0.678	1.079	1.580***	1.640***	1.811	0.849	4.203***	12.777**
	[0.493]	[1.118]	[3.776]	[0.436]	[0.372]	[2.791]	[1.508]	[0.910]	[5.269]
N	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: OLS Estimates

	OIS1m	**OIS3m**	**OIS6m**	**OIS9m**	**OIS1y**	**OIS2y**	**OIS3y**	**OIS5y**	**OIS10y**
FG	-0.931***	-1.685***	-2.770***	-3.583***	-4.151***	-5.322***	-5.216***	-4.889***	-3.983***
	[0.176]	[0.147]	[0.114]	[0.074]	[0.065]	[0.099]	[0.166]	[0.168]	[0.204]
OilPrice	0.028	-0.019	-0.016	-0.011	-0.032	0.012	-0.002	0.062	0.071
	[0.059]	[0.050]	[0.044]	[0.033]	[0.024]	[0.041]	[0.062]	[0.059]	[0.080]
EUROSTOXX50	0.004	0.003	0.001	-0.000	-0.002	-0.002	-0.001	0.000	0.003
	[0.003]	[0.003]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.003]	[0.004]
CISS	-1.341***	-0.685	-0.478	-0.607**	-0.066	0.192	0.134	1.114**	1.894***
	[0.506]	[0.433]	[0.337]	[0.263]	[0.216]	[0.345]	[0.427]	[0.529]	[0.688]
ESI	0.015**	0.013**	0.007	-0.003	0.002	-0.015***	-0.008	-0.000	0.009
	[0.006]	[0.006]	[0.005]	[0.004]	[0.004]	[0.005]	[0.007]	[0.008]	[0.011]
Constant	-1.163*	-1.147*	-0.534	0.406	-0.177	1.430***	0.753	-0.191	-1.185
	[0.632]	[0.600]	[0.501]	[0.466]	[0.448]	[0.545]	[0.750]	[0.818]	[1.106]
N	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339	1,339
$\mathbf{R^2}$	0.162	0.369	0.687	0.826	0.886	0.874	0.771	0.711	0.484

Notes: The forward guidance coefficient is in units of basis points per standard deviation change. Heteroskedasticity-robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B: Further Details of the Swanson Decomposition

As discussed previously, the identification of forward guidance followed a method proposed by Swanson (2021). In Section IV, the key steps of the method are explained and this part of the Appendix aims to extend this description with further mathematical and computational details.

First, the matrix X is standardized to have zero mean and unit variance, before extracting the three principal components. After extracting the factors, attention centres on the rotational matrix U, as it is key for the correct identification of factors according to the desired interpretation, such that the first column of F (the first factor) represents policy rate changes, the second column (the second factor) represents forward guidance, and the third column (the third factor) represents LSAPs.

As discussed, three restrictions are needed to identify the orthogonal rotational matrix U. The first two restrictions imply that forward guidance and LSAPs have no impact on the current policy rate, which can be represented as:

$$U'\Lambda_1 = \begin{bmatrix} . \\ 0 \\ 0 \end{bmatrix} \tag{7}$$

where Λ_1 represents the first column of Λ.

The third restriction is that the LSAP factor is as small as possible in the pre-ZLB period (defined as the period before 2014), which implies minimizing the sum of squared values of this factor over this period. Mathematically, it implies minimizing:

$$U_3'(F^{pre})'F^{pre}U_3 \tag{8}$$

where U_3 denotes the third column of U and F^{pre} represents the matrix of values of F in the pre-ZLB period.

Computationally, the first two zero restrictions are implemented first and then the optimization problem relative to the third restriction is solved. It is assured that U remains orthogonal and has unit length across this exercise.

Finally, F is sign normalized such that the first column has a positive effect on the one-month

maturity euro OIS rate, the second column has a negative effect on the one-year maturity euro OIS rate, and the third column has a negative effect on the ten-year maturity euro OIS rate. Therefore, a positive shock in forward guidance and LSAPs can be read as a looser monetary stance.