Monetary transmission to financial markets in the Euro Area

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October 31, 2023

Abstract

This paper examines the impact of monetary policy and risk premium shocks on financial markets in the Euro Area using an event study approach. We extract four factors from high frequency surprises in financial market data that are orthogonal to information shocks. Restrictions on the factor model provides a structural interpretation to these factors - conventional policy, forward guidance (FG), quantitative easing (QE) and country risk factor, the latter being specific to Euro Area sovereign bond markets. Findings suggest that all factors impact risk-free and sovereign bond yields. The quantitative easing factor has the largest impact on exchange rates. The risk factor makes a significant impact on Italian and Spanish bonds, and the largest impact on the stock index among all factors. The effect of each factor differs in its persistence based on the maturity of bonds. The FG and QE factor had greater impact for longer in other asset classes of the financial market.

*This paper is part of a collaborative project on Euro Area monetary policy with Giovanni Ricco and Emanuele Savini. I thank them for our discussions on the paper.

1 Introduction

Financial markets are the gateway through which monetary policy transmits to the real economy. It is the first step in a chain of events that ultimately impacts various decisions of firms and households. From the perspective of a central bank, it is important to assess the speed of pass-through of monetary policy decisions to financial markets. This is likely to have an effect on the lags with which monetary policy will achieve its objectives.

In this paper, we examine the extent of pass-through of monetary policy shocks to financial markets in Europe. The European Central Bank(ECB)'s Governing Council (GC) announces policy decisions in a press release that is followed by a press conference by the President to explain its policy decisions. Movements in financial markets after these policy announcements reflects a mix of unexpected policy changes and revision in expectations about the expected path of the policy rate in the economy, the perceived central bank policy rule, and information about economic fundamentals. We assess three major asset classes - bonds, stocks and exchange rates. Since financial markets incorporate new information almost immediately, announcement of monetary policy decisions are likely to lead to a swift response by financial market participants. This makes it possible to examine the extent of transmission using an event study approach. In addition, we also examine the persistence of monetary policy shocks on financial markets using the Local Projections (LP) methodology.

Monetary policy shocks are obtained from a factor model of surprises in Overnight Index Swap (OIS) yields, bond premium, exchange rates and stocks captured within an event window. The maturities of OIS yields used range from short-term 1 month to long-term 10 years. Since we are interested in capturing the total transmission of a policy decision, we sum up the surprises in the press release window and the press conference window. We obtain four factors from the model and impose restrictions to provide a structural interpretation to them. The first is a conventional policy factor that loads heavily on the short-medium maturity (1 month-1 year), the second is the forward guidance (FG) factor that loads heavily on medium term maturities (1-5 years), the third is the quantitative easing (QE) factor that loads heavily on long-term maturities (5-10 years) and the fourth is the sovereign or country risk factor that loads heavily on sovereign bond premium. The first three factors cover multiple policy tools utilized by the ECB over the past 2 decades - the conventional policy of setting the benchmark policy rates, providing forward guidance on the future course of policy decisions and purchasing long-term assets under various programmes. The risk factor captures the impaired transmission of monetary policy to sovereign yields during the sovereign debt crisis.

Our results point towards a strong impact of all policy factors on various segments of financial markets. First, all monetary policy factors impact OIS yields but differ in magnitude according to maturity. The conventional policy factor increases short-term OIS yield surprises, FG factor increases medium-term OIS yield surprises and QE factor increases long-term OIS yield surprises with a peak impact at OIS 1 year rate, OIS 2 year rate and OIS 10 year rate respectively. Second, sovereign yields move higher in response to increase in monetary policy factors. But the biggest impact on Italian and Spanish sovereign yields is from the risk factor, with a roughly 5 times larger magnitude relative to French yields. This is consistent with the idea that countries with higher sovereign default are disproportionately impacted by a spike in risk. Third, exchange rates appreciate in response to increase in the factors but the relevance of unconventional policies differ with sub-samples. The risk factor has a negative impact on exchange rates during the post-crisis period. Fourth, stock prices decline in response to increase in conventional and QE policy factor. Surprisingly, the FG factor does not significantly impact stock performance, even during the post-crisis period. Stock prices also decline in response to an increase in the risk factor. In fact, the risk factor had a larger impact on stock markets than any other policy factor. Fifth, QE and FG policy factor have the most persistent effect on various asset classes. The conventional shock and the risk shock have persistent effect only on exchange rates and stock markets respectively.

The construction of factors from market surprises of short to medium maturity yields to capture the impact of monetary policy surprises was pioneered by Gürkaynak et al. (2005). Recent work has extended this to include long term maturity yields, which enabled construction of the QE factor (Altavilla et al., 2019; Swanson, 2020).

We follow the approach taken by these studies. In addition, we add surprises in sovereign bond premium in the factor model where the bond premium is defined as the difference in yields between the Italian and German bond rates at 2 years, 5 years and 10 years maturity. Our construction of the sovereign risk factor complements the approach taken by Motto and Özen (2022) in examining the stabilizing impact of QE in the European sovereign bond markets. This inclusion ensures that the structural factor series' are orthogonal to any changes in sovereign risk premium factor. Country risk was an important factor in the impaired transmission of monetary policy to various member states of the Euro Area during the Euro-zone debt crisis (Leombroni et al., 2021) and orthogonality with the additional factor accounts for this.

The papers closest to this study are Altavilla et al. (2019) and Motto and Özen (2022). Our construction of monetary policy factors differs from these papers in two aspects. First, we combine both windows for constructing monetary policy shocks. We show that the combined surprises have different signs to signs of surprises in press release window. This choice has implication for understanding the effects of monetary policy on any policy announcement date using a factor series. For example, De Groot and Haas (2023) uses the estimates of Altavilla et al. (2019) to calibrate moments in their model for movements in risk-free rates in response to monetary policy shock. De Luigi et al. (2023) use the QE factor as a proxy for QE policy shocks in a LP model. Second, any information effects in the surprises data are sieved out before using the data in a factor model. This controls for any delphic forward guidance that moves the markets. We implement this by combining the narrative approach with high frequency identification. The narrative approach is helpful to identify a few dates where reaction of financial markets suggests either a change in communication style of the ECB or a combination of shocks that are tough to disentangle. This complements recent work by Badinger and Schiman (2023), who identify monetary policy shocks in the Euro Area by combining narrative approach with sign restrictions on the structural residuals.

Section 2 provides descriptive statistics on OIS market surprises and explains the construction of the proxy for each type of monetary policy shock and the country risk shock. Section 3 describes the empirical methodology for evaluating impact responses using event windows and persistence of monetary policy shocks through LP regressions. Section 4 presents the results and a discussion. Section 5 concludes.

2 Construction of monetary policy shock instruments

During 2002-2014, the ECB's GC met every month to decide the policy rate based on discussions about economic and monetary conditions. From 2015, this frequency reduced to 8 times a year with two meetings being held every quarter. While the frequency of meetings changed, communication of policy decisions remained the same. A press release is issued to announce the policy decision along with a brief explanation. This is followed by a press conference chaired by the ECB president where the rationale behind the decision is explained with detailed account of economic and monetary conditions as well as risks to achieving the inflation target. The Euro Area Monetary Policy Database (EA-MPD) introduced by Altavilla et al. (2019) is a collection of financial market surprises around the press release and the press conference of every monetary policy decision. We use the sum of surprises from both the windows in our analysis because it reflects the total change in financial markets due to the policy announcement. To think more about the implication of this choice, suppose that surprises for a particular asset were in the same direction in both windows. In this case, the total change in it's price will have a larger magnitude. If, however, surprises in the asset are in the opposite direction, then using a single window may not be a good indicator for not only the magnitude, but also the sign of the total surprise.

We document these two possibilities mentioned above by using OIS yields surprises for seven different maturities. In the period 2002-2019, there were 191 scheduled monetary policy meetings where both the press release and press conference took place. The first row of table 1 shows the number of events where surprises in press release and press conference window are different in sign. The second (third) row shows the number (percentage) of events where the surprise in the press conference window is greater than the surprise in the press release window. Hence, the sum of the surprises from the two windows will be different in sign from the press release window. Surprisingly, the surprises in the press conference window are greater at least 50% of the time and increase to over 80% at longer maturities.

Table 1: Reversal in sign of surprises in press release and press conference window

	Window	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
Difference	Rel $\neq$ conf [1]	103	103	105	103	98	105	96
in sign	Rel $\leq$ conf	52	66	76	81	80	85	79
		50.5	64.1	72.4	78.6	81.6	81.0	82.3

Notes: This table presents statistics for monetary policy decision events where OIS market surprises in the press release window and the press conference window moved in opposite direction. The first row documents the number of events where OIS surprises differ in sign for the two windows. The second row shows the subset of events (in row one) for which the magnitude of the press release window was less than that of the press conference window, i.e., the sign of the sum of surprise in the two windows is opposite relative to the sign of the press release window. The third row gives this information in percentage terms.

[1] Rel: Press release; Conf: Press conference

A lot of these events happened either on policy announcement days after the financial crisis or during the Euro-zone crisis, probably as a result of markets seeking to understand the direction on the future course of policy. We highlight a few such dates. First, after the January 2009 meeting, a rate cut of 50 bps was announced in the press release. Although this was consistent with expectations as per a Reuters poll, it did reverse the ECB president's claims of a rate pause in the December meeting. This potentially explains the large negative surprise in OIS rates during the press release window. However, OIS rates increased substantially during the press conference window. In the press conference, the president did not make any commitments on the question of quantitative easing. Further, he commented on the need to stay away from a liquidity trap. This may have led to higher rates as the president suggested that he defines it as a very low interest rate but not zero. This limited the scope of further decline in policy rates in upcoming meetings. Second, after the October 2011 meeting, OIS rates increased during the press release window as well as during the press conference window. The ECB kept rates unchanged, though markets were expecting a rate cut. During the press conference, the ECB president announced the Covered Bond Purchase Program (CBPP2) for alleviating stress in some segments of the markets[1]. This may have reversed some of the safe haven flows and led to an increase in OIS rates at the medium-long end of the yield curve. Hence, the total transmission to financial markets was greater than what is captured by individual windows. To conclude, the above examples highlight that the transmission of the policy may look different by summing up surprises of the two individual windows.

Monetary policy shocks in the Euro Area are constructed by applying a factor model on financial markets surprise data The idea of the factor model is to capture the common variation in movement of financial market indicators in a succinct way. The financial market indicators are forward looking series that capture the stance of monetary policy. We include data on OIS yields, sovereign bond premium, exchange rates and stock market data. The addition of sovereign bond premium is an addition to the indicators traditionally used in the literature. The GC commented on this issue in several meetings during the Euro-zone crisis and it will be interesting to see how the factors load on to the sovereign bond spreads.

The following two steps are used. First, we regress surprises in financial market data on forecasts and revisions of real GDP and inflation. Data are taken from the ECB macroprojections and Reuters' polls. In addition, Reuters' polls also conducts a poll on the MRO rate, which we believe will be important to sieve out expected path of the policy rate from surprises in financial data. A dummy variable is used to control for unusually large movements on 3 announcement days. We think that these days were associated with a change in the ECB's style of communication and may have been behind these changes. To delve deeper into understanding what happened during these events, additional information surrounding these dates are reported in table 2. This includes the Marginal Refinancing Operations (MRO) rate prior to the meeting, the expected current and one quarter ahead MRO rate as per Reuters' polls held prior to the meeting, the decision of the ECB, and surprises in OIS rates representing short-long term maturities, STOXX50 index and 2 year sovereign bond

[1] This was not announced in the press release.

Table 2: List of events with change in communication style

Date	MRO rate prior to meeting	E_tMRO_t[1]	E_tMRO_{t+1}	Policy decision	OIS1M	OIS6M	OIS2Y	OIS10Y	Stock	1 year sov bond spread
Nov 7, 2002	3.25	2.75	2.75	-	6.9	1.25	-2.65	-2.2	-1.04	0.05
Oct 8, 2008[2]	4.25	4	3.75	50 ↓	-20.1	-3.2	1.9	5.5	1.83	-3.2
Aug 4, 2011	1.50	1.58	1.75	-	-6.8	-13.4	-16.91	-3.5	-0.74	13.55

Notes: This table contains details of events for which large surprises in OIS rates were recorded. These surprises are examined and interpreted alongside data on the MRO rate prevailing in the Euro Area one day prior to the meeting, expectations of MRO rate, policy decision, and surprises in STOXX50 index and one year sovereign bond spread (difference between one year Italian bond yield and German bond yield). Bond surprises are in basis points.

[1] E_tMRO_{t+i} is the expected MRO rate for quarter $t+i$ at time t.

[2] The ECB met via video-conference on this date and there was no press conference.

spread.

The first date is November 2002. Expectations of a rate cut did not materialize which led to a flattening of the yield curve. However, during the press conference, yields across maturities declined, with a greater drop for maturities at the longer end of the curve. This was probably due to the fact that the ECB president mentioned that "the Governing Council has discussed extensively the arguments for and against a cut in the key ECB interest rates". The focus on a rate cut due to higher downside risk to medium-term economic growth may have exacerbated this decline in long-term yields. In addition, stocks declined probably due to the rate cut not materializing and/or greater uncertainty about economic environment. On October 8, 2008, the ECB convened for an unscheduled video-conference in light of the financial crisis. It reduced rates after the emergency meeting. Short term yields declined by 20bps but long term yields rose. This might be due to reduced credibility of the ECB in the eyes of market participants since only a week ago, the ECB had committed to stay the course on fighting elevated risks to inflation. Another potential reason may be that investors flocked towards safe haven assets such as US treasuries, gold and/or silver. Finally, the third date is August 2011. On this day, market participants expected higher rates but this did not materialize. However, surprises in the stock index was negative and the 2 year sovereign risk was positive. A potential reason for this could be that during the press conference, the ECB president commented on need for reforms in Italy rather than suggesting solutions from the ECB's side. To conclude, all these dates reflect a change in communication style of the ECB that caught the market by surprise.

Since we have 74 data series on forecasts and revisions, we first conduct a selection of regressors from these candidates based on the increasingly popular LASSO estimator. Let this set of selected variables be denoted by X_t^{LASSO}. Then, the estimation using these regressors is done by OLS:

$$y_t = X_t^{LASSO} * \beta + X_t^{IR}$$

where y_t is the financial market surprise at time t, X_t^{IR} is the residual from the regression that is orthogonal to information effects about economic fundamentals. This will ensure that any information shocks do not impact results from the event study regressions or Local Projections. The residuals are used in the factor model:

$$X_{IR} = F\Lambda + \varepsilon$$

where F is the matrix of common latent factors, Λ is the matrix of factor loadings and ε is the idiosyncratic error. The loadings state the contribution of each series in X_{IR} within each factor. However, an important point to note here is that these factors lack a structural interpretation. This is because we can always find an orthonormal matrix M that enables us to write the factor model as: $X_{IR} = F.M.M'.\Lambda + \varepsilon$. The matrix $M'.\Lambda = \tilde{\Lambda}$ provides an alternate loadings matrix that is consistent with the data. A structural interpretation of the factors requires identification of elements of the matrix M so that it satisfies a set of restrictions. The number of restrictions depends on the number of factors that are extracted from the data. The Cragg and Donald test (1997) suggests there are 4 factors that appropriately capture the variation in the data. Hence, 16 restrictions are required to identify the parameters of the orthonormal matrix. The restrictions are:

1. Orthonormality of matrix - this provides 4 restrictions for unit length of the vectors and 6 restrictions for orthogonality between the vectors. This places 10 restrictions.

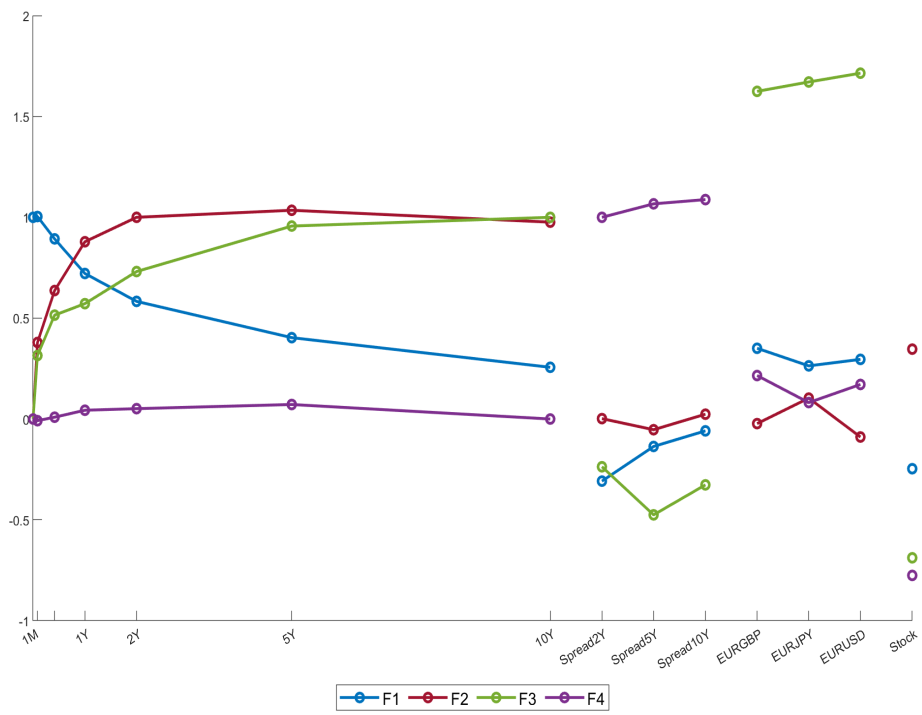
2. Three factors do not load onto 1 month OIS surprises. This provides 3

restrictions.

3. The fourth factor has zero loading on the 10 year rate. This is to ensure that the factor does not represent an expansionary policy effect, as the focus is to ensure a homogeneous change in policy rates rather than outright expansionary policy effect.

4. Minimize variance of two factors prior to the pre-crisis period.

Figure 1: Identified loadings of factor model



Note: This figure shows the factor loadings for the monetary window. For each maturity, loadings are obtained by regressing the OIS surprises onto the estimated factors and surprise in US Initial Jobless Claims. The F1/ conventional factor and the F2/ FG factor are normalized to have a unit effect on the one year OIS rate and two year OIS rate respectively. The F3/ QE factor and the F4/ risk factor are normalized to have a unit effect on 10 year OIS rate and the ten year bond spread.

Figure 1 presents the identified loadings of factors on X_{IR}. Examining loadings of the factor model suggests that the first factor loads heavily on OIS surprises at the short-end of the yield curve, capturing conventional policy surprises. The second factor loads more on medium-term OIS surprises. The third factor captures more of the longer end of the OIS yield curve. Finally, the fourth factor has near zero loadings on the OIS yield curve. Rather, it loads positively on to the sovereign bond spreads. Based on the above loadings, we call the four factors the conventional policy factor, the forward guidance factor, the quantitative easing factor and the sovereign risk factor respectively.

3 Empirical methodology

A notable characteristic of financial markets is that they quickly incorporate any new information that may affect the future price of assets. This feature fits perfectly within an event study design where changes in financial market data are recorded around these unexpected policy changes to examine the response. For example, an exogenous contractionary monetary policy shock should lead to an increase in sovereign bond yields. The time span used for recording the change is called the event window. In economics and finance, the availability of high frequency financial markets data allows construction of intra-day windows. This isolates changes in financial markets only due to the shock of interest and that ensures that no other shock contaminates the results (Cook and Hahn, 1989; Kuttner, 2001; Gürkaynak et al., 2005). This is relevant since financial markets respond to several news throughout the day. Hence, a regression at lower frequency is likely to provide biased coefficients. The estimating equation regresses surprises in financial markets on estimated factors at the GC meeting frequency:

$$\Delta y_i = \alpha + \tilde{F}\beta + \epsilon_t \tag{1}$$

where i indexes the GC meeting, Δy is the change in financial indicator recorded around the meeting, $\tilde{F}$ is the vector of identified factors, β is the vector of coefficients associated with the factors and ϵ_t is the error term. Since most policy announcements coincided with release of Initial Jobless Claims (IJC) data, we control for surprises in the series based on Reuters' polls. We also estimate the response of the model on different sub-samples. For comparability, we follow Altavilla et al. (2019) in splitting the sample into a pre-crisis period (Jan 2002-Dec 2007), post-crisis period (Jan 2008-Dec 2013) and post-QE period (Jan 2014-Dec 2019).

In the next step, we evaluate the persistence in effects uncovered in event study regressions using the LP approach (Jordà, 2005). The following regression is estimated at daily frequency to uncover these dynamic effects:

$$y_{i,t+h} - y_{i,t-1} = \tilde{F}_{i,t}\beta_h + \epsilon_{i,h}, \forall h = 1 : H \tag{2}$$

where h is the horizon, H is the maximum horizon set at 90 and β_h is a vector of horizon specific coefficients that captures the cumulative response of the dependent variable y to a unit change in the j_{th} column of the matrix $\tilde{F}_{i,t}$. Since all dependent variables are integrated of order 1 at daily frequency, I estimate the impact of monetary policy shocks on daily change in the financial market indicator rather than in levels. Hence, the cumulative response measures the overall percentage point change in y up to horizon h. Note that the columns of $\tilde{F}$ are orthogonal to each other by construction, therefore the estimated coefficients are the same as including the j_{th} column of $\tilde{F}_{i,t}$ as a regressor and running regressions with each of them one at a time. The advantage of LP for estimating dynamic effects relative to a VAR model is that it is less prone to misspecification of the VAR. However, the downside is there is higher estimation uncertainty. The error term $\epsilon_{i,h}$ is a moving average of forecast errors from i to $i + h$ which implies that error term is serially correlated. Therefore, we use heteroskedasticity and autocorrelation (HAC) adjusted standard errors.

4 Results

4.1 Results for information effects in OIS yields

Table 3 and 4 presents results from regression of OIS surprises on forecasts and revisions. The LASSO selects forecasts of both ECB and Reuters' polls along with some terms that were interacted with the dummy. The only exception is the ten year bond spread. The adjusted R^2 for some market surprises such as OIS 1M rate and STOXX 50 index is substantial and highlights the presence of signalling effects.

4.2 Event study results

I begin the analysis by examining the response of OIS yields on the factors. Table 5 contains the results. All three monetary policy factors have a significant impact on yields barring where a restriction were placed for providing a structural interpretation[2]. The F-statistic is rejected at 1% level of significance, pointing towards the importance of these factors in explaining movements in OIS yield surprises. As expected, the policies differ on the maturities for which they have the biggest impact - the conventional MP shock, FG shock and QE shock have the largest impact on the 1 year, 2 year and 5 year rate respectively. The response of short-medium term OIS yields is stronger in response to FG policy factor and QE policy factor, probably as a result of the summing up of the two windows. Coming to the risk factor, it has no significant impact on any of the OIS maturities except the OIS 5 year rate. This is consistent with the idea that OIS yields are risk-free in nature. Results for sub-samples are in Tables 9-11 in appendix B. They paint a similar picture for conventional policy. The impact of QE policy factor, barring the 10 year rate, is higher during the post-crisis period relative to the post-QE period.

Table 6 presents results for sovereign yields from France, Italy and Spain for three different maturities - 2 years, 5 years and 10 years. The conventional factor has a significant positive impact on all yields. The French yields are the most responsive across all maturities while magnitude of change in Italian and Spanish yields are in a similar range. The FG factor had the largest impact on sovereign yields amongst all

[2]Note that in the regression of OIS 1M rate on the FG factor and QE factor, coefficients are non-zero because in this regression, we are using raw OIS 1M rate surprises rather than the informationally robust version that were used in the factor model. In the presence of information effects, this has no implication for consistency of estimated coefficients since the factors themselves are derived from informationally robust data and thereby uncorrelated with the error term.

Table 3: Projection of OIS surprises on forecasts and revisions

	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
ΔMRO_q	-1.593	-4.264	-4.926				
	(-4.127)	(-2.949)	(-3.205)				
ΔMRO_{q+1}	(1.343)						
	(-3.452)						
ΔMRO_{q+2}	-1.210						
	(-1.554)						
Oil price	-0.009					-0.017	
	(-0.006)					(-0.015)	
$\Delta\text{GDP}^{ECB}_{q+2}$	-1.410						
	(-3.346)						
$\Delta\text{GDP}^{ECB}_{q+3}$	-2.246						
	(-3.782)						
GDP^{ECB}_t	-0.473						
	(-0.66)						
$d_2{*}\Delta\text{GDP}_q$	-23.308***						
	(-4.645)						
d_2* Risk	-22.329***						7.525***
	(-1.394)						(0.708)
$d_2{*}\Delta\text{HICP}_{q+1}$		20.795***	16.126*			19.312*	
		(7.716)	(9.255)			(11.110)	
d_2*Oil price		-0.087***	-0.034***				
		(-0.009)	(-0.003)				
HICP^{ECB}_q			0.411				
			(0.348)				
$d_2{*}\Delta\text{HICP}_t$			70.384***	165.671***	152.496***	66.591***	56.122***
			(12.752)	(18.160)	(13.838)	(23.532)	(8.308)
HICP^{ECB}_{q+6}					1.013**		0.778***
					(0.427)		(0.261)
ΔGDP_q						6.130	5.494
						(5.696)	(3.432)
HICP_{q+1}						-0.668	-0.535
						(0.597)	(0.427)
ΔHICP_{q+2}						1.657	1.026
						(2.475)	(2.009)
HICP^{ECB}_{q+3}						0.876**	
						(0.409)	
$\Delta\text{HICP}^{ECB}_{q+3}$						2.158	1.558
						(2.102)	(1.802)
GDP_t							-0.356
							(0.255)
ΔHICP_t							4.429
							(3.181)
ΔGDP_{q+1}							-9.379**
							(-3.698)
ΔGDP_{q+2}							-6.993
							(-4.983)
ΔGDP^{ECB}_q							2.052
							(2.82)
Constant	0.695	0.072	-0.142	0.168	-0.637	1.638	0.748
	(0.432)	(0.183)	(0.264)	(0.288)	(0.392)	(1.519)	(0.682)
Adjusted R^2	0.358	0.166	0.136	0.083	0.088	0.086	0.153
R^2	0.388	0.179	0.158	0.088	0.098	0.123	0.205
Observations	197	197	197	197	197	197	197

Notes: This table reports results for regression of OIS market surprises at different maturities on a select number of ECB and Reuters' forecasts data based on LASSO. The dummy variable d_2 takes the value one for dates where we believe market participants reacted to a potential change in ECB communication style. Sample length is Nov, 2002-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Standard errors in parentheses.

Table 4: Projection of other market surprises on forecasts and revisions

	2 year sov bond spread	5 year sov bond spread	10 year sov bond spread	EUR GBP	EUR JPY	EUR USD	STOXX 50
d_2*$\Delta HICP_t$	-125.439***	-104.875***			15.170***		15.151***
	(-16.74)	(-25.006)			(-0.785)		(-4.103)
ΔMRO_q		-4.441					1.572***
		(-3.039)					(-0.378)
$HICP_q$		0.896**					
		(-0.347)					
Risk		1.862					
		(-1.386)					
IP_t				-0.023			0.028
				(-0.019)			(-0.027)
ΔGDP_q				0.193	0.786		-0.743
				(-0.322)	(-0.54)		(-0.819)
$\Delta HICP_{q+2}$				0.386**	0.303	0.705***	
				(-0.172)	(-0.254)	(-0.188)	
GDP_{q+7}^{ECB}				0.231**	0.352**	0.274*	
				(-0.108)	(-0.14)	(-0.147)	
ΔGDP_q^{ECB}				0.642*			
				(-0.332)			
ΔIP_t					0.037		
					(-0.042)		
ΔGDP_{q+1}					-1.662***		
					(-0.579)		
$\Delta HICP_{q+3}$					0.454		-0.996
					(-0.419)		(-0.637)
ΔGDP_{q+6}^{ECB}					1.196		
					(-1.208)		
d_2*MRO_q					0.267***		
					(-0.017)		
Oil price						-0.002	0.002
						(-0.001)	(-0.002)
$HICP_t$							-0.197*
							(-0.117)
$\Delta HICP_t$							-0.197*
							(-0.762)
ΔUN_t							-0.187
							(-0.357)
ΔGDP_{q+3}							-2.077*
							(-1.081)
$\Delta HICP_q$							0.587
							(-0.502)
$\Delta HICP_{q+1}$							0.805
							(-0.744)
ΔGDP_{q+2}^{ECB}							1.022
							(-1.004)
ΔGDP_{q+5}^{ECB}							1.846
							(-1.703)
ΔGDP_{q+7}^{ECB}							-4.143*
							(-2.283)
$\Delta HICP_t^{ECB}$							-0.299
							(-0.271)
d_2*GDP_q							-1.643
							(-1.326)
d_2*Risk							2.461***
							(-0.144)
Constant	-0.278	-2.167***	-0.022	-0.011	-0.077**	0.071	0.062
	(-0.303)	(-0.643)	(-0.333)	(-0.042)	(-0.035)	(-0.098)	(-0.216)
Adjusted R^2	0.043	0.069	0	0.081	0.128	0.083	0.191
R^2	0.048	0.088	0	0.104	0.168	0.097	0.266
Observations	197	197	197	197	197	197	197

Notes: This table reports results for regression of financial market surprises on a select number of ECB and Reuters' forecasts data based on LASSO. The dummy variable d_2 takes the value one for dates where we believe market participants reacted to a potential change in ECB communication style. Sample length is Nov, 2002-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Standard errors in parentheses.

Table 5: Impact of monetary policy factors on OIS yields

Variables	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
Conventional factor	2.49***	2.68***	2.73***	2.82***	2.52***	1.78***	0.71***
	(8.53)	(13.31)	(15.50)	(18.20)	(22.23)	(15.89)	(5.44)
FG factor	0.18	1.13***	2.13***	3.48***	4.40***	4.19***	2.66***
	(0.68)	(7.25)	(12.33)	(12.63)	(14.18)	(22.38)	(10.56)
QE factor	-0.02	0.89***	1.65***	2.42***	3.28***	3.85***	2.80***
	(-0.06)	(4.01)	(7.11)	(8.90)	(11.98)	(15.31)	(7.61)
Risk factor	0.11	0.02	0.01	0.05	0.08	0.18	-0.01
	(1.39)	(0.22)	(0.12)	(0.38)	(0.67)	(1.17)	(-0.03)
IJC	0.15*	-0.02	-0.05	-0.00	0.07	0.05	-0.01
	(1.79)	(-0.24)	(-0.68)	(-0.04)	(0.52)	(0.38)	(-0.05)
Constant	0.07	0.02	0.05	-0.04	-0.23	-0.27*	-0.08
	(0.53)	(0.18)	(0.42)	(-0.29)	(-1.60)	(-1.87)	(-0.80)
Observations	194	194	194	194	194	194	194
R-squared	0.44	0.66	0.73	0.78	0.84	0.86	0.69
Adjusted R^2	0.428	0.652	0.729	0.778	0.834	0.855	0.681
F-test	37.14	91.27	130.8	170	242.8	286.2	104.2
Prob>F	0	0	0	0	0	0	0

Notes: This table reports results for a regression of risk-free OIS rates on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2002-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

the three policies. Moreover, responses of all countries are similar across maturities. The QE factor had a big impact on French yields, but not as much on the Italian and Spanish yields. Finally, the risk factor predominantly impacts long term yields and is smallest at the 2 year maturity. More importantly, it has at least 4 times larger impact on Italian and Spanish bond yields relative to French yields. This is consistent with the idea that in response to change in risk, sovereign bond premium disproportionately impacts countries with higher risk rating. Motto and Özen (2022) find the impact of QE stabilization factor on Germany yields to be negative. They impose the condition that the product of the structural loading of the fourth factor on the 5 year OIS rate and the 5 year Italian yield should be negative. Since we do only impose the condition that the fourth factor should have no loading on the long-term risk-free rates, our results differ in sign. However, this does not change the main result that the risk factor correctly captures changes to sovereign bond premium. A 1 unit increase in the risk factor increases the Italian bond premium by 4 bps and the Spanish bond premium by 3 bps.

Table 6: Impact of monetary policy factors on sovereign yields

Variables	IT 2Y	IT 5Y	IT 10Y	ES 2Y	ES 5Y	ES 10Y	FR 2Y	FR 5Y	FR 10Y
Conventional factor	1.60***	1.18***	0.55*	2.06***	1.21***	0.54**	2.79***	1.92***	0.78***
	(7.45)	(5.80)	(1.93)	(9.86)	(5.63)	(2.12)	(14.27)	(7.98)	(3.55)
FG factor	4.49***	4.08***	2.59***	4.11***	3.81***	2.75***	4.18***	3.97***	2.63***
	(11.33)	(17.48)	(7.23)	(7.68)	(14.69)	(8.87)	(8.87)	(16.01)	(7.48)
QE factor	2.62***	2.10***	1.81**	1.94***	1.91***	1.64**	3.55***	4.13***	3.33***
	(5.37)	(6.34)	(2.53)	(4.06)	(5.01)	(2.57)	(9.75)	(13.52)	(5.69)
Risk factor	4.34***	5.45***	4.99***	2.99***	3.78***	4.28***	0.04	0.61**	0.81**
	(11.06)	(10.44)	(16.47)	(8.86)	(12.75)	(13.31)	(0.30)	(2.20)	(2.33)
IJC surprise	-0.02	-0.05	-0.10	0.04	-0.10	-0.04	0.05	0.00	0.03
	(-0.15)	(-0.34)	(-0.49)	(0.26)	(-0.81)	(-0.25)	(0.29)	(0.01)	(0.19)
Constant	-0.39**	-0.35**	-0.19	-0.50***	-0.54***	-0.19	-0.26	-0.38**	-0.20
	(-2.53)	(-2.27)	(-1.08)	(-2.74)	(-2.99)	(-1.03)	(-1.47)	(-2.28)	(-1.38)
Observations	194	194	194	194	194	194	194	194	194
R-squared	0.86	0.89	0.81	0.78	0.83	0.78	0.83	0.81	0.61
Adjusted R^2	0.854	0.890	0.807	0.778	0.831	0.775	0.823	0.805	0.602
F-test	282.8	390.3	203.4	170.2	237.4	166.8	225.9	200	73.92
Prob>F	0	0	0	0	0	0	0	0	0

Notes: This table reports results for a regression of sovereign bond yields on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2002-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Table 7 shows results for exchange rates, along with the crisis and post-crisis periods. The conventional policy factor has a significant positive impact on the currency in the range of 0.12-0.16% points. The QE factor had a 7 times larger impact on exchange rates, much higher than the estimate in Altavilla et al. (2019). These results are consistent across sub-samples. The FG factor is a significant driver of movements during the crisis periods. The results for the risk factor are interesting from the perspective of crisis episodes. During this period, the imapct of rise in sovereign spreads was a depreciation of the Euro. This is consistent with the view that investors were unsure about the stability of the union.

Table 7: Impact of monetary policy factors on exchange rates

Variables	EUR USD	EUR GBP	EUR JPY	EUR USD	EUR GBP	EUR JPY	EUR USD	EUR GBP	EUR JPY
Conventional factor	0.16***	0.14***	0.12***	0.10***	0.09***	0.07	0.10***	0.13***	0.15**
	(8.15)	(7.57)	(7.24)	(3.01)	(4.69)	(1.63)	(2.92)	(2.95)	(2.55)
FG factor	-0.03	0.00	0.04	0.19***	0.15***	0.24***	-0.00	0.03	0.22**
	(-1.02)	(0.01)	(1.57)	(3.29)	(3.31)	(3.81)	(-0.03)	(0.60)	(2.55)
QE factor	0.78***	0.58***	0.75***				0.83***	0.57***	0.83***
	(33.02)	(20.52)	(19.93)				(23.82)	(10.33)	(17.35)
Risk factor	0.08***	0.07***	0.02	-0.06	-0.04	-0.12***	0.06***	0.07**	0.03
	(6.10)	(5.27)	(1.42)	(-1.61)	(-1.13)	(-3.48)	(2.85)	(2.55)	(0.76)
IJC surprise	0.01	0.00	0.02	-0.04	-0.04	-0.03	-0.03	-0.02	-0.00
	(0.33)	(0.13)	(1.51)	(-0.91)	(-1.07)	(-0.68)	(-0.68)	(-0.38)	(-0.08)
Constant	-0.04***	-0.01	-0.02	-0.06	-0.01	-0.02	-0.04	-0.03	0.00
	(-2.66)	(-0.74)	(-1.22)	(-1.37)	(-0.16)	(-0.63)	(-1.60)	(-1.14)	(0.13)
Sample	01/2002	01/2002	01/2002	01/2008	01/2008	01/2008	01/2014	01/2014	01/2014
	12/2019	12/2019	12/2019	12/2013	12/2013	12/2013	12/2019	12/2019	12/2019
Observations	194	194	194	72	72	72	52	52	52
R-squared	0.84	0.80	0.78	0.82	0.75	0.73	0.92	0.90	0.90
Adjusted R^2	0.839	0.791	0.778	0.810	0.733	0.712	0.917	0.887	0.896
F-test	252.4	183.6	169.8	76.75	49.69	44.86	142.1	100.9	111.3
Prob>F	0	0	0	0	0	0	0	0	0

Notes: This table reports results for a regression of exchange rates on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Finally, table 8 contains results for equity markets. Columns (1)-(3) contain results for Stoxx50, the benchmark index for the Euro Area while columns (4)-(6) contain results for the banks index. Conventional policy response is on expected lines - one unit change in the factor leads to a decline of 0.14% points. This effect was lower during the crisis period, perhaps reflecting the zero lower bound constraint of policy.

The QE factor reduces the stock index by more than three times the decline due to conventional policy. This impact remained strong as the ECB shifted its stance to use QE not only as a financial market stabilization tool, but also as a tool for achieving its 2% inflation target. The results on QE are stronger than found in Altavilla et al. (2019) and statistically significant.

The biggest impact on stock markets is through the newly constructed factor that captures risk. A unit increase in the risk factor decreases STOXX50 by 0.5% points. This impact is more than any other monetary policy factor and was even stronger in the pre-crisis period and has since halved.

Table 8: Impact of monetary policy factors on stock markets

Variables	STOXX 50	STOXX 50	STOXX 50	SX 7E	SX 7E	SX 7E
Conventional factor	-0.14***	-0.09**	-0.22	-0.11	-0.12*	-0.09
	(-3.50)	(-2.51)	(-1.29)	(-1.63)	(-1.68)	(-0.26)
FG factor	0.13**	-0.08	0.24*	0.10	-0.10	1.01***
	(2.05)	(-0.81)	(1.76)	(1.14)	(-0.80)	(2.75)
QE factor	-0.45***		-0.48***	-0.19		0.03
	(-6.17)		(-4.65)	(-1.40)		(0.14)
Risk factor	-0.53***	-0.43***	-0.50***	-0.90***	-0.94***	-0.59**
	(-13.77)	(-15.21)	(-3.96)	(-7.71)	(-10.77)	(-2.48)
IJC surprise	-0.03	-0.02	-0.06	-0.04	-0.04	-0.01
	(-0.77)	(-0.52)	(-0.82)	(-0.83)	(-0.70)	(-0.05)
Constant	-0.11***	-0.19***	-0.01	-0.19***	-0.39***	0.02
	(-3.34)	(-3.42)	(-0.14)	(-2.87)	(-4.47)	(0.13)
Observations	194	72	52	194	72	52
R-squared	0.65	0.60	0.78	0.52	0.70	0.37
Adjusted R^2	0.583	0.614	0.766	0.510	0.691	0.315
F-test	88.05	34.05	42.73	51.24	53.85	6.862
Prob>F	0	0	0	0	0	0

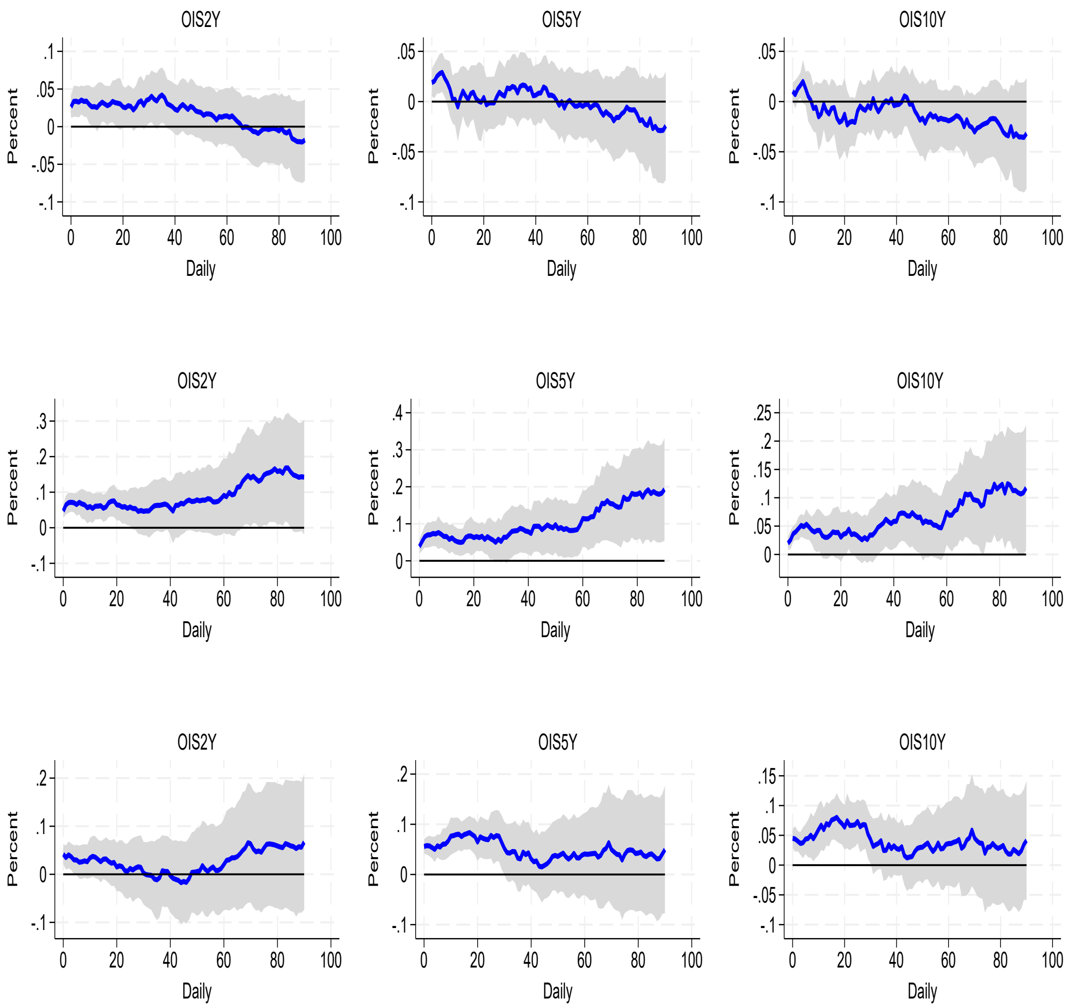
Notes: This table reports results for a regression of stock markets on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length for columns (1) and (4) is Jan, 2002-Dec, 2019, for columns (2) and (5) is Jan, 2008-Dec, 2013, and for columns(3) and (6) is Jan, 2014-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

4.3 Persistence

In this section, I examine the persistence of the impact responses presented in the previous sub-section. The results are estimated for a period of one month after a monetary policy announcement. How persistent is the impact of policy factors on the exchange rates? Do sovereign bond spreads decline subsequently? Does the FG impact on stock markets turn negative eventually?

I begin with figure 2 that plots persistence in medium-long term OIS rates

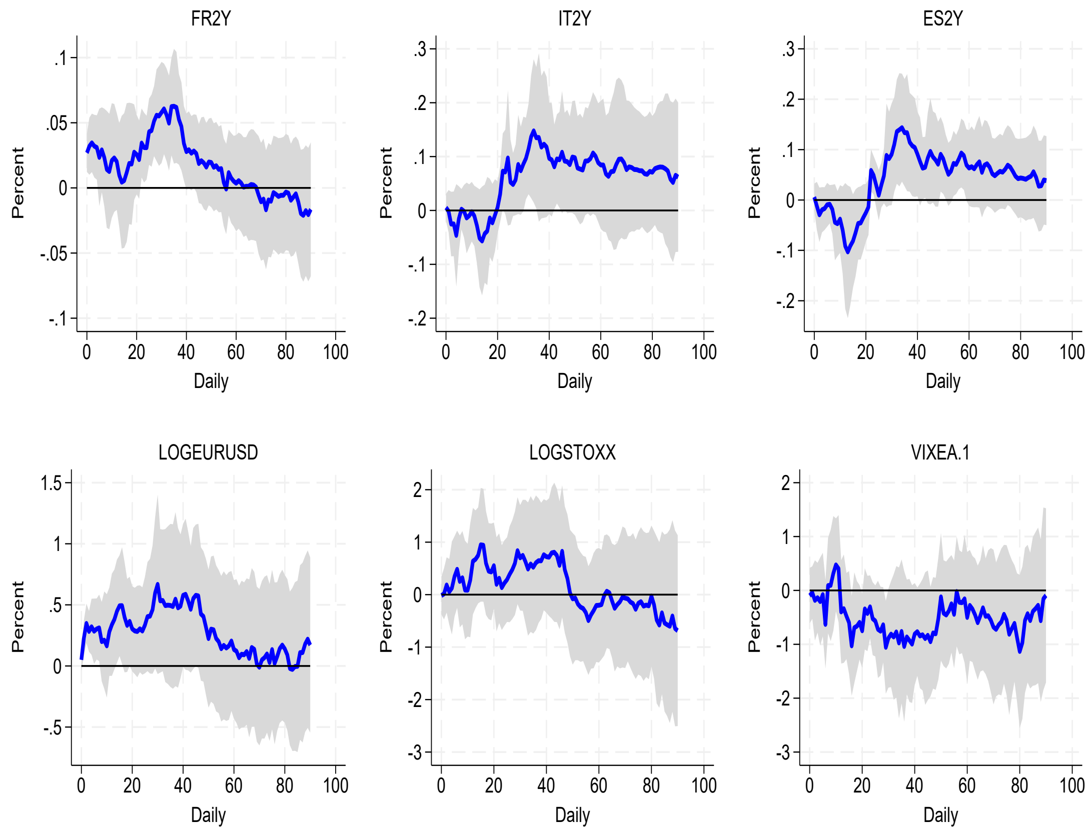
Figure 2: Persistence of monetary policy shocks



Note: This figure reports estimates of LP regression at daily frequency. Each row contains the dynamic response of OIS rates at two year, five year and ten year maturity for a unit increase in a monetary policy factor. The first row contains responses to a conventional policy shock, the second row contains responses to a FG shock. The third row contains responses to a QE policy shock. Shaded area represents HAC standard errors at 5% level.

for monetary policy factors. The responses are in basis points. The impact of conventional policy factor remains for about 10 days on the two year rate and 6 days on the five year rate. This is expected, given that the factor is concerned with changes in policy in the short-term. In contrast, the FG factor moves all the yields but they differ in magnitude. The two year yield increases by about 5 bps for more than 3 weeks with a peak impact. The five year moves similarly. The ten year rate

Figure 3: Persistence of Conventional policy shocks

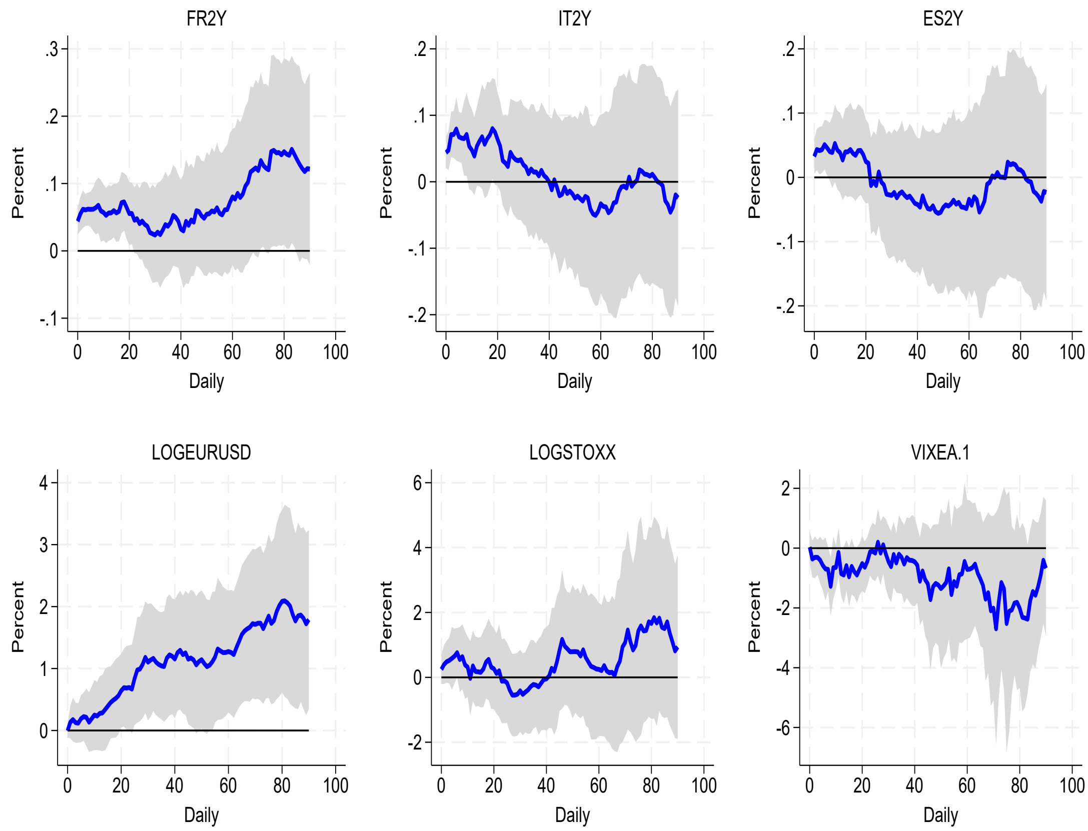


Note: This figure reports estimates of LP regression for conventional policy factor at daily frequency. Dependent variables include two year French yields (FR2Y), two year Italian yields (IT2Y), two year Spanish yields (ES2Y), log of Euro US dollar exchange rate (LOGEURUSD), log of Stoxx 50 index (LOGSTOXX) and the Volatility Index (VIXEA.1). Shaded area represents HAC standard errors at 5% level.

have a lower magnitude - it reaches its peak magnitude at 5bps after a week and then declines to about 2 bps within 2 weeks. The QE factor has the most persistent and strongest effect. It increases the two year rate by almost 5bps and is significant for about 3 weeks. The five year rate was about 5bps and the ten year rate was abut 7bps.

Next, I discuss the response of conventional policy shock on other financial variables. Figure 3 contains the impulse responses. Persistence in sovereign yields is heterogeneous. The French 2 year yield is impacted by the shock for about a week. There is a positive response of the exchange rate but stock response and VIX

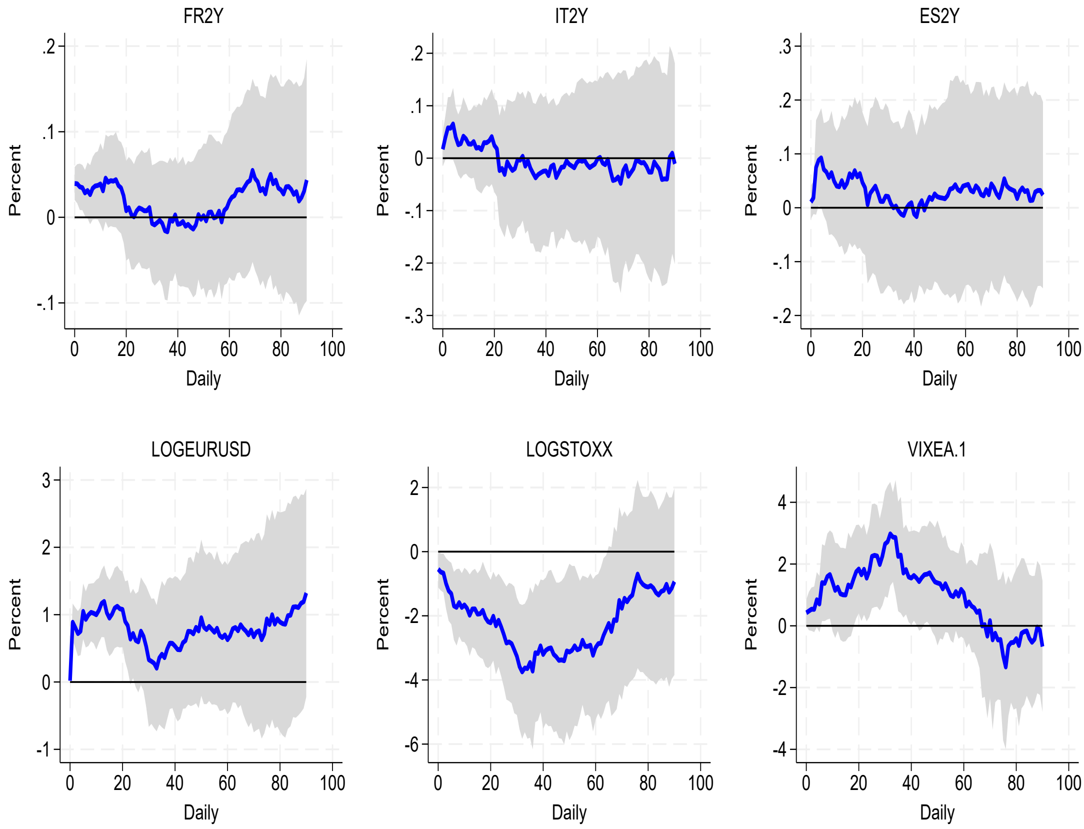
Figure 4: Persistence of FG policy shocks



Note: This figure reports estimates of LP regression for FG policy factor at daily frequency. Dependent variables include two year French yields (FR2Y), two year Italian yields (IT2Y), two year Spanish yields (ES2Y), log of Euro US dollar exchange rate (LOGEURUSD), log of Stoxx 50 index (LOGSTOXX) and the Volatility Index (VIXEA.1). Shaded area represents HAC standard errors at 5% level.

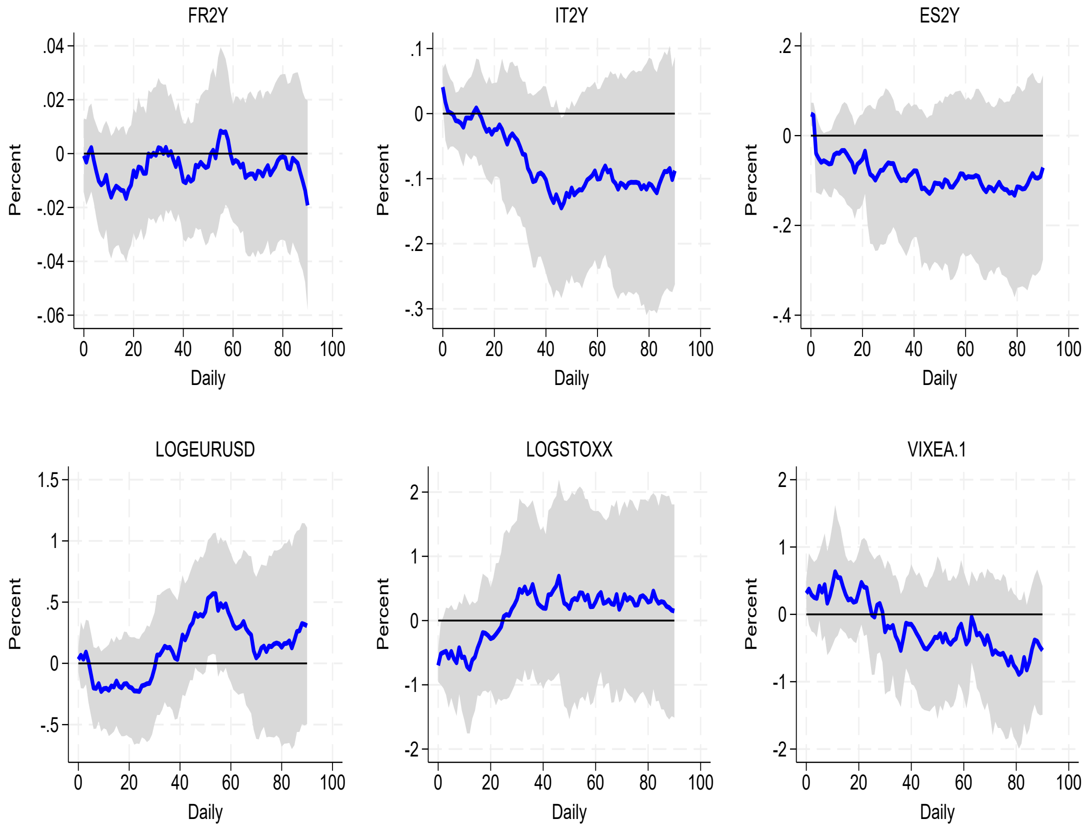
response is muted. Figure 4 presents results for the FG shock. Yields of all the three countries increases. However, there is no significant response for exchange rates, equities of volatility. Results for the QE policy shock are in figure 5. While the impact on sovereign yields is similar to the FG shock, it has the strongest responses on other asset segments amongst all the policy options. A one unit change in QE shock appreciates the currency by a peak 1.5% within 1 week while stock markets tumble by about 40% over the month. There is also a modest persistent upward movement in VIX. Finally, the risk factor in figure 6 shows no movement for the French yields but a temporary positive movement in the Italian and Spanish yields. This is reasonable since this indicator captures sovereign risk. In addition, the stock index declines by about 0.8% while the VIX index increases by about 0.4%.

Figure 5: Persistence of QE policy shocks



Note: This figure reports estimates of LP regression for QE policy factor at daily frequency. Dependent variables include two year French yields (FR2Y), two year Italian yields (IT2Y), two year Spanish yields (ES2Y), log of Euro US dollar exchange rate (LOGEURUSD), log of Stoxx 50 index (LOGSTOXX) and the Volatility Index (VIXEA.1). Shaded area represents HAC standard errors at 5% level.

Figure 6: Persistence of Risk shocks



Note: This figure reports estimates of LP regression for sovereign risk premium factor at daily frequency. Dependent variables include two year French yields (FR2Y), two year Italian yields (IT2Y), two year Spanish yields (ES2Y), log of Euro US dollar exchange rate (LOGEURUSD), log of Stoxx 50 index (LOGSTOXX) and the Volatility Index (VIXEA.1). Shaded area represents HAC standard errors at 5% level.

5 Conclusion

This paper examines the impact of monetary policy decisions on financial markets in the Euro Area for three major asset classes namely, bonds, currencies and stocks. To obtain measures of monetary policy shocks, we utilize the total market surprise during a monetary event obtained by summing up surprises during the press release window and the press conference window. In addition, we explicitly incorporate the role played by market participants in extracting signals about the macroeconomy from policy decisions. We operationalize this in a two step procedure. In the first step, we take a broad range of market surprises in OIS rates of different maturities, sovereign bond premium, exchange rates and stock indices, and sieve out effects of signalling using forecasts and revisions of aggregate macroeconomic data. In the second step, we estimate a factor model using the variation in market surprises that is independent of signalling effects and obtain four factors. We impose restrictions on the model that allows us to interpret these factors as the conventional policy factor, FG factor, QE factor and a novel risk factor. The first three factors capture the impact of various policy tools of the ECB while the risk factor captures sovereign risk premium in bond markets.

Our results with the conventional policy, FG and QE factors are broadly consistent with expectations on OIS rates and sovereign bond yields. The risk factor makes a significant impact on Italian and Spanish bonds as well as on stock markets. It also leads to a depreciation of the Euro during the post-crisis period that includes the sovereign debt crisis. We also examine the persistence of factors using a LP model using daily data. We find that the conventional factor has a persistent effect on the two year OIS rates and sovereign bonds while FG and QE factor have more persistent effects on the five year and ten year rate. Among other asset classes, the FG and QE factor have stronger effects on exchanges rates and stock markets relative to the conventional factor. Finally, the risk factor does not generate any persistent effects.

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A Details of Factor model

Let X_{IR} denote the matrix of $(T \times 14)$ data on which to fit the factor model:

$$X_{IR} = F\Lambda + \varepsilon$$

where F is the matrix of common latent factors, Λ is the matrix of factor loadings and ε is the idiosyncratic error. The matrix Λ is not unique since for any orthonormal matrix M, the factor model can be written as:

$$X_{IR} = F.M.M'.\Lambda + \varepsilon \implies X_{IR} = \tilde{F}\tilde{\Lambda} + \varepsilon \tag{3}$$

Hence, to provide a structural interpretation to the factors in $\tilde{F}$, it is important to identify M. Since the Cragg and Donald test (1997) suggests there are 4 factors that appropriately capture the variation in the data. Hence, 16 restrictions are required to identify the parameters of the orthonormal matrix up to sign. Let $_{.j}$ denote the j_{th} column of any matrix. The first ten restrictions come from orthonormality:

1. Orthogonality

$$M'_{.1}M_{.2} = 0, M'_{.1}M_{.3} = 0, M'_{.1}M_{.4} = 0M'_{.2}M_{.3} = 0, M'_{.2}M_{.4} = 0, M'_{.3}M_{.4} = 0 \tag{4}$$

2. Normalization to unit length

$$M'_{.1}M_{.1} = 1, M'_{.2}M_{.2} = 1, M'_{.3}M_{.3} = 1, M'_{.4}M_{.4} = 1$$

Four zero restrictions are placed on the OIS rates:

1. Three restrictions on the OIS 1 month rate surprise:

$$U'_{.2}\Lambda_{.1} = 0, U'_{.3}\Lambda_{.1} = 0, U'_{.4}\Lambda_{.1} = 0$$

2. The fourth factor does not load onto the 10 year OIS rate surprise:

$$U'_{.4}\Lambda_{.7} = 0$$

Finally, the last two restrictions are that the third factor and fourth factor have the smallest variance in the pre-crisis period. This minimization is subject to the above constraints and provides elements up to a sign. We therefore normalize the factors $\tilde{F}$ such that a unit increase in the conventional factor, FG factor, QE factor and risk factor are equivalent to a unit increase in OIS1M rate, OIS2Y rate, OIS10Y rate and 10 year bond spread.

B Sub-sample results for OIS rates and sovereign yields

B.1 OIS yields

Table 9: Impact of monetary policy factors on OIS yields: 2002-2007

Variables	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
Conventional factor	2.09***	2.11***	2.14***	2.36***	1.85***	1.28***	0.59**
	(5.99)	(6.13)	(5.61)	(5.53)	(4.25)	(4.35)	(2.21)
FG factor	-0.00	0.70***	1.54***	2.82***	3.70***	3.85***	2.75***
	(-0.02)	(4.92)	(8.00)	(9.74)	(13.58)	(19.40)	(15.69)
IJC	0.23	0.05	-0.18**	-0.44***	-0.79***	-0.71***	-0.60***
	(1.15)	(0.43)	(-2.10)	(-3.90)	(-4.79)	(-3.87)	(-3.35)
Constant	0.29	0.12	0.16	0.02	-0.27	-0.23	-0.30**
	(1.29)	(0.74)	(1.02)	(0.12)	(-1.41)	(-1.42)	(-2.13)
Observations	70	70	70	70	70	70	70
R-squared	0.44	0.66	0.73	0.78	0.84	0.86	0.69
Adjusted R^2	0.428	0.652	0.729	0.778	0.834	0.855	0.681
F-test	37.14	91.27	130.8	170	242.8	286.2	104.2
Prob>F	0	0	0	0	0	0	0

Notes: This table reports results for a regression of risk-free OIS rates on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2002-Dec, 2007. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Table 10: Impact of monetary policy factors on OIS yields: 2008-2013

Variables	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
Conventional factor	2.62***	2.72***	2.71***	2.64***	2.24***	1.44***	0.49***
	(6.81)	(11.21)	(13.25)	(13.48)	(9.01)	(6.49)	(3.40)
FG factor	0.15	1.56***	2.90***	4.56***	5.77***	5.24***	2.88***
	(0.31)	(5.71)	(11.77)	(13.30)	(13.55)	(11.63)	(8.03)
Risk factor	0.15	-0.10	-0.23*	-0.29**	-0.45***	-0.58**	-0.70**
	(1.48)	(-1.10)	(-1.88)	(-2.19)	(-2.96)	(-2.01)	(-2.59)
IJC	0.19**	-0.19***	-0.24***	-0.23*	-0.11	-0.21	-0.07
	(2.04)	(-2.93)	(-2.84)	(-1.73)	(-0.57)	(-0.83)	(-0.37)
Constant	-0.08	-0.13	-0.06	-0.24	-0.43	-0.45	0.11
	(-0.32)	(-0.56)	(-0.22)	(-0.78)	(-1.26)	(-1.15)	(0.48)
Observations	72	72	72	72	72	72	72
R-squared	0.44	0.66	0.73	0.78	0.84	0.86	0.69
Adjusted R^2	0.428	0.652	0.729	0.778	0.834	0.855	0.681
F-test	37.14	91.27	130.8	170	242.8	286.2	104.2
Prob>F	0	0	0	0	0	0	0

Notes: This table reports results for a regression of risk-free OIS rates on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2008-Dec, 2013. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Table 11: Impact of monetary policy factors on OIS yields: 2014-2019

Variables	OIS 1M	OIS 3M	OIS 6M	OIS 1Y	OIS 2Y	OIS 5Y	OIS 10Y
Conventional factor	2.66***	2.68***	2.58***	2.70***	2.81***	1.93***	0.73
	(7.74)	(17.23)	(17.56)	(6.71)	(7.02)	(8.67)	(1.54)
FG factor	0.87**	1.23***	1.76***	2.57***	3.37***	3.85***	4.31***
	(2.40)	(9.55)	(10.54)	(9.56)	(9.59)	(9.75)	(6.92)
QE factor	0.34	0.69***	1.41***	1.96***	2.79***	3.68***	3.47***
	(1.11)	(6.03)	(10.13)	(7.08)	(10.09)	(15.62)	(5.75)
Risk factor	0.18	0.12	-0.09	-0.25	-0.23	0.40	0.57
	(1.29)	(1.47)	(-0.88)	(-1.53)	(-1.13)	(1.47)	(0.87)
IJC	-0.06	0.03	-0.11	-0.02	0.06	-0.18	-0.26
	(-0.37)	(0.28)	(-0.86)	(-0.13)	(0.25)	(-0.95)	(-0.73)
Constant	0.05	0.09	0.12**	0.23**	0.14	0.12	0.27
	(0.58)	(1.28)	(2.46)	(2.28)	(1.42)	(0.79)	(0.98)
Observations	52	52	52	52	52	52	52
R-squared	0.44	0.66	0.73	0.78	0.84	0.86	0.69
Adjusted R^2	0.428	0.652	0.729	0.778	0.834	0.855	0.681
F-test	37.14	91.27	130.8	170	242.8	286.2	104.2
Prob>F	0	0	0	0	0	0	0

Notes: This table reports results for a regression of risk-free OIS rates on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2014-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

B.2 Sovereign yields

Table 12: Impact of monetary policy factors on sovereign yields: 2002-2007

Variables	IT 2Y	IT 5Y	IT 10Y	ES 2Y	ES 5Y	ES 10Y	FR 2Y	FR 5Y	FR 10Y
Conventional factor	1.89***	1.31***	0.58**	2.00***	1.38***	0.54**	1.59***	1.25***	0.58**
	(4.52)	(4.31)	(2.40)	(4.38)	(4.09)	(2.14)	(3.07)	(3.55)	(2.21)
FG factor	3.63***	3.78***	2.70***	3.44***	3.85***	2.75***	3.53***	3.80***	2.81***
	(14.31)	(18.45)	(15.42)	(10.76)	(18.00)	(15.31)	(9.73)	(18.69)	(15.19)
IJC	-0.63***	-0.67***	-0.55***	-0.41*	-0.67***	-0.57***	-0.56**	-0.62***	-0.60***
	(-4.56)	(-3.76)	(-3.25)	(-1.72)	(-3.62)	(-3.16)	(-2.64)	(-3.07)	(-3.16)
Constant	-0.10	-0.27*	-0.35**	-0.06	-0.22	-0.32**	-0.04	-0.15	-0.32**
	(-0.55)	(-1.74)	(-2.39)	(-0.31)	(-1.33)	(-2.21)	(-0.19)	(-0.75)	(-2.25)
Observations	70	70	70	70	70	70	70	70	70
R-squared	0.86	0.89	0.81	0.78	0.83	0.78	0.83	0.81	0.61
Adjusted R^2	0.854	0.890	0.807	0.778	0.831	0.775	0.823	0.805	0.602
F-test	282.8	390.3	203.4	170.2	237.4	166.8	225.9	200	73.92
Prob>F	0	0	0	0	0	0	0	0	0

Notes: This table reports results for a regression of sovereign bond yields on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2002-Dec, 2007. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Table 13: Impact of monetary policy factors on sovereign yields: 2008-2013

Variables	IT 2Y	IT 5Y	IT 10Y	ES 2Y	ES 5Y	ES 10Y	FR 2Y	FR 5Y	FR 10Y
Conventional factor	1.40***	1.28***	0.68**	1.96***	1.08***	0.63**	2.64***	1.62***	0.63***
	(6.09)	(5.40)	(2.40)	(8.04)	(3.68)	(2.02)	(10.57)	(4.37)	(2.98)
FG factor	5.64***	4.52***	2.29***	5.26***	4.13***	2.54***	5.56***	4.90***	2.67***
	(9.60)	(9.74)	(5.27)	(6.72)	(7.69)	(6.02)	(7.07)	(9.26)	(6.09)
Risk factor	4.16***	5.11***	4.39***	2.94***	3.56***	4.05***	-0.53***	-0.15	-0.06
	(6.59)	(7.12)	(17.34)	(5.53)	(9.92)	(17.64)	(-3.05)	(-0.34)	(-0.17)
IJC	-0.27	-0.03	0.03	-0.11	-0.11	0.18	-0.24	-0.34	-0.01
	(-1.18)	(-0.11)	(0.14)	(-0.54)	(-0.58)	(0.98)	(-0.83)	(-1.22)	(-0.06)
Constant	-0.47	0.14	0.36	-0.64	-0.51	0.40	-0.64	-0.60	0.17
	(-1.14)	(0.41)	(1.15)	(-1.34)	(-1.12)	(1.09)	(-1.50)	(-1.33)	(0.63)
Observations	72	72	72	72	72	72	72	72	72
R-squared	0.86	0.89	0.81	0.78	0.83	0.78	0.83	0.81	0.61
Adjusted R^2	0.854	0.890	0.807	0.778	0.831	0.775	0.823	0.805	0.602
F-test	282.8	390.3	203.4	170.2	237.4	166.8	225.9	200	73.92
Prob>F	0	0	0	0	0	0	0	0	0

Notes: This table reports results for a regression of sovereign bond yields on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2008-Dec, 2013. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.

Table 14: Impact of monetary policy factors on sovereign yields: 2014-2019

Variables	IT 2Y	IT 5Y	IT 10Y	ES 2Y	ES 5Y	ES 10Y	FR 2Y	FR 5Y	FR 10Y
Conventional factor	1.65*	0.64	0.39	1.75***	1.69***	0.99	2.78***	2.09***	0.60
	(1.75)	(1.56)	(0.38)	(4.66)	(5.62)	(1.35)	(6.30)	(4.56)	(0.86)
FG factor	3.50***	3.43***	4.87***	1.44**	2.88***	4.65***	2.46***	3.67***	5.33***
	(2.77)	(6.21)	(4.18)	(2.08)	(5.33)	(4.38)	(6.59)	(5.78)	(6.04)
QE factor	2.73***	2.43***	3.38***	2.04***	2.40***	3.38***	3.18***	4.69***	4.93***
	(4.25)	(8.13)	(3.65)	(5.36)	(6.38)	(3.83)	(11.64)	(13.39)	(5.56)
Risk factor	3.23***	5.41***	5.98***	1.56***	3.03***	3.79***	-0.29	0.50*	1.57*
	(4.63)	(22.09)	(6.71)	(3.13)	(5.05)	(3.71)	(-1.31)	(1.70)	(1.88)
IJC	-0.11	-0.54*	-0.93	-0.48*	-0.79**	-1.04*	-0.28	-0.30	-0.25
	(-0.30)	(-1.68)	(-1.39)	(-1.74)	(-2.29)	(-1.69)	(-1.27)	(-1.28)	(-0.51)
Constant	-0.53***	-0.71***	-0.06	-0.73***	-0.83***	-0.34	0.08	-0.16	-0.01
	(-3.80)	(-3.10)	(-0.15)	(-3.62)	(-3.05)	(-0.90)	(0.55)	(-0.67)	(-0.02)
Observations	52	52	52	52	52	52	52	52	52
R-squared	0.86	0.89	0.81	0.78	0.83	0.78	0.83	0.81	0.61
Adjusted R^2	0.854	0.890	0.807	0.778	0.831	0.775	0.823	0.805	0.602
F-test	282.8	390.3	203.4	170.2	237.4	166.8	225.9	200	73.92
Prob>F	0	0	0	0	0	0	0	0	0

Notes: This table reports results for a regression of sovereign bond yields on monetary policy and risk premium factors. Coefficients are expressed in percentage per annum per standard deviation change in factors. Sample length is Jan, 2014-Dec, 2019. *p<0.1, **p<0.05,***p<0.01. Robust standard errors in parentheses.