Unconventional monetary policy in the Euro Area: a tale of three shocks.

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Abstract

To identify the effects of monetary policies, high-frequency surprises around central bank meetings are largely employed in the literature. This identification strategy assumes that these surprises reflect a single monetary policy shock. We argue that this is actually not the case for Euro Area monetary policy after 2008, for which we instead assume three shocks operate simultaneously around ECB press conferences. Besides a monetary shock, meant to abstract from conventional policies, and the information shock identified in the recent literature, we allow for a third shock resulting from the ECB targeting directly the risk premia of the periphery countries. We disentangle these three components from the high-frequency data and use them in a proxy-SVAR to trace out the dynamic causal effects of the three different types of policy shocks. We show that the novel identified shock has significant effects on Euro Area economy and it allows a more reasonable identification of the effects of unconventional policies on financial variables, especially on the transmission of policies like QE to peripheral countries risk premia.

Keywords: Monetary Policy Shock, Structural VAR, ECB

JEL codes: E43, E44, E52,E58,G10

1 Introduction

Identifying the effects of monetary policies is a central question in the empirical macro literature. The endogeneity issue implied by the reaction function of the central bank has been historically tackled by assuming a lagged response of macroeconomic variables to innovations in the policy rate (see Christiano et al. (1999) for a review). In the empirical macro jargon, this means assuming a triangular structure in the matrix of structural parameters in a Structural Vector Autoregression (SVAR) context. This approach has proved weak for two main reasons. First, the assumption of no contemporaneous response of macro variables to policy shocks has been largely questioned in light of the predictions of monetary New-Keynesian models. Second, with the Zero Lower Bound a "Taylor rule" approach is no longer defensible (Rossi (2019)). With unconventional monetary policy the relevant policy instrument is the long term rate, which is affected by many other variables beyond monetary policy decisions, namely expectations about the future state of the economy, risk aversion, etc. Identifying exogenous variations in long term rates which reflect monetary policy actions proves challenging in this context.

Since Kuttner (2001), the use of high-frequency (HF) interest rate surprises within the central banks' announcements window has made the life of empirical monetary economists much easier as they allow to isolate unexpected variations in the policy rate or in the long term rate (Gürkaynak et al. (2005)). These variations can be then used to trace out the effects of exogenous monetary policy shocks (Gertler and Karadi (2015)). The central assumption in this literature is that whatever happens within the narrow window around announcements only reflects a single exogenous monetary policy shock.

In this paper we focus on the Euro Area and provide evidence of the presence of three independent shocks, rather than a single one, operating within ECB press conferences, and identify them by looking at high-frequency co-movements of default-free long term rates, risk premia on Euro Area periphery bonds and the stock market index. The three shocks are:

1. A "classic" monetary policy shock, which (if contractionary) raises the default-free Eurozone yield curve, lowers the stock index and spills over to EA periphery risk premium, increasing it. We call it a *monetary shock* and it is meant to encompass all unconventional measures, from Forward Guidance to QE, aimed at mainly targeting the risk-free yield curve. An increasing short/long term risk-free rate induces a drop in the stock market index as higher discount rates and lower expected dividends cause a downward revision in stock prices.

2. A *information shock*, as recently identified in the literature (Nakamura and Steinsson (2018),Jarocinski and Karadi (2019), Andrade and Ferroni (2019)). By announcing policy decisions central banks simultaneously release private information about their forecast for the future state of the economy, thus affecting the expectations of market participants. Assume that an ECB press conference causes an upward revision in market participants expectations about the

future path of the economy: this leads to an increase in the long term rate, an increase in the stock index and possibly a decrease in the periphery risk premium. Not taking into account this second shock, the *information shock*, could bias the estimates of the impact of monetary policy on macroeconomic variables and asset prices.

3. Finally, we introduce a third and novel *spread shock*, which we interpret as the result of the ECB communication and measures affecting directly the risk premia on peripheral countries and only indirectly the default-free yield curve. When this shock hits we observe a negative high-frequency co-movement of default-free long term rates and periphery risk premium. We will explain throughout the paper the interpretation and the implications of this third shock and why we need to take it into account.

This three-shocks description of the surprises around ECB press conferences allows to obtain a non-biased estimation of the financial and macroeconomic effects of unconventional monetary policy in the Euro Area, without the need of spitting the sample or focusing on specific measures adopted. We apply a sign-restrictions approach to build three orthogonal factors extracted from HF surprises around all ECB press conferences. We then use the obtained factors as external instruments, using proxy-SVAR and local projection techniques to trace out the dynamic causal effect of unconventional monetary policy.
The paper is organized as follows. In section 2 we explain the puzzle we face when looking at high-frequency responses of periphery spreads to ECB announcements. In section 3 we explain the implications of the novel spread shock, while in section 4 we provide details on the methodology we use to identify the different shocks from high-frequency surprises. In section 5 we analyze dynamic responses of asset prices to the identified shocks using a daily SVAR, while in section 6 we focus on the macroeconomic effects using local projections.

Related literature.

We speak to a recently developing literature which identifies multiple shocks around monetary policy events, taking into account the information effect. Nakamura and Steinsson (2018) focuses on US data. Regarding the Euro Area the most relevant papers are Jarocinski and Karadi (2019) and Andrade and Ferroni (2019) who split information shocks from monetary policy shocks by looking at high frequency responses of the stock market and inflation expectations respectively and imposing the proper sign restrictions. We build on their method to identify our novel spread shock.

Cieslak and Schrimpf (2019) assume three types of structural shocks affect high-frequency variations of interest rates around monetary policy announcements: a monetary shock, an information shock and a risk premium shock. The latter refers to news affecting the price of risk in financial markets. To identify the three shocks they exploit sign restrictions on high-frequency co-movements of the yield curve and stock prices. Similarly to Cieslak and Schrimpf (2019) we identify a risk shock, though we specifically focus on the risk premium on the sovereign bonds of Euro Area periphery.

A large literature has focused on estimating the effects of unconventional monetary policies in the Euro Area. Prominent examples are Altavilla et al. (2015), Altavilla et al. (2016), Gambetti and Musso (2017),Krishnamurthy et al. (2018). All these studies focus on single types of unconventional measures separately, while our aim is to provide a comprehensive estimate for the whole lifetime of the Euro Area. Altavilla et al. (2019) moves in this direction, by building a set of factors extracted from high-frequency variations around ECB meetings, following the studies made for US data by Gürkaynak et al. (2005), Swanson (2017).

Our paper closely relates to Hachula et al. (2019), in which they solve the issue of having different types of monetary policy shocks in the Euro Area by splitting the sample into two parts: a "phase 1" (2007-2014) in which they assume the ECB is targeting the periphery spreads; a "phase 2" (2014-2016) in which ECB is assumed to target the risk-free yield curve. Accordingly, they use HF variation in periphery yields for "phase 1" and HF variations in core countries yields for "phase 2" to achieve identification. Our approach allows to account for this multiplicity of MP shocks without splitting the sample and taking a "a priori" stand on the dates in which either of the two shocks must be considered.

2 The OIS-spread puzzle and the policy surprises

Monetary policy conducted by the European Central Bank in the Euro Area is characterized by some distinctive features which make it substantially different from that of other major central banks in the advanced economies. Though the mandate to which the ECB is submitted is very simple, that is to reach an inflation rate lower but close to 2%, reaching this goal has proven quite difficult for the monetary authority. Especially since the beginning of the Great Recession in 2008, it has been clear that the ECB should have been ready to undergo several types of "non-standard" measures to fulfill successfully its mandate. Besides the challenge implied by having reached the Zero Lower Bound, and the consequent need for the implementation of unconventional monetary policies, the ECB had to face the risks connected with the sovereign debt crisis. After 2010 we have observed a sharp increase in the risk premia associated to sovereign debts of Euro Area periphery countries reflected in higher spreads between periphery and core countries interest rates. These premia can be attributed to two main reasons: a decrease in the perceived ability of some countries to repay their sovereign debt, and an higher probability associated to a breakup of the Euro Area and to the consequent redenomination of sovereign debts in local currencies (Krishnamurthy et al. (2018)). The debt crisis has made clear all the contradictions implied by an imperfect currency area with a fragmented sovereign bond market and the need for the ECB to take actions aimed at compress risk premia (De Grauwe (2011)). After an initial inertia the ECB seemed to have started addressing the issue directly, with the governor Mario Draghi trying to reassure financial markets about the irreversibility of the monetary union in his famous "whatever it takes" speech on 26^{th} July 2012.

Accordingly, several studies tried to understand how effective were the measures taken by the ECB in reducing risk premia on sovereign bonds (Altavilla et al. (2015),Altavilla et al. (2016),Gambacorta et al. (2014) among others). To answer this question, one needs first to identify a clear measure of monetary policy shock, and then see how spreads react to this shock. Most of the studies which address this issue, assume *a priori* a direct effect of monetary policy on the spreads. For example, Altavilla et al. (2015) use an event study analysis and show that the QE launched in January 2015 effectively reduced spreads on periphery bonds. In an event study analysis the spread is regressed on relevant date dummies and other covariates. The identification of the monetary policy shock then boils down to identifying the relevant policy events, using a two-day, one-day or intra-day window. Although this approach has proved useful for providing a *prima facie* evidence on the effects of monetary policy, a more "agnostic" approach is desirable, where an incontrovertible measure of monetary policy shocks is identified *ex ante* and only then its effects on the spreads can be traced out. This is the approach followed by Altavilla et al. (2019), who construct four measures of policy surprises in the Euro Area by extracting four factors from the set of high-frequency surprises in Overnight Indexed Swap rates (OIS) at different maturities around ECB governing council meetings. They rotate the factors in order to interpret them as: *target, timing, forward guidance and QE* factors. OIS yield curve constitutes the relevant risk-free term structure of interest rates which is directly related to the ECB monetary policy. [1]

Altavilla et al. (2019) regress the Italian rates at different maturities on these factors. Besides the effect of the QE factor in the 2014-2018 period, they get no clear-cut evidence that expansionary monetary policy by ECB reduced the spread Italy-OIS. This can be seen in Table 1, where we show the results of a regression of high-frequency variations of the 10-year spread ITA-OIS around ECB press conferences on variations of the 10-year OIS rate around the same press conferences, which can be interpreted as a maesure of monetary policy surprises and basically accounts for both the FG and QE factors. We run the regression separately in three periods: 2002-2007 (PRE08), 2008-2013 (CRISIS) and 2014-2018 (QE). In the first period the coefficient is not statstically different from zero, which is not surprising given the very small variation of the ITA-OIS spread in this period. During the QE period, we instead observe the expected positive correlation between the OIS rate

[1] OIS (Overnight Indexed Swaps) are derivatives in which a fixed leg of a given time-length (from 3 months to 10 years) is exchanged for a floating leg given by the EONIA rate. These contracts are used by investors for two objectives: bet of the future path of the short term rate and insure against duration risk. For this reason long term OIS rates are equivalent to the yield of a default-free long term bond, net of any difference coming from "convenience yields" on sovereign bonds.

and the risk premium on Italian bonds. In the crisis subsample (2008-2013), however, we record a puzzling negative correlation, which at a first glance would lead to the counter-intuitive result that a restrictive policy actually reduces the risk premium. This makes the coefficient estimated over the full sample negative, though not significant.

[Table 1 about here.]

[Table 2 about here.]

Notice that by focusing on the surprises around the ECB press conference which takes place after the press release, we focus on market reactions to unconventional measures, as conventional policies (cuts/increases in the policy rates) are announced in the press release. However, similar results are obtained if we look at the surprises in the whole monetary event, i.e. press release plus press conference, see Table 2.
The puzzle can be seen also from Figure 1, which documents the fact that for a large fraction of ECB press conferences we see a negative co-movement of OIS rates and periphery risk premium.

One possible explanation for this puzzle relates to the presence of an *information shock*. As shown by Nakamura and Steinsson (2018), Jarocinski and Karadi (2019), Andrade and Ferroni (2019) and others, an increase (decrease) in the long term rate can be unrelated to a restrictive (expansionary) policy shock, but rather to a disclosure of positive (negative) information about the future state of the economy by the central bank during the press conference. Under this scenario, a decrease in the long term OIS rate could well be a consequence of a negative information shock (i.e. a worsening of market expectations about future economic activity) rather than the result of an expansionary policy like a QE. An increase in the periphery risk premium could then be the result of this information shock. Throughout the next sections we show that accounting for an information shock is not enough to explain the puzzle. Moreover, the fact that episodes in which the spread IT-OIS and the OIS itself negatively co-moves are clustered in the 2008-2014 period suggests something more than an information shock should be accounted for, as there is no specific reason to believe that central bank information mattered more during the crisis. In fact, estimates of the information shocks in the literature do not point to an increase of its variance during the crisis.

We instead explain the puzzle by considering a third type of shock, call it a *spread shock*, which we explain in details in the next section.

[Figure 1 about here.]

3 Spread vs OIS driven surprises.

Why is it important to consider and account for a *spread shock*? Assume the ECB has two ways to affect the spreads of peripheral countries:

- By applying a "classic" monetary policy rule, the ECB affects the common Eurozone risk-free rate, measured by the OIS rate. It is worth stressing that by "classic" we don't mean "conventional". The ECB can affect the OIS rates at long maturities through unconventional measures, typically QE.[2] This type of policy spills over to the periphery risk premia. In particular, we expect an expansionary monetary policy, which reduces the OIS rates, to reduce the spreads as well. The mechanism through which this can occur are several: improved economic conditions can increase confidence of investors about sustainability of risky sovereign debt. Policies like QE are also expected to reduce the price of risk by taking some risk out of the market, through the *portfolio rebalancing effect.* Policies like LTROs (Long Term Refinancing Operations) are aimed at increasing the supply of long term loans by banks, thus reducing long term risk free rates. These liquidity injections have been used by banks also to increase their exposure to risky sovereign debt (Crosignani et al. (2019)), again leading to a reduction in sovereign spreads.
  An example of this type of comovement is observed on 22^{th} January 2015 when the QE was announced: we observe a similar reaction of the 10-year OIS rate, and the 10-year IT-OIS spread. (see Table 7). This is consistent with the idea that an expansionary unconventional monetary policy like the QE reduces risk premia.

- By implementing a "spread-targeting" monetary policy aimed directly at affecting the periphery risk premia, the ECB directly targets the periphery spread. This in turn can affect the OIS risk free rate, through a mechanism different from the one previously described. If this policy successfully reduces the spread, we can expect the OIS rate to increase rather than decrease. In fact market participants could revise their expectation about future policies needed to keep spreads low. In particular they will revise their expectation about future OIS rates upwards, this will drive up long term OIS rates. Moreover, a successful reduction of risk premia could induce the market to revise their expectations about future real economic activity upwards and therefore long term OIS rates.
  This is what we observe on the 6^{th} September 2012, when the details of the Outright Monetary Transactions (OMT) were announced by the ECB: a large reduction in the risk premium on Italian bonds associated to an increase in long term OIS risk free rate, as we can see from Table 7. [3]

[2]Notice that we refer to the OIS yield curve as the risk-free yield curve. Obviously this definition is not completely appropriate, as long term OIS commands a risk premium as they incorporate some duration risk. A better definition would be the default/redenomination risk free yield curve.

[3]The actual OMT announcement took place on the 2^{nd} August 2012. This is actually quite a peculiar case

[Table 3 about here.]

To sum up, we expect to observe a positive co-movement of long term OIS rate and the risk premium when a "classic" *monetary shock* hits, a negative co-movement when the *spread shock* is instead hitting.

Notice that by not taking into account the *spread shock* we might possibly incur into two kinds of problems. First, if one is interested in estimating the effects of "classic" monetary policy on the risk premia, the omission of the reverse effect of the "spread" shock on the risk free rate leads to underestimate the true effects. Second, even if we abstract from the periphery risk premia, using OIS rates surprises, or the factors constructed by Altavilla et al. (2019) from the OIS yield curve, as measures of monetary policy shocks could lead to systematic biased results when the "spread shock" is hitting. For instance, we would interpret an increase in the long term OIS rate as a restrictive monetary policy shock, while this can be the result of an "expansionary' spread shock", that is a reduction in the risk premium. This can in turn lead to biases in the estimates of the effect of monetary policy shocks on e.g. real economic activity and inflation. Given the short life of the Euro Area and the high importance played by unconventional MP in its lifetime span, this appears to be a relevant issue.

4 Extracting multiple factors from high-frequency surprises

To identify the multiple shocks affecting HF surprises around ECB announcements and evaluate their dynamic effects on macro and financial variables, we use a two-step identification procedure. First we use HF data to extract different orthogonal proxies for the different shocks, which we use later in a second step as external instruments in a proxy-SVAR. In this section we explain the first step.

because the OMT announcement has been initially interpreted as a decision that the ECB was not willing to protect countries in trouble. This is why we see a steep increase in the risk premium. This initial reaction was then counterbalanced in the subsequent days. What is interesting for us, though, is that this "restrictive" spread shock, is linked to a decrease in the OIS rate, as expected (see Table 7). "Il Sole 24 ore", the main financial newspaper in Italy, comments market reactions on August 3^{rd} by saying: "In the current situation, with high spreads and highly fragmented markets, the effects of monetary policy do not transmit to the whole Eurozone." In other words, the easing monetary policy, measured by the reduction in OIS rates, does not spill over to the Italian risk premium. Is it the case, or is it the other way round, i.e. the restrictive shock on Italian spread, measured by an increase in the latter, spilled over to OIS rates, reducing them? We want to explore this second interpretation. Another example is 26^{th} July 2012, the day the famous "whatever it takes" speech was carried out by Mario Draghi. That day we observe a large decrease in the periphery spreads, while the 10-year OIS rate increased, as expected in response to a spread driven monetary policy shock.

First, we ignore the possible presence of a *spread shock* and assume two shocks affect the OIS yield curve in the narrow window around ECB press conferences: a *monetary shock* and an *information shock*. We therefore follow an approach similar to Andrade and Ferroni (2019) and Jarocinski and Karadi (2019) to extract two proxies for these two shocks. Later on we will account for a third *spread shock*.

We collect in the vector δ_t the high-frequency variations around press conference of OIS rates at 3-month 1,2,5,10 years maturity and of the STOXX50 index. We then assume this vector δ_t is explained by two factors, collected in f_t, and consider:

$$\underset{5\times 1}{\delta_t} = \underset{5\times 2}{\Lambda}\underset{2\times 1}{f_t} + \underset{5\times 1}{e_t} \tag{1}$$

where Λ is the matrix of factor loadings. In the matrix form:

$$\underset{T\times 5}{\Delta} = \underset{T\times 2}{F}\ \underset{2\times 5}{\Lambda'} + \underset{T\times 5}{e} \tag{2}$$

Equation (2) is still valid for any orthonormal matrix $\underset{2\times 2}{H}$ such that:

$$\Delta = (FH)(\Lambda H)' + \varepsilon = F^*\Lambda^* + e \tag{3}$$

where the orthonormal matrix H rotates the factor and changes the loadings accordingly. We select H, among the infinite possible orthonormal matrices, such that the following sign restrictions are satisfied:

$$\begin{bmatrix} \Delta OIS_{3m,t} \\ \Delta OIS_{1y,t} \\ \Delta OIS_{2y,t} \\ \Delta OIS_{5y,t} \\ \Delta OIS_{10y,t} \\ \Delta STOXX50_t \end{bmatrix} = \begin{bmatrix} + & + \\ + & + \\ + & + \\ + & + \\ + & + \\ - & + \end{bmatrix} \begin{bmatrix} f_{monetary,t} \\ f_{info,t} \end{bmatrix} \tag{4}$$

In practice, we are forcing the monetary factor to load positively both on the OIS yield curve and negatively on the STOXX50, while the information factor loads positively both on the OIS yield curve and the STOXX50.

Figure 2 depicts the loadings of the two factors on the OIS yield curve. Not surprisingly, the information factor loads mainly on the 1-2 years segment of the yield curve. Figure 4 depicts the estimated factors.

[Figure 2 about here.]

[Figure 3 about here.]

[Figure 4 about here.]

If we look at Figure 3 we see that the monetary factor loads in opposite directions on the OIS and on the spread IT-OIS yield curve, i.e. a positive value of the monetary factor (a restrictive policy) is associated with a decrease in the spread IT-OIS. Moreover, the estimated information factor however does not load significantly on the spread curve. These results show that accounting for an information shock is not enough to describe the puzzle explained in section 2. We need therefore to introduce a third shock into the picture.

We augment the vector δ_t with the variations around ECB press conferences in spread IT-OIS yield curve (2,5,10 maturity) and the vectors of factors with the new *spread factor*. Therefore we have:

$$\underset{T\times 8}{\Delta} = \underset{T\times 3}{F} \underset{3\times 5}{\Lambda'} + \underset{T\times 8}{e} \tag{5}$$

Table 4 summarizes the assumed signs of the loadings of the three factors of the high-frequency variations contained in vector δ_t. Equation (4) then changes to:

$$\begin{bmatrix} \Delta OIS_{3m,t} \\ \Delta OIS_{1y,t} \\ \Delta OIS_{2y,t} \\ \Delta OIS_{5y,t} \\ \Delta OIS_{10y,t} \\ \Delta IT - OIS_{2y,t} \\ \Delta IT - OIS_{5y,t} \\ \Delta IT - OIS_{10y,t} \\ \Delta STOXX50_t \end{bmatrix} = \begin{bmatrix} + & + & + \\ + & + & + \\ + & + & + \\ + & + & + \\ + & + & + \\ + & - & - \\ + & - & - \\ + & - & - \\ - & + & + \end{bmatrix} \begin{bmatrix} f_{monetary,t} \\ f_{info,t} \\ f_{spread,t} \end{bmatrix} \tag{6}$$

[Table 4 about here.]

An issue comes from the fact that the signs imposed to identify the information and the spread factors are the same. This causes an identification problem that we solve in two ways. First, we impose that the variance of the spread factor during the crisis (2010-2014) is at least 3 times larger that outside this time span. [4] Second, we impose that the loadings of the spread factor on the IT-OIS spread curve to be larger (in absolute value) than the loadings of the information factor on the spread curve. Figure 5 plots the estimated factors using these restrictions. Figures 6 and 7 depict factor loadings on the OIS and the spread IT-OIS curves.

[Figure 5 about here.]

[Figure 6 about here.]

[4] Clearly the choice of 3 as a threshold is quite arbitrary, so in the appendix we check how results are robust to this choice.

[Figure 7 about here.]

We will use the estimated factors as external instrument in a proxy-SVAR. Notice again how the methodology we apply differs from that of Jarocinski and Karadi (2019), which estimate the latent factors by imposing sign restrictions directly in the structural parameters of a bayesian proxy-SVAR. In a frequentist approach this would mean obtaining set identification instead of point identification and related confidence intervals. By using sign restrictions only in the constructions of the external instruments we instead can obtain standard point identification in the proxy-SVAR. In this regard we are closer to Andrade and Ferroni (2019), though they use daily variations in the inflation-linked-swap rates to disentangle monetary and information shocks, while we exploit higher-frequency variations in the STOXX50 index.

5 Financial SVAR

We trace out the dynamic causal effects of the three shocks by using them as external instruments in a proxy-SVAR, following the methodology of Gertler and Karadi (2015),Mertens and O. Ravn (2013),Stock and Watson (2012), Stock and Watson (2018), and compare the obtained impulse responses to those obtained when ignoring the *spread shock*. We start by estimating a financial SVAR at daily frequency.

Our set of endogenous variables contains the 5-year sovereign AAA-rates yield, constructed by the ECB by averaging yields from Euro Area sovereign rates with triple A rating; the 10-year spread IT-OIS; the log of the STOXX50 index; the 2-year inflation-linked swap rate; the log of the Eur-Usd exchange rate. This set of variables is very similar to that used by Altavilla et al. (2019). We estimate the reduced form VAR using three lags and allowing for a deterministic trend.

We then estimate a proxy-SVAR separately for each shock, by using the factors extracted in the previous section as external instruments for the reduced form innovation of the policy indicator equation. Notice that for the monetary shock and the information shock we use the 5-year AAA rate as the relevant policy indicator, while for the spread shock we use the 10-year IT-OIS spread.

Figure 8 compares the estimated responses to a monetary shock, when using the three factors decomposition for obtaining the instrument and when using only two factors, thus ignoring the spread shock. We obtain the expected response of the IT-OIS spread, which reacts to a monetary shock which lowers by 10bp the 5-year risk-free rate by decreasing by the same magnitude. The effect is quite persistent and lasts almost 1 year. In the right column, where the spread shock is ignored, the spread reacts in the opposite way at the beginning, then the effect is insignificant. Interestingly, in both cases the 2-year inflation-linked swap rate does not react significantly. Suggesting this type of unconventional policies have struggled to move inflation expectations.

Figure 9 compares in the same fashion the responses to a negative information shock, normalized to lower by 10bp the 5-year risk-free rate. Quite surprisingly, the increase in the spread IT-OIS

is much higher (20bp) when the spread shock is taken into account than when it is ignored (5bp increase). A negative information shock is estimated to reduce inflation expectations in both cases, but the magnitude of the effect is decreased when including the spread shock.
Finally, Figure 10 plots the responses from the estimated spread shock, normalized to lower the IT-OIS spread by 10bp. The shock is estimated to have no significant effect on the stock index and on inflation expectations.

[Figure 8 about here.]

[Figure 9 about here.]

[Figure 10 about here.]

6 Macroeconomic effects of policy shocks.

We turn now to the identification of the macroeconomic effects of the newly identified *spread shock*, which is meant to be a synthetic measure of all the policies implemented by the ECB aimed at controlling the risk premium on peripheral countries debt. As explained in Foroni and Marcellino (2016), estimating a low-frequency VAR on time series obtained by aggregating high-frequency data generated by an high-frequency DGP creates important problem for identification. We think this is the case in our application, as the shock is estimated at daily frequency. Macro variables are instead observed at monthly frequency, so we need to aggregate the shock. In this regard we will follow the approach of Gertler and Karadi (2015): each observation of the proxy for the shock is assumed to last 30 days, or less if a press conference is held before. We then take the monthly average of the resulting daily series to get the monthly proxy. To avoid incurring in the issues explained by Foroni and Marcellino (2016), we estimate the dynamic causal effects of the spread shock by running local projections (Jordà (2005)), using the estimated spread factor as an external instrument.
We run local projections using as endogenous variables: the 5-year ECB AAA rate (monthly average), the 10-year spread IT-OIS, the log of the Euro Area industrial production index (excluding construction), the log of the STOXX50 index, the log of the HICP index, the CISS index of uncertainty constructed by the ECB and the IMF index of commodities prices.[5] We estimate local projections regressions using 12 lags and allowing for a time trend.
Figure 13 shows estimated impulse responses to a spread shock, normalized to lower the the 10-year spread IT-OIS by 10 basis points on impact. The estimated reduction in the Italian risk premium is quite short-lived (10 months) and it is accompanied by an increase in the 5-year AAA rate of similar duration. The shock causes a significant increase in output and a persistent increase in the

[5]This set of variables is more or less the same used by Baumgärtner and Klose (2019)

price index. This latter result is particularly interesting as for the other two shocks we struggle to detect the expected transmission to inflation, as we can see from figures 11 and 12. In particular we estimate a quite strikingly persistent decline in consumer prices following an expansionary monetary shock normalized to lower the 5-year AAA rate by 10 basis points. These results confirms the idea that policies like the QE have struggled to inflate the economy.

[Figure 11 about here.]

[Figure 12 about here.]

[Figure 13 about here.]

7 Conclusion

When looking at high-frequency co-movement of long term OIS rates and Euro Area peripheral countries risk premia around ECB press conferences we detect a puzzle as the expected positive correlation is not there. The puzzle cannot be resolved by allowing for a central bank information type of shock. We solve the puzzle by allowing for a third shock, called a *spread shock*, which results from the ECB directly affecting risk premia of EA periphery and only indirectly long term OIS rates. This procedure allows us to separately identify:

- A monetary shock, meant to capture all unconventional policies/announcement aimed at reducing the long term risk-free rate, measured by OIS rate.
- An information shock, in the spirit of Nakamura and Steinsson (2018).
- A novel spread shock, which synthesizes all policies/announcements by the ECB aimed at reducing pressures on the risk premia on peripheral countries.

We have shown this third type of shock has significant effect on relevant Euro-Area macroeconomic variables and seems to have been more effective than the other two types of shocks in boosting inflation in the Eurozone.

References

Altavilla, C., Brugnolini, L., Gurkaynak, R. S., Motto, R., and Ragusa, G. (2019). Measuring Euro Area Monetary Policy.

Altavilla, C., Carboni, G., and Motto, R. (2015). Asset purchase programmes and financial markets: lessons from the euro area. *ECB Working Paper Series*.

Altavilla, C., Pagano, M., and Simonelli, S. (2016). Bank exposures and sovereign stress transmission. (ECB Working Paper 1969):1–64.

Andrade, P. and Ferroni, F. (2019). Delphic and Odyssean monetary policy shocks: Evidence from the euro area.

Baumgärtner, M. and Klose, J. (2019). Cash is King - Effects of ECB's Conventional and Unconventional Measures.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? *Handbook of Macroeconomics*, 1:65–148.

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

Crosignani, M., Faria-e Castro, M., and Fonseca, L. (2019). The (Unintended?) consequences of the largest liquidity injection ever. *Journal of Monetary Economics*.

De Grauwe, P. (2011). The Governance of a Fragile Eurozone.

Foroni, C. and Marcellino, M. (2016). Mixed frequency structural vector auto-regressive models. *Journal of the Royal Statistical Society.*, 179(2):403–425.

Gambacorta, L., Hofmann, B., and Peersman, G. (2014). The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis. *Journal of Money, Credit and Banking*, 46(4):615–642.

Gambetti, L. and Musso, A. (2017). The effects of the ECB's Expanded Asset Purchase Programme.

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

Gürkaynak, R. S., Sack, B., and Swanson, E. (2005). The sensitivity of long-term interest rates to economic news: Evidence and implications for macroeconomic models. *American Economic Review*, 95(1):425–436.

Hachula, M., Piffer, M., and Rieth, M. (2019). Unconventional Monetary Policy, Fiscal Side Effects and Euro Area (Im)balances. *Journal of European Economic Association*, 0(0):1–30.

Jarocinski, M. and Karadi, P. (2019). Deconstructing Monetary Policy Surprises: The Role of Information Shocks. *American Economic Journal: Macroeconomics*.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1):161–182.

Krishnamurthy, A., Nagel, S., and Vissing-Jorgensen, A. (2018). ECB Policies Involving Government Bond Purchases: Impact and Channels. *Review of Finance*, 22(1):1–44.

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

Mertens, K. and O. Ravn, M. (2013). The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States. *American Economic Review*, 103(4):1212–1247.

Nakamura, E. and Steinsson, J. (2018). High-frequency identification of monetary non-neutrality: The information effect. *Quarterly Journal of Economics*, 133(3):1283–1330.

Rossi, B. (2019). Identifying and Estimating the Effects of Unconventional Monetary Policy in the Data : How to Do It And What Have We Learned ?

Stock, J. H. and Watson, M. W. (2012). Disentangling the Channels of the 2007–09 Recession. *Brookings Papers on Economic Activity*.

Stock, J. H. and Watson, M. W. (2018). Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments. *Economic Journal*, 128(610):917–948.

Swanson, E. T. (2017). Measuring the effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets.

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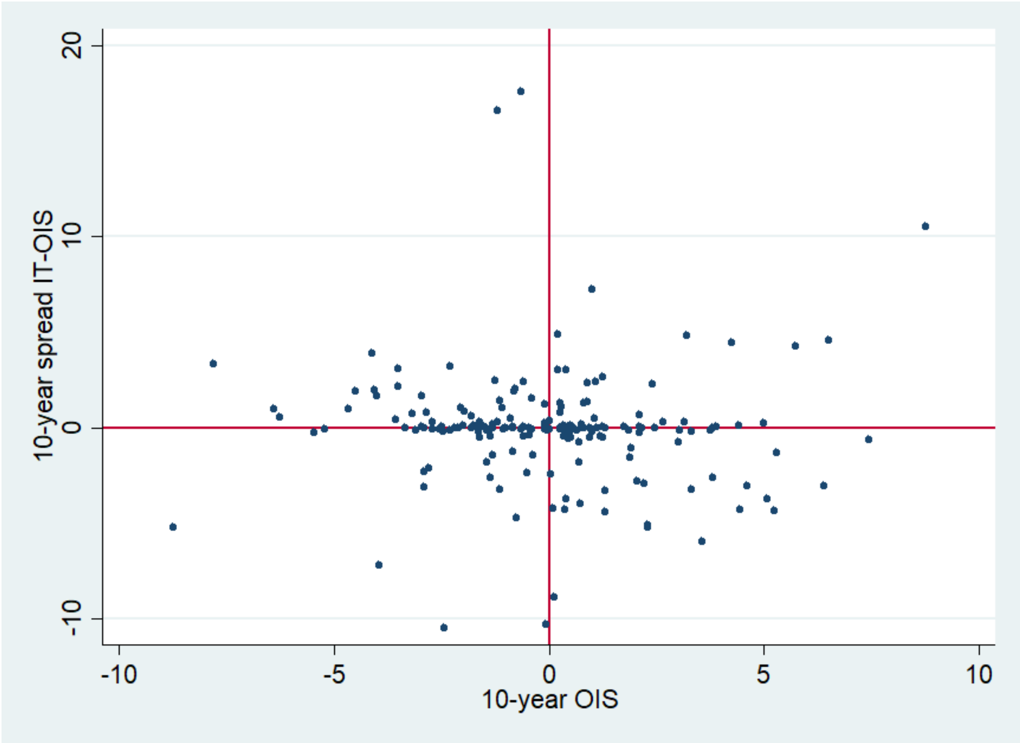

Figure 1: Scatter plot of surprises in 5-year OIS rate and 10-year ITA-OIS spread around ECB press conferences.

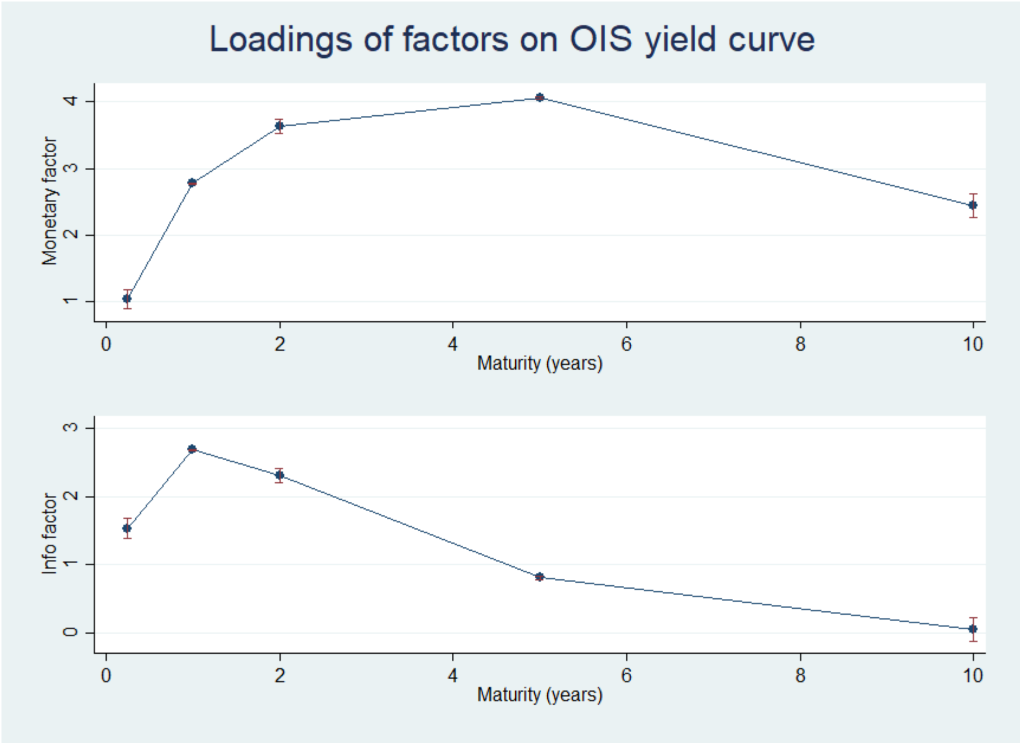

Figure 2: Monetary and information factor loadings, obtained by regressing OIS variations on the two factors. Red bands show 95% confidence intervals.

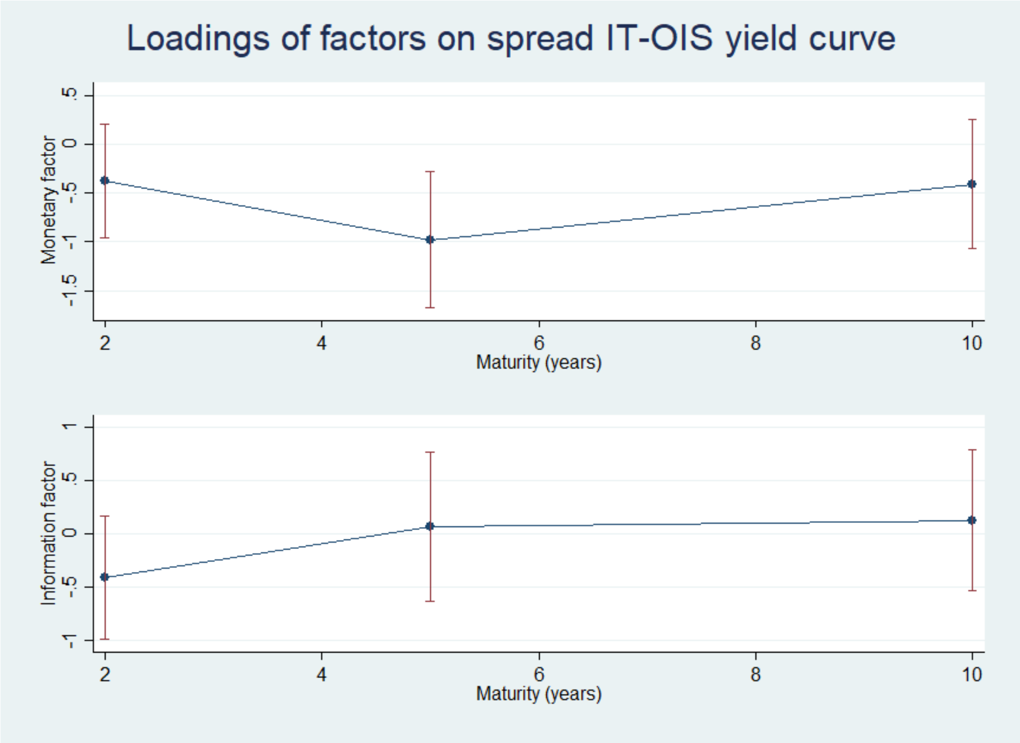

Figure 3: Monetary and information factor loadings, obtained by regressing spread IT-OIS variations on the two factors. Red bands show 95% confidence intervals.

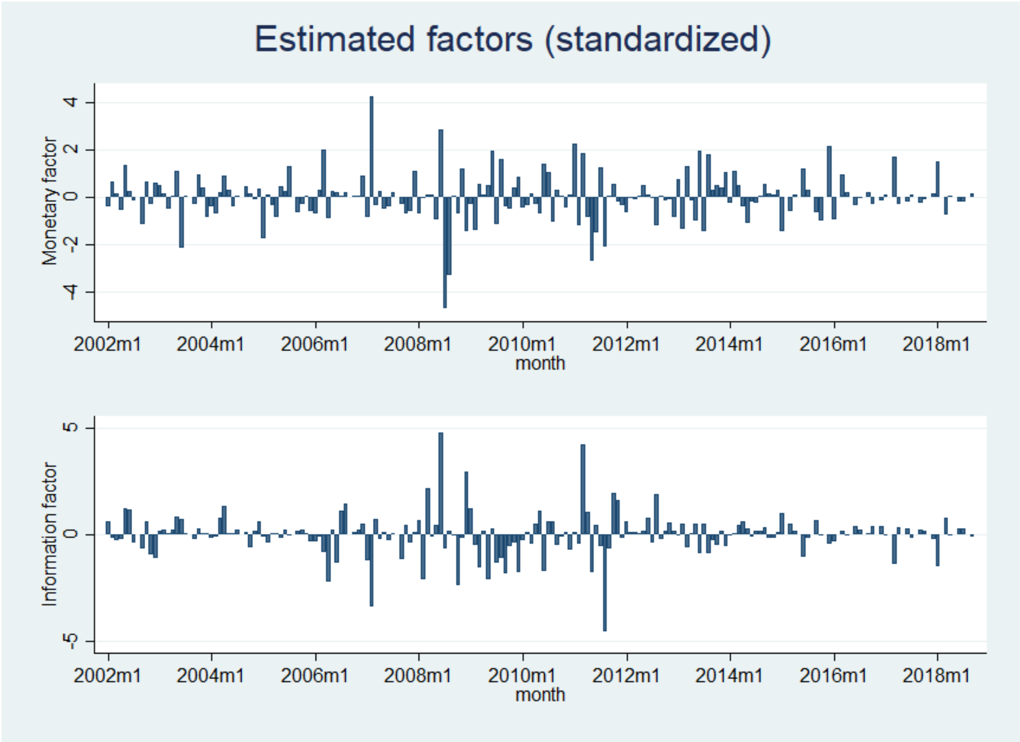

Figure 4: Estimated monetary and information factors over the sample. Factors are standardized to have zero mean and unit variance.

Figure 5: Estimated monetary, information and spread factors over the sample. Factors are standardized to have zero mean and unit variance.

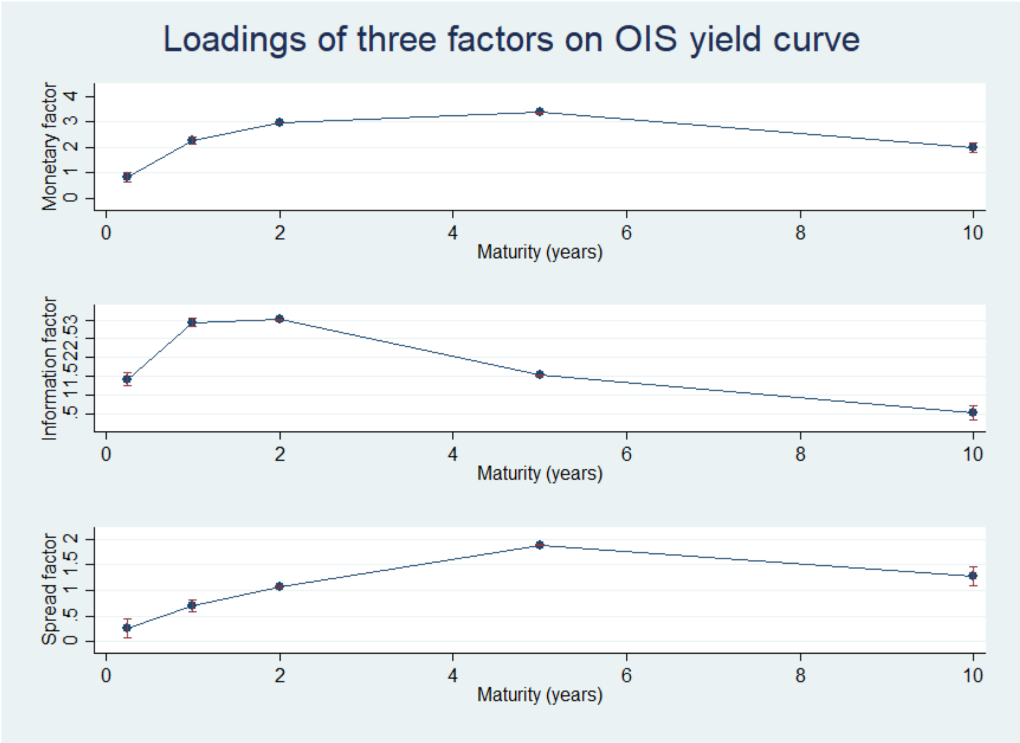

Figure 6: Monetary, information and spread factor loadings, obtained by regressing OIS variations on the three factors. Red bands show 95% confidence intervals.

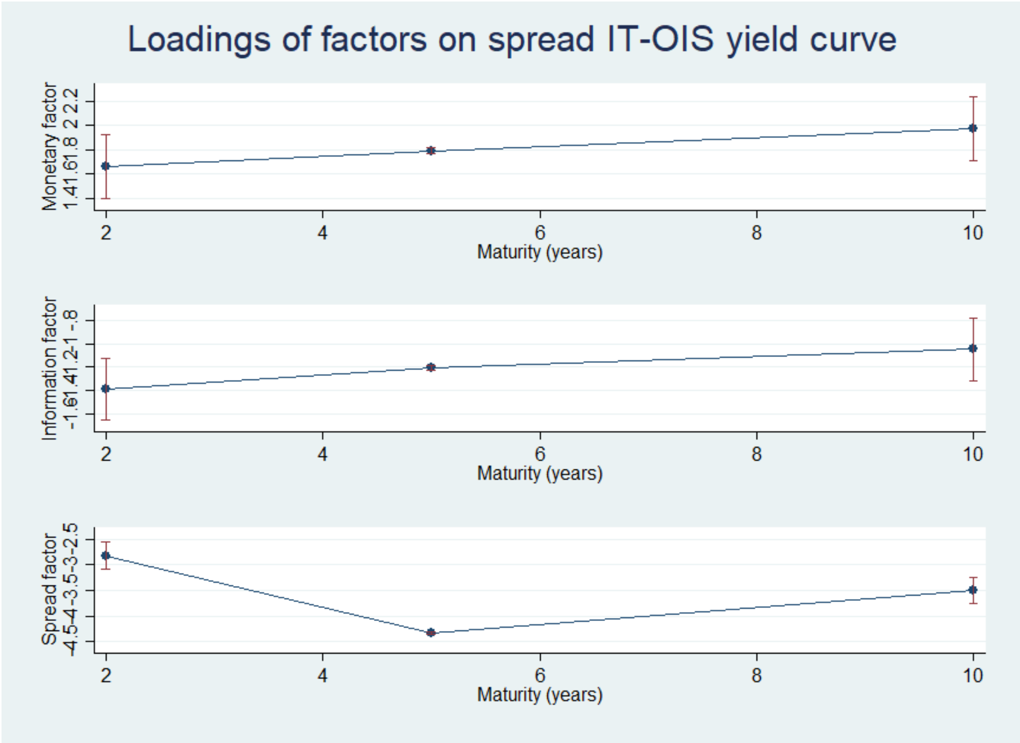

Figure 7: Monetary, information and spread factor loadings, obtained by regressing spread IT-OIS variations on the three factors. Red bands show 95% confidence intervals.

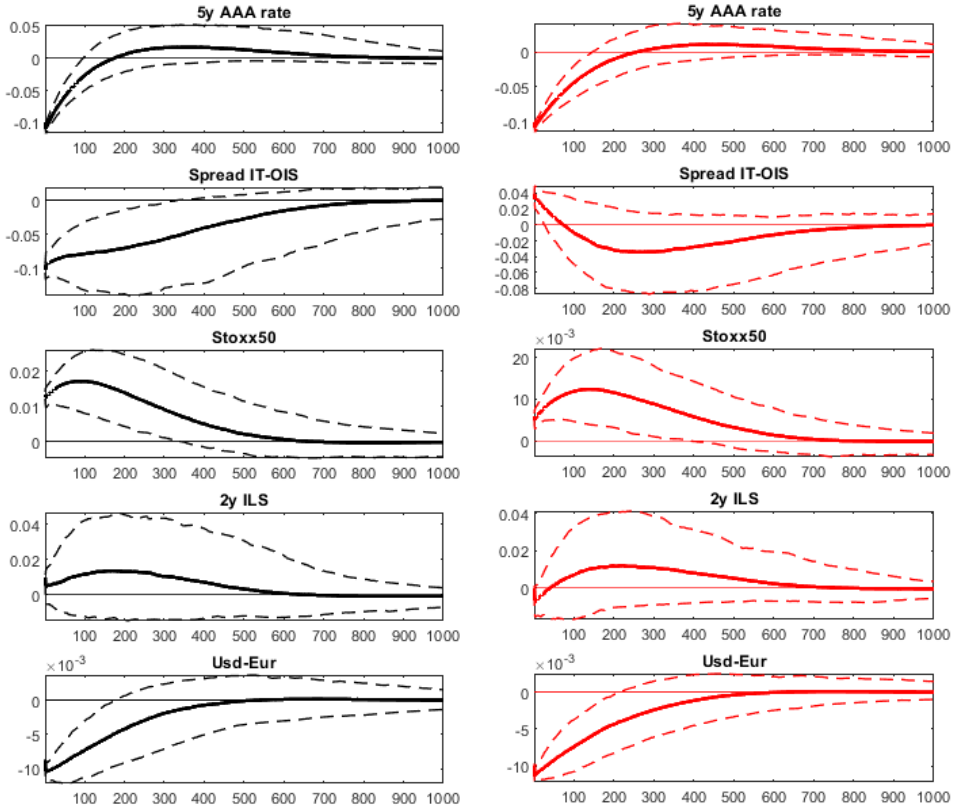

Figure 8: Estimated impulse responses to a monetary shock, taking into account the spread shock (left figure, black) and ignoring it (right figure, red). Dotted lines depict 90% bootstrap confidence intervals.

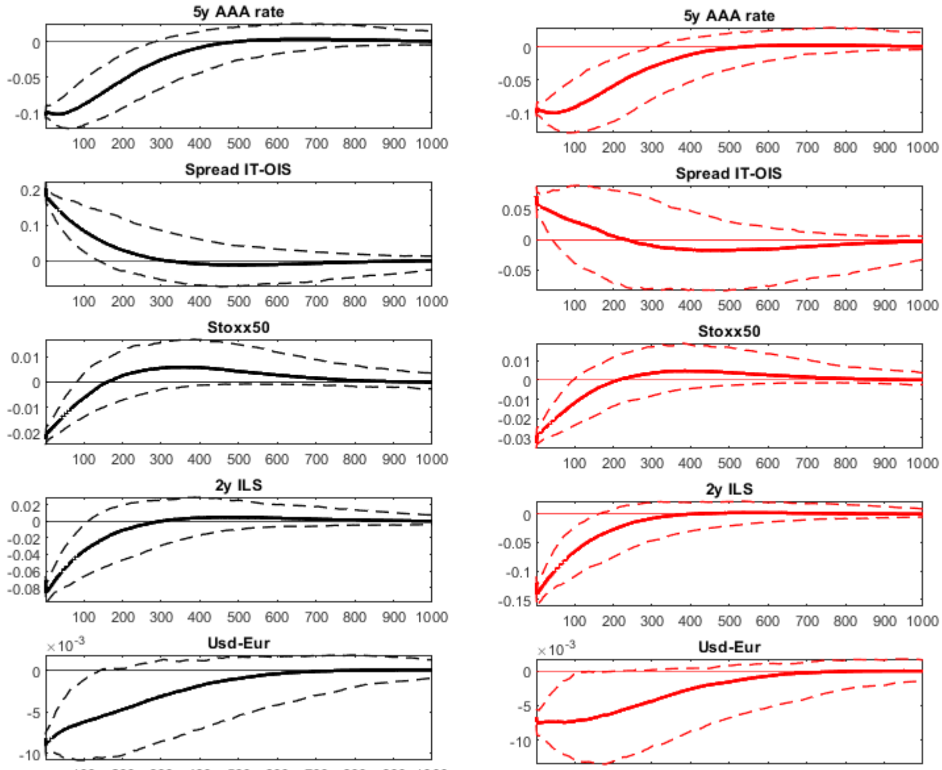

Figure 9: Estimated impulse responses to a information shock, taking into account the spread shock (left figure, black) and ignoring it (right figure, red). Dotted lines depict 90% bootstrap confidence intervals.

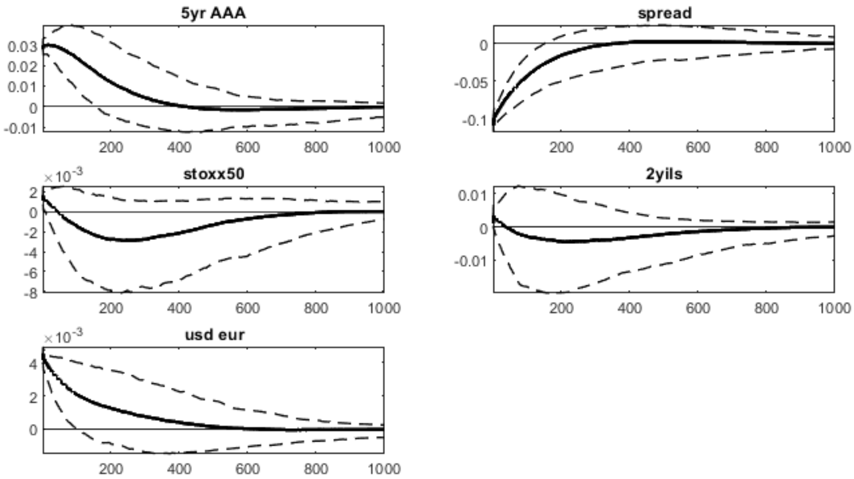

Figure 10: Estimated impulse responses to a spread shock. Dotted lines depict 90% bootstrap confidence intervals.

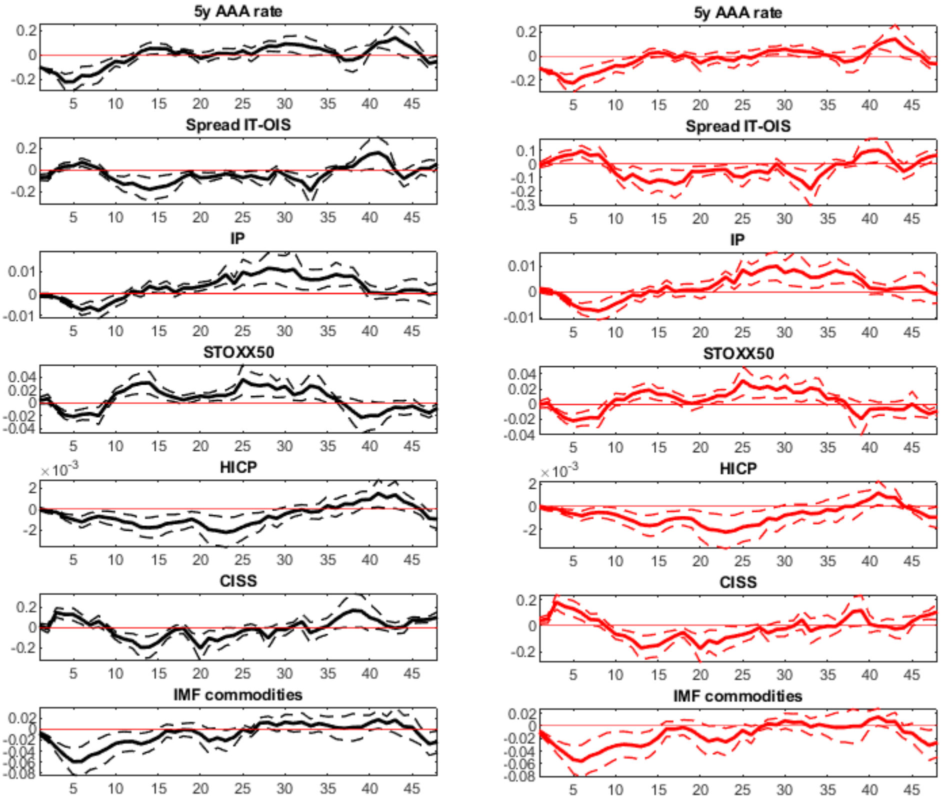

Figure 11: Estimated impulse responses to a monetary shock, taking into account the spread shock (left figure, black) and ignoring it (right figure, red). Dotted lines depict 95% robust confidence intervals.

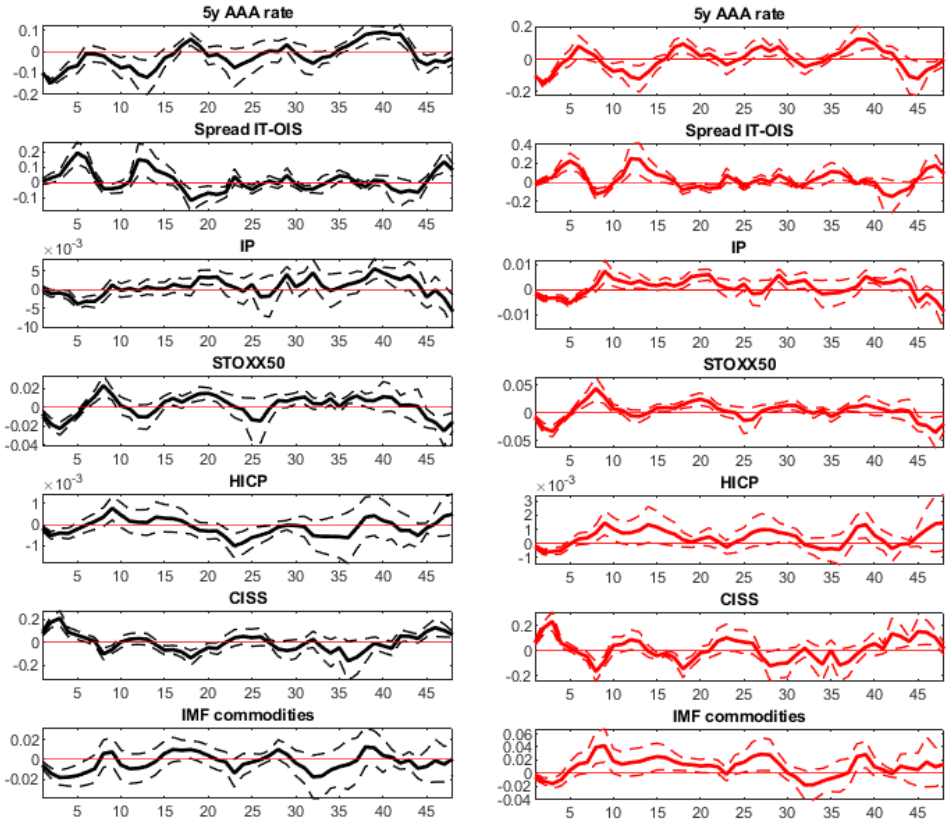

Figure 12: Estimated impulse responses to a information shock, taking into account the spread shock (left figure, black) and ignoring it (right figure, red). Dotted lines depict 95% robust confidence intervals.

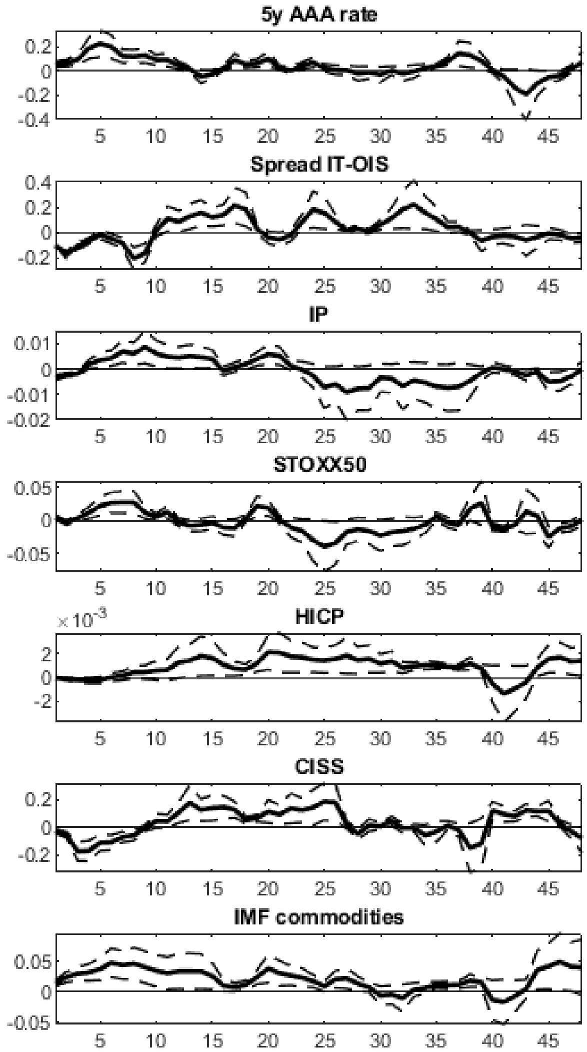

Figure 13: Estimated impulse responses to a spread shock. Dotted lines depict 95% robust confidence intervals.

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	FULL SAMPLE	PRE08 (2002-07)	CRISIS (2008-13)	QE (2014-18)
10-year OIS	-0.216	-0.026	-0.736**	0.687***
	(0.1232)	(0.0131)	(0.2427)	(0.1422)
constant	0.147	-0.076**	0.600	-0.511
	(0.3348)	(0.0281)	(0.7513)	(0.4059)
N	181	67	72	42
R2	0.02	0.06	0.12	0.37

Table 1: Dependent variable: 10-year spread ITA-OIS, surprises during ECB press-conference. Standard errors in parenthesis. $*p < 0.05, **p < 0.01, ***p < 0.001$.

	FULL SAMPLE	PRE08 (2002-07)	CRISIS (2008-13)	QE (2014-18)
10-year OIS	-0.101	-0.02*	-0.611**	0.778***
	(0.108)	(0.009)	(0.212)	(0.144)
constant	-0.114	-0.0503*	0.454	-1.111*
	(0.328)	(0.022)	(0.723)	(0.471)
N	181	67	72	42
R2	0.005	0.067	0.105	0.422

Table 2: Dependent variable: 10-year spread ITA-OIS, surprises during ECB monetary events. Standard errors in parenthesis. $*p < 0.05, **p < 0.01, ***p < 0.001$.

	10-year OIS surprise	10-year ITA-OIS surprise
6^{th} September 2012: OMT announcement	0.12	-8.87
2^{nd} August 2012: OMT announcement	-6.09	38
22^{th} January 2015: QE announcement	-8.74	-14

Table 3: Surprises around ECB press conferences in the 10-year OIS rate and in the 10-year spread ITA-OIS on two relevant dates. Variations in basis points.

	Monetary factor	Info factor	Spread factor ($Var_{10-14} >> Var_{08-10,14-18}$)
OIS yield curve	$+$	$+$	$+$
Spread IT-OIS curve	$+$	$-$	$--$
STOXX50	$-$	$+$	$+$

Table 4: Sign restrictions for 3-factors rotation.