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Quantitative Easing in a fragmented Bond Market: core and periphery transmission channels.

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Abstract

We study how the Asset Purchase Program (APP) of the ECB affected core and periphery specific components of sovereign yields, using a novel proxy-SVAR specification. We identify a persistent increase in the convenience yield associated to safe German bonds in response to the identified APP shock. Through a decomposition exercise of the estimated impulse responses, we argue that this "convenience yield" effect has partially offset the expansionary effect produced by the reduction in the common component of long-term yields of the euro area. This result is achieved by estimating a flexible proxy-SVAR which permits to isolate different components of a single structural shock.

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1 Introduction

After reaching the Effective-Lower-Bound (ELB)[1] major central banks had to resort to unconventional monetary policies to keep stimulating the economy, thereby focusing on affecting long term rates directly, instead of adjusting short term policy rates. After other central banks, the ECB as well started a Quantitative Easing (QE) program in 2015, the Asset Purchase Program (APP), which involved the purchase of long term sovereign bonds. Purchases were split across euro area countries according to their economic size. The peculiarity of QE in the euro area relates to the fragmentation of its sovereign bond market, with different yield curves across different countries, the main distinction being between core countries (whose sovereign debt is considered safe) and peripheral countries (whose debt is considered risky).

Fragmentation posed peculiar challenges to the ECB, which faced the dilemma on how should its policies affect country-specific components and common components of sovereign yields. Should the ECB have focused on reducing the sovereign spreads on peripheral countries' yields or was it more important to reduce the Eurozone-wide long term yield? Moreover, did the purchase of core sovereign debt contribute to an increase in its scarcity, making it more expensive to safely store liquidity in the euro area? (Courè, 2017) This is a relevant issue, because a scarcity of safe assets could impede economic activity, as in Caballero and Farhi (2018).

To address this question we use Overnight Indexed Swap (OIS) rates as a measure of the euro area common component of sovereign rates and build a *periphery risk premium* and a *core safety premium*, or *convenience yield*. Throughout the paper, we will use Italy and Spain as representatives of peripheral countries and Germany for core countries.[2] We include the two yield premia in a proxy-SVARs estimated at daily and monthly frequency to evaluate the effects of APP on these different components of sovereign rates. Results show that the APP announcements significantly increases the spread between long term OIS rates and the corresponding German rates (a measure of the convenience yield) and seems weaker in reducing the spread between peripheral yields and OIS rates (a measure of the risk premium). This result raises some questions on the optimality of the design of APP in the euro area. In fact an increase in the expensiveness of safe sovereign debt in the Eurozone could have impeded the transmission of expansionary measures to economic activity.

To verify this hypothesis we re-estimate the monthly proxy-SVAR using an innovative methodology, employing the AC-SVAR model developed by Angelini and Fanelli (2019) in a AB-SVAR framework (Amisano and Giannini, 1997). This strategy allows us to disentangle different channels of the transmission of the APP shock to euro area economic activity, related to the effects produced, respectively, on the three components of sovereign rates: the common component, the peripheral risk premium and the core convenience yield. Through this empirical analysis we identify a contractionary component in the APP shock, which partially offsets the overall expansionary effect. We interpret this contractionary channel as resulting from the scarcity effect induced by the large purchases of safe German bonds, which made them more expensive. On the contrary the more

[1] Interest rates are in theory subject to a Zero-Lower-Bound. In practice, however, interest rates may enter into the negative territory, even though they are still bounded from below, hence the term Effective-Lower-Bound is more appropriate.

[2] Italy and Spain together account for more than of 80% the total GDP of the periphery; Germany is by far the biggest core country and considered the safe heaven par excellence, thus for the purposes of this paper we consider this choice as an appropriate approximation.

expansionary channel is estimated to be the reduction in long-term risk free OIS rates, while the reduction in peripheral sovereign spreads is found to play a negligible role for the transmission of APP to euro area economic activity.

This paper contributes to several strands of the literature. First of all our identification strategy constitutes a novelty in the related econometric literature: to the best of our knowledge, this is the first paper to separately identify the matrices A and B in a proxy-SVAR, in particular in the monetary policy literature. We thus contribute to the existing literature on proxy-SVARs, which has recently developed quite intensively. Stock and Watson (2018) provide a comprehensive analysis of the use of external instrument for identifying structural macroeconomic shocks. Gertler and Karadi (2015) shows how to use external instruments to estimate monetary shocks within SVARs. Angelini and Fanelli (2019) provide a framework in which the use of external instruments not only makes a partial identification possible, but helps the researcher in the identification of the full matrix of structural parameters. The number of *a priori* restrictions needed to obtain this full identification is lower than what it would be without the use of the external instrument. To obtain this result they augment the SVAR with the instrument, instead of using it in an IV setup to estimate the structural parameters of interest.

Moreover, this paper contributes to the large literature on the effects of central banks large scale asset purchases on real and financial variables. Regarding the Asset Purchase Program of the ECB the literature is more limited as it started years after other major central banks. Still, there are already many studies addressing the topic; outstanding examples areAltavilla *et al.* (2015), Andrade *et al.* (2016),Gambetti and Musso (2020) and Altavilla *et al.* (2019).

Finally, our paper addresses the topic of the effects of QE in a fragmented bond market and its possible unintended consequences. It thus relates to the literature focusing especially on possible scarcity effects of the program on the pool of safe sovereign bonds. Aggarwal *et al.* (2020) for instance study the effects of ECB measures on safe asset scarcity, in particular the securities lending program launched in 2016 to overcome possible side-effects of the APP. They however have in mind a "short term" definition of safe asset scarcity, while here we employ a "long term" measure which detects the expensiveness of safe assets with respect to a reference risk-free rate. In this way we can analyze as well the persistence of any scarcity-effect. To the best of our knowledge this is the first paper to identify a persistent scarcity-effect of QE and to quantify its role in mitigating the expansionary effects of the purchase program.

The rest of the paper proceeds as follows. In section 2 we formalize the relationship between QE and safe assets' scarcity. In Section 3 we estimate a daily proxy-SVAR to estimate the effects of APP on the different components of sovereign rates and a monthly proxy-SVAR to identify the macroeconomic effects of APP. In Section 4 we isolate the different channels of APP using the AB-proxy-SVAR methodology. In Section 5 we provide some concluding remarks. Appendix A explains in details the methodology employed to identify the APP shock in proxy-SVARs. Appendix B explains in details how we manage to isolate the different transmission channels of APP in Section 4.

2 QE and safe asset scarcity

The aim of QE is to lower the long term yield, in order to boost investment and economic activity. There is a large literature investigating the possible channels through which QE can affect long term yields (Krishnamurthy and Vissing-Jorgensen, 2011, see e.g.). The main channels are two. Through the *signaling channel* the central bank is affecting the expectations about the future path of conventional monetary policy: by implementing the QE the central bank displays to market participants its will to commit to an expansionary monetary policy for a long period of time. This is akin to a forward guidance policy, but the commitment is stronger with QE, as by keeping long term bonds in its balance sheet the central bank exposes itself to duration risk, hence it would suffer a loss from any future increase in the short term rate.

Through the *portfolio rebalancing channel* the central bank can directly affect the prices of the securities purchased, by a reduction in the risk premia. For this channel to operate, some form of segmentation à la Vayanos and Vila (2021) should exist along the yield curve. In this way the price of risk can be affected by central bank purchases, which alter the demand/supply in the bond market.

We are interested in understanding how heterogeneous has been the impact of the APP on euro area sovereign bond markets, considering a core/periphery dichotomy. This is important in order to provide an ex-post evaluation on the way the APP was designed, in particular on how the purchases of government bonds were split among Eurozone countries. The ECB purchased sovereign bonds from the different countries according to their capital key, that is according to the GDP of the countries. This is clearly a design aimed at focusing on the Eurozone-wide component of yields. We ask whether this was optimal for the final transmission of QE to economic activity. In other words: would have been more effective to focus on reducing country specific risk premia? A second question relates to the issue of safe assets scarcity: did the APP actually alleviate or worsen the scarcity of safe sovereign bonds in the euro area? Again this question relates to how the APP was designed, involving the purchase of very large amount of core countries' sovereign debt.

To analyze how QE affects long term yields across euro area countries, let us decompose the yield on a zero-coupon bond with residual maturity M, issued by country j as follows:

$$y_{t,M,j} = E_t\left[\sum_{i=1}^{M} r_{t+M}\right] + tp_{t,M} + cp_{t,j,M} \qquad (1)$$

where r_t is the ECB short term rate, $tp_{t,M}$ is the term premium and $cp_{t,j,M}$ is the country-specific premium. QE can affect all these 3 components of a long term yield, through several channels. By the *signaling channel*, QE is a way through which the central bank commits to keep short term rates low for a long period of time, thus influencing the first component of $y_{t,M,j}$, the *expectation hypothesis* component. The term premium $tp_{t,M}$ can be affected through the *portfolio re-balancing channel*, by which QE affects the price of duration risk. These first two components are common across all euro area countries, since they are linked to the short term rate set at euro area level.

$cp_{t,j,M}$ is a country specific premium which could be either positive or negative. A positive premium should be interpreted as deriving from a country specific default/re-denomination risk, which is the case for countries of euro area periphery. A negative premium on the contrary can be interpreted as a *convenience yield* on the safest sovereign bonds, for which there is a specific demand as it serves the purpose of a safe asset, or quasi-money (Gorton, 2017).

We measure the common euro area component using Overnight Indexed Swap rates, that is expected to be a proxy for the first two components of $y_{t,M,j}$ in (1):

$$OIS_{t,M} = E_t\left[\sum_{i=1}^{M} r_{t+M}\right] + tp_{t,M} \tag{2}$$

By taking spreads of sovereign bonds versus the OIS rate at the correspondent maturity, we get a measure of the country specific premium $cp_{t,j,M}$.
Figure 1 display the 10-year OIS rate, the periphery-specific component (measured by the spread between the average 10-year yield of Italian and Spanish bonds and the 10-year OIS) and core-specific component (measure by the spread between the 10-year German yield and the 10-year OIS).

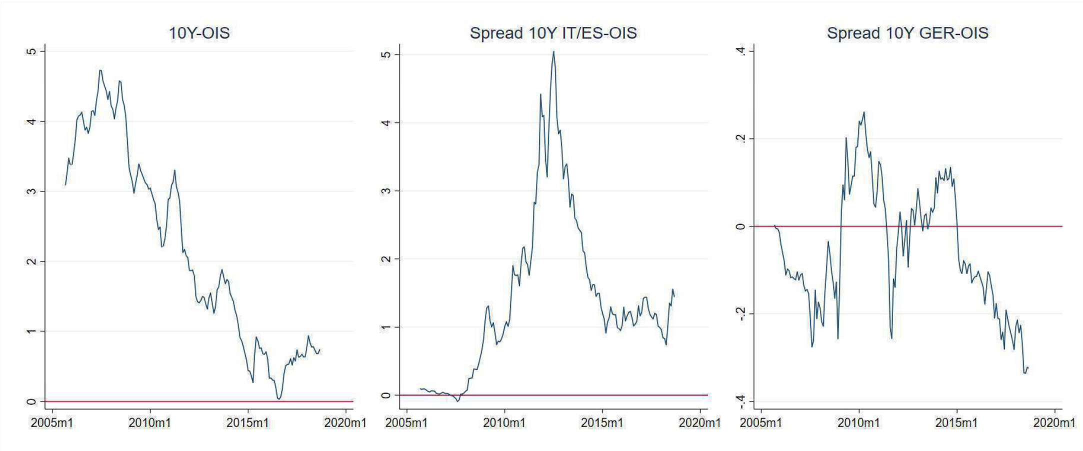

Figure 1: 10-year OIS rate, and yield spreads for Italy/Spain (average) and Germany.

3 Financial and macroeconomic effects of the APP

To evaluate the effects of the APP on periphery and core specific components we estimate two proxy-SVARs. We employ the methodology proposed by Angelini and Fanelli (2019) denoted the AC-SVAR, which consists in augmenting the set of variables with the external instruments, at the same time imposing the proper restrictions of the matrix of structural parameters. We refer to Appendix A for a detailed explanation of proxy-SVARs and the AC-SVAR. The first SVAR is estimated on data observed at daily frequency to study the response of financial variables; the second one on monthly data to analyze the response of macroeconomic variables. Table 1 summarize the specifications employed for the two SVARs[3]. The sample period for the daily-SVAR is the APP period. For the monthly-SVAR this would imply a too small number of observation, thus we extend the sample by using observations from 2005 (OIS rates are not available earlier). In both cases we perform a partial identification exercise, meaning that we identify a single structural shock, namely the APP shock, using as external instrument high-frequency variations in the 10-year Italian rate around ECB press conferences, taken from the database made

[3]Variables observed at daily frequency are aggregated to the monthly level by taking the average of daily observations. Regarding the instrument, i.e. high-frequency variations around ECB press conferences, we employ the same aggregation procedure used by Gertler and Karadi (2015)

available by Altavilla *et al.* (2019). This choice is motivated by the fact that Italian rates are those who displayed the higher variability on the relevant days in which the APP was announced. Outside the APP period (2014-2018) the instrument is set to zero. The policy indicator is the 10-year OIS rate. The *risk premium* on peripheral bonds (i.e. the periphery spread) is measured by the average of the 10-year sovereign spreads of Italian and Spanish bonds, computed with respect to the 10-year OIS rate. The *covenience yield* on core bonds is measured by the 10-year spread between OIS rate and German rate.

	Daily SVAR	**Monthly SVAR**
Endogenous variables	10-year OIS 10-year spread IT/ESP-OIS 10-year spread OIS-GER STOXX50 (log) 2-year Inflation Linked Swap rate EUR-USD exchange rate (log)	10-year OIS 10-year spread IT/ESP-OIS 10-year spread OIS-GER EA industrial production (log) HICP (log) CISS index IMF commodity prices index
External instrument for the APP shock	HF variations around ECB press conferences of 10-year IT rate from 2014 to 2018	HF variations around ECB press conferences of 10-year IT rate from 2014 to 2018
Sample	01/01/2014-24/09/2018	08/2005 - 09/2018
Observations	1193	158
Linear trend	YES	YES
Number of lags (AIC criterion)	3	2

Table 1: Specifications of the daily and monthly proxy-SVARs.

Figure 2 shows the estimated impulse response functions (IRFs) to an APP shock in the daily specification, normalized to lower the 10-year OIS rate by 10 basis points on impact. The estimated shock has a quite short-lasting effect on the 10-year OIS rate, whose reduction lasts less than three months. The impact on the periphery risk premium is sizable on impact but very short lived. On the contrary we estimate a significant and more persistent effect of the convenience yield on German bonds, which lasts almost 1 year. The response of the other variables is the one expected in response to an expansionary monetary policy shock: an increase in the stock market index, an increase in the 2-year ahead inflation expectations and a depreciation of the Euro with respect to the US dollar. These results raise some questions on the way the APP has been designed as the convenience yield component of long term rates has been significantly affected. To gauge whether this constituted a significant issue for the Eurozone economy we then focus on the macroeconomic effects of the APP, by estimating a proxy-SVAR at monthly frequency.

Figure 3 shows IRFs to the estimated APP shock. Results partially confirm what we observed at daily frequency. The shock is normalized to lower the OIS rate by 10 basis points on impact, but the decrease becomes non significant soon after. The point estimate of the response of the periphery risk premium implies a strong and persistent decline in sovereign risk premia. The effect is however not significant at 90% confidence level. The increase in the convenience-yield on German bonds is instead confirmed at monthly frequency, and it lasts almost one year. The effects on the other macroeconomic variables

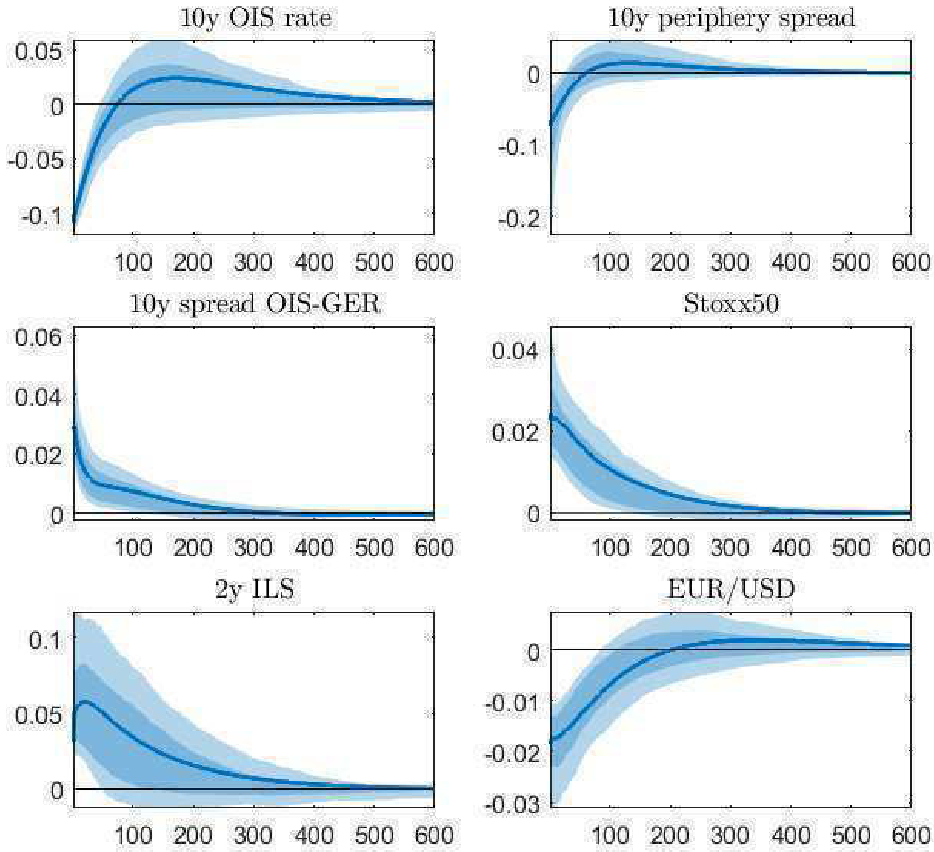

Figure 2: Impulse responses to an APP shock, normalized to lower 10-year OIS rate by 10 basis points. SVAR estimated at daily frequency. Horizon (days) on the x axis. Shaded areas shows 90% bootstrap intervals computed using moving block bootstrap. Darker areas show 68% confidence intervals.

are those expected. We observe an increase in the industrial production index, an increase in the price-level and a reduction in the systemic-risk index.

4 A flexible SVAR to isolate transmission channels

The partial identification of the SVAR on monthly data provides an estimate of the overall effect of the APP on macroeconomic variables. We have highlighted in the previous section how long term sovereign rates have responded to APP announcements, decomposing them into three components: a common component, a peripheral risk premium and a core convenience yield. We now aim at understanding how important has been the reaction of each of these three components for the final transmission of the APP to economic activity. To do this we will employ again the proxy-SVAR methodology in an innovative way. We perform a decomposition of the IRFs, where for each IRF we obtain the contribution of each component. This is typically done in fully-identified SVARs where multiple structural shocks are estimated. In our case however, we have a single APP shock, which we expect to operate through the three above-mentioned components of sovereign rates.

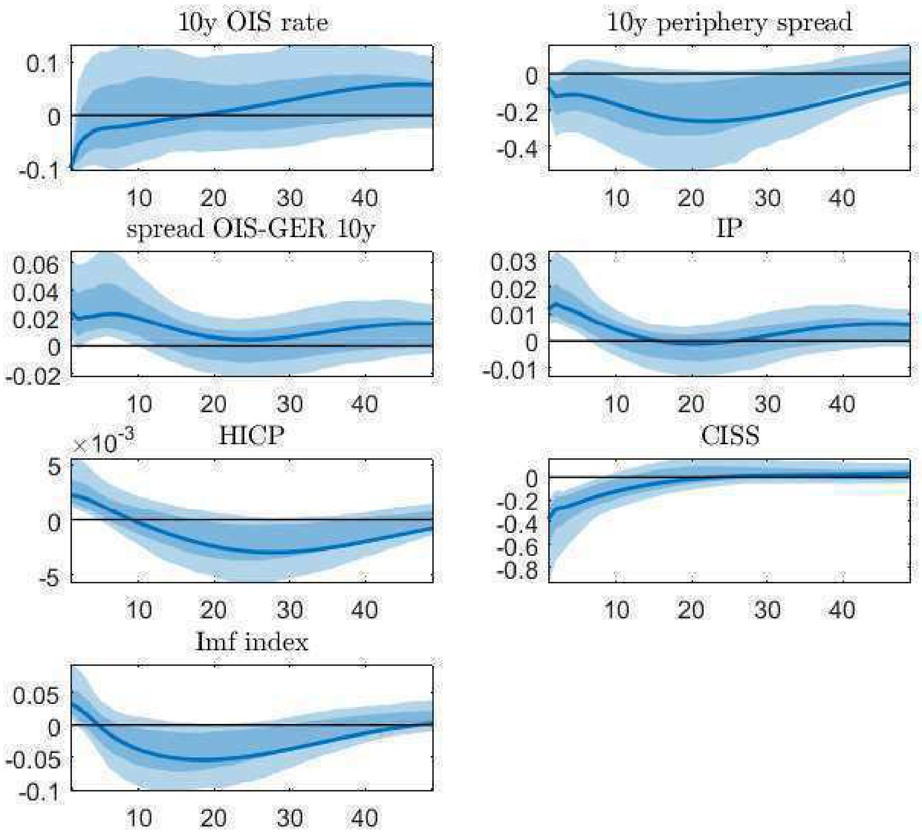

Figure 3: Impulse responses to an APP shock, normalized to lower the 10-year OIS rate by 10 basis points. SVAR estimated at monthly frequency. Horizon (months) on the x axis. Shaded areas shows 90% bootstrap intervals computed using wild bootstrap. Darker areas show 68% confidence intervals.

In Appendix B we explain in details how we can employ an AB framework (Amisano and Giannini, 1997) to estimate the proxy-SVAR and decompose IRFs to the identified APP shock into three components: (i) the effects produced by the reaction of the common component of yields, measured by the OIS rate (ii) the effects produced by the reaction of the peripheral risk premium (iii) the effects produced by the reaction of the convenience yield on core sovereign debt. The methodology we use controls for the possible interdependence among these three components.

The impulse response of variable g, at horizon h, to the APP shock ($\varepsilon_{QE,t}$) is decomposed as follows:

$$IRF_{g,QE}(h) = IRF^{p}_{g,QE}(h) + IRF^{r}_{g,QE}(h) + IRF^{s}_{g,QE}(h) \tag{3}$$

where $IRF^{p}_{g,QE}(h)$ denotes the component due to the 10-year OIS, $IRF^{r}_{g,QE}(h)$ denotes the component due to the 10-year periphery spread, $IRF^{s}_{g,QE}(h)$ denotes the component due to the 10-year spread GER-OIS. Notice that the variable used in the SVAR are the same employed in the previous section in the monthly-frequency specification. Again we refer to Appendix B for the explanation of the restrictions imposed to achieve identification and perform the IRF decomposition.

Figure 4 shows the obtained decomposition of the impulse responses into the three com-

ponents. The estimated APP shock is normalized to lower by 10 basis points the 10-year OIS rate. Notice that the "total" IRFs, depicted by the black lines, are very similar to those obtained from the partial identification of the APP shock (Figure 3). This suggests that the set of restrictions we imposed on the matrices A and B (see Table 2 in Appendix B) are quite plausible. The only exception concerns the response of the HICP price index, for which we estimate a lagged decline with no increase on-impact. In what follows we will mainly focus on the obtained decomposition of impulse responses at short horizons, namely in the first 6-12 months after the shock. In fact, from Figure 3 we have seen that all the estimated effects of the QE shock on the variables included in the VAR tend to vanish after few months. Having this in mind, we also acknowledge the fact that the estimated magnitude of the three "channels" of the APP is less to be trusted at long horizon. By focusing on short horizons we also shelter from the main drawback of this analysis, i.e. we do not have proper confidence bands for the three estimated "channels".
The decomposition analysis highlights the presence of a contractionary component of the APP shock, possibly related to the "scarcity effect" and an expansionary component related to the reduction in long term OIS rates. The reduction in the risk premium on peripheral debt does not seem instead to play a sizable role. Red bars in Figure (3) denote the $IRF^{p}_{g,QE}(h)$ component in equation (3). This channel behaves like the expansionary component of the APP. It lowers the OIS rate on impact, though the effect is reversed at long horizons. It is responsible for a massive and persistent decline in the risk premium on peripheral bonds. It lowers the convenience yield on German bonds for the first months after the shock. Furthermore, it is responsible for the observed increase in industrial production and the decrease in the index of systemic risk. Quite strikingly though, the effect on consumer prices is opposite, as it pushes them toward a persistent decline.

Blue bars in Figure (3) denote the $IRF^{s}_{g,QE}(h)$ component in equation (3). This "shock" behaves like the contractionary component of the APP shock: it increases substantially the convenience yield on German bonds at short horizons, it increases the long term OIS rate and the risk premium on peripheral debt. It partially offsets the positive impact on industrial production of the OIS channel. Again the impact on consumer prices is instead reversed, the "shock" is inflationary. These observed responses points to the conclusion that the direct impact of APP purchases of safe German bonds, which increased the convenience-yield on them, has given origin to a contractionary component in the transmission of APP to real economic activity.

Finally, green bars in Figure (3) denote the $IRF^{r}_{g,QE}(h)$ component in equation (3). This channel does not contribute substantially to the observed impulse response functions.

The observed decomposition of impulse responses points to the conclusion that the direct impact of APP purchases of safe German bonds, which increased the convenience-yield on them, has given origin to a contractionary component in the transmission of APP to real economic activity. This is possibly an identification of the "scarcity" channel described in section 2. On the other hand, this analysis suggests that the expansionary effect of APP is mainly a result of the reduction of long term OIS rates, that is the euro area common component of sovereign rates, while the reduction in the sovereign spreads of the periphery did not play an important role for boosting economic activity.

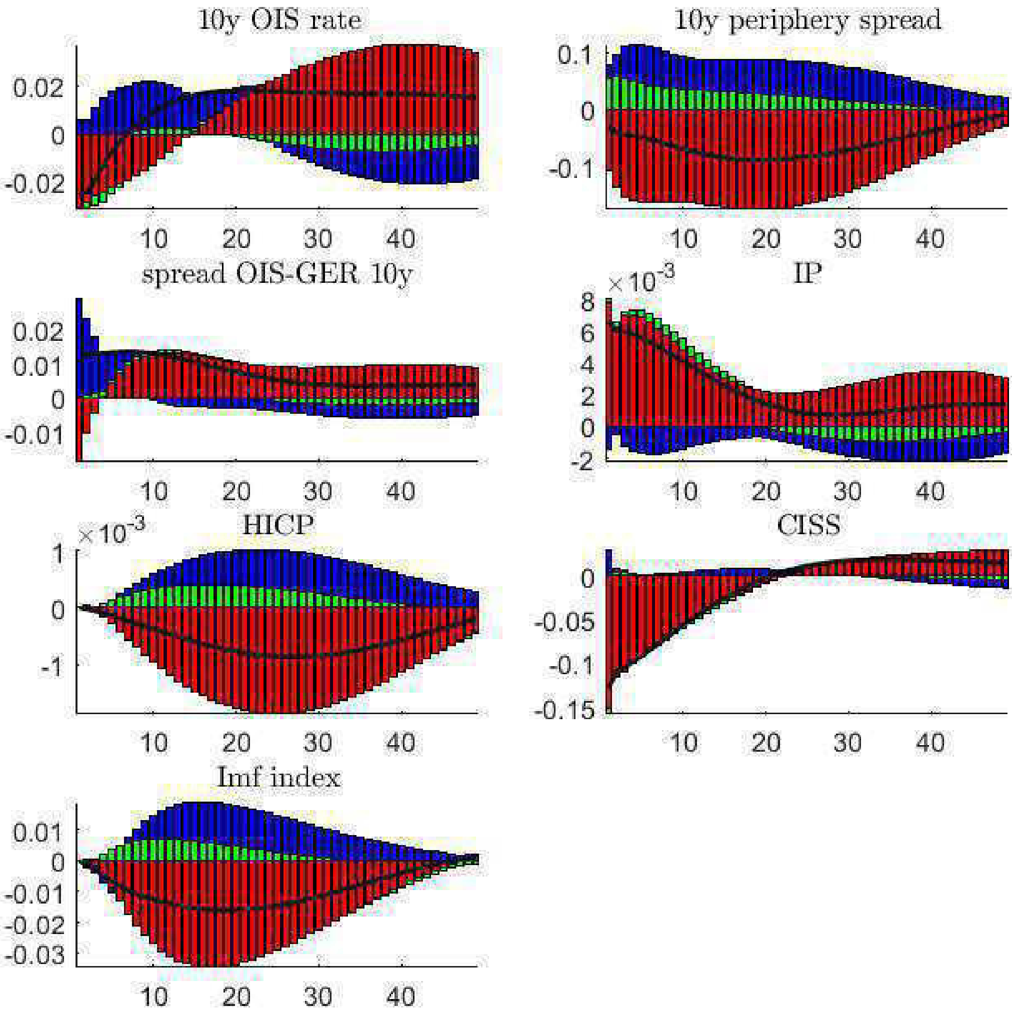

Figure 4: Estimated IRFs to a QE shock (black line), obtained thorough identification of A and B matrices, and their decomposition into the three channels: 10-year OIS rate channel (red), 10-year IT-OIS channel (green), 10-year OIS-GER channel (blue).

5 Conclusion

In this paper we have analyzed the effects of the APP implemented by the ECB using a core/periphery perspective. Results show a clear and persistent increase in the convenience yield associated to German sovereign bonds in response to the estimated APP shock. The convenience yield measures the expensiveness of safe bonds, which stems from their scarcity. Using an innovative empirical strategy we have shown that this increase have partially offset the expansionary effects of the APP on euro area economic activity. These findings have a clear policy implication: the design of the APP, where purchases of sovereign bonds have been split across euro area countries according to their economic size, was detrimental for its effectiveness. The new QE implemented in 2020, the PEPP (Pandemic Emergency Purchase Program), have been indeed designed differently: by allowing some flexibility in how purchases should be split across euro countries, the ECB has been able to improve the effectiveness of the policy in reducing sovereign spreads.

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