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How the Quantitative Easing program of the ECB affected the bank lending in the Euro Area

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Abstract

This study examines how the expanded asset purchase program (EAPP), also known as Quantitative Easing (QE), that the European Central Bank (ECB) introduced in March 2015 had affected the bank lending in the Euro Area (EA). Using monthly data from March 2015 to September 2020 in the context of a SVAR model, I find that banks in the EA increase their provision of loans to non-financial corporations after a positive shock in QE. I also find a reduction in the bank interest rate on loans to corporations and the long-term government bond yield. Overall, these results indicate that the EAPP had managed to activate the bank lending channel in the EA and incentivize banks to ease their financial conditions. This is an important conclusion for the European economy, given the bank-centric character of the financial system in the EA.

1. Introduction

A large debate has started around the policy of Quantitative Easing (QE), also known as large-scale asset purchases (LSAPs) policy, especially during the period of the global financial crisis of 2008, when this policy was introduced by some of the main central banks of the world, like the Federal Reserve (Fed), the European Central Bank (ECB), the Bank of England (BoE) and the Bank of Japan (BoJ). This kind of policy is very often referred in the literature as unconventional (non-standard) policy, since it departs from the standard monetary policy implemented by central banks. As Falagiarda (2014) states, conventional monetary policy may be difficult to implement when the economy reaches the zero lower bound (ZLB) of interest rates and therefore central banks should find other ways to provide support to the economies. That was for example the case in the U.S. where the financial crisis created an environment of zero bound threshold and therefore the Fed could not continue decreasing the main monetary policy rate, meaning that its conventional monetary policy was not appropriate anymore (Jakl, 2017). That is how the unconventional monetary policies came into play in order to boost the economies and restore economic growth.

Before going into the literature and see how QE was used by banks as a main tool of monetary policy, it is important to have an idea of what we mean by this policy. Although we might come across different explanations regarding QE, a simple but also comprehensive definition is that QE involves the policies implemented by central banks, that affect the composition and/or the size of their balance sheet and the purpose of them is to ease liquidity and credit conditions in order to stimulate the economic system in a situation close to the ZLB (Falagiarda, 2014). In the case of the ECB's QE program that was introduced in 2015, which is described later on, we would say that it is more related to the size of the balance sheet and not the composition, since it encompassed

both existing and new programs, with the purchases being of a large scale relative to programs implemented previously.

The rest of the paper is organized as follows. Section 2 provides a review of the existing literature. Section 3 describes some of the transmission channels through which the monetary policy can affect the economy. Section 4 discusses some main features of the ECB's conventional and unconventional measures. Section 5 presents the empirical approach followed in this study, with a description of the model specification and the data that are used. Section 6 discusses the benchmark estimation results, along with some robustness checks, a forecast-error variance decomposition analysis and also some additional results. Finally, Section 7 concludes.

2. Literature Review

The majority of the existing literature around QE examines the macroeconomic impact that this unconventional policy had, especially in the U.S., during and after the period of the global financial crisis. A lot of emphasis is also given to the reaction of the assets prices as well as the interest rates and yields, not only of the assets purchased in the context of the different programs that were implemented by the central banks, but also of other assets in the economy. For example Gagnon, Raskin, Remache and Sack (2010) find that the LSAPs by the Fed reduced the term premium because of the lower net supply of assets with long duration. The effect of these programs was found to be even stronger on longer-term interest rates by enhancing market liquidity and reducing the number of assets with a high prepayment risk in private portfolios. The asset purchases stimulated economic activity by reducing the private borrowing costs, and also reduced the interest rates not only of the securities that were bought, but also of those not included in the LSAPs programs. Jakl (2017) finds that the yield of Treasury securities fell, mainly because term

premiums fell, and that the change in the yield of Treasury securities affected the yield of other assets as well. Using a counterfactual exercise (which is a very common practice in the literature studying the impact of QE policy) Baumeister and Benati (2010) find that the inflation would be negative, and the GDP growth would reach -10% in the first quarter of 2009 in the U.S., and for the case of the U.K. they find that without QE the deflation would be higher and the recession deeper reaching approximately -19% in the first quarter of 2009.

The literature assessing the different unconventional programs that the ECB introduced in the face of the crisis is scarce relative to the one focusing on the cases of the U.S. (e.g. Engen, Laubach, & Reifschneider, 2015; Falagiarda, 2014; Gagnon et al., 2010; Jakl, 2017; Reis, 2017; Rodnyansky & Darmouni, 2017) or the U.K. (e.g. Joyce, Lasaosa, Stevens, & Tong, 2011; Falagiarda, 2014; Bridges & Thomas, 2012; Kapetanios, Mumtaz, Stevens, & Theodoridis, 2012; Reis, 2017; Churm, Joyce, Kapetanios, & Theodoridis, 2018). What makes the Euro Area (EA) case more interesting is the fact that, albeit the common monetary policy set by the ECB across the 19 members, no single fiscal policy exists. This, combined with the heterogeneity that characterizes the Eurozone states, probably makes the ECB's task more difficult, but also the analysis of the ECB's unconventional monetary policy measures more complicated relative, for example, to the case of the U.S. or the U.K. But using the existing EA data and drawing conclusions about the effectiveness of those measures is crucial for understanding the mechanisms through which such policies might have affected the Eurozone economy, as well as for future monetary policy design and implementation. Thus, the concerns above should not be a limit but a challenge for further research around the ECB's non-standard monetary policies.

As expected, once the ECB started introducing its own unconventional policies in response to the financial crisis, the question of whether these measures were indeed effective for the EA economy

became part of a large debate in the literature, with a large number of papers trying to assess specifically the macroeconomic impact of the two three-year longer-term refinancing operations (LTROs) implemented by the ECB in December 2011 and February 2012 respectively in the face of the sovereign debt crisis. For example Darracq-Paries and De Santis (2015) conclude that the three-year LTROs managed to avoid a credit crunch and improve bank lending by reducing bank funding risks and the lending rate spread, and increasing the prices of goods. An increase in banks' lending to firms is also found by Andrade, Cahn, Fraisse and Mésonnier (2019) who also interestingly find that the impact of the LTROs on bank lending is higher for banks that are more financially constrained. The latter is in line with the finding of Carpinelli and Crosignani (2017), who study the case of Italy, that the banks which were more affected by the dry-up of the wholesale funding have used the three-year LTRO program to improve their credit supply. Similarly, using bank-firm data from Spain, Garcia-Posada and Marchetti (2016) find that the LTROs improved the supply of bank credit to firms, albeit moderately, and this effect was larger for the banks that were less liquid. In terms of output and inflation Boeckx, Dossche and Peersman (2017), using a counterfactual analysis, conclude to lower levels in 2012 without the implementation of the three-year LTROs, and state also that the ECB's policies had a stronger impact on the output of those EA countries with a well-capitalized banking system. Furthermore, examining the unconventional policies introduced by the ECB between 2007 and 2012, Fratzscher, Duca and Straub (2016) find that the ECB's policies were effective in reducing bond spreads, and again through a counterfactual exercise they state that without the unconventional monetary measures equity prices would have been lower. Furthermore, they conclude that the ECB's non-standard programs (in particular the outright monetary transactions (OMT), the securities markets program (SMP), and LTROs of different maturities) managed to reduce the risk aversion significantly. They also examine whether

such policies have had any international spillover effects, and they actually find that they have caused strong decrease in bank and sovereign credit risk in the EA and worldwide as well.

Taking into account all these studies we would say that indeed, the policies adopted by the ECB in order to mitigate the negative effects of the crisis seem to have been successful, at least to a satisfactory degree. However, some studies support the opposite, making the picture less clear again as it means that doubts about the effectiveness of all these unconventional policies still exist. Brunetti, Di Filippo and Harris (2011), using data from 2006-2008 and examining both standard and non-standard operations, state that ECB interventions have led to higher spreads and lower trading volume, and generally increased volatility in the interbank market while failing to reduce the asymmetric information. Similarly, Daetz, Subrahmanyam, Tang and Wang (2016) find no evidence that the two three-year LTROs helped the real economy, albeit they had affected the financial economy. The authors attribute this result to the fact that economic uncertainty was in very high levels and the corporations had strong precautionary motives to hold cash because of their uncertainty regarding future demand and costs of their goods and services. Therefore, it seems that more research is still needed in order to be confident that the policy measures used to enhance the toolkit of the ECB when it could no more use the standard tools that it had on hand were indeed effective.

3. Transmission Channels

Something that seems to be of high importance and actually very intuitive about how the policy of QE works in practice are the mechanisms through which this policy affects the economy. In particular, many papers refer to the transmission channels of asset purchases. One of the channels, which seems to dominate in the existing literature, is what we call “portfolio balance effects”. The

purchase of assets by the central bank increases the price of the assets bought but also the price of other assets in the economy. The sellers of the assets hold more money now, after the central bank buys the assets, and therefore they may want to buy other assets to rebalance their portfolios (if money is not a perfect substitute for the particular assets). Repeating this process we finally see an increase in the assets prices which means lower yields (and higher net wealth of asset holders), firms and households face lower borrowing costs and so spending increases.

Another channel through which spending is supported by the asset purchases is the "policy signaling effects" which is based on what the asset purchases communicate to economic agents. Actually the asset purchases may be a signal that the central bank tries to achieve the inflation target that it has set and this subsequently leads to expectations that the policy rate will remain at low levels for longer. A third channel is the so-called "confidence effects". If the policy of the central bank has positive effects on the economy, then this can make people more willing to spend because they are more confident that things are improving (Joyce, Tong, & Woods, 2011).

The LSAPs of long-term assets may encourage investors to trade in the markets of those assets, since they know that if needed they will be able to sell the assets to the central bank. Therefore the liquidity risk premiums can be lower due to the improved trading opportunities, and this can finally lead to lower asset yields providing again stimulus to the economic activity. People refer to this type of mechanism as the "liquidity channel" (Gagnon et al., 2010). Last but not least, regarding the way bank lending is affected by the LSAPs, the "net-worth channel" refers to the fact that if the effect of asset purchases on asset prices is large, the monetary policy raises the mark-to-market value of bank security holdings which consequently increases the net worth of the bank. This in turn encourages banks to expand lending (Rodnyansky & Darmouni, 2017).

4. ECB's conventional and unconventional measures: main features

As it is commonly well known, what the ECB mainly tries to achieve through its monetary policy measures is what it calls "price stability" in the EA. More specifically, it tries to maintain an inflation level (measured as a year-on-year increase in the Harmonized Index of Consumer Prices (HICP)) below, but close to, 2% over the medium term. In normal times, when no unconventional measures are needed, the ECB uses its three key interest rates to affect the broader EA economy and finally meet its main objective of price stability. In particular, the ECB sets the main refinancing operations (MROs) rate, the deposit facility rate and the marginal lending facility rate. The rate on the MROs is the rate at which the Eurosystem (the ECB and the national central banks (NCBs) of the EA Member States) lends liquidity to banks against collateral on a weekly basis. The rate on the deposit facility is the rate at which banks can make overnight deposits with the Eurosystem, and finally the rate on the marginal lending facility is that which the Eurosystem charges for overnight credit to banks. Note also that the corridor for the overnight interest rate at which banks lend to each other is set by the deposit facility rate which is actually the floor of that corridor and the marginal lending facility which acts as the ceiling. Under no unusual circumstances the Eurosystem communicate its monetary policy stance through open market operations, like MROs (described above) and LTROs (with the standard ones having maturity of three months), the two already mentioned standing facilities (the deposit facility and the marginal lending facility), and last but not least the minimum reserve requirements for credit institutions. The latter is simply related to the deposits that credit institutions in the EA are required (by the ECB) to hold on accounts with their NCB.

In general, these are the tools that the ECB normally uses to conduct monetary policy in the EA. But when the financial crisis began in 2007 the ECB was forced to enhance its toolkit with

unconventional policies, since the traditional ones were not enough to face the severe consequences of the crisis. As the financial market began to erode and with the economic conditions getting worse and worse, the Governing Council of the ECB started introducing a series of measures in order to help the economy recover. Initially, the hampered lending in the interbank markets led to the implementation of a fixed-rate tender procedure with full allotment for the MROs in October 2008, meaning that banks could borrow unlimited from the Eurosystem at a fixed rate, and to the decision on an enlarged range of assets that could be used as collateral in refinancing operations. As Lenza, Pill and Reichlin (2010) note, in an environment characterized by a lot of stress, the fixed-rate tender with full allotment measure provided financial institutions with the certainty that liquidity by the central banks was available and thus contributed to the stabilization of the banking sector in the EA. Furthermore, in July 2009 the Eurosystem started purchases of covered bonds under the covered bond purchase program (CBPP). Since the specific financial market segment was important for the funding of banks, the purpose of those purchases was to support the financial institutions that were issuing covered bonds by improving their funding conditions. On 10 May 2010, the Governing Council announced the introduction of the SMP through which public and private debt securities would be purchased in order to support the dysfunctional securities markets. A second covered bond purchase program (CBPP2) was introduced, after the first one was completed in June 2010, with its operation starting in November 2011 and ending in October 2012. In addition, on 8 December 2011 the introduction of two LTROs with a maturity of three years (also known as very long-term refinancing operations (VLTROs)) was decided in order to provide further liquidity and support the bank lending in the EA money market. OMTs in secondary markets for sovereign bonds in the EA were decided on 6 September

2012 to deal with distortions in government bond markets and also preserve the transmission mechanism in the EA countries.

With the HICP inflation rate diverging from the target of 2%, falling from 1.7% in March 2013 to 0.5% one year later, the ECB had decided to implement further measures to address the risk of deflation. But since the rates on the marginal lending facility and MROs were already very close to the ZLB, and more specifically being at 0.75% and 0.25% respectively from November 2013, and with the deposit facility rate having already reached the ZLB since July 2012, there was almost no room for the ECB to continue using its main interest rates in order to affect the market interest rates and consequently the financial conditions of the banking system in the EA. And with this situation prevailing in the area, the ECB was led to the introduction of some of the most important monetary policy measures for the European economy. First of all it is important to note that on 6 June 2014 the deposit facility rate entered the negative territory. In particular, when the MROs rate fell from 0.25% to 0.15%, the deposit facility rate was reduced to -0.10 % to leave the corridor unchanged. The Governing Council decided on the introduction of three series of targeted longer-term refinancing operations (TLTROs) announced on 5 June 2014, 10 March 2016 and 7 March 2019 respectively. A highly significant feature of these programs is the fact that how much banks can borrow depends directly on the loans they provide to non-financial corporations (NFCs) and households. Constructed in this way, these programs aim to support the overall bank lending in the EA by giving incentives to the participating banks to lend more and therefore benefit more favorable borrowing conditions. On 20 October 2014, the Eurosystem restarted purchases of covered bonds under a third covered bond purchase program (CBPP3). Shortly afterwards, the ECB launched a new program to provide further support to the bank lending in the EA. From 21 November 2014 the Eurosystem could purchase asset-backed securities under the asset-backed

securities purchase program (ABSPP). This program would incentivize banks to securitize loans and sell them to raise the necessary funds that could subsequently lend to the real economy.

After the introduction of all these policies the inflation rate was still far away from the price stability target that was set by the ECB. For example in December 2014 the HICP inflation rate was just -0.2%, going even deeper (-0.6%) one month later. Therefore, fears of a too prolonged period of low inflation were still there, leading the ECB to take further action to address the risks of such a scenario. In particular, purchases of a combination of both private and public sector assets under new but also existing programs formed what the ECB has called the expanded asset purchase program (EAPP). Also characterized as a QE program, the EAPP was announced by the ECB on 22 January 2015 and started on 9 March of the same year. This program combines the CBPP3 and the ABSPP, which have already started from October 2014 and November 2014 respectively (as mentioned above), with the public sector purchase program (PSPP). The latter included bonds issued by central, regional and local governments, recognized agencies, international organizations and multilateral development banks located in the EA (note that regional and local government bonds as well as debt securities issued by European international and supranational institutions are purchased only by NCBs, not the ECB). The allocation for the purchases of securities under the PSPP that the ECB had set was 12% (after March 2016 this percentage became 10%) for securities issued by international organizations and multilateral development banks and the remaining for the other eligible securities mentioned above. NCBs were allowed to buy securities only in their own jurisdiction and each NCB had a share of purchases set by the ECB. If the marketable debt instruments that were issued by the central government and agencies were not enough to cover the NCB's share, then the NCB could conduct substitute purchases (it could buy for instance debt

instruments issued by international or supranational institutions) (ECB, 2020). These are some of the most important features of the PSPP, which was actually the largest part of the EAPP.

From June 2016 the Eurosystem could buy corporate sector bonds under a new program, the corporate sector purchase program (CSPP), which also became part of the EAPP. So under the EAPP the Eurosystem could conduct purchases of a variety of assets such as government, corporate and covered bonds, asset-backed securities and securities issued by European supranational institutions. Net purchases were conducted from March 2015 until December 2018, with the average monthly amounts ranging from €15 billion to €80 billion. Specifically, the net purchases amounted to €60 billion from March 2015 to March 2016 and then increased to €80 billion from April 2016 until March 2017. From April 2017 to December 2017 the monthly net purchases decreased to the initial amount of €60 billion, before go even lower, to €30 billion, from January 2018 until September 2018 as the end of the program was near. Finally, the monthly amount was set to €15 billion from October 2018 until the end, in December 2018. However, it is important to note that the termination of the net purchases did not mean the termination of the Eurosystem's actions under the EAPP as well. In January 2019, immediately after the end of the net purchases, the Eurosystem started reinvesting the principal payments from the securities that were reaching maturity. By October 2019 they were reinvested in full. Another recalibration came on 12 September 2019 with the decision on the restarting of net purchases from 1 November 2019 at the monthly amount of €20 billion. The Governing Council has taken this decision in order to enhance the accommodative role and impact of the policy rates. The last recalibration, at the time of writing, was that on 12 March 2020, with the addition of €120 billion of net asset purchases until the end of the year.

The net asset purchases implemented in the context of the EAPP could be expected to provide significant support to the financial system in the EA by improving the financial conditions, mainly through a favorable impact on a range of interest rates, and consequently stimulate the economic growth in the area and more importantly stabilize inflation below, but close to, 2% over the medium term. From the research that has been done around the ECB's EAPP, focusing mainly on its effect on the EA macroeconomy and financial markets, we would say that the overall results are encouraging, with many papers concluding in an increase in output and prices and also lower interest rates, mainly the long-term ones. For instance, Gambetti and Musso (2017) in the context of a time-varying parameter vector autoregression (VAR) model with stochastic volatility find that the program affected significantly both real GDP and HICP inflation, with the effect on HICP increasing over time while that on GDP being stronger in the short term. Cova, Pagano and Pisani (2015), estimating a large-scale multi-country dynamic general equilibrium model, support that the EAPP has led to lower long-term interest rate and also to persistently higher GDP and inflation. Similarly, using intra-day information in a VAR model, Andrade, Breckenfelder, De Fiore, Karadi and Tristani (2016) conclude to an improvement in inflation and output, and to a significant and persistent reduction in long-term bonds yields. But as they note, effects on asset prices are observed on announcement. They find no statistically significant effects when purchases take place. As it has been mentioned previously for other unconventional measures introduced by central banks, the EAPP has reduced the yields, not only of those assets that were purchased in the context of the program, but for a broader set. Moreover these effects seem to rise with assets' maturity and riskiness (Altavilla, Carboni, & Motto, 2015). In a similar path, but using an event-study regression analysis, Georgiadis and Gräb (2016) conclude that the announcement of the program has improved the confidence of investors and reduced deflation risk, leading to higher equity prices

around the world. On the other hand, they find only a limited impact on bond prices and they attribute the small decline in global sovereign bond yields to the fact that they were already at very low levels. Therefore we could say that, more or less, there is a general consensus on the contribution of the EAPP, with the main results being a positive impact on the level of prices and output, and also lower long-term interest rates and yields.

5. The empirical approach: model specification and data

This paper contributes to the existing literature by studying specifically the EAPP using monthly data for the EA and a time horizon that covers the period from March 2015 to September 2020. Since the research made on the EAPP is scarce relative to the one examining the effects of other non-standard policies (e.g. LTROs and SMP), probably because it is a relatively more recent event and therefore some time is needed for more data to become available for analysis, this study can shed some light on the uncertainty regarding the contribution of non-traditional policy measures in general and the QE monetary policy in particular.

The purpose of this study is to examine if and how the EAPP had affected the bank lending in the EA. This specific part of the financial system of the EA is considered very important, since banks are the main source of funding for the private sector. In order to answer this question I analyze the effects of the program in the context of a structural vector autoregressive (SVAR) framework. SVAR models are widely used in the literature, especially to estimate the effects of changes in monetary policy, because they allow the researcher to identify shocks and set restrictions in line with the relative economic theory. Furthermore, as Peersman (2012) and Boeckx et al. (2017) mention, not much theoretical structure is imposed on the data and also under these models researchers can establish relevant stylized facts.

They may have been typically used for analyzing the macroeconomic effects of shocks in the conventional monetary policy measures (Boeckx et al., 2017), but the same idea could be reasonably adopted also for unconventional policies and for effects other than the macroeconomic ones. But before describing the baseline model, it is important to understand how the SVAR model is built in order to have in mind the intuition behind it. Consider first a SVAR model represented by:

$$A_0 Y_t = a_0 + A_1 Y_{t-1} + \ \dots + A_q Y_{t-q} + B u_t \qquad (1)$$

where Y_t is a $(k \times 1)$ vector of endogenous variables at time t, a_0 is a $(k \times 1)$ vector of constant terms, A_j, with $j = 1, \dots, q$, is a $(k \times k)$ matrix of coefficients (structural parameters), u_t is a $(k \times 1)$ vector of structural shocks with $E(u_t) = 0$, $E(u_t u_t') = I_k$, and $E(u_t u_s') = 0_k$ for all $t \neq s$, and A_0 is a $(k \times k)$ matrix that includes the contemporaneous relationships between the k endogenous variables of the structural model. The $(k \times k)$ matrix B captures the contemporaneous effects of the structural errors. Both A_0 and B are assumed to be nonsingular. We can then multiply each side by the inverse of A_0 to get the reduced form of the model (because the parameters in (1) are not identified). So we get:

$$Y_t = c_0 + C_1 Y_{t-1} + \ \dots + C_q Y_{t-q} + e_t \qquad (2)$$

with $c_0 = A_0^{-1} a_0$, $C_j = A_0^{-1} A_j$ with $j = 1, \dots, q$, and $e_t = A_0^{-1} B u_t$ (a $(k \times 1)$ vector of error terms) is a linear combination of the structural shocks, with $E(e_t) = 0$, $E(e_t e_t') = \Sigma$, and $E(e_t e_s') = 0_k$ for all $t \neq s$. Under the SVAR model one can analyze the effects of different shocks, but for identification to exist some restrictions on the matrices A_0 and/or B must be imposed (Pfaff, 2008). A very common approach to impose the necessary restrictions is the Cholesky decomposition. One way to achieve this in the context of the Cholesky identification scheme, and this is actually the

method I follow in this study, is to let B be an identity matrix and impose restrictions on A_0 which we let to be lower triangular. Specifically, the minimum number of restrictions that must be imposed on the A_0 matrix is $k(k-1)/2$. That is because the variance-covariance matrix of the reduced-form errors, the Σ matrix, contains $k(k+1)/2$ pieces of information (since it is symmetric) and A_0 has k^2 parameters. Therefore, in order for A_0 to be uniquely estimated from Σ at least $k(k-1)/2$ restrictions are needed. A last note, which is basically very important to keep in mind when using the Cholesky decomposition, is that the ordering of the variables that are included in the VAR model matters. The way it works is that each variable in a specific ordering can have contemporaneous effects on the variables below it, but can affect the variables above it only with a lag. Therefore one has to decide on the ordering of the variables in the model, based for example on subjective beliefs, which should be reasonably justified, and most importantly the theoretical literature that exists around the specific topic.

To assess how bank lending reacted to the QE policy of the ECB I use a vector of seven endogenous variables, including both monetary and non-monetary variables. Specifically the baseline model includes the Industrial Production Index as a proxy for economic activity *(IP)*, the percentage change in the HICP for inflation *(HICP)*, the cumulative net purchases under the EAPP in euro millions *(QE)*, the VSTOXX as index of the market volatility *(VSTOXX)*, the domestic lending to NFCs in euro millions *(loans)*, the bank interest rate on loans to corporations *(IR)*, and the EA 10-year Government Benchmark bond yield for a measure of long-term yield *(LTyield)*. The variables of industrial production and loans are in logarithmic form. Also, since I use time series data, I test for the stationarity of all the variables included in the VAR model using the Augmented Dickey Fuller statistic (ADF). I use the de-trended purchases for *QE*, and all the other variables except from *VSTOXX* are in first differences (therefore integrated of order one, I(1)).

Since many papers adopt the idea of using the levels (or log-levels) of the variables, even of those that are non-stationary (e.g Boeckx et al., 2017; Peersman, 2012 and Schenkelberg & Watzka, 2013), following the argument of Sims, Stock and Watson (1990) that transforming models to stationary form whenever the data seems to be integrated is in many cases unnecessary, I also do a robustness check using the variables in their non-differenced form. Furthermore, the model includes seven lags decided as commonly based on the lag-length selection criteria.

Note that for the Cholesky decomposition that I discussed above the variables are ordered in the way they are mentioned. By ordering the variables in this way, with the non-monetary variables appearing before the monetary ones, I basically restrict the QE program to have only a lagged impact on the macroeconomic variables (the output and inflation in this case), but a contemporaneous impact on the remaining variables. Since the central bank decided on the EAPP given the sluggish recovery in the level of inflation and the poor economic performance in the area, allowing the Industrial Production Index and HICP inflation to affect immediately the net purchases of the central bank seems to be a reasonable choice. Financial variables are ordered last as they are expected to response contemporaneously to the program. This is also supported by Gambetti and Musso (2017) when they refer to the fast reaction of financial variables to shocks. This form of variable ordering is one that is widely followed in the literature when examining the transmission mechanism and the effects of monetary policies, both conventional and unconventional ones (see Peersman, 2011; Gambetti & Musso, 2017; Peersman & Smets, 2001; Boeckx et al., 2017 for the EA; Bernanke & Blinder, 1992; Bernanke & Mihov, 1998 for the U.S.; Sousa & Zaghini, 2007 for the G5; Nguyen, Papyrakis, & Van Bergeijk, 2019 for Vietnam; Chuku, 2009 for Nigeria).

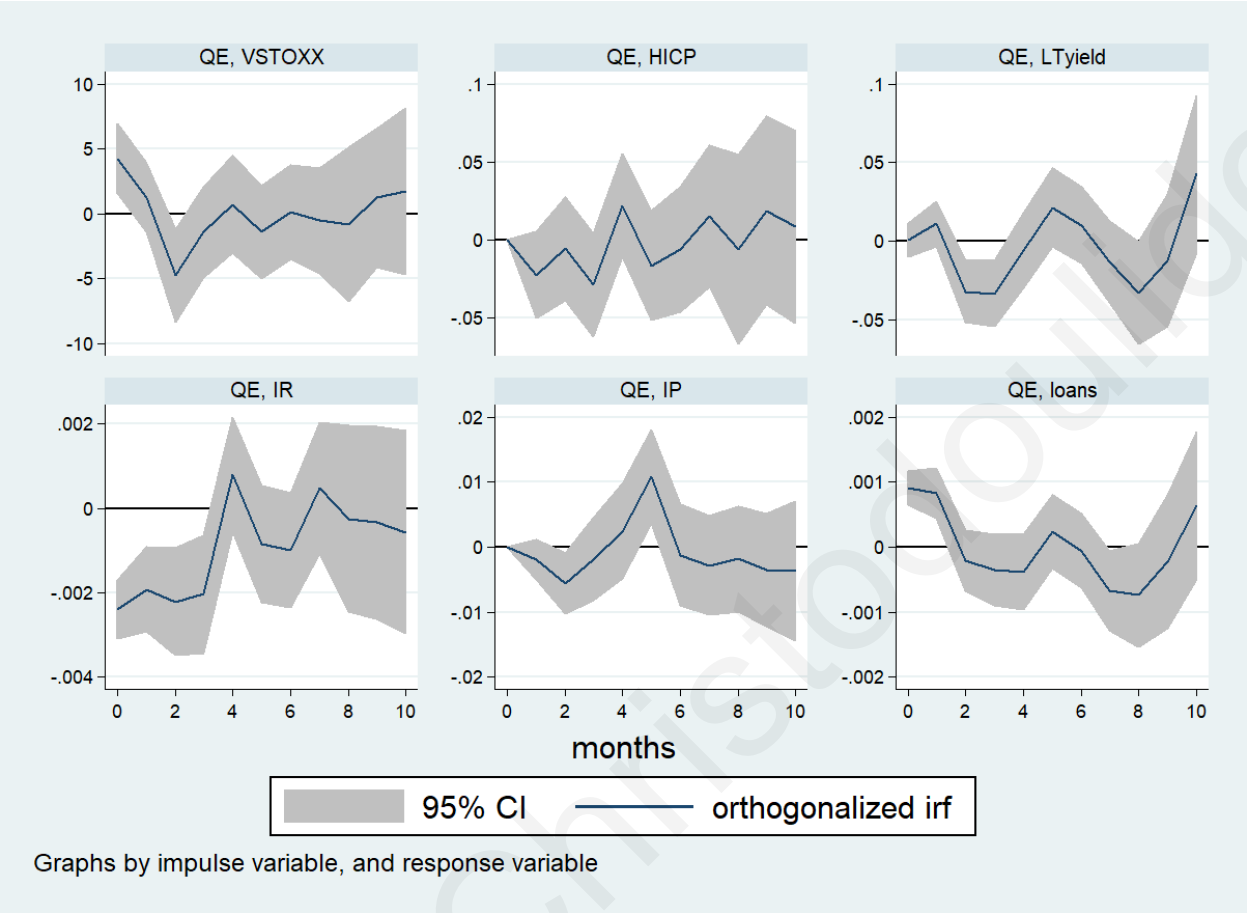
6. Results

6.1 Benchmark estimation results

As already mentioned, the interest of the particular study is focused mainly on the response of the bank lending to the QE program. However, some attention is also paid to the interest rates as they are directly linked to the banking system. Impulse response functions (IRFs) is the most common tool that is used in order to identify how a variable reacts to exogenous shocks in other variables included in the model. Note that the calculated standard errors are the asymptotic ones in all IRFs in the study, and therefore the shaded areas in the figures below indicate the asymptotic confidence bands.

Figure 1 depicts the IRFs of the variables in the baseline model to a shock (measured by a one standard deviation increase, since the orthogonalized IRFs are used) in *QE*. Regarding the main variable of interest (*loans*) we clearly see an immediate significant, positive response to the shock in *QE*. This supports the argument that the EAPP had indeed managed to improve the bank lending in the EA, at least temporarily. Therefore, it seems reasonable to argue that the QE program had managed to activate the bank lending channel in the EA (see e.g Boeckx et al., 2017; Gambetti & Musso, 2017; Altavilla, Boucinha, Holton, & Ongena, 2018; Albertazzi, Becker, & Boucinha, 2020). We also see that the lending rate declines on impact after the shock. This result can be attributed to that the ECB, by introducing such a large-scale asset purchase program, signaled to the markets that it would keep the interest rates at low levels for a longer period of time (see Andrade et al., 2016 for the signaling channel) removing in this way part of the uncertainty from the banking system. This subsequently incentivized banks to lower their own lending rates through funding cost reliefs resulted by the QE policy (Altavilla, Canova, & Ciccarelli, 2020), easing the borrowing conditions for the private sector. A significant, negative response is observed also for

Figure 1. IRFs of the variables in the baseline model to a shock in *QE*

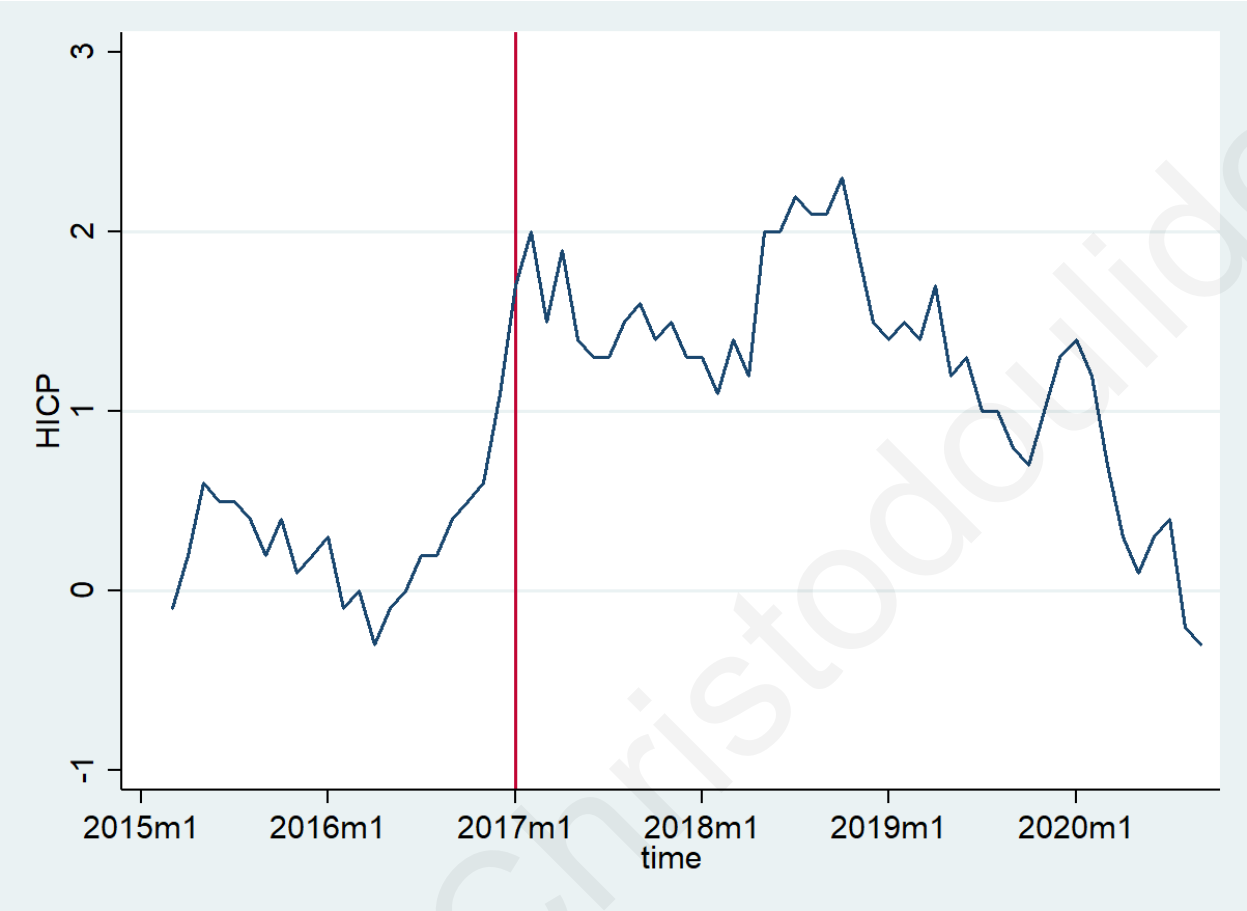


Note: The impulse responses for *IP*, *HICP*, *loans*, *IR* and *LTyield* are expressed in percent, and for *VSTOXX* in percentage points.

the long-term yield, not immediately but with a lag. These two latter results are in line with the general finding highlighted in Section 4 that the EAPP managed to put downward pressure to interest rates and yields, mainly the long-term ones. The conclusions above and especially the increased lending can also be supported by the argument of Garcia-Posada and Marchetti (2016) that the EAPP caused a decline in sovereign yields, and therefore banks faced a lower opportunity cost of lending to NFCs and households.

Regarding the other variables, we observe a very temporary positive response of *VSTOXX* to the shock on impact, which then becomes negative again for a short period. The initial increase in the volatility index can be explained by the argument that at the beginning of the program market participants did not know exactly how the policy of QE was going to affect the economy (see Jakl, 2017) and therefore uncertainty was initially higher. As for *IP* and *HICP*, the results do not seem to be what one would expect. *IP* shows a significant but temporary increase only after about four months. This result is supported by Peersman (2011) who concludes that non-standard monetary policy shocks that affect the credit supply lead to significant increase in output only after about one year. A similar result is also found in the case of other countries that introduced unconventional measures. For example, examining the QE policy in Japan Schenkelberg and Watzka (2013) find that industrial production rises significantly ten months after the QE-shock. Furthermore it is important to keep in mind that the industrial production is a proxy for economic activity. Using a more accurate measure such as the real GDP or its growth would be a better approach, but data on these measures are not available on a monthly frequency and therefore they could not be used directly. Finally, we do not observe any significant increase in *HICP* as we would expect based on the main objective of the ECB when introducing the QE program, but also on the existing theoretical and empirical literature. Although it seems that this result is not in line with other papers examining the macroeconomic effects of the EAPP, it can be well justified if we take into account some important elements regarding the inflation in the EA. The first support for this finding comes directly from the data. When the program started in March 2015 the HICP inflation was -0.1% and it stayed below 1% until November of 2016, more than one year after the introduction of the program. And it basically converged to the price stability target of 2% in January 2017 when it raised to 1.7%, almost two years since the implementation of the QE policy (see Figure 2). This

Figure 2. HICP inflation in the EA



Note: The figure shows the EA HICP inflation from March 2015 to September 2020. The vertical line in January 2017 (about two years after the introduction of the EAPP) indicates the month in which inflation approached the 2% inflation target after the QE program.

evidence indicates a very sluggish response of inflation to the QE shock. Secondly, this insignificant response of inflation can also be supported theoretically, and more specifically on the basis of the Phillips curve. The main idea is that the inverse relationship between unemployment and inflation that was observed in the past does not seem to hold anymore. Consequently, this weaker connection has led to the flattening of the Philips curve. When the inverse relationship between economic slack and inflation holds, the impact that demand policies in general and the

monetary policy of the ECB in particular have on prices is strong. But when such a connection does not exist, then this would mean that such policies do not have a significant impact on prices (Moretti, Onorante, & Zakipour-Saber, 2019). Therefore this statement supports the insignificant impact of the QE policy on the HICP inflation observed in Figure 1.

The observation from the data that I have mentioned above (the first support to the insignificant inflation response) is also in line with what Abdih, Lin and Paret (2018) refer to as a "missing inflation" period. With this term they characterize the period from 2014Q2 until 2017Q4 explaining that during this period the inflation in the EA was very stable despite the fact that the unemployment rate was declining considerably. This also shows a weaker response of inflation to changes in the economic performance, implying again a flatter Phillips curve. Most importantly, they attribute the low inflation levels to the observation that the inflation process in the EA is backward-looking, meaning that the inflation is very persistent (lagged inflation levels play an important role for the current inflation). In order to confirm this and see if it also holds for the case examined in this study, I use an autocorrelation test for inflation. And indeed the correlation of inflation with its first lag is about 0.92 and still very high (about 0.6) with the fifth lag, indicating that the inflation process in the EA is highly persistent. Therefore, this analysis can strongly support the weak response of inflation to the shock in *QE*.

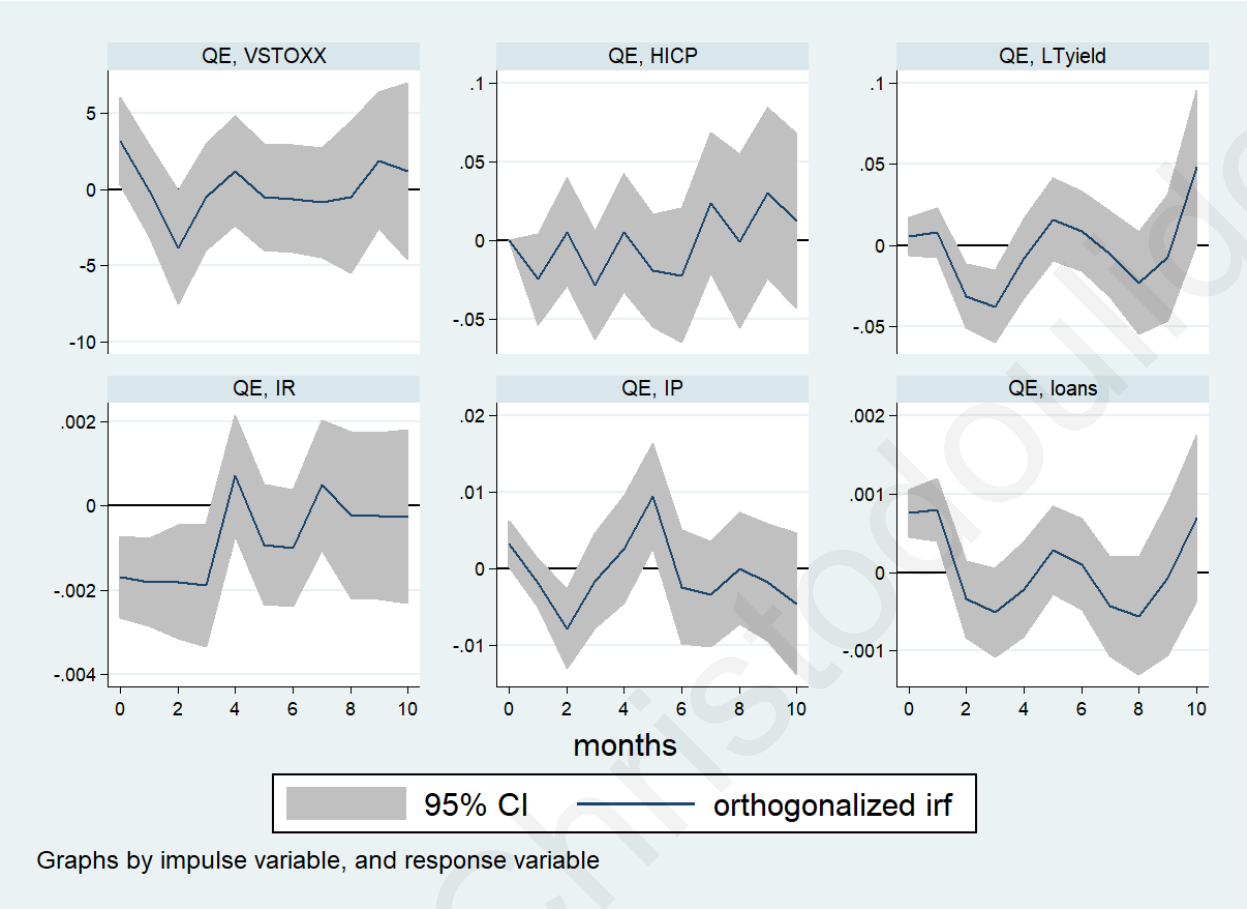
Although the response of most of the variables to the shock becomes insignificant after a few months, it is important to note that the variables are in fist-difference form and not in levels, thus the effects refer to the growth rates of those variables. Therefore, the effects in levels are going to be more persistent than this indicated by the figure. A reasonable question regarding the increased bank lending to NFCs that needs to be answered is about the possibility that this increase is due to higher demand for loans by the corporations after the introduction of the EAPP, and not to

increased credit supply by banks. There are at least two reasons why this does not seem to be the case. The first one comes from the IRF of the bank interest rate. If the increase in bank lending after the shock in *QE* was demand driven, then we would expect to see an increase in the lending rate (due to the higher demand). Instead, as already described, the interest rate decreases significantly after the shock implying that the rise in the volume of lending is supply and not demand driven. The second one concerns the Bank Lending Survey (BLS) and more specifically the answers given by banks in the EA regarding the EAPP and also the loan supply and demand. Banks stated that they have used the additional liquidity from the EAPP particularly for granting loans and that the program has also led to a net easing on credit standards and credit terms and conditions, particularly for loans to enterprises. An explanation to this answer might be the fact that unconventional policies can increase the valuations of long-term assets, leading to large capital gains for banks with a large sovereign exposure. Therefore, their capital position is improved and this can subsequently lead to an easing on their lending conditions (Albertazzi, Nobili, & Signoretti, 2016). Last but not least, according to the survey the use of internal financing sources by the firms had a negative impact on loan demand. All these can confirm that it is the supply of credit and not the demand that rises after the QE policy, further supporting a bank lending channel of the unconventional monetary policy in the EA.

6.2 Sensitivity analysis

In this part I perform some sensitivity analyses in order to check the robustness of the baseline results described above. Figure 3 shows the impulse responses for the same variables as in the baseline model after the monetary policy shock, but the variables in the model are now ordered in the way indicated by the Granger causality test (*HICP, QE, IR, VSTOXX, IP, loans, LTyield*). The

Figure 3. IRFs of the variables to a shock in *QE* - Granger causality ordering



Note: The impulse responses for *IP*, *HICP*, *loans*, *IR* and *LTyield* are expressed in percent, and for *VSTOXX* in percentage points.

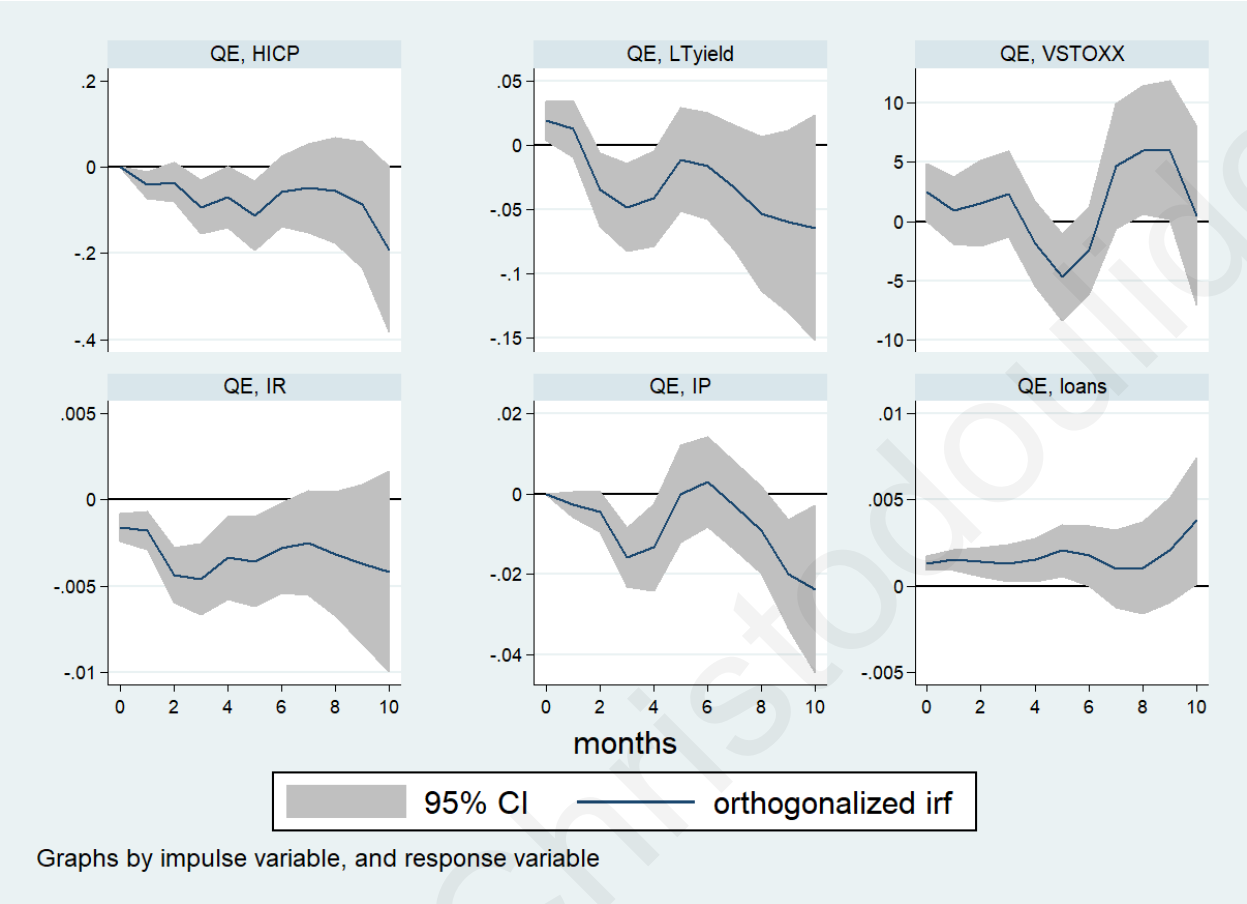
results for the key variables, mainly the bank lending but also the interest rate and the long-term yield, are very similar to those observed in Figure 1 supporting the initial findings. More specifically, we still observe an increase in loans after the monetary shock, and a decline in the lending rate and government yield. One difference compared to Figure 1, albeit not remarkable, is that now we do not see any significant response of *VSTOXX* to the one standard deviation increase in *QE*.

As already mentioned in Section 5, an approach followed by a number of relevant papers in the existing literature is using the levels of the variables included in the model, despite the presence of non-stationarity in all or some of the time series. Therefore, I also do a robustness check regarding a model without transforming the non-stationary variables in first differences. The results are depicted in Figure 4. The main conclusions are still observed, but as expected the persistency is higher and the reason, as noted previously, is simply that the variables here are in levels and not in growth rates as before. However, we see now some short significant negative responses of inflation, and also a reduction in *IP* in a way that has not been observed in any of the previous robustness checks. This might be an indication that using first differences for the unit root series is an important element in the estimation of the model. Overall, the sensitivity analyses above support the results on the primary variables of the study obtained from the baseline SVAR model, meaning a higher provision of loans to NFCs and also lower interest rate and long-term yield after the introduction of the QE policy program.

6.3 Forecast-error variance decomposition

In this part I use the forecast-error variance decomposition (FEVD) in order to see how much each of the variables in the model contributes to the variability of bank lending which is the variable of interest. The variance decomposition indicates that indeed a shock in *QE* explains a significant part of the forecast error variance of *loans*. More specifically, *QE* accounts for 47.59%, 40.08% and 30.53% of the total variance of *loans* after one, two and three months respectively, confirming the importance of the LSAPs for bank lending to the private sector. The contribution of an exogenous shock in *VSTOXX* is also important, in contrast to that of lending rate and

Figure 4. IRFs of the variables in levels to a shock in *QE*



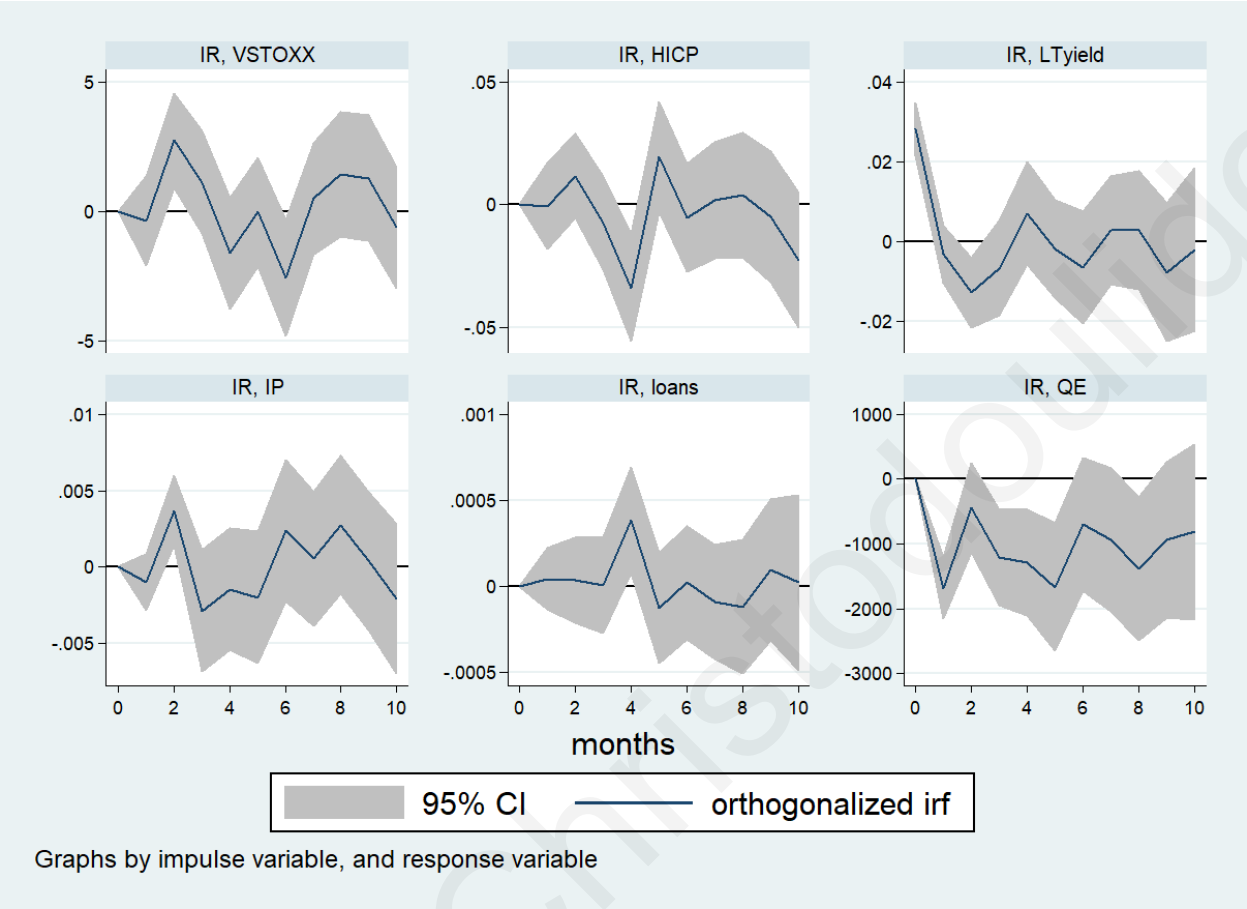
Note: The impulse responses are expressed in percentage points.

government yield which is very small (ranging from 0% - 2.16% for the rate and 0% - 1.43% for the yield during the first ten months after the introduction of the program).

6.4 Responses to other shocks

Finally, I examine how bank lending reacts to shocks in variables other than the asset purchases. Specifically, Figures 5 and 6 show the response of *loans* to shocks in the bank interest rate on loans to corporations and the 10-year government bond yield respectively. We observe that a shock in

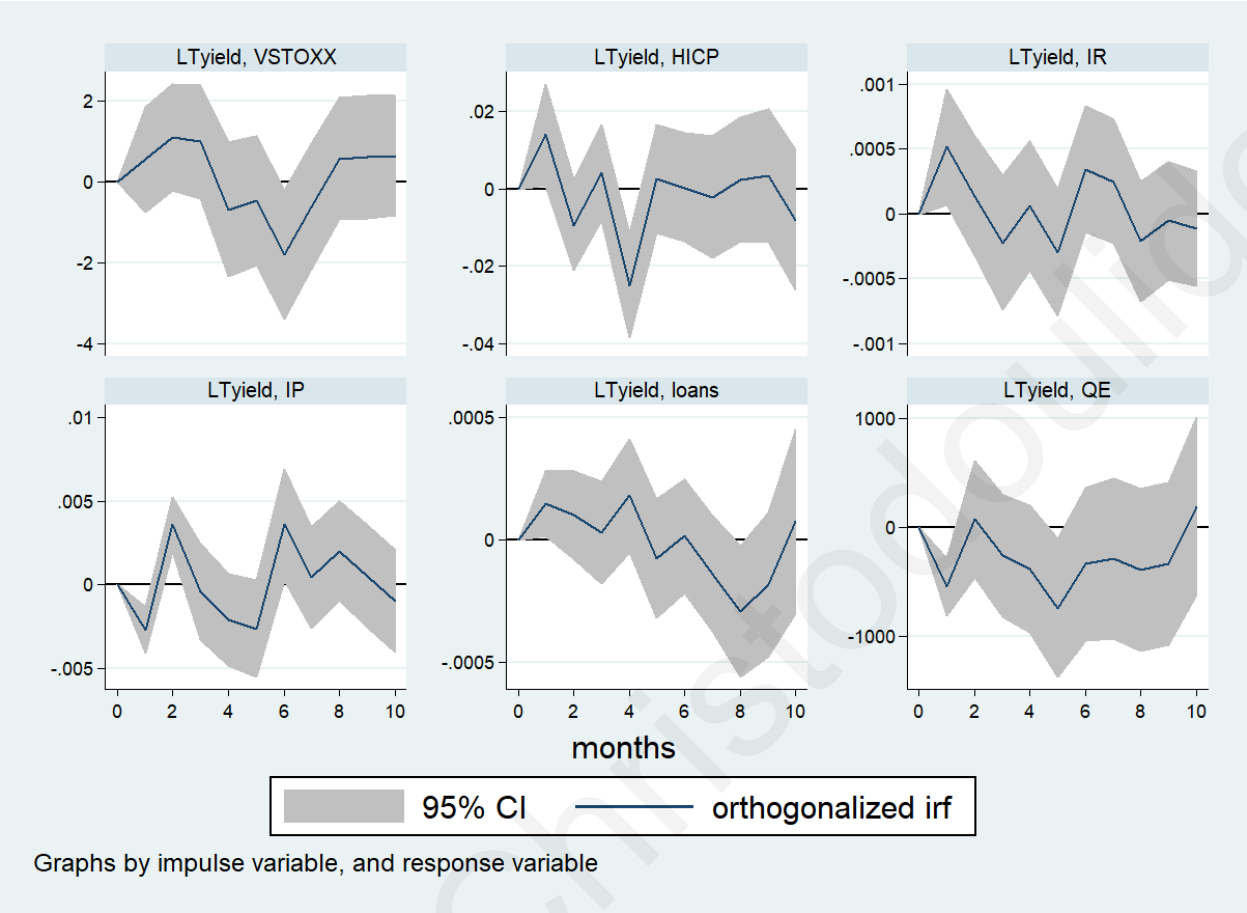
Figure 5. IRFs of the variables in the baseline model to a shock in *IR*



Note: The impulse responses for *IP*, *HICP*, *loans*, and *LTyield* are expressed in percent, for *QE* in euro millions, and for *VSTOXX* in percentage points.

IR leads to a negligible increase in lending after four months, almost insignificant, and also no important effect is observed after a shock in *LTyield*. Therefore, bank lending does not seem to change significantly after an exogenous increase in either of those variables. These two impulse responses confirm the previous conclusions made in the context of the FEVD, that the interest rate and the government yield have a very small contribution to fluctuations in lending.

Figure 6. IRFs of the variables in the baseline model to a shock in *LTyield*



Note: The impulse responses for *IP*, *HICP*, *loans*, and *IR* are expressed in percent, for *QE* in euro millions, and for *VSTOXX* in percentage points.

7. Conclusion

After the onset of the financial crisis of 2007-2008 many central banks started introducing different monetary policy measures, both conventional and unconventional, in order to face the adverse effects of the crisis and help the economies recover. The focus of this study is around the QE policy programs and more specifically the EAPP introduced by the ECB in 2015, with its main

objective being the achievement of an inflation level below, but close to, 2% over the medium term.

Since the financial system in the EA is mainly bank-centric, meaning that banks account for the largest part of the provision of credit to the private sector, it is important to assess the impact of that unconventional policy program on bank lending in the EA. I estimate a SVAR model using monthly data from March 2015 to September 2020 in order to examine the response of bank lending to a QE-shock. I conclude that banks in the EA increase their provision of loans to NFCs after an increase in net purchases under the EAPP, indicating that the QE program had provided support to the bank lending. Furthermore, the bank interest rate on loans to corporations as well as the EA 10-year Government Benchmark bond yield decline after the non-standard monetary policy shock. This result is in line with the common argument that LSAPs put downward pressure to interest rates and yields. Overall, the analysis shows that the EAPP had managed, at least to some extent, to activate the bank lending channel in the EA. Last but not least, the insignificant response of the HICP inflation to the shock, although not in line with the general finding of a positive impact on inflation that relevant studies in the existing literature support, can be reasonably justified in the context of the Phillips curve. More specifically, the flattening of the curve that has been observed some decades ago implies a weaker relationship between inflation and unemployment. This means that the response of inflation to an improvement in economic conditions will probably be less significant. Based on this, inflation would not be expected to react by much to a demand policy like the ECB's QE monetary policy.

This study could be extended to incorporate some other variables, such as the exchange rate and asset prices, in order to capture different transmission channels of the QE program. Many papers support that the rise in the value of assets caused by unconventional policies can benefit banks

through an increase in the net worth of their balance sheet, which can subsequently lead to higher capital gains and risk appetite of the banking system and finally to greater loan supply (see Peersman, 2011; Albertazzi et al., 2016; Andrade et al., 2016). Therefore, including asset prices in the model would be important in order to determine whether a net-worth channel was activated after the implementation of the EAPP.

Another issue that starts to seem of high importance and probably deserves some further examination is the question of when it is the right time for the central bank to stop these assets purchases, also known in the literature as 'tapering'. The reason is that, if the central bank exits from the unconventional monetary policy in an inappropriate way, for example abruptly, then this can possibly create distortions in the market since it might reverse market participants' expectations regarding the future path of interest rates and inflation, having subsequent consequences for the economy in the EA. Just to mention that, related to the description of the QE program in the beginning of the study, the issue of tapering can be reasonably considered to be a possible justification of the reinvestments started by the Eurosystem in January of 2019, immediately after the first phase of net purchases was completed. This implies that the exit strategy from the EAPP needs to be implemented taking into consideration all the possible effects that this decision might have.

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