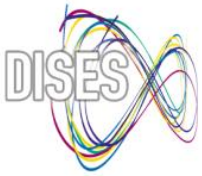

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The impact of ECB Unconventional Monetary Policies

Coordinatore

Ch. ma Prof.ssa Alessandra Amendola

Relatore

Ch. mo Prof. Matteo Fragetta

Candidato

Federica Santucci

Matr. 8801000022

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Abstract

This dissertation is aimed at addressing two questions about unconventional monetary policies in the Eurozone. First, what policies are being tried and their effectiveness. In doing so, this study surveys the literature on the effectiveness of UMP in responding to financial crisis and boosting economic activities. Second, focusing on the unconventional policies adopted by the ECB, we assess their effects on the main macroeconomic aggregates and financial variables by using observations of Euro Area countries. In doing so, we highlight the differences in the effects among countries included in the sample. Furthermore, compared to other dataset, we use data up to M12 2019, thus also the very recent QE announcement by President Draghi delivered in September 2019 is also taken into consideration. A VAR model is used to analyse the common monetary policies in the Eurozone since the VAR allows for a better identification of the real effects of UMP shocks. Results confirm the heterogeneity of the effects of UMPs on inflation, industrial production and producer price index among different countries of the Eurozone in the period 2010-2019.

In the last paper, we analyse the impact of Draghi's famous announcement made in July 2012 on sovereign bond spreads through the Generalized Synthetic Control Method. We analyse the period from Q2 2009 to Q4 2015 with quarterly data. Results show that the announcement of UMPs in the Eurozone contributed to the reduction of sovereign bond spreads for the nine Eurozone countries included in the sample.

CHAPTER 1

1. Introduction

The present work deals with analysing more deeply the nature, motivations and effects, however measurable, of the unconventional monetary policies, with a special focus on QE, implemented in the Eurozone from 2010 to today.

In order to introduce the study, the first part of the work describes monetary policy measures. They are the ECB main tool to manage the stability in the Eurozone.

The focus of this work will be placed on "unconventional" monetary policies (UMP) announced since the collapse of Lehman Brothers from the European Central Bank, whether adopted, aimed at buying the debt sovereign of the Euro Area, within the limits set by the Lisbon Treaty, and destined to stop the financial crisis of 2007-2008. Among these: OMT, TLTRO, balance sheet policies (commonly termed “quantitative easing”), negative rates and forward guidance. Literature shows that their effects on the financial markets will be on financial instruments in terms of impact on rates and yields on government securities. I also analyse the QE programme from its first launch by the Governing Council of the European Central Bank (ECB) on 22 January 2015. The APP programme was subsequently extended and re-calibrated on various occasions, increasing the duration and total amount of purchases. Finally, it was launched again on 14 September 2019.

I then test the effect of the implementation of ECB unconventional policies on the time evolution of the financial linkages in the macro-network of the Euro Area as well as the effect on macroeconomic variables, such as output and prices.

Finally, I conclude with an overview on the UMPs measures adopted by ECB to contrast the pandemic caused by Covid-19.

2. *Monetary Policy of European Central Bank*

On 1 January 1999, a new currency - the euro – was created and today it is adopted by 19 European countries, which form the so-called "Eurozone". The European Central Bank is the central bank responsible for implementing the monetary policy for the European Union countries that have joined the euro.

As provided by the Article 106 of the Treaty on European Union (the Maastricht Treaty), the European System of Central Banks (ESCB) comprises the European Central Bank and the national central banks of the EU member states regardless the adoption of the single currency. The Treaty assigns the Eurosystem the primary objective of maintaining price stability, reflecting a broad consensus in society that maintaining stable prices is the best contribution that monetary policy can make to economic growth, job creation and social cohesion.

One of the major challenges for the success of the euro from the beginning of the Economic and Monetary Union (EMU) in 1992 was to enhance the capacity of the euro-member countries to withstand negative macroeconomic and financial shocks. It is a fact that the EMU constitution eliminated the traditional adjustment mechanism between national economies, nevertheless the monetary union was not a springboard to reach a significant degree of banking union or fiscal union. Given the above, euro area did not match the design of the "dollar union" of the United States (Lane, 2012). This deficiency is at the heart of the current European crisis, which has revealed the need for a quantum leap forward towards reinforcing the institutional framework of the EMU.

The operational framework of the Eurosystem to reach those goals consists of three sets of instruments:

- *open market operations* (OMO). The central bank purchases and sells securities on the open market to regulate the supply of money. They are the Eurosystem's main tool for liquidity management;

- *standing facilities*. Central banks' counterparties purchase and sell securities to restrict the volatility of short-term money market interest rates;
- minimum reserve requirements for credit institutions, whose main function is to stabilize money market interest rates.

2.1 "Unconventional" Monetary Policy of ECB

Unconventional monetary policies gained prominence in the wake of the global financial crisis (GFC), as traditional monetary policy tools proved less effective in tackling the financial crisis and providing the required liquidity. The ECB initially referred to these undertakings as 'non-standard' policies (Coeuré, 2013) although, as of 2014, the expression 'unconventional' was more widely used. The primary objective of the Eurosystem's monetary policy is to maintain price stability, defined as the inflation rate below but close to two per cent on a medium period horizon. However, the zero-lower bound (ZLB) decreases the effectiveness of central banks' conventional monetary policies thus they must resort to UMP. The origins of UMPs, though, can be traced to measures taken by the Bank of Japan in March 2001, which deployed some forms of quantitative easing (QE) to tackle economic stagnation and combat deflation. Since those initial steps, UMPs[1] have pursued by several other central banks, they have evolved and have taken various forms: forward guidance (FG), negative interest rate policy (NIRP), and a variety of policies that exploit the balance sheets of central banks like the large-scale asset purchasing programmes (APP) implemented initially by the Federal Reserve and the Bank of England as a response to the financial meltdown in 2008.

While balance sheet policies involve direct intervention in the monetary system, another set of UMP tools aims to change expectations by sending signals about the future policy path. Studies identify four sets of UMP tools: negative

[1] For a more extensive account of these policies see, for example, Ball et al. (2016) and IMF (2013).

interest rate policies, new central bank lending operations, asset purchase programmes, and forward guidance.

Programme	
ABSPP	Asset-backed securities purchase programme
CBPP	Covered bond purchase programme
CSPP	Corporate sector purchasing programme
(T)LTRO	(Targeted) long-term refinancing operations
NIRP	Negative interest rate policy
OMT	Outright Monetary Transactions
PSPP	Public Sector Purchase Program
SMP	Securities Markets Program

Negative interest rate policies (NIRP) were introduced by the European Central Bank (ECB), the Danmarks Nationalbank (DN), the Swiss National Bank (SNB) and the Bank of Japan (BoJ) to provide additional monetary policy stimulus between mid-2014 and early 2016, in the aftermath of the crisis. Five years after negative interest rates first appeared, they were still in place in most of Europe. As of October 2019, ECB had -0,5%, the Danmarks Nationalbank -0,75% and the Swiss National Bank -0,25%.

> *[In] the first full year with negative interest rates, [banks' net interest income] went up. […] So, all in all the [NIRP] experience has been positive.*
> *Mario Draghi, April 2016*

NIRP are associated with a particular friction because the remuneration of retail deposits tends to be floored at zero. It consists of a cut of bank deposit facility rate (DFR) to negative territory. The friction associated with NIRP should have an impact on banks' profitability as the remuneration of their assets declines because of NIRP, while a significant part of their funding costs remains unchanged. The objective is the reduction of excess reserves by increasing lending and purchasing other financial assets by individual banks. The final goal is to ward off the threat of deflation, or a spiral of falling prices that could deepened economic distress. But NIRP are not always welcome by banks which appear reticent in adopting them because they harm bank profitability and possibly prevent a reduction in lending rates.

Asset purchase programmes (APPs) consist of net purchases of securities. Net purchases of the ECB financial assets began with covered bonds in June 2009 (CBPP1 lasting one year), renewed in 2011 (CPP2 until October 2012) and extended in October 2014 (CPP3). The ABSPP securitization purchase program was announced in June 2014 and started in November 2014. In January 2015, was announced the EAPP (Euro asset purchase program) which included CPP3, asset-based securities purchase program (ABSPP) and the public sector purchase program (PSPP), the latter being the new purchases of government bonds with a residual life between 3 and 30 years (with capital key).

APPs include *targeted long-term refinancing operations (TLTRO)* which are loans granted by the ECB to European banks with a duration of up to four years, aimed (targeted) at the financing of private debtors, companies or families. Long term refinancing operation (LTRO) consists of a "liquidity auction" with which the European Central Bank grants loans to banks that request it. Loans have a duration of three years, after which they must be repaid. LTRO and TLTRO are open market operations, and therefore do not provide for the creation of money, as QE provides. TLTROs are financing transactions that create a debtor-creditor relationship between commercial banks and the European Central Bank. Buying these assets provides liquidity to the banking system in exchange for the sale of the securities. The banks, thanks to the TLTRO, can access a subsidized loan to finance, in turn, the real economy. There were two LTROs, one in 2011 and one in 2012. The main purpose of the two operations was to support the public debt of European countries following the sovereign debt crisis. Government securities of Greece were excluded from the purchasable securities. Because of the economic stagnation, in June 2014 the ECB implemented TLTRO. Unlike the previous LTROs, the TLTROs are specifically aimed at "strengthening the transmission of monetary policy by encouraging banks to lend to the real economy". In this case the target was financing the real economy, namely the private non-financial sector. Three series of TLTROs were made: in June 2014, in March 2016 and during the 2019-2020. In 2018 the first series was reimbursed. The second portion of the TLTROs, as regards Italian banks, will have to be returned between June 2020 and March 2021. The interest rate of TLTRO II has

been calibrated on banks' behaviour. Particularly, the interest rate of TLTRO II is established "later" and regulated after the expiration of the loan, thus it could go down to that deposit facility which is -0.4%.

Outright monetary transactions (OMT) allow the ECB to purchase government bonds with a residual life of up to three years from a country that has requested and obtained assistance from the ESM States-saving fund (a full program or an ECCL precautionary credit line) on the secondary market. The purchases of the ECB are not automatic but are made with discretion: based on the evaluation of the respect of the country that asked for help from the commitments made by signing the Memorandum of Understanding. And only if the State-saving fund has opened the option to purchase government bonds on the primary, at auction. Anyway, this tool has never been used so far.

Until 2010, the ECB practice was not to participate in the secondary public debt market. After the Greek crisis, the ECB exceptionally launched a program of sporadic purchases, aimed at giving liquidity to Greek, Irish, Portuguese, Spanish and Italian stocks. This was not enough to face the crisis. The inclusion of the OMT among the monetary policy instruments has radically changed the practice of the ECB, marking the most significant "regime change" in the twenty-year history of the single currency. To safeguard the liquidity of the government bonds of a country in difficulty, the ECB would have purchased them on the secondary market without any pre-established limit, provided that the country joined a financial assistance program. With OMT operation the central bank would effectively eliminate the credit risk of debts created not by a central political authority, but by the various participants in the euro. It should be noted that in the United States the Fed does not guarantee debt issued by lower than central government levels. In this sense, the ECB "does more" than the Fed. The fact that the ECB had the option of resorting, if necessary, to the OMT was enough to obtain the desired effect: a rapid and conspicuous reduction in the yield differentials of the securities issued by the various countries, and therefore a realignment of the financial conditions member countries under the conditions set

by the monetary policy of the ECB. As said before, although never used, the creation of the OMT had a decisive impact on the single currency.

Forward guidance policies (FG) use communication to affect policy outcomes through the expectations of people's behaviour. In fact, with FG central banks communicate about the likely future course of their policy stance. Eggertsson and Woodford (2003) suggest that communicating low future rates should stimulate aggregate demand today and may even break deflationary spirals at zero interest rates, based on the New Keynesian paradigm. On the other hand, empirical studies (see, e.g., Del Negro et al., 2015) suggest that New Keynesian models tend to overstate the effects of forward guidance announcements. Central banks have used different types of FG, where the horizon, over which policy rates are expected to remain at current levels, has been defined by means of i) a state-contingent threshold, ii) a calendar date, or has been iii) left open-ended (Ehrmann et al., 2019). They were introduced by the BoJ almost two decades ago (see, inter alia, Filardo and Hofmann, 2014). The ECB began using forward guidance in July 2013. FG can be made in qualitative or quantitative criteria. In the form of qualitative guidance, announced by Bank of Japan in October 2010, FG involves communicating the central bank's views about future policy actions but stops short of offering any sort of commitment. More precisely, if a central bank gives forward guidance, it means it is providing information about its future monetary policy intentions, based on its assessment of the outlook for price stability (ECB website). In the form of quantitative guidance, announced by Bank of England in August 2013, FG involves communicating the central bank's views about future policy actions related to other quantitative goals. Nevertheless, FG is not always able to condition people's behaviour, this happens mainly when the announcement concerns already existing expectations.

Following Lehman's collapse, the spread between unsecured interbank deposit rates (EURIBOR) and overnight indexed swap (OIS) rates at the three-month maturity peaked at 200 basis points in the Euro Area. Thus, since 2009 the ECB has implemented several non-standard monetary policy measures to complement the regular operations of the Eurosystem (Giannone et al. 2011). The ECB actions

were guided by the limitations placed on it by the Lisbon Treaty which prohibits the Eurosystem from conducting purchases of sovereign debt that are interpreted as sovereign bailouts (Article 125) or monetary financing (Article 123). Asset purchases, the magnitude of which are practically negligible, have been therefore conducted with the objective of addressing market dysfunctions and repairing the transmission mechanism of monetary policy (2014, RSW). Those adopted monetary policies include longer-term refinancing operations (LTROs) which are 1-, 6-, 12-, 24- and 36-month operations, fixed-rate full allotment operations (FRFA), the securities market programme (SMP) in May 2010, the outright monetary transactions (OMT) in August 2012, various vintages of asset purchase programmes (APPs), new collateral rules and reserve requirements and two Covered Bond Purchase Programmes (CBPP1 and CBPP2) in 2009 and 2011. In the wake of the GFC, policymakers argued that using these policy tools was necessary to prevent an even worse contraction. Once the crisis passed, they argued that the continued application of such policies could speed up the recovery from crisis conditions (Lombardi et al., 2018).

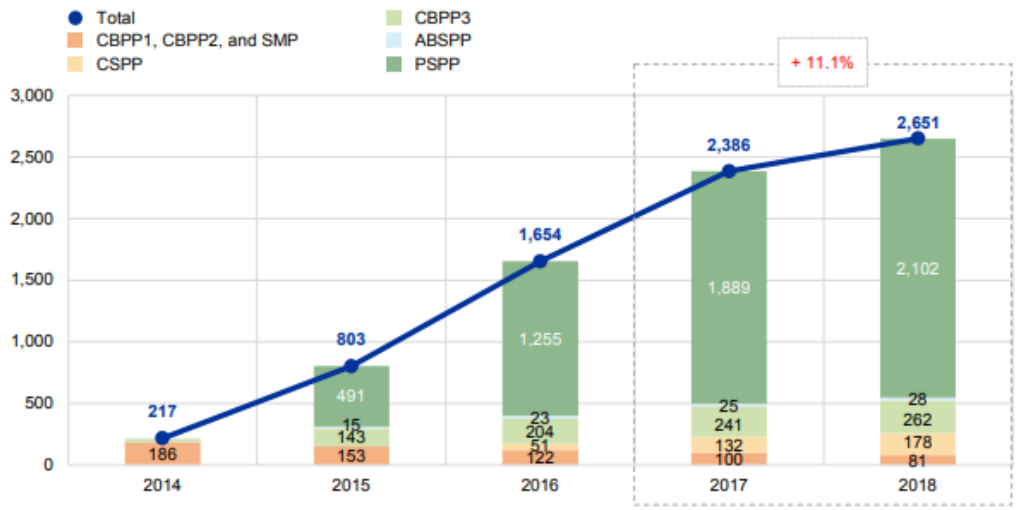
For the ECB, the effect of the expansionary monetary policy shock goes in the opposite direction from the Fed, BOE or BOJ. The Euro Area expansionary monetary policy surprise leads the euro to appreciate significantly and causes German bond and euro-area corporate bond yields to rise significantly, presumably because the surprise lessened safe-haven flows into bunds and promoted financial stability and confidence in the survival of European monetary union. The euro-area expansionary monetary policy surprises cause the pound to appreciate slightly (but significantly) vis-à-vis the dollar and causes Spanish sovereign yields to fall sharply and boost stock prices.

Furthermore, while the Fed or the Bank of England were trying to encourage real expenditure by boosting liquidity and reducing long-term interest rates in the aftermath of the financial crisis, the ECB focus was arguably different. Joyse et al. (2012) argue that the ECB QE programmes aimed at the same goal by primarily shoring up the banking system and stopping the momentum of a process

that resembled a bank run, as deposits from the Euro Area periphery's banks shifted to the core's (see also Sinn and Wollmershauser, 2011).

Looking at the last ECB balance sheet, Euro-denominated securities held for monetary policy purposes constituted 56.4% of the Eurosystem's total assets as at the end of 2018. Under this balance sheet position the Eurosystem holds securities acquired in the context of the APP and the terminated purchase programmes, e.g. the Securities Markets Programme (SMP) and the first two covered bond purchase programmes (CBPP1 and CBPP2). In 2018 the portfolio of securities held for monetary policy purposes by the Eurosystem increased by €265.3 billion to €2,651.3 billion (Figure 1), with PSPP purchases accounting for a great part of this increase. The decrease of €18.5 billion in holdings under the terminated programmes (CBPP1, CBPP2 and SMP) was mainly due to redemptions. QE episodes lead to an expansion in the central bank balance sheet (the rise in real central bank assets is between 10% and 20% in the medium term). Under QE the ECB balance sheet has ballooned to about 4.65 trillion euros. That is more than doubled since the start of 2015 and is second only to the Bank of Japan.

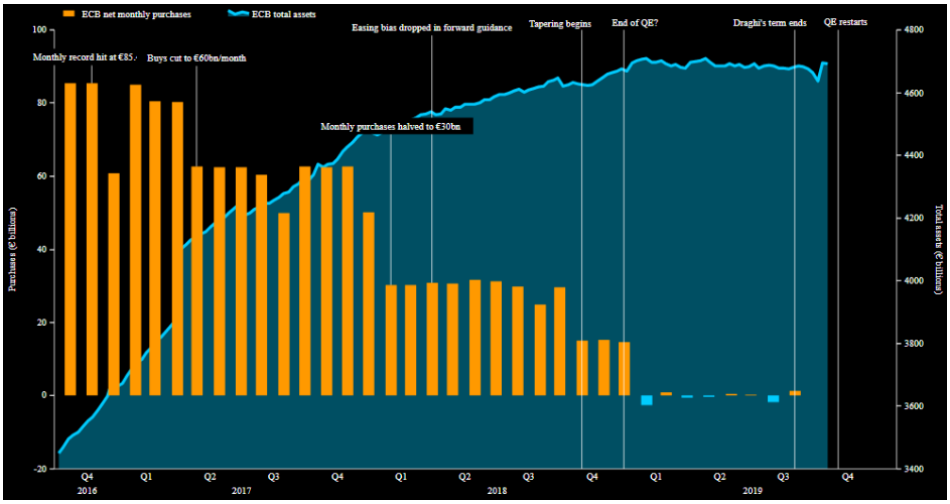
F1. Securities held for monetary policy purpose (EUR billions)



Source: Eurosystem.

Figure 2 shows the trend of ECB total asset compared to the QE programme from 2014 to 2018.

2: ECB's QE programme



Source: Refinitiv

Furthermore, penalizing credit institutions for the extension of credit in support of economic growth, eliminating their interest margins, does not benefit their balance sheets, as can be seen from the depressed price of European banks' shares. The Euro Stoxx Index is down more than 40% since the ECB launched negative rates in mid-2014 (Figure 3).

F3: Euro Stoxx Banks Index

Source: CNN

2.2. Quantitative Easing

The asset purchase program, known as QE, consists of an intervention by the Central Bank that buys securities on the market. Particularly, the ECB will buy securities from all the countries of the Euro Area, in proportion to the share

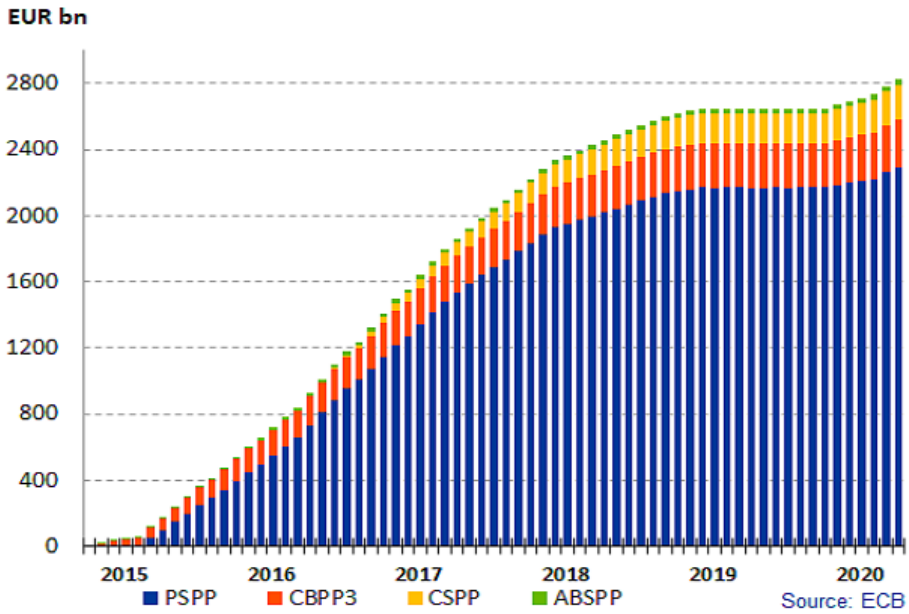
that each central bank has in the capital of the ECB (the capital of the ECB is held by the Bank of Italy, Bank of France, Bundesbank, etc. Each National Bank has a certain share of the ECB capital, and purchases will be made in proportion to this share). The ECB "creates money" – it is an unconventional instrument of expansive monetary policy - and uses it to buy mainly government bonds (like Italian BTPs). The purchase is only made on the secondary market[2]. The programme also establishes some guarantees, in fact, ECB buys government bonds of Country X, but if the country X defaults, or it does not repay the debt, it is expected that 20% of the risk will be borne by the ECB, while 80% will be shared by the central banks of the individual European countries.

The introduction of quantitative easing was the first answer of ECB to the negative contingency of the GFC, it was used to stimulate economic growth through purchases of government bonds, with the aim of directing credit supply and financial markets (Draghi 2014). The goals were: reducing substantially the geographic bias in the flight to safety, as the safe asset is (in regulatory terms) a Europe-wide one; eliminating the moral hazard induced by current arrangements (governments can default in this world, as the banks are protected from the fallout). Markets would thus monitor the governments instead of second guessing the (bailout) intentions of the ECB; eliminate the diabolic loop between banks and their governments, since a sovereign in trouble does not jeopardise its own banks (who hold a senior tranche of a diversified portfolio); reducing the geographic segmentation of Eurozone financial markets.

The stock of Eurosystem APP bonds stood at €2822 billion at the end of April 2020.

F4: Cumulative Asset purchase programme (APP)

[2] The primary market is the State that issues Bot or BTP and places them on the markets, and in this case the ECB cannot intervene. Once the government bonds are placed, they can then be bought and sold between investors, and this is the secondary market.



Source: ECB website

Table 1 provides a summary of the QE employed in advanced economies.

T1: Quantitative easing programmes in advanced economies (Chronological).

Balance Sheet Policies			
Quantitative Easing	Japan	Quantitative Easing (QEJ)	March 2001 to March 2006
	United States	Large Scale Asset Purchase Program (LSAP1)	January 2009 to March 2010
	United Kingdom	Asset Purchase Facility – Gilt (BQE1)	January 2009 to February 2010
	Japan	Comprehensive Monetary Easing (CME)	October 2010 to March 2013
	United States	Large Scale Asset Purchase Program (LSAP2)	November 2010 to June 2011
	United Kingdom	Asset Purchase Facility – Gilt (BQE2)	October 2011 to October 2012
	United States	Large Scale Asset Purchase Program (LSAP3)	September 2012 to October 2014
	Japan	Quantitative and Qualitative Monetary Easing (JGB purchases)	April 2013 to present
	Euro area	Public Sector Purchase Programme	January 2015 to present
	United Kingdom	Asset Purchase Facility – Gilt (BQE3)	August 2016
	Switzerland	Expansion of Sight Deposits (Reserves)	August 2011
	Sweden	Government bonds	Febbraio 2015

Source: Individual country central banks accessible via the BIS's Central Bank Hub (https://www.bis.org/cbanks.htm).

The ECB launched the first QE in March 2015 to prevent sub-zero inflation from further hitting an economy still reeling from the Eurozone debt crisis. QE has lifted economic growth while wages and lending have risen but inflation remains subdued, complicating the QE exit and ensuring interest rates will stay at record lows for some time. Nevertheless, the ECB has been criticized because the bond buying has depressed interest rates and hurt European banks' profitability.

Furthermore, President Draghi announced a new QE programme in September 2019.

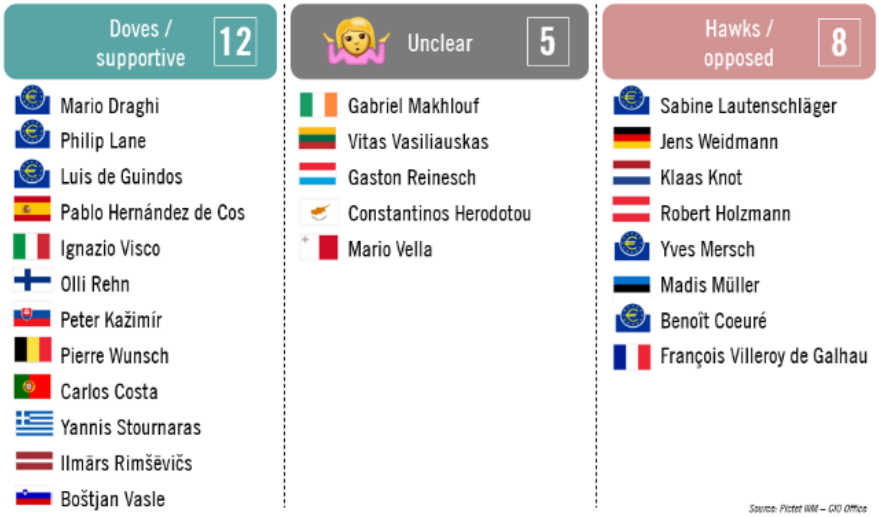
T2: September meeting measures

Summary of ECB Sept policy measures	
Adjustment	**Outcome**
Deposit rate	Cut by 10 bps to -0.50%
Rates forward guidance	Data dependent
Tiering	Exemptions set at 6x minimum reserves
TLTRO	Maturity increase from 2 to 3Y; 10bp rate reduction
APP length*	Open ended
APP mix	Unknown
APP limits	No change

* Note Asset Purchase Programme

Figure 5 provides a summary of the votes about QE of the Eurozone 19 countries during the September meeting.

F5: ECB: Who backed QE during the September meeting, and who opposed it.



Source: Refinitiv

Objectives / advantages of QE

Looking deeper at the objectives that ECB hope to achieve with QE, they are essentially of two types. The first is a decline in the yield on securities, the second a depreciation of the euro.

- *Falling in securities yield* - To finance its public debt, States must turn to the financial markets, which set the interest rate (e.g., if nobody wants Italian BTPs because they consider Italy at risk, the Treasury must offer interest rates more and more high to place them – it is the spread). If the

ECB intervenes by buying these government bonds, it will be easier for Italy to place them, and therefore the interest rate will fall.

- *More money, more access to credit* - A second goal linked directly to the decline in the return on securities is the fact that money is free to be invested in other ways. Banks are among the largest holders of government bonds. If the ECB goes to private banks and proposes their purchase, the banks enter "fresh money" that can be used to give credit to families and businesses. Even more so if the rates on government bonds fall, for private banks it becomes less and less convenient to keep BTPs and therefore will be pushed to use the money in another way. First, by providing credit to the economy. Secondly, part of the money will move to the stock market. The increase in the demand for shares raises the price, with other advantages for companies. QE should therefore make it possible to revive credit and the economy, after years in which families and businesses have seen banks shutting down taps (the so-called credit crunch).
- *Depreciation of the euro* - It is the second major goal. More euros circulating for the same goods and services means that money tends to "be worth less". It is the definition of inflation. The ECB tends to an inflation of 2%, while today a large part of the EU is in deflation (the fall in prices, which has terrible impacts on the economy, sales, on who has a debt, etc.). Furthermore, there is a second fundamental fallout from the depreciation of the euro: for countries that use the single currency, exports become simpler, and imports are more expensive. With the QE the euro should fall (particularly with respect to the dollar, but also with respect to other major currencies) and this should lead several countries that adopt the single currency to increase exports, with positive effects on public accounts.

Negative aspects

Some of the advantages exhibited also have negative consequences, which are not necessarily expected. The major negative aspects are:

- Increase in credit disbursed. Are we sure that banks will provide more credit by transferring QE money to families and businesses? The current problem, for many countries, including Italy, is another: the banks are suffering from increasingly high suffering (the suffering is the percentage of loans disbursed that are not returned, and in Italy we are now around 10%), this leads the banks to not trust their customers and close the credit taps, which increases the difficulties of the companies, and therefore the suffering, in a spiral that feeds on itself. Today on the financial markets, there are approximately 1.200 billion euros invested in securities at negative rates: many investors (including banks) prefer to lose something to park liquidity in safe ports, instead of providing loans. In other words, the current problem is the *liquidity trap*.
- To confirm this risk, it is possible to see how the manoeuvres fielded by the ECB so far have been completely ineffective, starting from the conventional ones, such as the reduction in the reference rates (the "cost of money" to which the ECB lends) to banks which should in turn allow banks to provide more credit. Rates fell to 0.05% with no appreciable results. Just as the previous interventions of the ECB injecting liquidity did not give the expected results: the 1,000 billion given to banks in recent years with LTRO and the first feedback on the new operation launched a few months ago by the ECB for banks, the TLTRO, in which additional liquidity is conditioned precisely by the provision of credit but which currently does not seem to work.
- Another huge doubt about the ability of QE to relaunch the European economy is related to the freedom of movement of capital. The ECB injects liquidity into Europe, it cannot guarantee that these capitals will remain in the economy of the old continent because of the absence of any control over capital. Taking the Central Bank of Japan as example, much

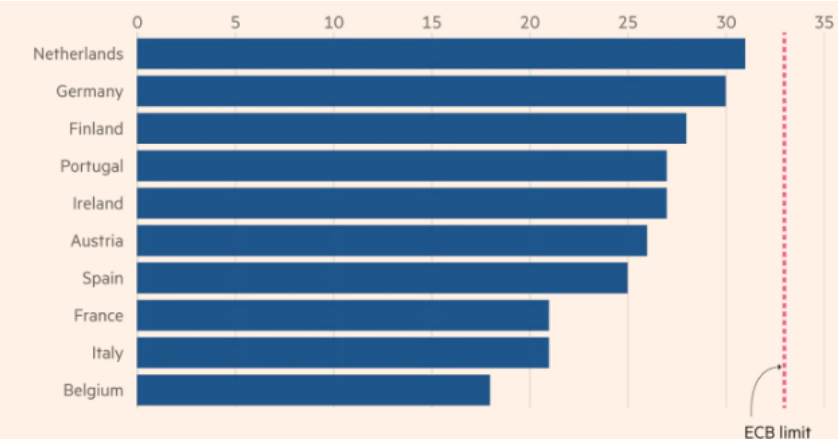
of the liquidity injected with its QE has been poured into the international financial markets, in emerging economies and in speculative operations.

- The risk is therefore not only that of an ineffective QE to boost credit and economic growth. Even worse, financial markets on which more and more money is circulating could be further detached from an economy that remains at stake: the very definition of a new financial bubble. It is true that QE could lead to an increase in stock prices, but this increase would go only to the richest segments of the population and would not be distributed to the whole of society.
- Decrease in spread and rates. The second objective linked to the decline in returns is to bring down the spread, particularly for countries in difficulty in the European periphery. It is true that a central bank that undertakes to buy government bonds should hold back the speculative impulses of the markets, but it is equally true that the pro-share purchase of the securities of the various European countries means that in fact the ECB will purchase many German securities, which have already negative rates, and much less than countries such as Portugal or Greece, which would need them most.
- It is precisely the Hellenic country that is the one that causes the greatest concerns. Draghi has already clarified that the ECB may also buy securities from countries with a bad rating, but only if the country accepts the so-called "Troika[3]" assistance program.
- The depreciation of the euro should lead to increasing exports.

In September 2019, the ECB announced its package of renewed bond-buying (QE) and an interest-rate cut. The ECB is due to start acquiring €20bn of bonds a month in November, the program can run until the end of 2020 before bumping up against the central bank's self-imposed limits, under which it can own no more than a third of any Eurozone country's bond market (Figure 6).

[3] Consisting of the European Commission, the European Central Bank and the International Monetary Fund.

F6: ECB nears bond-buying limit for some Eurozone states



Source: Pictet Wealth Management

As of September 2019, Figure 6 shows the percentage of eligible bonds held by the European System of Central Banks.

The immediate response of the market to the new QE was the euro fall and bonds rally. Nevertheless, after a few hours the euro was stronger, and bonds fell back. Those reactions show investors' doubt about long-term effectiveness of the ECB efforts about whether the package can get the Eurozone out of the low growth.

2.3. Effects of Unconventional Monetary Policies

IMF (2013) suggests that asset purchases may be most effective at times of crises.

Although the ECB UMP actions were criticized as being 'too little, too late' (see Kang et al., 2016; Wyplosz, 2011), the evidence shows that the ECB policies were just as effective at lowering long-term yields and more effective at lowering short-term yields than the policies implemented in the US and the UK. The normal presumption in the event study literature about the effect of monetary policy shocks is that the effects are long-lasting (Fama et al., 1969). However, Rogers (2014) studies the immediate effect of monetary policy shocks and finds that there are several natural mechanisms that might cause the effects of

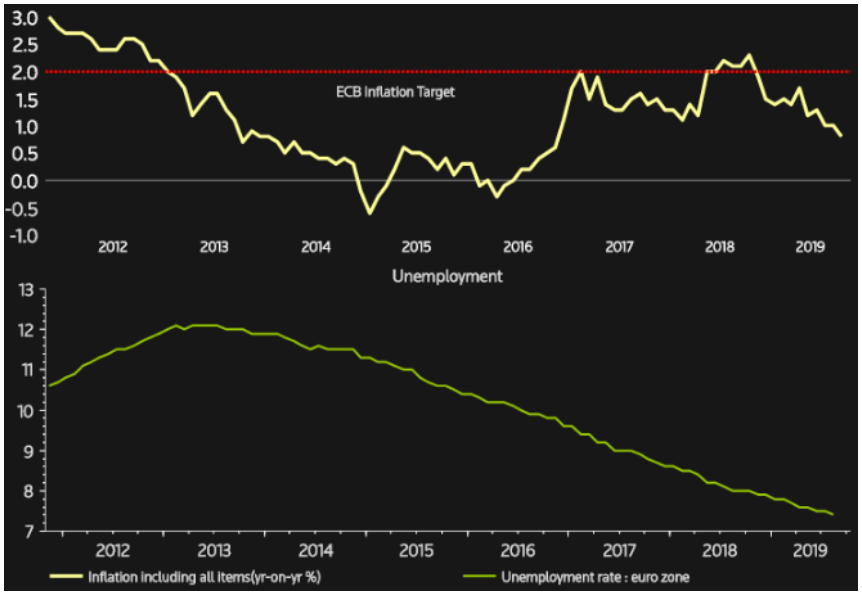
unconventional monetary policy surprises to wear off over time. Some of those mechanisms are:

1) Quantitative easing may make the economy recover faster than would otherwise have been the case, ultimately driving interest rates back up.
2) Quantitative easing may induce more corporate issuance of long-term bonds (Stein, 2012), which would in turn also tend to push long-term rates higher.
3) Frictions may make arbitrage capital slow-moving - and thus better able to offset the impact of preferred habitat investors in the long-run than in the short-run (Duffie, 2010; Mitchell et al., 2007).
4) Many of the important unconventional monetary policy surprises took place at a time when financial markets were impaired. Thus, effects of asset purchases on bond yields may have been particularly large. As arbitrage capital returned to financial markets, the effects would have got smaller.
5) Some part of the effect of unconventional monetary policy surprises was to lower the near-term expected path of the federal funds rate. But, in the absence of any further news, the impact of this shift on the ten-year yield mechanically disappears with the passage of time.

Studies about effects of unconventional monetary policy are addressed in two ways: effects on macroeconomic outcomes are analysed for example by Giannone et al. (2011) and Lenza et al. (2010), while other studies (Rogers et al. 2014) focus on the effects of unconventional monetary policy on asset prices.

Looking at data trend (Figure 7), Draghi's UMP program has a track record on employment growth but not on inflation. Since 2013, unemployment rate in the Eurozone has gone down while inflation has been always around 2%.

F7: Key economic indicator - Eurozone.

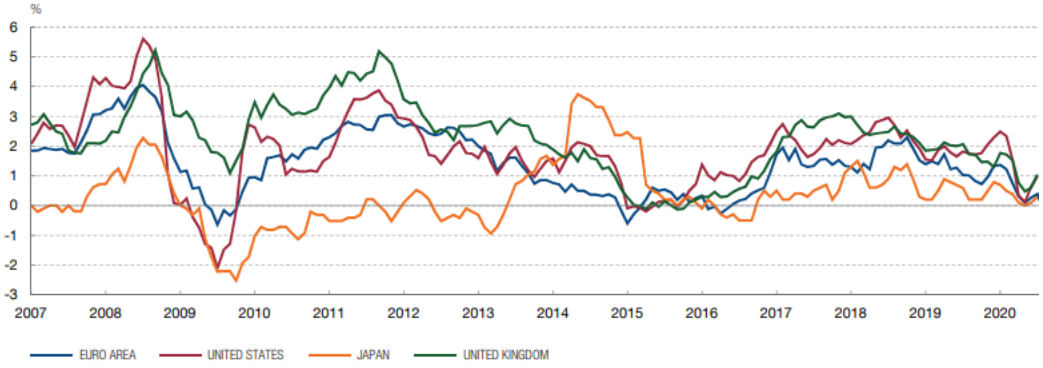


Source: Refinitiv

3. Insights into the ECB Unconventional Monetary Policy response to the Covid-19

When in February 2020 the Covid-19 crisis burst in Europe, ECB was using a series of unconventional monetary policies because of the disinflationary pressure which led to a low inflation decade with policy interest rates close to zero or at a negative level (NIRP). Particularly, the main "unconventional" in force to get an extensive monetary stimulus were the new APP and the TLTRO III programme.

F8: Inflation (CPI) – YoY rate.



Source: Refinitiv Datastream

Table 3 summarizes the response of ECB to the pandemic which has been swift and characterized by UMPs programmes such as asset purchase programmes (APP and PEPP) and longer-term refinancing operations (LTRO, TLTRO III and PELTRO) in order to:

1) safeguard its accommodative monetary policies;
2) preserve the monetary policy transmission channel;
3) restore liquidity conditions in the financial system as a mean of supporting the monetary policy transmission mechanism.

T3: ECB UMP measures in response to the COVID-19 (Chronological).

Measures	12 March	18 March	7 April	22 April	30 April	4 June	10 December
Support for credit	– TLTRO III more favourable conditions (-25 bp) – LTRO: 12 additional operations to bridge liquidity needs, maturing in June 2020 (average deposit facility rate)	– 15 March: weekly USD operations with 84-day maturity – 20 March: weekly operations: frequency increased to daily			– TLTRO III: improved conditions during the crisis period (–50 bp) – PELTRO: 7 additional operations maturing in 2021 Q3 (–25 bp)		– TLTRO III: improved conditions during the crisis period (–60 bp) – PELTRO: 4 additional operations maturing in 2021
Collateral easing measures		Adjusted collateral standards announced	– 20% reduction of collateral valuation haircuts – Enlarged scope of eligible assets under ACC framework	– Marketable assets meeting requirements on 7 April will remain eligible as long as their rating remains at or above BB (CQS5 on the Eurosystem scale and CQS4 for ABS)			Extended to June 2022 the duration of collateral valuation haircuts
Asset purchases	– APP: additional net asset purchases of €120 bn until end-2020	PEPP: extraordinary asset purchase programme with envelope of €750 bn until end-2020				– PEPP: additional increase of €600 bn (overall envelope €1.35 tn) and extension to end-2021 Reinvestments until at least end-2022	– PEPP: additional increase of €500 bn (overall envelope €1.85 tn) and extension to end-March 2022 Reinvestments until at least end-2023 – APP: continuing net asset purchases of €20 bn per month

Source: Our elaboration

On 12 March 2020, the ECB adopted the first package of expansionary unconventional monetary policy measures in response to the Covid-19 crisis. First, additional LTROs were introduced in order to provide immediate liquidity support to the Euro Area system while waiting for TLTRO III operation in June 2020. From June 2020 to June 2021 with TLTRO III more favourable terms are applied through an interest rate 25 basis points below the average rate applied in the Eurosystem's main refinancing operations. Second, an additional APP of €120 billion is added until end-2020 to reinforce the accommodative impact of EU policy rates. The ECB thus intended to encourage lending to the agents hardest hit by the spread of COVID-19, particularly small and medium-sized enterprises (SMEs) and the self-employed.

Considering that uncertainty on the economic front was creating severe strains in the financial markets, on 18 March the Governing Council reassessed its monetary policy stance and instruments to address the economic consequences of the evolving coronavirus pandemic. First, a new temporary asset purchase programme of private and public sector securities was launched. This new pandemic emergency purchase programme (PEPP) has had an overall envelope of €750 billion, with purchases conducted until the end of 2020. The Governing Council decided to launch the PEPP "to counter the serious risks to the transmission mechanism and the outlook for the euro area posed by the outbreak and escalating diffusion of the coronavirus". The key difference between the APP and the PEPP is that under the latter purchases will be conducted in a flexible manner and fluctuations in their distribution will be allowed over time, among jurisdictions and across asset classes. The PEPP's announcement has had positive effects on financial market since the sovereign debt yield declined significantly. Further effects on the stock market indices have been visible on the euro/dollar exchange rate, spreads over the German Bund and inflation expectation obtained from inflation swaps. With regards to the effects on the main macroeconomic variables, research find an increase in GDP and employment (Banco de España, 2020).

With the 30 April meeting further measures about TLTRO III were adopted with interest rate 50 basis points below the average rate applied in the Eurosystem's main refinancing operations.

On 4 June Governing Council met again to review its monetary policy basing on the financial market developments. Empirical evidence suggested that the UMP measures adopted to contrast the pandemic crisis should have been reinforced to preserve policy transmission across the entire Euro Area, considering that financial conditions had continued to ease since the April monetary policy meeting. For this reason, an additional increase of the PEPP envelope of €600 billion was introduced with and extension to end-2021. Anyway, this increase had a smaller impact than that triggered when it was initially announced being the financial market tension lower than that observed in April. Furthermore, the Governing Council would continue to expect monthly net asset purchases under the APP at a monthly pace of €20 billion with the aim to improve financing conditions on financial markets by reducing the interest rates applicable to government and corporate bonds.

The persistent contraction in the Euro Area economy since the escalation of the pandemic conducted to a new meeting on 10 December. Particularly, the inflation projections showed a more protracted weakness. Nevertheless, monetary policy had likely also been a key factor mitigating the spread of the ten-year German Bund over the corresponding overnight index swap (OIS) rate. Thus, the ECB recalibrated monetary policy measure to contribute to calm financial markets. Most notably the PEPP envelope was expanded by €500 billion at least until the end of March 2022 in order to consider the expected timeline for the roll-out of vaccines. Second, the TLTRO III was extended until June 2022 adding three additional operations and increasing the borrowing allowance to 60% of the eligible loan stock. Furthermore, the APP would continue to conduct purchases at a monthly pace of €20 billion.

Looking ahead, although the immediate ECB responses have provided a great support to the economy, the unexpected und unprecedent crisis introduced

by Covid-19 pandemic is still visible and creates uncertain on the future. This means that monetary policy must remain vigilant.

CHAPTER 2

1. Introduction

Following Lehman's collapse, the spread between unsecured interbank deposit rates (EURIBOR) and overnight indexed swap (OIS) rates at the three-month maturity peaked at 200 basis points in the euro area. Thus since 2009 the ECB has implemented several non-standard monetary policy measures to complement the regular operations of the Eurosystem through a further monetary stimulus (Giannone et al. 2011).

A VAR model is used to analyse the common monetary policy in the Eurozone since the VAR allows for a better identification of the impact of UMP shocks on the considered variables. Through our model we assess the effects of UMP shocks for nine member countries of the Eurozone. Particularly, the model delivers impulse responses to an unconventional monetary policy shock. The paper investigates how European Central Bank monetary policy shocks impact inflation (prices) and industrial production (output) across 2010-2019. By conducting the analysis country by country, we aim at highlighting differences in the effects of unconventional monetary policies on the countries considered.

This paper links to the strand of the literature which analyses UMP through the shadow interest rate. Examples include Lombardi and Zhu (2014), who derive a shadow policy rate from a dynamic factor model. Christensen and Rudebusch (2015) and Wu and Xia (2015) extract the Fed's shadow policy rate from nonlinear term structure models. A broad part of academic work has focused on effects of non-conventional monetary policy on macroeconomic variables, mainly output and inflation. The most prominent studies find a modest positive effect of US unconventional actions to GDP and a smaller effect on inflation. Meinusch and Tillmann (2016) find a medium and positive impacts on output and prices in the USA. Wu and Xia (2016) also find a positive effect on output and prices. For other studies effects of ECB UMP led to a medium increase in output and inflation

(Casiraghi et al. (2013)) or also a smaller output gap and higher inflation (Rogers et al. (2014)). In spite of extensive amount of research on this field, there is a lack of integration among diverse empirical results. Consistent with the existing literature focused on Eurozone, I find that output and inflation are more responsive to monetary policy shocks in the medium period. We find that an UMP shock leads to a peak impact of about 0.11% of HICP variation and 74% of output variation in Austria after five years while the lowest impact is in the Netherlands.

Furthermore, as in Murgia (2019) I estimate the impulse response of HICP and output with a classical baseline VAR approach. I use monthly data since January 2010 when the policy was first introduced. As stated in Papadamou et al (2019) and in Stanley and Doucouliagos (2012), useful information can be derived from impulse response functions.

The paper proceeds as follows: Sections 2.1 and 2.2 describe the empirical analysis: the VAR model, the data and the specification of the model, the identification strategy, and the estimation; results of the analysis are presented in sections 2.3 and 2.4; Section 2.5 draws some conclusions.

2. Analysis

2.1. Empirical strategy

To evaluate the effects of the non-standard monetary policy measures, I first identify UMP episodes in the Eurozone using a structural VAR approach. I run a vector autoregression model with four variables and including one lag[4] as indicated by the Schwarz (Schwarz, 1978) information criterion on the lag length:

Sample: 2010M01 2019M12
Included observations: 108

	Austria	Belgium	Finland	France	Germany	Ireland	Italy	Netherlands	Spain
Lag	SC	SC	SC	SC	SC	SC	SC	SC	SC
0	15,66758	18,04241	16,254	14,88934	14,76175	17,65532	16,99858	17,96993	17,10049
1	6.680013*	10.13079*	7.191522*	6.501310*	6.815242*	10.68610*	7.728285*	9.180956*	7.903777*

* indicates lag order selected by the criterion
SC: Schwarz information criterion

[4] Results with 6 lags have a similar pattern.

VAR techniques are one of the most extensively used tool to analyse the macroeconomic effects of conventional and unconventional monetary policy innovations/shock (Gambacorta et al. 2014).

To verify if the estimated VAR(1) is stationary I look at the characteristic polynomial running a VAR stability condition check for each of the 10 groups The estimated VAR is stable, being all roots less than one.

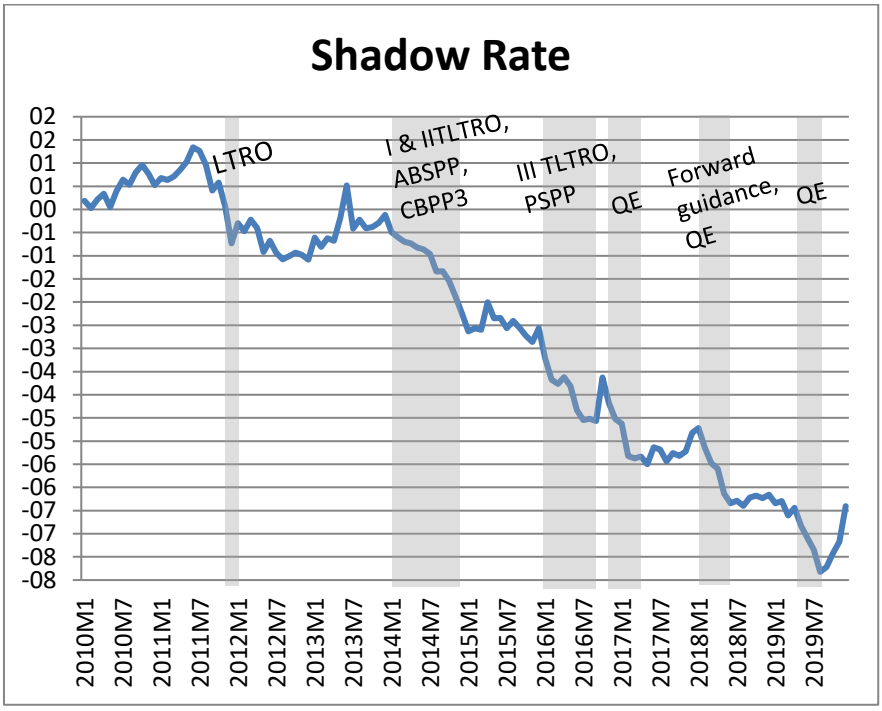
2.2. Data

I use a sample composed of 9 countries of the Eurozone: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands and Spain. Data are used at a monthly frequency and start in January 2010. The sample ends in December 2019. This amounts to a maximum of 108 country-month observations. The variables included in the model are:

- shadow rate
- inflation (harmonised indices of consumer prices)
- industrial production
- producer price index

Shadow interest rates (SR). Since Wu J.C. and Xia F. D. (2016) introduced it as a proxy to capture macroeconomic effects of unconventional monetary policies on economic aggregates, the shadow rate is a quantitative measure which has been broadly used by economists to indicates the overall stance of the monetary policy since interest rates stopped working because they hit zero, the so called “zero lower bound”. Looking at the estimated shadow yield curve it is identified as its shortest maturity and it is equal to the policy rate in presence of a non-ZLB environment (Kuusela et al. 2017).

F9: Shadow rate - Eurozone.



Source: Our elaboration

The shaded areas indicate unconventional monetary policies.

Figure 9 shows the evolution of shadow rate from January 2010 until December 2019 in the Eurozone. The rate is positive and below the 1,5% until the end of 2011, after that moment its value becomes constantly more negative until the end of 2019 with the only exception of mid 2013 when it reaches the positive value of 0,5%. The most visible decreases are driven by the implementation of ECB UMPs such as the implementation of LTROs, TLTROs, NIPR, APP program and forward guidance. In the figure we can see the effect of those UMPs in the negative shadow rate trend. In correspondence of each of these UMPs the response of shadow rate is more or less evident. Firstly, there were two Covered Bond Purchase Programmes (CBPP1 and CBPP2) in 2009 and 2011. There were two LTROs, one in 2011 and one in 2012. Because of the economic stagnation, in June 2014 the ECB implemented TLTRO. Three series of TLTROs were made: on June 2014, on March 2016 and on 2019-2020. Forward guidance was introduced for the first time by ECB in July 2013. The ECB launched the first QE in March 2015, in December 2015 it was extended until March 2017, in October

2017 was extended until September 2018 and, finally, President Draghi announced a new QE programme in September 2019.

Harmonised consumer price indices (HICP). One of the main objectives of QE is to provide the necessary monetary stimulus to the euro area to bring inflation back to 2 percent. Gambetti et al. 2017 find that effects of QE on CPI are more marked in the medium period, but the analysis only provides a quantification of the impact of the initial APP package introduced in early 2015.

Industrial production (IP). Several event studies have shown that the announcement of unconventional monetary policies had a significant upward effect on output (measured by industrial production) (MacDonald and Popiel 2017).

Producer price index (PPI). It measures the rate of change in prices of products sold as they leave the producer, in other words it is the inflation from the point of view of producers. PPIs provide measures of average movements of prices received by the producers of various commodities. They can be considered as indicators of price changes throughout the economy. Huang and Liu (2005) suggest that monetary policies should consider PPI to not generate large welfare losses[5].

The data for industrial production is expressed in monthly log levels, while shadow rates, annualized inflation and producer price index data are already expressed in terms of monthly rates.

All the variables of interest are downloaded from Refinitiv Datastream Economics database.

2.3. Impulse Response Analysis

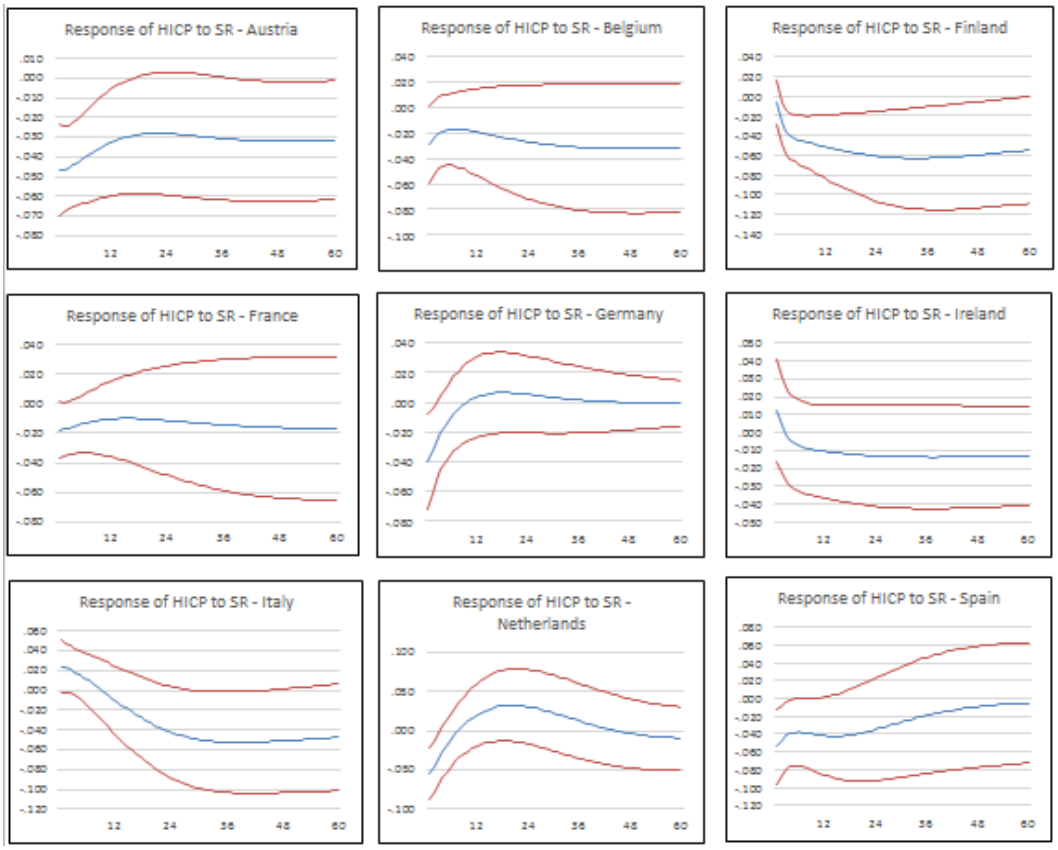
The impulse response function represents the mechanism through which shocks spread over time. We consider the impulse response of expansive

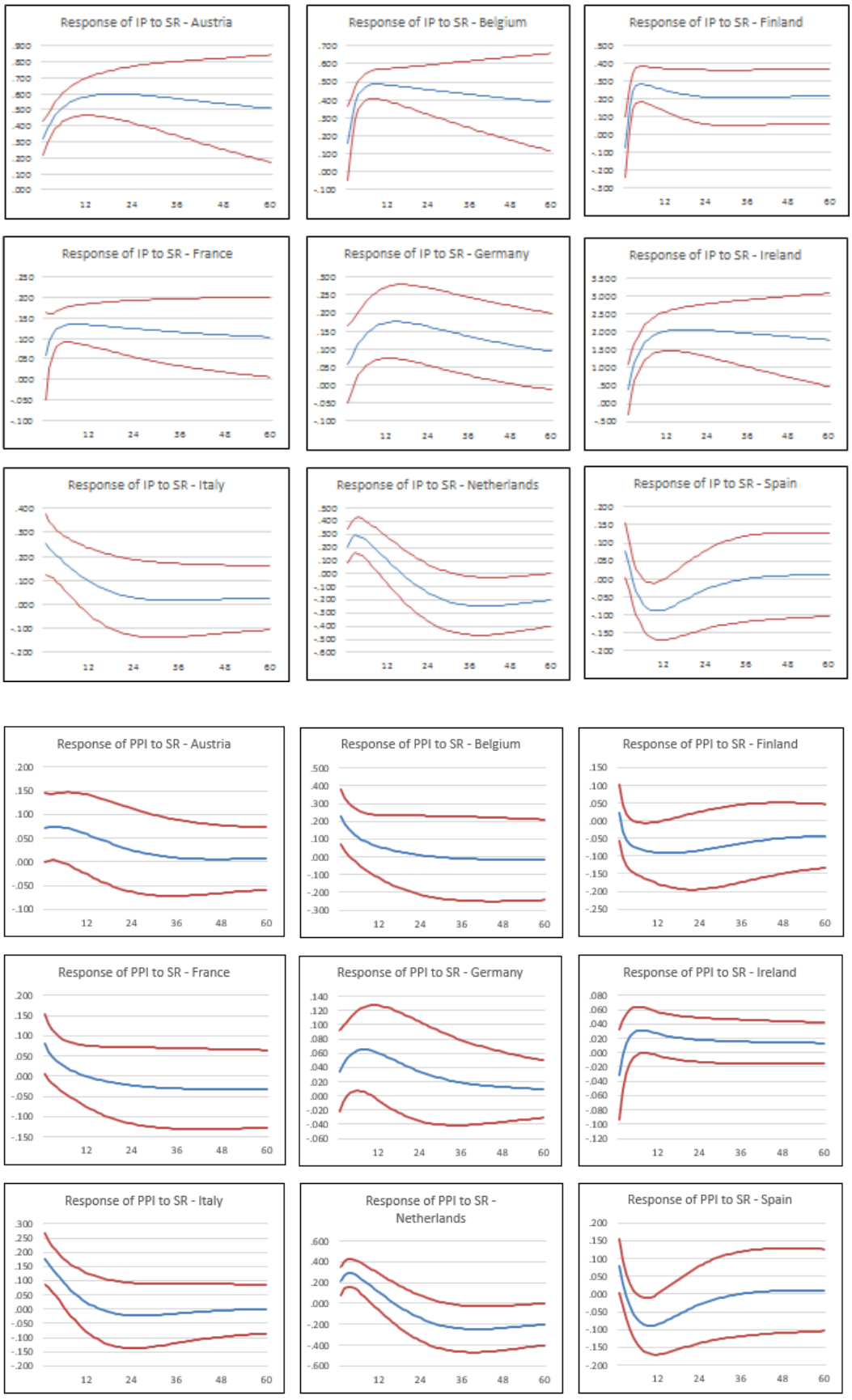
[5] Producer price index has been introduced to solve the price puzzle.

monetary policies (expressed by the shadow rates) on inflation, industrial production and producer price index for nine countries of the Eurozone. In order to identify an UMP shock, we order, in a Cholesky fashion, the euro shadow rate as first variable followed by inflation, industrial production and producer price index. The rationale for such a choice is that the Euro shadow rate is exogenous to the macroeconomic condition of each country that we consider separately.

Impulse response functions of HICP, industrial production and producer price index to the shadow rate shock are plotted in the next figures. The confidence bands are based on a 95% confidence interval.

F10: Impulse Response Functions – 9 Countries.





Source: Our elaboration

The impact of an expansive monetary policy on HICP is slightly negative in Austria in the short run while it becomes statistically not significant after one and half year and again significant after three years. In Finland, the impact of UMP is negative in all the considered periods. It has an impact statistically not significant at all in Belgium, France, Germany, Ireland, Italy, the Netherlands and Spain.

In those cases, in fact, all confidence intervals of impulse response function graphs contain the zero-horizontal axis, which means that the response is insignificant at 95% confidence level. Therefore, the impact of UMPs on HICP is very light and negative only in some of the analysed Eurozone countries whilst it is generally statistically not significant[6].

Looking at the impact of expansive UMPs on industrial production in the period 2010-2019, it is evident the positive effect in Austria where the magnitude is quite high, almost 0.60% in the short period decreasing to the 0.50% at the end of the fifth year. In Belgium, Finland and France the trend is similar to the one registered in Austria but with a slightly lower magnitude. In Italy the reaction of industrial production is statistically not significant in the medium run while the effect is positive in the short term, even if very low. In Germany there is a positive impact on industrial production in the short run followed by a null effect in the medium term. In Ireland I find the highest positive impact in the short and medium term, almost 2%. Finally, the impact is positive and very low in the Netherlands in the short run while it becomes negative in the medium one.

Overall, I find different effects of UMPs on HICP, industrial production and producer price index among countries and different magnitude. The impact on HICP is negative, very low and generally visible in the short run. The impact on industrial production is positive and with a higher magnitude. It is visible both in the short and medium term with a decreasing trend but for some countries the impact is statistically significant only in the short term. The impact on PPI is

[6] The statistical non significance might be explained by the persistent low level of inflation had in the countries considered.

overall statistically not significant, it is positive but very low in the short run in some countries.

2.4. Forecast Error Variance Decomposition

The forecast error variance decomposition analysis shows much of the forecast error variance of each of the variables that can be explained by exogenous shocks. Looking at the proportion of variation of the forecast error of inflation, industrial production and producer inflation explained by the shadow rate shock we obtain the following results.

First, it evolves over time, so the shocks on time series are not very important in the short-run but very important in the medium-run.

Second, shadow rate is very useful to explain the forecast error variance of industrial production in Austria, 72% in the fifth year. It is a good indicator also in Belgium and in Ireland, where it drives almost the 57% and 43% of the variance, respectively. In France and Spain, it explains only a quarter of the variance in the medium period. While the shadow rate explanation capacity is almost null in Italy and in the Netherlands. The shadow rate explanatory capacity of forecast error variance of industrial production next to the 15% in Finland and in Germany.

Third, the variance in the HICP is not explained by shadow rate. The highest contributions are in Finland and Austria in the medium period where values swing between 10-16% in the medium period while in the short period they are around 4%. The shadow rate explanatory capacity of forecast error variance of HICP is next to 0% in Germany, France, Ireland, the Netherlands and Spain both in the short and medium period. In Italy it is visible a slight increase from the short period to the medium one, shadow rate shock does not explain the variance in the HICP in the first three years while in the fifth year it is of the 8%. In Belgium it explains only the 4% of the variance until the medium period.

Finally, as per HICP, shadow rate is not able to explain the forecast error variance of producer price index. The higher value is visible in the Netherlands, where it

drives almost the 9% of the variance in the medium period and the 4% in the short one. In Finland and Germany, it is visible a very slight increase from the short period to the medium one. For all the other countries values are assessed around the 1-2% in both periods.

Therefore, I find a different capacity of shadow rate to explain the forecast error variance of each of the variables. The forecast error variance of industrial production is better explained by the shadow rate exogenous shock in the medium period in Austria and Belgium. In other countries the effects are different both in terms of magnitude and time. The forecast error variance of HICP and PPI is not well explained by the shadow rate exogenous shock. Anyway, also in this case results are heterogeneous among different countries of the Eurozone.

T4: Variance Decomposition – 9 Countries.

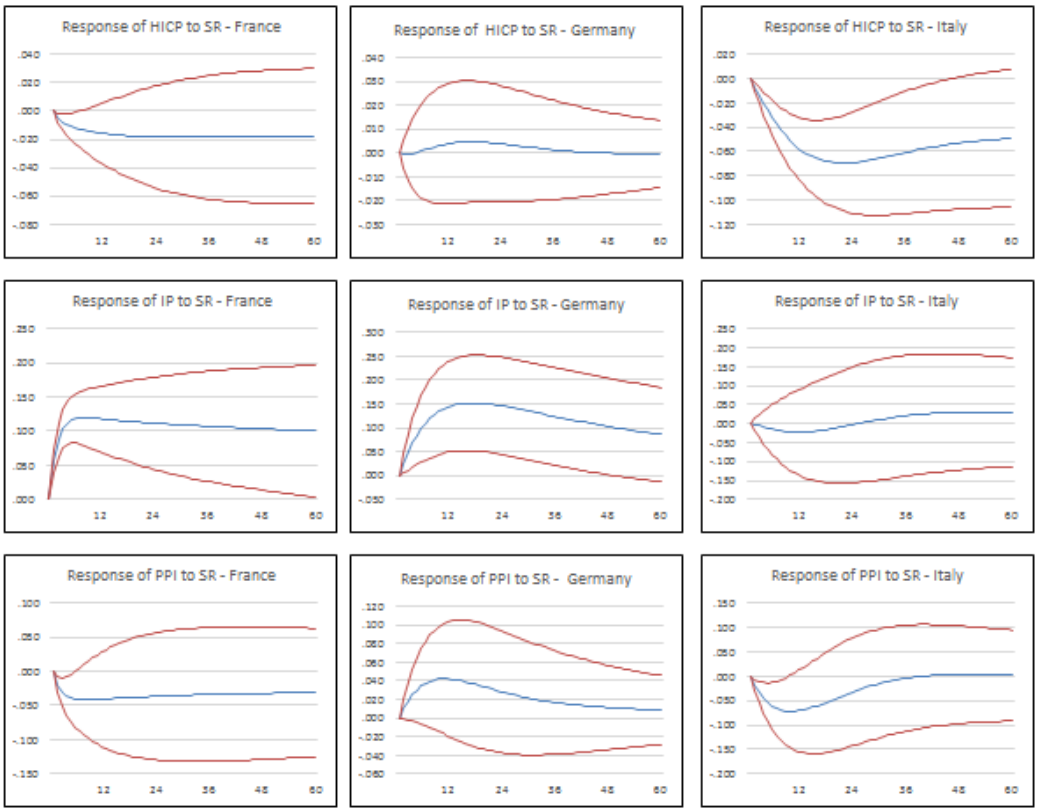
	Austria	Belgium	Finland	France	Germany	Ireland	Italy	Netherlands	Spain
Variance Decomposition of HICP:									
Period	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**
12	4.75588	0.64461	3.869088	0.608373	0.842363	0.163372	0.388779	0.872078	1.669989
24	5.510965	1.222287	6.791624	0.6352	0.820829	0.461101	1.215674	1.608307	2.398036
36	7.005911	2.200723	10.31573	0.893275	0.830531	0.838737	3.384336	1.984005	2.661986
48	8.86006	3.362799	13.70256	1.308291	0.829908	1.223349	5.725282	1.976103	2.736427
60	10.68115	4.524576	16.52762	1.800981	0.830132	1.582772	7.69387	2.018076	2.759874
Variance Decomposition of IP:									
Period	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**
12	38.86588	22.21689	6.703083	6.380092	3.742516	13.55132	3.394536	2.020047	2.645311
24	55.36743	37.329	9.780313	11.46721	8.247884	25.9038	3.169644	2.585486	8.064397
36	63.82097	46.35763	12.29284	15.45825	11.22818	33.75971	3.157273	3.441649	14.45845
48	69.02652	52.38926	14.60895	18.76635	13.06597	38.97101	3.184528	4.763119	20.14458
60	72.45682	56.6923	16.97997	21.55947	14.2336	42.6243	3.230475	6.287984	24.68145
Variance Decomposition of PPI:									
Period	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**	**SR**
12	1.391933	1.020838	1.342157	0.408865	1.702372	0.735224	1.993148	3.568086	1.318324
24	1.635175	0.917676	2.567622	0.428201	2.398163	1.160006	1.677946	2.974387	1.646037
36	1.660472	0.899892	3.264347	0.628415	2.634305	1.420696	1.723122	4.753551	1.635146
48	1.659316	0.907042	3.643086	0.889045	2.725005	1.631431	1.733402	7.217594	1.640212
60	1.667099	0.920824	3.930749	1.153704	2.771168	1.813839	1.73248	9.061274	1.660636
Cholesky Ordering: SR HICP IP PPI									

Source: Our elaboration

3. Focus: Germany, France and Italy

We consider the impulse response to shadow rate of HICP, industrial production and producer price index for three of the main countries of the Eurozone: Germany, France and Italy. In order to identify the impact of UMPs shock, we order, in a Cholesky fashion, inflation as first variable followed by industrial production, producer price index and euro shadow rate so that the macroeconomic variables are in the information set of the monetary policy.

F11: Impulse Response Functions – 3 Countries.



Source: Our elaboration

Graphs show that the response of inflation is statistically not significant in France and Germany. The impact of euro shadow rate on inflation is negatively effective in Italy in the short run with a maximum magnitude of 0.7% whilst it becomes not significant after the fourth year.

Looking at the impact on industrial production in the period 2010-2019 in Germany and France, it is significant and positive. There is a peak in the short

period and after that a slow decreasing. In Italy the effect is not statistically significant at all.

Finally, the impact on producer price index is not significant in the considered three Eurozone economies both in the short and medium period.

T5: Variance Decomposition – 3 Countries.

	France	Germany	Italy	France	Germany	Italy	France	Germany	Italy
	Variance Decomposition of HICP:			Variance Decomposition of IP:			Variance Decomposition of PPI:		
Period	SR	SR	SR	SR	SR	SR	SR	SR	SR
12	0.447609	0.009754	2.615996	4.68846	2.033362	0.02832	0.409869	0.54736	0.609071
24	0.941392	0.050182	6.647724	8.764724	5.560343	0.046701	0.757377	1.017019	0.921327
36	1.498588	0.062436	9.847615	12.17855	8.082099	0.060567	1.074853	1.203604	0.950229
48	2.08043	0.062946	12.28701	15.2038	9.674271	0.125881	1.359748	1.280117	0.947647
60	2.642734	0.063294	14.20227	17.87246	10.69226	0.209415	1.618489	1.319978	0.947447
Cholesky Ordering: HICP IP PPI SR									

Source: Our elaboration

Looking at the capacity of the shadow rate shock in explaining the forecast error variance of each of the variables, the forecast error variance of HICP is not explained by shock in euro shadow rates in France and Germany. It explains the 14% of variation in the Italian HICP in the medium period.

The variance in the industrial production is explained by shadow rate. The highest contributions are in France and Germany in the medium period where values swing between 11-18% in the medium period while in the short run they are around 2-5%. The shadow rate explanatory capacity of forecast error variance of IP is next to 1% in Italy.

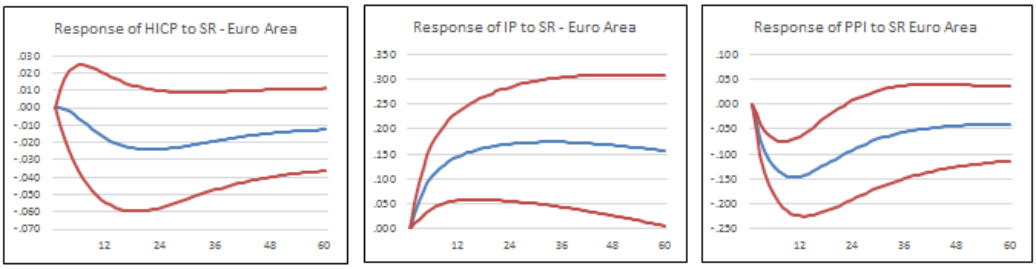
Shadow rate is not able to explain the forecast error variance of producer price index in the three considered Euro Area countries.

4. Euro Area analysis

Now we consider the impulse response of expansive monetary policies (expressed by the shadow rates) on inflation, industrial production and producer price index for the Eurozone (19 countries included from 2015). To identify an UMP shock, we order, in a Cholesky fashion, the euro shadow rate as the last variable in our method.

Impulse response functions of HICP, industrial production and producer price index to the shadow rate shock are plotted in the next figures. The confidence bands are based on a 95% confidence interval.

F12: Impulse Response Functions – Euro Area.



Source: Our elaboration

The impact of an expansive monetary policy on HICP is statistically not significant when we consider aggregate data for the Euro Area. The impact of UMP on industrial production is positive in all the considered period. Particularly, the magnitude reaches the peak of 0.17% in the third year decreasing slowly at the end of the fifth year. On producer price index the impact is negative in the short run and statistically not significant in the medium run.

T6: Variance Decomposition – Euro Area.

Euro Area			
Period	HICP SR	IP SR	PPI SR
12	0.134588	3.079529	4.263583
24	0.834568	7.604208	6.330006
36	1.445536	11.92264	7.1802
48	1.805197	15.66278	7.623084
60	2.039594	18.64686	7.932604
Cholesky Ordering: HICP IP PPI SR			

Source: Our elaboration

The variance decomposition analysis shows that the 19% of the forecast error variance of industrial production in the medium period and the 3% in the short one is explained by shadow rate shocks. It is visible the increase from the short period to the medium one. Shadow rate is not able to explain the forecast error variance of HICP in the Euro Area whilst it explains only the 8% of the forecast error variance of PPI in the medium run.

5. Conclusions

In this paper, the effects of ECB UMPs are analysed on a group of nine Eurozone countries with monthly data for the period January 2010 – December 2019 through the estimation of a VAR(1) model, where the VAR model is broadly used to identify the impact of UMP shocks. In our analysis the VAR results show the effects on inflation, industrial production and producer price index for single country. We find differences in the effects of unconventional policies on the countries considered.

Such as in Wu and Xia (2015), we try to capture UMP shocks through the shadow rate. The shadow rate is very useful to explain the shock variance of industrial production and less of inflation but with substantial heterogeneity among countries, in line with Elbourne et al. 2018.

Firstly, we estimate the impulse response of HICP, output and producer inflation with a classical baseline VAR approach and we find that output, inflation and producer price index are more responsive to monetary policy shocks in the medium period. In line with Casiraghi et al. (2013) we find that ECB UMPs cause a medium increase in output while the effect on inflation has a lower magnitude. Similar results are found for USA by Meinusch and Tillmann (2016), who show a medium and positive impacts on output and prices in the USA, and Wu and Xia (2016), who show a positive effect on output and prices.
Our results related to the impulse response function show different effects of UMPs on HICP, industrial production and producer price index among countries and with different magnitude. The impact on HICP is negative, very low and generally visible in the short period. The impact on industrial production is positive and with a higher magnitude. Finally, the impact on producer price index is generally statistically not significant both in the short and medium term.

Running the forecast error variance decomposition analysis, we have found a different capacity of shadow rate to explain the forecast error variance of each of the variables. The forecast error variance of industrial production is better explained by exogenous shocks in the medium period in some countries. In other

counties the effects are different both in terms of magnitude and time. The forecast error variance of HICP and producer price index is not well explained by exogenous shocks.

Similarly, results of IRFs for the Euro Area show that the impact of an expansive monetary policy on HICP is statistically not significant whilst on industrial production is positive in all the considered periods.

Finally, changing the Cholesky ordering of the VAR model, we find results for three main European economies – Germany, France and Italy - considering shadow rates as last variable. Such as the previous analysis, results confirm the heterogeneus impact among countries.

This work sought to identify the effects produced by the unconventional monetary policies adopted by the ECB and a certain heterogeneity in the results emerged. In future work, it would be interesting to include all countries in the same model, in order to consider the spillover effects between countries and to better identify the exogenous variation of monetary policy.

CHAPTER 3

1. Introduction

The aim of this section is to estimate the impact of Draghi's famous announcement made in July 2012 on sovereign bond spreads.
We start by analysing the existing empirical literature on the effects of unconventional monetary policies on sovereign bond spreads. Waltfe (2015) suggests that the most significant effect is due to the Securities Markets Programme (SMP), which contributes to a sovereign spread reduction. Alfonso et al. (2019), through pooling and country-fixed effects OLS regressions, find that UMP's announcements (LTROs and CBPP1) contribute to decreasing the sovereign yield spread of the analysed 9 EMU countries.

In our analysis we use the Generalized Synthetic Control Method (Xu, 2017). Nine Eurozone countries represent the treated group and nine countries not included in Eurozone plus Germany are our control group. We have collected quarterly data on 10-year bond yield spread, GDP and public debt to GDP ratio for 19 countries from Q2 2009 to Q4 2015. Confirming Alfonso et al. (2019) results, but with a different methodology, the estimated Average Treatment Effect on the Treated (ATT) shows that Draghi's announcement has a strong immediate impact on the sovereign bond spread of all the analysed Eurozone countries in the considered period.

The paper is organised as follows. Sections 2 focuses on empirical literature. Section 3.1 describes the model - the generalized synthetic control method -, section 3.2 and 3.3 show data and our empirical analysis with results, respectively. Section 4 concludes.

2. Literature review

There is not a large empirical literature describing the effects of the unconventional monetary policies on sovereign bond spreads. Literature focuses

more on the impact on yields. Watfe (2015) analyses the effects of the asset purchases programmes on European sovereign bond spread and he finds that they triggered a reduction of spreads. More specifically, the most significant immediate effect on European sovereign bond spreads is due to the Securities Markets Programme (SMP) while the Public Sector Purchase Programme (PSPP) had generally not significant immediate effects. Falagiarda and Reitz (2015) suggest that the effect of event days, non-event days and non-event Thursday on long-term government bond yield is negative on the analysed stressed Euro area economies, results are investigated in a standard linear regression framework. Szcerbowicz (2014) finds that bank-covered bond purchases diminish sovereign spreads while sovereign bond purchases reduce covered bond spreads.

Anders et al. (2006) suggest that economic announcements affect sovereign bond yields. Alfonso et al. (2019) implement pooling and country-fixed effects OLS regressions to assess the impact of unconventional monetary policies on the 10-year sovereign bond yield spreads of 10 EMU countries during the period 1999 - 2016. The findings show that UMP announcements (LTROs and CBPP1) contribute to decrease the sovereign yield spread of the analysed countries. Bernoth and Erdogan (2012) study the impact of macroeconomic fundamentals changes on 10 EMU countries in the period 1999 – 2010 and their findings show how deteriorating fundamentals increase interest rate spread. On the same way, De Grauwe, Ji and Macchiarelli (2017) say that changing fundamentals affect government bond markets. Furthermore, De Grauwe et al. (2017) realize an empirical analysis for the period post-Outright Monetary Transaction in the Eurozone. They find that the OMT-announcement created positive market sentiments which lead to a rapid decline in spreads during 2012-2015, thus the impact on spreads of changes in fundamentals was very hight. Altavilla et al. (2014) suggest that the OMT-announcement in four Eurozone countries (Germany, France, Italy and Spain) lead to reduction in bond yield in a horizon of three years after the announcement. They use a model with six variables: real GDP, consumer prices, M3, retail credit, and government bond rates for 2- and 10-year maturities.

Other studies analyse the impact on sovereign bond yields or spreads of fiscal policies events, international risk (Afonso et al., 2015; Silvapulle et al., 2016) or liquidity risk (Favero et al., 2010).

3. Analysis

3.1. The model

The Generalized Synthetic Control Method, of which difference-in-differences (DID) is a special case, was proposed for the first time by Yiqing Xu in 2017. It unifies two approaches: the linear interactive fixed effects (IFE) model and the synthetic control method (Abadie, Diamond and Hainmueller (2010)).

Difference-in-differences

Difference-in-differences was introduced in the 1850's by John Snow and it is called the 'controlled before-and-after study'. It was used further in the Ashenfelter and Card's work (1985) and since than it is very widespread used for casual inference in time-series cross-sectional data. DID is typically used to estimate the effects of a specific treatment through the "parallel trends" assumption, which considers parallel paths for control and treated groups in the period before and after the treatment. The set up considers two observed groups for two time periods, before and after the treatment. The control group is that one not exposed to the treatment in both periods while the treatment group is exposed to it in the second period. In the period before the treatment researchers should find that the average outcomes of the treated and control units follow parallel paths. We can write the model as follows:

$$y = \beta_0 + \beta_1 dB + \delta_0 d2 + \delta_1 d2 * dB + u \quad (1)$$

where y is the outcome variable, d2 is a dummy variable for the time period after the treatment (period 2), u is the noise. dB is a dummy variable which captures possible differences between the treatment and control groups before the

treatment. δ_1 is the coefficient of interest and multiplies the interaction term $d2 * dB$ which is a dummy variable equal to one for those observations in the treatment group in the period after the treatment. The DID estimated is:

$$\widehat{\delta_1} = \left(\bar{y}_{B,2} - \bar{y}_{B,1}\right) - \left(\bar{y}_{A,2} - \bar{y}_{A,1}\right)$$

(2)

However, the "parallel trends" assumption can fail because of the presence of unobserved time-varying confounders. In literature we find some approaches which try to overcome this problem in different ways. One of these is the generalized synthetic control method which results from a combination of the synthetic control method and the interactive fixed effects model.

Synthetic control method

The synthetic control method was introduced by Abadie and Gardeazabal in 2003. It is called "synthetic" because it uses a combination of control regions/countries which have most of the relevant characteristics of the treatment regions/countries before the treatment. This synthetic control group is used to build a "counterfactual/comparison group" for the second period, and it is compared to the treated group after the treatment. The number of countries is J+1, where J expresses the control group and 1 is the treated group.

In the synthetic control method, the control group is expressed by a weighted average, where W = $(w_2, \ldots, w_{J+1})'$ is a (J x 1) vector of weights. Thus, the estimator for $\alpha_{i,t}$ is:

$$\hat{\alpha}_{1,t} = y_{1,t} - \sum_{j=2}^{J+1} w_j^* \, y_{j,t}$$

(3)

where $y_{1,t}$ is the observed outcome for the treated group and $\sum_{j=2}^{J+1} w_j^* \, y_{j,t}$ is the outcome for the synthetic control group.

This method has the limit that it only applies in presence of one treatment group and that uncertainty of the estimates are not easily interpretable. On the other hand, it needs aggregate/macro data which are often available because policy interventions take place at an aggregate level and, in case of absence, they can be replaced by a sample of disaggregate units and inferential techniques, but this implies a measure of uncertainty. Nevertheless, even if aggregate data are available, persists the presence of an estimated error which is not reflected by the standard error. In fact, the counterfactual outcome trajectory is only a hypothesis of how the treated group could have appeared in absence of treatment. Furthermore, the selection of comparative units made by researchers, based on subjective elements of affinity found between control and treated groups, creates a certain level of ambiguity.

Interactive fixed effects model

The interactive fixed effects (IFEs) model was studied by Bai (2009) and Moon and Weidner (2017). Thanks to it, researchers can consider unobservable heterogeneity allowing it to vary across both time and groups.

The model is expressed as:

$$y_{it} = X'_{it}\beta + u_{it} \tag{4}$$

and

$$u_{it} = \lambda_i^{'} F_t + \varepsilon_{it} \qquad (i = 1, 2, \ldots, N;\ t = 1, 2, \ldots, T) \tag{5}$$

where $X'_{it}$is a (p x 1) vector of observable regressors, β is a (p x 1) vector of unknown coefficients, u_{it} has a factor structure, λ'_{it} (r × 1) is a vector of factor loadings, and F_t (r x 1) is a vector of common factors. The vectors λ and F are both unobserved and their interaction gives the name to this model. From this point, the difference with the additive-effects model is that these two variables are not entering additively but interactively. Nevertheless, for r =2, the additive-effects model is a special case of the interactive effects model when the

unobserved vectors represent the time effects, ε_t, and the country effects, α_i, respectively:

$$F_t = \begin{bmatrix} 1 \\ \varepsilon_t \end{bmatrix} \quad \text{and} \quad \lambda_i = \begin{bmatrix} \alpha_i \\ 1 \end{bmatrix}$$

The advantage of the additive-effects model is that the unobservable effects can be removed by the within-group transformation.

Generalized synthetic control method

The generalized synthetic control method (GSC) unifies two approaches: the linear interactive fixed effects (IFE) model and the synthetic control method (Abadie, Diamond and Hainmueller (2010)). The first part of the model estimates an IFE model through its control group to get latent factors. Through the linear projection in period two of the outcome related to the pretreatment period of treated group, we obtain factor loadings for each treated group. The last step consists in using the estimated factors and factor loadings to impute treated counterfactuals. Being based on the IFE model, the GSCM allows to consider unobserved time varying confounders.

The main element in common with the synthetic control method is related to the weights this model takes from the pretreatment treated outcomes to create a benchmark in choosing weights for the control group through a reweighting scheme. Furthermore, such as in the SCM, this model predicts treated counterfactuals using cross-sectional correlations between treated and control groups.

The advantages of GSC method are of three types. Compared to the synthetic control method it is more general in the sense that it is applicable to multiple treated groups and/or treated periods. Second, with the production of frequentist uncertainty estimates about standard error and confidence intervals, when the model is correctly specified it is more efficient than the SCM. Third, it can collect the correct number of factors thanks to the cross-validation scheme

that uses treated observations in pretreatment period as validation dataset for the selection.

The functional form assumption of the GSC method is as follows:

$$y_{it} = \delta_{it} D_{it} + x'_{it}\beta + \lambda'_i f_t + u_{it} \tag{6}$$

where y_{it} is the outcome of interest of unit i at time t, Γ and C represent the treated and control group, respectively, N = $N_{Tr} + N_{Cr}$ is the total number of the two groups. T= 1, 2, …T is the total number of pretreatment periods, T+1 is the first posttreatment period in which the only treaded group is exposed to the treatment. D_{it} is a dummy variable equals to 1 if unit i is exposed to the treatment and 0 otherwise. δ_{it} is the heterogeneous treatment effect on unit i at time t, x'_{it} is a (k x 1) vector of observed covariates, β is a (k x 1) vector of unknown parameters, f_t is an (r x 1) vector of unobserved common factors, λ'_{it} is an (r x 1) vector of unknown factor loadings, and u_{it} represents the error term.

The method requires that the same set and number of factors affect treated and control groups. Moreover, the vector of unknown factor loadings, λ'_{it}, takes a linear additive form and it covers almost all the unobserved heterogeneities.

The generalized synthetic control method is based on Bai (2009)'s interactive fixed effect model, where the estimator for the treatment effect on treated group is given by the difference between the actual outcome and its estimated counterfactual:

$$\hat{\delta}_{it} = y_{it}(1) - \hat{y}_{it}(0) \tag{7}$$

where $\hat{y}_{it}(0)$ is obtained in three steps:

1) the control group data is used to estimate $\hat{\beta}, \hat{F}, \hat{\lambda}$ through the IFE model:
$$\left(\hat{\beta}, \hat{F}, \widehat{\Lambda_{co}}\right) = argmin \sum_{i \epsilon C} (Y_i - X_i\tilde{\beta} - \tilde{F}\tilde{\lambda}_\iota)'(Y_i - X_i\tilde{\beta} - \tilde{F}\tilde{\lambda}_\iota) \tag{8}$$

2) the factor loadings for the treated $\hat{\lambda}$ is estimated minimizing the mean square error of the predicted treated outcome (MSPE) in pretreatment periods:

$$\hat{\lambda}_i = argmin \sum_{i\epsilon C}(Y_i^0 - X_i^0\hat{\beta} - \hat{F}^0\widetilde{\lambda}_\iota)'(Y_i^0 - X_i^0\hat{\beta} - \hat{F}^0\widetilde{\lambda}_\iota)$$

$$=\frac{1}{\left(\hat{F}^{0\prime}\hat{F}^0\right)}\hat{F}^{0\prime}\left(Y_i^0 - X_i^0\hat{\beta}\right), \quad i\epsilon\Gamma \tag{9}$$

where $\hat{\beta}$ and $\hat{F}$ are taken from the first step estimation, "0"s express the pretreatment periods and Γ indicates the treated units;

3) treated counterfactual based on $\hat{\beta}, \hat{F}, \hat{\lambda}$ are calculated:

$$\hat{Y}_{it}(0) = x_{it}'\hat{\beta} + \hat{\lambda}_i'\hat{f}_t \qquad i\epsilon\Gamma, \mathrm{t} > T_0 \tag{10}$$

where $\hat{\beta}$ and $\hat{F}$ are taken from the first step estimation and $\hat{\lambda}_i$ from the second step estimation.

Given the previous steps, an estimator for the average treatment on the treated can be expressed as follows:

$$\widehat{ATT}_t = \left(\frac{1}{N_{tr}}\right)\sum_{i\epsilon\Gamma}[\,Y_{it}(1) - \hat{Y}_{it}(0)],\ for\ t > T_0 \tag{11}$$

A parametric bootstrap procedure allows us to get the uncertainty estimates of the GSC estimator.

Identifying the number of factors

Considering that researchers do not know the exact number of factors to include in the model, Xu (2017) selects the number of factors before estimating the causal effects through a cross-validation procedure.

In order to cross-validate the number of factors, the procedure starts estimating an IFE model using the control group data and a given number of factors. With this procedure we get $\hat{\beta}\ and\ \hat{F}$. After that, we go through all T_0 pretreatment periods with a cross-validation loop and calculate more times the mean square prediction error (MSPE) given a different number of factors r. Finally, we choose r* that minimize the MSPE. In other words, we get the model that on average makes the most accurate predictions. This is possible thanks to control units not exposed to the treatment which are the basis for estimating time-

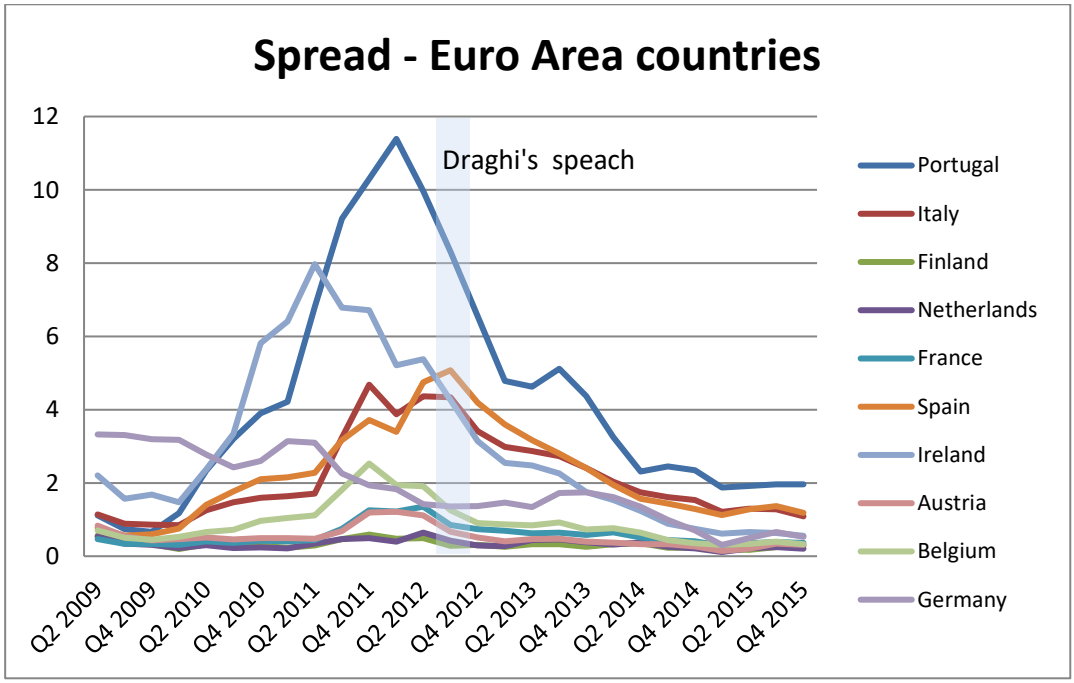
varying factors. Furthermore, the validation set for candidate models is constituted by the pretreatment periods of treated units.

3.2. Data

We have collected quarterly data on 10-year bond yield spread, GDP and gross government debt to GDP ratio for 19 countries from Q2 2009 to Q4 2015. For stationarity issues, all variables are taken in first differences. Data source is Refinitiv Datastream and data refer to ten countries for the control group: Australia, Canada, Denmark, Germany, Japan, New Zeland, Norwey, Sweden, Switzerland and UK. Data for treated group refer to nine countries: Austria, Belgium, Finland, France, Ireland, Italy, the Netherlands, Portugal and Spain.

The *10-year sovereign bond yield spread* in our analysis is a quantitative measure of the difference between one country's bond yield to the German one. It reflects the relative risk of the compared bonds, thus the higher the spread, the higher the risk is. Studies prove that UMP's affect bond spreads, reducing them (Jäger and Grigoriadis, 2017; Alfonso et al., 2019).

F13: 10-year sovereign bond yield spread over Germany – basis points.



Source: Our elaboration

The shaded area indicates Draghi's announcement on 26 July 2012.

Figure 13 shows the trend of 10-year sovereign bond yield spread over Germany for the 9 Euro Area countries included in our analysis. Since Q2 2009 spreads have been persistently widening over time. Excluding Portugal, Ireland and Italy which register a spike between Q2 2011 and Q1 2012 followed by a striking decline, ten-year government bond yield spreads have been fallen from Q3 2012 for the other Euro Area countries, as expected.

Gross domestic product is defined by OECD as "an aggregate measure of production equal to the sum of the gross values added of all resident and institutional unit engaged in production and services". IMF defines it as follows "GDP measures the monetary value of final goods and services—that are bought by the final user—produced in a country in a given period of time".

Gross government debt ratio is the ratio of a country's public debt to its gross domestic product (GDP). It is an indicator of the country's capability to pay off its debt.

3.3. Empirical analysis

Our objective is to estimate the impact of Draghi's announcement on sovereign bond spread on a group of Eurozone countries. For this reason, following the GSC method, we derive an Average Treatment Effect on the Treated (ATT). Nine countries of the Eurozone are included in our treatment group, while nine countries outside the Eurozone constitute our control group. Germany is the benchmark to calculate spreads. We allow for a maximum of 5 factors and our cross-validation procedure selects one factor. Below results of our analysis:

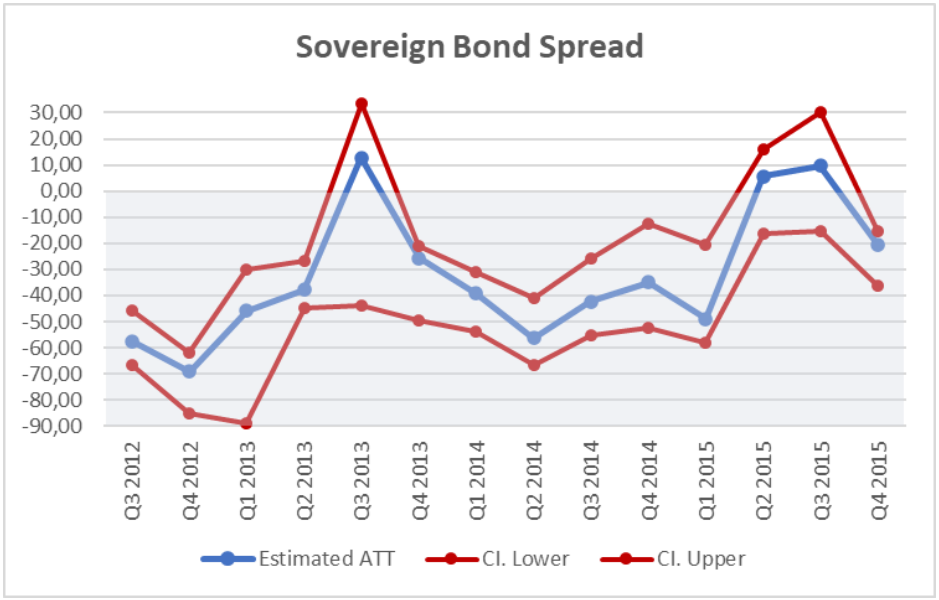
T7: ATT Sovereign bond spread - Eurozone.

Average Treatment Effect on the n. 9 Treated:			
Period	**Spread**	**S.E.**	**p. value**
Q3 2012	-57,38589	5,42000	0.0000
Q4 2012	-69,05162	6,17200	0.0000
Q1 2013	-45,87205	15,31600	0.0000
Q2 2013	-37,88207	4,69400	0.0000
Q3 2013	12,67686	19,27200	0.9278
Q4 2013	-25,55660	7,24900	0.0000
Q1 2014	-39,21281	5,81100	0.0000
Q2 2014	-56,39292	6,45800	0.0000
Q3 2014	-42,28165	7,64800	0.0000
Q4 2014	-34,95746	10,16600	0.0024
Q1 2015	-48,82084	9,67800	0.0004
Q2 2015	5,68790	8,30000	0.8048
Q3 2015	9,75114	11,69000	0.4434
Q4 2015	-20,74298	5,28600	0.0000
Coefficients for the Covariates:			
	beta	**S.E.**	**p. value**
DEBT	0,6012	0,6033	0,3018
GDP	3,0169	1,6141	0,0762

Source: Our elaboration

The Average Treatment Effect on the Treated (ATT) is plotted in the figure below. The confidence bands are based on a 95% confidence interval.

F14: ATT Sovereign bond spread - Eurozone.



Source: Our elaboration

Draghi's announcement on 26 July 2012 has a strong immediate impact on the sovereign bond spread of all the analysed Eurozone countries. The negative

effect on sovereign bond spreads is significant in all periods from Q3-2012 to Q4-2015 except for Q3-2013, Q2-2015 and Q3-2015 when the p-value is 0.9, 0.8 and 0.4, respectively. The highest responses of spread are in Q3-2012, Q4-2012 and Q1-2015 when the spread diminished of 57, 69 and 49 basis points, respectively[7].

Looking at the graph we can better understand the impact on sovereign bond spreads. In the immediate period after Draghi's announcement there is a strong diminishing impact on spreads, after that the negative impact becomes weaker until it disappears in Q3-2013. After that, the effects on the spread re-emerge and become stronger until reaching new peaks in Q2-2014 and Q1-2015.

4. Conclusions

In this paper we studied the impact of Draghi's unconventional monetary policies announcements on financial market, more specifically, on sovereign bond spreads in 9 Eurozone countries for the period from Q3 2012 to Q4 2015.

We include in the treated group nine countries of the Eurozone, while the control group is composed by nine countries outside the Eurozone. Germany is the benchmark to calculate spreads. Our control variables are GDP and gross government bond ratio. For stationarity issues, all variables are taken in first differences.

Such as in Alfonso et al. (2019), our results showed that the announcement of EMPs in the Eurozone contributed to the reduction of sovereign bond spreads for all the countries included in the sample.

The results show that Draghi's announcement had positive effects on the sovereign spread of the countries considered. Due to the technique used (robust to the assumption of parallel trends) the temporal sample considered a period following the announcement of Draghi, where other policies have been

[7] The GSCM requires a minimum number of observations in order to be reliable. We consider an extended post treatment period in which other policies have been implemented (e. g. TLTRO and PSPP) that might contaminate our estimates. Therefore, results after Q32013 must be taken with some cautions.

implemented. It would be interesting, in future work, to utilize a technique that allows us to consider only the period potentially affected by Draghi's announcement to obtain probably more precise estimates.

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