



Erasmus School of Economics

Master Thesis

Department of Finance

**Unconventional Monetary policy in Europe and bond yields: Is
debt our way out?**

An empirical investigation of sovereign bond yields and sovereign borrowing costs during the European Central Bank's unconventional monetary policy programs (2007-2017)

Author: M.D. Muntendam, MSc. MiM
Student number: 373985
Thesis supervisor: J. Zhao, MSc.
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Preface and Acknowledgements

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Maarten Diederik Muntendam

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Abstract

This report analyses the unconventional monetary policy programs pursued by the ECB in response to the financial- and sovereign debt crises. An event study with high-frequency data is used to investigate the impact of various monetary policy announcements on sovereign bond yields and government borrowing costs in France, Germany, Italy and Spain. LTRO, SMP, OMT and QE have been ineffective in reducing bond yields across different bond maturities and have not lowered borrowing costs in all investigated countries. In addition, evidence for significant increases in sovereign yields in Spain and Italy around SMP and OMT announcements is found. In contrast to ECB policy (announcements), investor sentiment and global market uncertainty are significant explanatory variables in predicting the variability of sovereign bond yields. Policy makers should put a stronger focus on creating policies that credibly signal monetary policy stance, and policies that take into account the needs of individual Eurozone sovereign states and differences between sovereign states.

JEL classification: E58, G12, G14

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1 Introduction

In the aftermath of the financial crisis of 2008, central banks needed to find ways in which the economy could be brought back to a steady state of growth. Monetary transmission channels were significantly impaired and additional liquidity provided through open market operations showed only transitory effectiveness. The malfunctioning of these channels further intensified as the sovereign debt crisis unraveled in Greece and further spread across the Eurozone. Countries in financial distress saw (sovereign) security prices drop, interest rates rise and suffered a resulting loss in investor confidence (Szczerbowicz, 2011). The Eurozone showed to be financially fragmented, access and cost of credit differed significantly. Solvency became questionable, resulting in an unreliable relationship (break) between market- and official interest rates. Moreover, banks were very likely to hold on to reserves to improve solvency, rather than to provide credit to the private sector. The ECB's inability to control key interest rates (overnight rate of interbank money market), by setting targets and adjusting money supply through open market operations, meant that conventional monetary policy would be largely ineffective¹. These challenges asked for a "new" policy, namely unconventional monetary policy (Joyce et al., 2012).

Unconventional policy differs from its conventional counterpart in the sense that it does not attempt to influence the short-term official rate, but focuses on changing other interest rates. A central bank thereby aims to directly influence access to and costs of financing for banks, households and (non-financial) institutions. Unconventional monetary policy comes in many types, generally it involves the large expansion of balance sheets of central banks². Refer to Section 2 "Literature Review" for an overview of unconventional monetary policy tools.

For the Federal Reserve (Fed) this meant large asset/security purchases (QE) in the form of mortgage-backed securities (MBS). Likewise, in response to the financial- and sovereign debt crises the European Central Bank (ECB) started to apply unconventional monetary policies. Programs such as longer-term refinancing operations (LTRO), the Securities Market Program (SMP), Outright Monetary Transactions (OMT) and Quantitative Easing (QE) were brought into effect.

¹ The ECB also offers two standing facilities where central banks can deposit or borrow liquidity, and makes use minimum reserve requirements under conventional monetary policy (see Pattipleilohy et al., 2013)

² Sometimes a central bank "swaps" short-term bonds for long-term bonds to influence long-term bond prices and yields

LTROs were primarily a liquidity providing operation, whereas QE, SMP and OMT were focused on restoring monetary transmission channels through asset-purchases (mainly sovereign bonds) in the secondary markets.

Please refer to Table 1 for an overview of all unconventional monetary policies employed by the ECB, alongside aims and corresponding measures.

As often confirmed in the literature, these policies have not been implemented without effect. Ciccarelli et al. (2014) finds that unconventional monetary policy in Europe and in the US have caused a better functioning of credit channels and has had a positive impact on GDP. In addition, smaller yield spreads in the US (QE) have prevented deflation and increased output (Baumeister & Benati, 2012). Similarly, QE (ECB) has caused significant reductions in long-term sovereign yields (van Lamoen et al., 2017; De Santis, 2016). Gambacorta et al. (2014) finds, however, only temporary effects in both prices and economic growth for unconventional monetary policies implemented by the Fed and ECB. Please refer to Section 2 for a review of related literature.

Although all policies are implemented to create or restore economic growth, their channels of transmission differ. Asset purchase programs (e.g. QE) work through an asset-price channel, holders of securities see their wealth increase as demand for their holdings (e.g. bonds) increases and spend the capital gains. Large scale liquidity provisions (e.g. LTROs) make use of a bank-lending channel. Liquidity as well as credit availability improve through loan provision by the central bank, “normal banks” are expected to channel through the money received to the private sector³. Overall, unconventional monetary policies ease financing conditions and improve liquidity in financial markets, which may prove to be very beneficial for national economies. A more elaborate discussion on channels may be found in Section 2.

Despite these mechanisms, the danger remains that through policies such as QE, a level of inflation is attained at which the nominal change that it may bring in expenditures by households is fully “eaten up”. The latter puts doubt on the effectiveness of unconventional monetary policy, especially in the long run. The element of surprise is important, as agents predict more inflation in times of high unemployment, the size of purchases must be increasing over time to show any lasting effects (Gertler & Karadi, 2014).

³ Banks may choose to keep some of the loans provided in their reserves for multiple reasons, such as solvency

Having described the risks, channels and possible ineffectiveness of (unconventional) monetary policy the question arises whether unconventional monetary policy has indeed been effective in influencing its main channel of transmission, namely bond yields (asset-price channel).

This paper investigates sovereign bond yields, of 2-, 5- and 10-year maturity, in four major European economies. Thereby making an assessment of borrowing costs for governments during times of unconventional monetary policies pursued by the ECB.

The report makes use of the following research question:

“Have the ECB’s Unconventional Monetary Policies (2007-2017) reduced financing costs for the Eurozone’s sovereign states?”

A high-frequency event study on ECB policy announcements will be performed to investigate bond yields, as well as the borrowing costs for governments of the selected countries.

This research focuses on major European economies (France, Italy, Germany and Spain) due to the reliability of data and applicability of the programs. The report makes use of Datastream as its main data source, namely for the collection of bond yields and chosen control variables. Data regarding ECB announcements is collected manually from related literature as well as from the ECB’s website.

This report innovates in a way that it is the first to investigate all of the ECB’s unconventional monetary policy programs simultaneously, thereby controlling for potential overlap of programs, and does so at multiple bond maturities. In addition, as the effectiveness of QE within Europe is researched to a lesser degree we include data until the end of 2017⁴. Lastly, this report includes some more recent announcements (2013/2014/2015) regarding OMT that have not been touched upon in previous research.

Besides the academic relevance of the topic, this research may be useful for future policy. The four investigated economies represent a significant part of total economic activity in the Eurozone, therefore investigating the effectiveness of unconventional monetary policy in these economies could provide central banks with key insights on unconventional program design.

⁴ Announcements, yields and data on control variables

Using the above-mentioned event study methodology, it is found that the ECB has been largely ineffective in reducing sovereign bond yields through its unconventional monetary policy programs. Repeated market interventions through LTROs have left sovereign yields of bonds with different maturities unchanged.

SMP and OMT have not significantly impacted yields in France and Germany, while causing sizeable upward pressures in Spanish and Italian sovereign yields. QE seems to have been most effective as (insignificant) declines in yields are found for all investigated bonds. The absence of any significant reduction in yields suggests that government borrowing costs across the investigated countries have not declined either. Although many of the possible channels of transmissions of unconventional monetary policy are unlikely to have played a part, factors such as global market uncertainty and investor confidence are found to be key determinants of the variability in sovereign bond yields. Monetary policy should emphasize credibility (thereby improving investor confidence), and should take into account the differences between Eurozone countries, as well as the needs of individual sovereign states.

This report continues as follows. Section 2: “Literature Review” provides a review of related literature on the topic of unconventional monetary policy. Section 3: “Methodology and Data” provides with an explanation of the event study methodology and the time series regression specifications, as well as a preliminary analysis of the data. Section 4: “Results” presents the results of the performed tests and a discussion of results. Section 5: “Conclusion” provides a conclusion, limitations, as well as some recommendations for future research.

Table 1: Overview of Unconventional Monetary Policies initiated by the European Central Bank*

This table represents an overview of all Unconventional Monetary Policy programs initiated by the ECB. The column "Start"/"End" refers to the start date/end date of all respective programs. The column "Program" refers to the name of the specific program, "Aim" summarizes the goal and "Measures" the measures taken by the ECB using that particular policy.

Start	End	Program	Aim	Measures
28-03-08	Open end	Longer-term refinancing operations (LTRO)	To provide liquidity to banks holding illiquid assets, and thereby maintaining interbank lending	Provision of loans at very low rates ("free money") to banks, countries may use their own holdings of sovereign bonds as collateral
10-05-10	06-09-12	Securities Market Program (SMP)	Restoring transmission channels (bond yield and volatility) and medium term price stability	Secondary market purchases (bond purchases) in Greece, Portugal, Ireland, Italy and Spain
02-08-12	Open end	Outright Monetary Transactions (OMT)	Overcome monetary and financial fragmentation (tail risk) caused by a risk of redenomination	(Unlimited) Secondary market purchases in countries with excessively high bond yields that complied with requirements**
22-01-15	Open end	Quantitative Easing (QE)	Primarily the aim of price stabilisation (<2% inflation) and economic growth in the Euro Area	Large-scale asset purchases, assets include mainly government bonds. The amount purchased is set at a predetermined rate

* Sources: ECB website, Lexicon FT, Belke (2013), Eser & Schwaab (2016), Fawley & Neely (2013), De Pooter et al. (2015)

** See Szczerbowicz (2012)

2 Literature Review

Literature on the topic of unconventional monetary policy is quite extensive. The majority of the literature focuses on the policies of the Federal Reserve (Fed), and to a lesser degree on Europe and the ECB's policies (in particular QE). Although this report's primary focus is on sovereign bond yields, borrowing costs and the ECB's unconventional monetary policy programs, a more complete overview of literature regarding unconventional monetary policy will be provided. In addition to bond yields, focus will be on the channels of transmission (including debt- and credit channels) and overall effectiveness (real effects and economic growth). A summary of the contents of this section can be found in Tables 2-4.

2.1 Bond yields and borrowing costs

Altavilla et al. (2014) focus on bond yields in Europe. A high-frequency event study is applied during the period of Outright Monetary Transactions (OMT). The sample in the paper consists of major European economies, being France, Germany, Italy and Spain. 2- and 10-year government bond yields are investigated, evidence suggests only those in Italy and Spain changed significantly. Downward pressure on short-term yields was shown to be larger than for longer maturities. Eser & Schwaab (2016) investigate the impact of the SMP on the yields of sovereign bonds of SMP countries⁵. Especially on days of announcements the effect, downward pressure on yields, is large. Effects are most prominent for shorter-maturity bonds (2- and 5-year maturity). In addition, the monetary interventions by the ECB reduced premium for risk of default in most countries investigated.

Pattipeilohy et al. (2013) investigate SMP and the ECB's longer-term refinancing operations (LTROs)⁶. As opposed to Eser & Schwaab (2016), the authors do not show any evidence for a (significant) reduction in government bond yields for SMP operations. However, many short-lived declines in yields are found during the period of LTRO interventions. De Pooter et al. (2015) conclude that it is not so much the pressure of demand that lowers the yields, but more a so-called "confidence effect".

⁵ Greece, Ireland, Portugal and later Italy and Spain (countries in financial distress that received SMP)

⁶ Literature review and some empirical research

The result is motivated by the fact that timing and purchase volume did not play a large role, at the announcement of SMP the effect on yields was significant. Szczerbowicz (2012) employs event-based regressions, thereby investigating the borrowing rates for banks and governments, in the period 2007-2012. Evidence in the paper suggests that SMP lowered yields of long-term assets most in comparison to OMT and LTRO. Refinancing costs of banks were reduced, LTRO was not effective in reducing borrowing rates for governments.

The ECB's newest policy, Quantitative Easing (QE), has been researched to a lesser degree. Van Lamoen et al. (2017) investigate the impact of QE on sovereign bond yields and prices through event-based regressions. Findings suggest significant impact on bond prices (increase) and a reduction in sovereign yields for long-term bonds. Analyzing news and announcement effects, De Santis (2016) finds that the impact on long-term sovereign yields is large. Countries in (greater) financial distress showed the largest reductions in yields. Interestingly, the effect is predominantly shown before the actual bond purchases take place.

Gilchrist et al. (2014) make a comparison between conventional and unconventional monetary policies by the Fed, and their effects on real borrowing costs. Results show that the effect on these costs was similar. In other words, the transmission of Treasury yields to private yields (with similar maturities) was smooth. Neely (2014), using an event study methodology, shows that unconventional monetary policy announcements by the Federal Reserve have reduced both long-term yields and the value of the US dollar. Rogers et al. (2014) investigate unconventional monetary policy on a large scale, focusing on the U.S., U.K. Japan and continental Europe. Particular interest lies in the policies of their respective domestic central banks and the effect of these on bond yields and stock prices. Results suggest that the policies have been quite effective in easing financial conditions. Stock prices tend to increase, whereas the decrease in yields is not that prominent for bonds.

2.2 Unconventional monetary policy tools and channels of transmission

Unconventional monetary policy makes use of three distinct tools by which it impacts transmission channels of financial markets. The first tool is associated with large-scale liquidity provision to (Eurozone) banks, for example the 3-year LTROs. Second, as seen from the ECB's recent QE policy, central banks can engage in unconventional monetary policy through interventions in financial markets (Pattipeilohy et al., 2013).

Sovereign bond purchases made through the OMT and SMP are other examples. A central bank may also influence financial markets through “forward guidance”. It thereby announces its future stance with regard to monetary policy, for instance stating that it believes inflation will remain low may influence interest inflation expectations (and actual inflation).

Interest in unconventional monetary policy lies not only in its tools and (potential) effects but also on channels of transmission. A key channel for unconventional monetary policy is that of interest rates, except for the short-term official rate, which distinguishes it from its conventional counterpart. The inflation that the policy creates, lowers real interest rates that may stimulate investments in equities as investors shift to more risky assets (Kuroda, 2013). In addition, asset purchase programs can directly influence long-term yields (interest rates) through increased demand for bonds⁷. Interest rates, especially expectations, may be further affected through a policy-signaling effect (forward guidance). As a central bank pursues asset purchases, it may thereby signal that it is committed and believes that interest rates are to stay low. Lower long-term interest rates (yields) may be beneficial for consumer spending (borrowing) as well as for corporate borrowing (can issue debt at lower rate), which in turn can support job creation and economic growth.

The bank-lending channel is another channel by which (unconventional) monetary policy can impact real variables. LTROs provide banks with low-interest rate loans, which can then be channeled through to the private sector. Consumers and SME’s rely heavily on bankloans and as availability of credit improves, this may have a beneficial effect on consumer spending and investment, and in turn on real variables such as GDP and employment.

Bowdler & Radia (2012) investigate two additional mechanisms by which QE (unconventional monetary policy) could affect financial markets as well as real variables. Asset prices may be affected through a portfolio rebalancing effect, as the central banks purchase assets (bonds) the yields of these bonds tend to decrease. This may induce investors to rebalance their portfolios towards more equities, criterion remains that fixed-income securities and equities are seen as (perfect) substitutes. Moreover as yields drop this may induce companies to invest more as debt can be issued at lower rates. The last channel that is described by the authors is that of liquidity. The inability (difficulty) to sell at the point at which an investor desires to sell, induces many to require a premium for risk. Easing financial conditions will likely reduce this premium, known as the liquidity effect.

⁷ Liquidity providing operations (e.g. LTROs) may influence yields indirectly as bonds can be used as collateral

Joyce et al. (2012) name an additional effect, namely the wealth effect. The wealth effect occurs as the central bank's asset purchases drive the prices of these assets up⁸, investors see their portfolio values rise. Real variables, such as GDP, may then be affected as investors spend the "capital gains".

2.3 Debt- and credit channels

Angeloni et al. (2015) assess the impact of unconventional monetary policy by the Federal Reserve on risk-taking behavior of banks. Monetary expansions affect banks in that they take on more risk, increase debt. Higher bank risk in turn, increases volatility in asset prices as does it decrease equilibrium output. Valencia (2014) finds similar evidence in the US. With limited liability a monetary expansion and resulting lower interest rates⁹ will cause banks to increase leverage, more incentive to take on additional risk. However, the result only holds when equity financing is not an option (anymore) for the respective bank.

Duca et al. (2016) investigate corporate bond issuance in the US during the Fed's LSAP program. The authors are especially interested in the so-called "spillover effects" of unconventional monetary policy. Results show that these asset purchases had a large effect on particularly developing economies. Two channels of transmission by which these purchases could have affected bond issuance are distinguished. Evidence suggests that the level of holdings of securities (in essence improved access to funding) was the most important channel for developing countries, whereas the purchases of securities ("flow effects" caused by QE) had a significant impact on bond issuance in developed economies.

Foley-Fisher et al. (2016) investigate the Fed's maturity extension program (MEP), their results show that during the program firms that are most dependent on long-term debt issue more long-term debt and have been responsible for more investments and job-creation. In addition, there is some evidence for a portfolio rebalancing effect among institutional investors as these shift towards equities and riskier corporate debt.

⁸ Assets such as government bonds

⁹ Monetary policy rates

Darracq-Paries & De Santis (2015) study the ECB's LTROs in 2011 and 2012. Using the Bank Lending Survey (BLS) and VAR models, these operations are identified as shocks in credit supply (affecting liquidity and funding risk). Their findings suggest that loan provision has improved, real GDP has increased and prices for consumer goods have increased moderately. Ferrando et al. (2015) investigate credit-availability during the ECB's OMT program for in particular small firms. Results show that the relative amount of companies with limited access to credit declined. Moreover, firms reduced the use of debt instruments.

Ciccarelli et al. (2014) investigate the channel of credit supply. Through surveys insight in loan demand and conditions of households and banks was acquired. For the U.S. and Europe it is found that the credit channel magnifies the effect of monetary policy on prices and GDP. Ciccarelli et al. (2013) assess the functioning of credit channels after the Great Recession (2007-2009), notably the impact of monetary interventions by the ECB on these channels. The effectiveness of rejuvenating the functioning of the credit mechanism remains doubtful. Findings suggest that credit availability has not yet been restored, especially for smaller companies in countries under financial distress. The authors note in addition that GDP growth has increased on the aggregate level, however large disparities in the rates are found.

2.4 Overall economic growth and real effects

Joyce et al. (2012) investigate QE in the United Kingdom (U.K.) and United States (U.S.) and other unconventional monetary policies just after the occurrence of the financial crisis. From their research it is concluded that, mainly because of poor economic growth and poor prospects, QE has not been effective (yet). Possibly because it has not sufficiently been implemented so far. QE has definitely boosted the economy, but it may be a game of diminishing returns as the economy may need ever-increasing impulses.

Estimating a panel Vector Auto Regression (VAR), Gambacorta et al. (2014) analyze effects of unconventional monetary policy on macroeconomic variables. Using international data (amongst which the Bank of England, Federal Reserve and ECB) they find that this type of monetary policy merely brings a temporary increase in prices and economic growth. The temporary effect witnessed, supports findings of Joyce et al. (2012). Results showed to be similar in magnitude across countries, whereas the measures taken by the respective central banks were inherently different.

Lenza et al. (2010) research the potential macroeconomic effects of unconventional monetary policy interventions by the ECB, Bank of England and Federal Reserve during the financial crisis of 2007. The main channel that is addressed as making the policies work is changing money market spreads. Using VAR models under different scenarios of the size of money market spreads the authors show evidence for macroeconomic effects of the policies. Transmitted (partially) through these spreads unconventional monetary policy has stabilized both the economy and the financial sector. Nevertheless, the policies were not sufficient as to prevent a decline in economic activity.

Kapetanios et al. (2012) investigate the effect of unconventional monetary policy (QE) on the variables GDP and inflation in the UK. Three VAR models are applied, each incorporating a specific scenario on the size of gilt spreads. Averaging these scenarios, the authors showed an effect of around 1.5% on real GDP and 1.25% on inflation (CPI). Szczerbowicz (2011) analyzes the impact of unconventional monetary policy on long-term interest rates and inflation expectations. QE-1 and QE-2 by the Federal Reserve are the policies of interest. Evidence suggests that the measures had different effects. QE-1 was effective in that it lowered long-term nominal interest rates and did not alter expectations of inflation, QE-2 showed the opposite. Nevertheless, QE-2 was capable of increasing demand as it lowered long-term real interest rates.

Baumeister & Benati (2012) assess unconventional monetary policy on an international scale, namely in the U.S. and the UK. Particular interest lies in examining real effects of yield spreads that have declined during large asset purchasing programs pursued by the central banks. Findings suggest two main conclusions. The first conclusion that may be drawn is that this smaller spread has significantly impacted output growth and inflation levels. In addition, the authors apply a VAR model to simulate that the large asset purchases have evaded large deflationary pressures. Inflation would be at 1% below zero, whereas output growth would be at a negative 10% over 2009. In addition, the effects of unconventional monetary policy on employment are also investigated.

Wu & Xia (2014) study monetary policy of the Fed after the financial crisis of 2009. The authors apply a term-structure model based on “shadow rates” that gives a good representation of macro-economic effects in an economy in which interest rates approach zero. Findings in the paper shows strong signs of improving employment; unemployment rates are estimated to be approximately one percentage point lower in the period 2009 until

2013. In addition, Sharpe & Watts (2013) investigate macroeconomic effects of QE policies in the United Kingdom. Findings suggest that there is no clear answer to whether QE has been effective as of now. QE managed to reverse deflation, however real GDP growth and employment have not bettered.

Chodorow-Reich (2014) investigates real effects of unconventional monetary policy on financial institutions, namely banks and life insurers. By means of event studies (high frequency), the author shows that unconventional monetary policy in the U.S had a positive impact on banks and especially on life insurers, primarily due to increases in the value of legacy assets.

2.5 Hypotheses formulation

As mentioned earlier, this report poses the following research question: **“Have the ECB’s Unconventional Monetary Policies (2007-2017) reduced financing costs for the Eurozone’s sovereign states?”**

In order to be able to answer this question hypotheses are formulated and these are based on earlier findings (see mainly Section 2.1) and some supporting economic rationale. As will be further elaborated on in Section 3, yields of 10-year sovereign bonds will be used as a proxy for government borrowing costs.

Longer-term refinancing operations (LTROs) could impact bond yields through multiple channels. Countries that these low-interest loans are provided to may use sovereign bonds as collateral. In addition, better credit availability to investors may increase demand for sovereign bonds, thereby increasing prices and reducing yields. Besides this theoretical effect, evidence from previous research is far from conclusive. Pattipeilohy et al. (2013) finds short-lived declines in yields, whereas Szczerbowicz (2012) for instance does not find a significant reduction in yields.

This research investigates LTROs over a longer horizon, and thus features more announcements, which overlap with all other policies (SMP, OMT, QE). Due to this overlap (individual) LTROs may prove to be insignificant. Given this element and inconsistency in results of previous research, no significant reductions in yields are expected across all investigated countries and bond maturities.

Hypothesis (1): *LTROs do not significantly reduce sovereign- bond yields and borrowing costs in France, Germany, Spain and Italy.*

As pointed out by Pattipeilohy et al. (2013), different authors with different methodologies have shown different impacts of SMP on bond yields. However, considering that the event studies performed in this report are closest to the methodology of Sczerbowicz (2012), this may point to a likely expected reduction in yields. However, one thing must be noted. Namely the distinction between SMP and non-SMP countries. Most researches (that found decreasing yields) have only investigated SMP countries. In addition, given the fact that approximately 8% of total outstanding sovereign bond value in the Eurozone was purchased it is not expected that a spillover to non-SMP countries would be significant.

Hypothesis (2): *SMP has not reduced sovereign- bond yields and borrowing costs in France and Germany.*

Hypothesis (3): *SMP has reduced sovereign- bond yields and borrowing costs in Spain and Italy.*

OMT, although never granted to any country within the Eurozone, has often shown to have reduced bond yields in previous literature. Altavilla et al. (2014) find, with comparable methodology to this report, that yields in Spain and Italy have declined due to OMT announcements, whereas this effect was not so prominent in France and Germany. As compared to Altavilla et al. (2014) this report includes more recent announcements in which the legality of OMT was often questioned, which may impact the overall effect found on yields¹⁰. It is hypothesized that in at least the cases of France and Germany these announcements have sufficiently impacted the (investor) confidence channel that was likely to have caused any initial reductions from previous announcements.

Hypothesis (4): *OMT has not impacted sovereign- bond yields and borrowing costs in France and Germany.*

Hypothesis (5): *OMT has reduced sovereign- bond yields and borrowing costs in Spain and Italy.*

¹⁰ See Table 7 for chosen announcements, Altavilla et al. (2014) only covers the first three announcements

QE has so far shown to have favourably impacted bond yields. Van Lamoen et al. (2017) and De Santis (2016) find large reductions in yields caused by announcements concerning QE. De Santis (2016) finds that long-term yields have declined most and the “most vulnerable” countries have witnessed the largest downward pressures on sovereign yields. As asset purchases are both large and ongoing, and taking into account findings of previous research it is expected that both yields and borrowing costs have declined due to QE.

Hypothesis (6): *QE has reduced sovereign- bond yields and borrowing costs for France, Germany, Spain and Italy. The largest declines in bond yields are faced in Spain and Italy.*

Table 2: Literature overview: Bond yields and borrowing costs

This table presents a summary of the literature review provided in section 2 of this report. The table is based on the contents of section 2.1 which describes the effects of unconventional monetary policy on bonds and their yields internationally. The columns "Central Bank and Scope" and "Results" refer to the countries/central banks investigated and the overall findings respectively of each paper discussed. Abbreviations may be used for the European Central Bank (ECB), Bank of Japan (BoJ), Federal Reserve (Fed) and Bank of England (BoE).

Author*	Topic	Central Bank and Scope	Methodology	Results
Altavilla et al. (2014)	Government bond yields	ECB (OMT), Europe	Event study and time series	Lower yields in Spain and Italy, larger reductions in short-term yields
Eser & Schwaab (2016)	Government bond yields	ECB (SMP), Europe	Event study and time series	Lower yields for SMP countries, larger reductions for short-term yields
Gilchrist et al. (2014)	Borrowing rates for governments and households	Federal Reserve, United States	Event study and time series	Comparable decline in both Treasury and private yields
Van Lamoen et al. (2017)	Government bond yields and prices	ECB (QE), Europe	Event study and time series	Significant decline in yields, increase in prices particularly for long-term sovereign bonds
Neely (2014)	Government- and corporate bond yields	Federal Reserve, US	Event study and time series	Long-term yields and value dollar declined
Pattipilohy et al. (2013)	Government bond yields	ECB (SMP & LTRO), Europe	Event study and time series	SMP no effect, LTRO lower yields
De Pooter et al. (2015)	Government bond yields	ECB (SMP), Europe	Event study and time series	Yields decreased through a confidence effect
Rogers et al. (2014)	Government bond yields	Fed, BoJ, BoE & ECB, Global scale	Event study and time series	Lower yields, higher stock prices
De Santis (2016)	Government bond yields	ECB (QE), Europe	Event study and time series	Lower yields for long-term sovereign bonds, especially for countries in financial distress
Szczerbowicz (2012)	Borrowing rates for banks and governments	ECB (SMP, OMT & LTRO), Europe	Event study and time series	SMP was most effective in lowering yields, LTRO not effective in reducing borrowing costs for governments

*Authors used as well as their respective papers can be found in the section "Bibliography" of this report.

Table 3: Literature overview: Debt- and credit channels

This table presents a summary of the literature review provided in section 2 of this report. The table is based on the contents of paragraph 2.3 which describes unconventional monetary policy and its effects on debt issuances and credit availability. The columns "Central Bank and Scope" and "Results" refer to the countries/central banks investigated and the overall findings respectively of each paper discussed. Abbreviations may be used for the European Central Bank (ECB), Bank of Japan (BoJ), Federal Reserve (Fed) and Bank of England (BoE).

Author*	Topic	Central Bank and Scope	Methodology	Results
Angeloni et al. (2015)	Risk-taking behavior of banks	Federal Reserve, United States	Time-varying VAR models**	Monetary expansion induces banks to increase leverage, lower equilibrium output
Ciccharelli et al. (2014)	Credit channels and real effects	Fed & ECB, US and Europe	Bank-lending survey & VAR models**	Unconventional monetary policy caused a better functioning of credit channels, these channels magnify the effect of policy on inflation and GDP
Ciccharelli et al. (2013)	Credit channels and real effects	ECB, Europe	Bank-lending survey & VAR models**	Effectiveness of policy in restoring credit channels remains doubtful. Credit availability has not yet been restored. However, GDP growth has improved
Darracq-Paries & De Santis (2015)	Credit availability and real effects	ECB (LTRO), Europe	Bank-lending survey & VAR models**	Loan provision improved, consumer prices and real GDP increased
Duca et al. (2016)	Corporate bond issuance	Federal Reserve, Global scale	Panel regression techniques	Large global effects of LSAP on corporate bond issuance, especially in many of the emerging markets
Ferrando et al. (2015)	Sovereign stress and SME access to finance	ECB (OMT), Europe	Models with credit-constrained SMEs	OMT vastly improved SMEs access to finance. SMEs relied significantly less on the use of debt securities
Foley-Fisher et al. (2016)	Corporate debt issuance and financing constraints	Fed (MEP), United States	Panel regression techniques	Most long-term debt dependent firms issue more long-term debt. These firms were responsible for a rise in investments and job-creation
Valencia (2014)	Risk-taking behavior of banks	Federal Reserve, United States	omic models with banks	Bank tends to increase leverage, but only when equity capacity is exhausted

* Authors used as well as their respective papers can be found in the section "Bibliography" of this report

** Vector Autoregressive Models, using one or multiple lags in dependent or independent variables

Table 4: Literature overview: Overall economic growth and real effects

This table presents a summary of the literature review provided in section 2 of this report. The table is based on the contents of paragraph 2.4 which describes unconventional monetary policy and its effects on real variables and economic growth. The columns "Central Bank and Scope" and "Results" refer to the countries/central banks investigated and the overall findings respectively of each paper discussed. Abbreviations may be used for the European Central Bank (ECB), Bank of Japan (BoJ), Federal Reserve (Fed) and Bank of England (BoE).

Author*	Topic	Central Bank and Scope	Methodology	Results
Baumeister & Benati (2012)	Output growth and inflation	Fed & BoE, US and UK	Time-varying VAR models**	Smaller yield spreads have prevented deflation and increased output
Chodorow & Reich (2014)	Real effects and financial institutions	Federal Reserve, United States	Event study and time series	Positive effect on financial institutions, primarily due to rise in value of legacy assets
Gambacorta et al. (2014)	Economic growth and effectiveness	Fed, BoE & ECB, US and Europe	Panel VAR models	Policy brings a temporary effect in prices and economic growth. Similar effects across countries
Joyce et al. (2012)	Economic growth and effectiveness	Fed, BoJ & BoE, Global scale	Survey of literature	QE has not (yet) been effective yet, economies may need ever-increasing (monetary) impulses
Kapetanios et al. (2012)	GDP and inflation	Bank of England, United Kingdom	Time-varying VAR models**	Inflation (+1.25%), Real GDP (+1.5%)
Lenza et al. (2010)	Economic growth and effectiveness	Fed, BoE & ECB, US and Europe	Time-varying VAR models**	Effective in stabilizing the economy and financial sectors. Policy has not prevented an overall decline in economic activity
Sharpe & Watts (2013)	Inflation, GDP and employment	Bank of England, United Kingdom	Survey of literature	Deflation reversed, GDP growth and employment unchanged
Szczerbowicz (2011)	Long-term interest rates and inflation	Fed (QE-1 & QE-2), United States	Event study and time series	QE-1 effective in lowering interest rates and no change in expectations, QE-2 only lower interest rates
Wu & Xia (2014)	Employment	Federal Reserve, United States	Term-structure model	Unemployment down by 1% (2009-2013)

*Authors used as well as their respective papers can be found in the section "Bibliography" of this report

** Vector Autoregressive Models, using one or multiple lags of dependent or independent variables

3 Methodology & Data

The purpose of this report is to investigate whether unconventional monetary policy has affected sovereign bonds of different maturities, in particular with respect to yields. Using these results inferences will be made on the impact of policies on government borrowing costs. This report is focused on unconventional monetary policy pursued by the ECB. The programs LTRO, OMT, SMP and QE will be considered for analysis. Please refer to Table 1 for a complete overview of all programs, corresponding targets and announcement- and termination dates. The remainder of this section will be used for preliminary data analysis and the methodology of this report will be explained. Section 3.1 introduces the dependent- and control variables and will focus on the event study methodology (event-based regressions) applied to investigate bond yields and borrowing costs. Section 3.2 provides the data sources and an analysis of the data used.

3.1 Methodology of event-based regressions

Unconventional monetary policy should theoretically, through (large) asset purchases, lead to lower bond yields. These lower bond yields can translate into lower borrowing costs for governments, through sovereign yields and companies (corporate yields). In this report this theoretical effect is verified by applying a high-frequency event study in which bond yields are estimated following the methodology of Altavilla et al. (2014). An event study with daily data of such frequency allows to eliminate confounding factors, other than announcements of the ECB (central bank), that affect bond yields as well as expectations. Similar to Sczerbowicz (2012) yields of long-term sovereign bonds will be used in assessing borrowing costs for governments. The majority of government debt (bonds) is long-term, thus 10-year sovereign yields are deemed an appropriate proxy.

Regression analysis is used to estimate the bond yields thereby regressing (sovereign) bond yields on so-called “event-dummies”. These event-dummies take value 1 in the event of an announcement by the ECB, and value 0 in all other instances. The dummies allow for a control period, and a comparison between periods of unconventional monetary policy, and no OMT (announcement) for instance.

$$(1) \quad Y_{it} = \alpha + \beta_1 D_t + \varepsilon_{it}$$

Where “ Y_{it} ” is the government bond yield of a specific country with specific maturity. “ D_t ” is a vector of event dummies, for each program these are given by the dates of announcements. ε_{it} is the error term that is assumed to be independent and identically distributed, $\varepsilon_{it} \sim N(0, \sigma^2)$. For each specific bond an additional model is estimated, with different control variables in place.

The controlled specification adds several variables to the initial event-based regressions. The control variables are similar across the different bonds. In the estimation of sovereign yields inflation is used as control variable. The Harmonized Index of Consumer Prices (HCIP) will be used as a proxy for inflation and is a country-specific variable. All country-specific HCIP’s make use of the year 2015 as base year. In addition, we control for movements in both the VSTOXX implied volatility index and sovereign CDS spreads. This allows for a control regarding investor sentiment and (global) market uncertainty. The CDS spread is a bond-specific variable, while the VSTOXX is a non-specific variable. Returns on the country-specific major equity index are another control; its relationship with bond yields is highly dependent on the state of the economy. Lastly, year-fixed effects are controlled for in the specification.

$$(2) \quad Y_{it} = \alpha + \beta_1 D_t + \beta_2 I_{it} + \beta_3 CDS_{it} + \beta_4 EQRET_{it} + \beta_5 VSTOXX_t + \tau_t + \varepsilon_{it}$$

Government bond yields are given by “ Y_{it} ”, “ D_t ” is again a vector of event dummies (announcement dates). “ I_{it} ” is inflation, “ CDS_{it} ” represents the spread on a specific sovereign CDS, “ $EQRET_{it}$ ” denotes the return on a specific equity index, “ $VSTOXX_t$ ” is the implied volatility, “ τ_t ” are year-fixed effects and “ ε_{it} ” is the error term considered to be a white noise process, $\varepsilon_{it} \sim N(0, \sigma^2)$.

All models make use of a 3-day event window to estimate announcement effects on yields. A small event window allows to better isolate the announcement effect. Moreover, the 3-day window controls for low liquidity on days of announcements.

To verify whether effects do in fact persist (robustness), an alternative specification with a larger event window is also presented. Please refer to Section 4: “Results” for a robustness analysis.

Analogous to Altavilla et al. (2014) unconventional policy by the ECB is the topic, however we extend to a larger sample of countries and show a comparison of the pattern in bond yields at announcements across countries during the period of Outright Monetary Transactions (OMT). In addition, the ECB’s LTRO, SMP and QE policies are added to show insights in recent developments of bond yields.

ECB releases (and information on the ECB website), as well as related literature, will provide with announcements that may have directly or indirectly impacted the bonds market.

An overview of all relevant announcements, grouped per policy can be found in Tables 5-8. Announcement dates in bold concern announcements regarding multiple policies, in the analysis these dates are attributed to the most relevant program.

Table 5: Overview of Longer-Term Refinancing Operations (LTRO) announcements by the European Central Bank*

This table represents an overview of all major announcements made by the ECB on LTROs. The column "Date" refers to the date of the announcement. The column "Program" refers to the program the particular announcement refers to. "Announcement" shows a brief description of the proposed measures by the ECB through a particular announcement.

Date**	Program	Announcement
07-02-08	LTRO	ECB Governing Council decides to renew two outstanding LTROs, hinting there could be a new series of unconventional monetary operations in the form of LTROs
28-03-08	LTRO	Longer-Term Refinancing Operations (LTROs) are announced. The ECB promises to provide countries with low interest loans, especially for those countries with many illiquid assets. Sovereign bonds are used as collateral, loans are to be repaid within 3 years. Loans with different (shorter) maturities would be issued at a later stage
31-07-08	LTRO	ECB Governing Council decides to extend two outstanding LTROs
04-09-08	LTRO	ECB Governing Council decides to extend three outstanding LTROs
07-10-08	LTRO	ECB Governing Council decides to increase LTRO announced on 04/09
15-10-08	LTRO	ECB Governing Council announces that LTROs are to be increased and more options for loan collateral
05-03-09	LTRO	ECB Governing Council announces that LTROs (in full) will continue beyond 2009. Interest rate on following LTROs reduced
07-05-09	LTRO	ECB Governing Council announces there will be three additional LTROs with a one-year maturity each
03-12-09	LTRO	ECB Governing Council announces proposed plans for Q1 2010 where it will provide last 6-month LTRO
04-03-10	LTRO	ECB Governing Council announces that it will continue LTRO & 3-month installments back to variable tender
10-05-10	LTRO	Securities Market Program (SMP) is announced, new 6-month LTRO introduced
10-06-10	LTRO	ECB Governing Council announces fixed rate on upcoming tenders LTRO
02-09-10	LTRO	ECB Governing Council announces fixed rate on upcoming tenders LTRO
02-12-10	LTRO	ECB Governing Council announces fixed rate on upcoming tenders LTRO
03-03-11	LTRO	ECB Governing Council announces fixed rate on upcoming tenders LTRO and to prolong allotments if necessary
09-06-11	LTRO	ECB Governing Council announces fixed rate on upcoming tenders LTRO and to prolong allotments if necessary
04-08-11	LTRO	ECB Governing Council announces additional LTROs with fixed rate and additional 6-month operation
06-10-11	LTRO	ECB Governing Council announces additional LTROs with fixed rate and additional 3- and 12-month operations
08-12-11	LTRO	ECB Governing Council announces additional LTROs with 3-year maturity
06-06-12	LTRO	ECB Governing Council announces additional LTROs with 3-month maturity
06-12-12	LTRO	ECB Governing Council announces additional LTROs with 3-month maturity, support continues for long as needed
02-05-13	LTRO	ECB Governing Council announces additional LTROs with 3-month maturity, fixed (interest) rate
08-11-13	LTRO	ECB Governing Council announces additional LTROs with 3-month maturity, fixed (interest) rate
05-06-14	(T)LTRO	ECB Governing Council announces all 3-month LTROs until end 2016 will be fixed and new 4-year TLTROs
18-09-14	(T)LTRO	ECB Governing Council announces that first TLTRO has been performed, value of 83 billion euros
07-11-14	LTRO	ECB Governing Council decides to suspend (early) repayments by the end of 2014
22-01-15	LTRO/QE	Quantitative Easing (QE) is announced, interest rates on remaining TLTROs reduced to MRO level
22-06-15	LTRO	ECB Governing Council announces planning of further MROs and LTROs for the remainder of 2015
10-03-16	(T)LTRO	ECB Governing Council announces the launch of the second sequence of 4-year TLTROs
14-09-16	(T)LTRO	ECB Governing Council confirms calendar of reserve maintenance periods and upcoming operations in 2017 and 2018
09-03-17	(T)LTRO	ECB President Mario Draghi: "TLTROs are going to expire soon, but no doubt on new TLTRO"
26-10-17	LTRO	ECB Governing Council announces that remaining 3-month LTROs will be performed until at least 2019

* Sources: Falagiarda & Reitz (2015), ECB website

** Dates in bold denote announcements that concern multiple programs

Table 6: Overview of Securities Market Program (SMP) announcements by the European Central Bank*

This table represents an overview of all major announcements made by the ECB on the SMP. The column "Date" refers to the date of the announcement. The column "Program" refers to the program the particular announcement refers to. "Announcement" shows a brief description of the proposed measures by the ECB through a particular announcement.

Date**	Program	Announcement
10-05-10	SMP	Securities Market Program (SMP) is announced, ECB intends to engage in secondary market purchases in countries where transmission channels in terms of bond volatility and yields have to be restored (e.g. Ireland and Portugal)
31-03-11	SMP	ECB Governing Council announces that it will scrap the minimum credit rating for debt instruments purchased from Ireland
07-07-11	SMP	ECB Governing Council announces that it will scrap the minimum credit rating for debt instruments purchased from Portugal
04-08-11	SMP	ECB President Jean-Claude Trichet hints on reactivation of SMP after Spain and Italy face rises in bond yields
06-10-11	SMP	ECB President Jean-Claude Trichet responds on disagreement in Governing Council: "SMP tough decision but on-going"
03-11-11	SMP	ECB President Mario Draghi: "SMP will remain temporary, balance sheet protected from potential Greek collapse"
09-02-12	SMP	ECB President Mario Draghi: "SMP bonds will be held under maturity, transfer of bonds to ESFS will not happen (illegal)"
12-07-12	SMP	ECB Governing Council announces effectiveness of SMP in lowering yields in Ireland, unemployment remains high
20-07-12	SMP	Buy-back deadline of debt instruments for Greece is approaching, 25th of July last possible transaction date
06-09-12	SMP	SMP terminated, OMT announced (ECB will engage in (unlimited) secondary market purchases when deemed necessary)

* Sources: Szczerbowicz (2012), ECB website

** Dates in bold denote announcements that concern multiple programs

Table 7: Overview of Outright Monetary Transactions (OMT) announcements by the European Central Bank*

This table represents an overview of all major announcements made by the ECB on OMT. The column "Date" refers to the date of the announcement. The column "Program" refers to the program the particular announcement refers to. "Announcement" shows a brief description of the proposed measures by the ECB through a particular announcement.

Date**	Program	Announcement
26-07-12	OMT	ECB President Mario Draghi hints that ECB might engage in Outright Monetary Transactions (OMT) to ensure price stability
02-08-12	OMT	ECB President Mario Draghi hints that ECB might engage in Outright Monetary Transactions (OMT) to ensure price stability
06-09-12	OMT	Outright Monetary Transactions (OMT) is announced by ECB Governing Council. ECB will engage in (unlimited) secondary market purchases in countries with excessively high bond yields and volatility, countries must request OMT and comply with requirements such as conditionality and coverage***
07-03-13	OMT	ECB President Mario Draghi: "OMT will not be used to bring countries back to (bond) markets"
04-07-13	OMT	ECB President Mario Draghi: "OMT ready to be activated, disapproval of Bundestag (EFSF/ESM) is irrelevant"
06-02-14	OMT	ECB President Mario Draghi confirms possible QE does not impede future operations under OMT
06-11-14	OMT	ECB President Mario Draghi responds to Bernanke comments: "OMT is within mandate"
14-01-15	OMT	Yves Mersch (member of Executive board) comments on legality of OMT after European Court of Justice questions policies
03-06-15	OMT	ECB President Mario Draghi comments on questions on decisions of European Court of Justice, QE design will not be affected

* Sources: Altavilla et al. (2014), ECB website

** Dates in bold denote announcements that concern multiple programs

*** See Szczerbowicz (2012)

Table 8: Overview of Quantitative Easing (QE) Announcements by the European Central Bank*

This table represents an overview of all major announcements made by the ECB on QE. The column "Date" refers to the date of the announcement. The column "Program" refers to the program the particular announcement refers to. "Announcement" shows a brief description of the proposed measures by the ECB through a particular announcement.

Date**	Program	Announcement
05-06-14	QE	ECB Governing Council announces that it will "intensify preparatory work on outright purchases of asset-backed securities"
04-09-14	QE	ECB Governing Council decided to change "loan-level reporting requirements for asset-backed securities"
22-01-15	QE	Quantitative Easing (QE) is announced. The ECB will engage in large scale asset purchases, mainly treasury bonds at pre-determined amounts. Thereby, it hopes to bring economic development and price stability in the Eurozone
05-03-15	QE	ECB President Mario Draghi: "Greece and Cyprus soon to benefit from QE"
15-04-15	QE	ECB President Mario Draghi: "Not worried about scarcity (yields Germany below deposit rate) for QE operations"
16-07-15	QE	ECB President Mario Draghi: "Cyprus receiving QE, Greece work-in-progress (bond ratings need to improve)"
03-09-15	QE	ECB President Mario Draghi announces that issue share limit will be increased from 25% to 33%
23-09-15	QE	ECB Governing Council will make use of national banks in asset purchases, rather than external (asset) managers
03-12-15	QE	ECB President Mario Draghi announces that asset purchase program (APP) will be extended, reinvest principal payments
10-03-16	QE	ECB Governing Council announces it will enhance monthly purchases, as well as launch corporate sector purchasing (CSPP)
21-04-16	QE	ECB Governing Council provides more specific details on the CSPP, to be operated by six national central banks
02-06-16	QE	ECB Governing council announces final requirements of CSPP
08-09-16	QE	ECB Governing Council announces that purchases will continue for as long as needed, at least until March 2017
20-10-16	QE	ECB Governing Council confirms unchanged stance towards unconventional monetary policies (at least until March 2017)
08-12-16	QE	ECB Governing Council announces that purchases beyond March 2017 will decline to 60 billion and new cash collateral system
19-01-17	QE	ECB Governing Council decides it will only purchase assets with yields below the deposit facility rate in the public sector (PSPP)
09-03-17	QE	ECB Governing Council confirms unchanged stance towards unconventional monetary policies (at least until April 2017)
27-04-17	QE	ECB Governing Council announces that monthly purchases of 60 billion will run until (at least) December 2017
08-06-17	QE	ECB Governing Council confirms that monthly purchases of 60 billion will run until (at least) December 2017
20-07-17	QE	ECB Governing Council confirms that monthly purchases of 60 billion will run until (at least) December 2017
07-09-17	QE	ECB Governing Council confirms that monthly purchases of 60 billion will run until December 2017
26-10-17	QE	ECB Governing Council announces that purchases in the period Jan-September 2018 will amount to 30 billion per month
14-12-17	QE	ECB Governing Council confirms that purchases in the period Jan-September 2018 will amount to 30 billion per month

* Sources: Urbschat & Watzka (2017), ECB website

** Dates in bold denote announcements that concern multiple programs

3.2 Data

For the analysis of sovereign bond yields a time frame of approximately 10 years has been chosen, the analysis runs from 1/1/2007 until 31/12/2017. To show effects across different maturities, data is collected on 2-, 5- and 10-year sovereign bonds across France, Germany, Italy and Spain amounting to 12 different sovereign bonds being investigated. This report makes use of Datastream as its primary data source¹¹. Data on sovereign yields, as well as the control variables (VOXX50 implied volatility index, equity indices returns, CDS spreads and inflation) are collected from this source.

¹¹ Only ECB announcements are retrieved from other sources

All data is of daily frequency except for the HICP, which has a monthly frequency for each country. Please refer to Table 9 for descriptive statistics on all dependent- and control variables.

Table 9: Descriptive Statistics on Dependent- and Control Variables

This table provides descriptive statistics for Sovereign bond yields, HICP (Inflation), sovereign CDS spreads, major equity market returns and VSTOXX implied volatility. The number of observations, Mean, Minimum, Maximum, Standard Deviation, Skewness and Kurtosis are provided for each dependent- and control variable that is part of the proposed event-based regressions specifications.

	<i>Observations^a</i>	<i>Mean</i>	<i>Min</i>	<i>Max</i>	<i>S.D.</i>	<i>Skewness</i>	<i>Kurtosis</i>
<i>Dependent</i>							
Sovereign bond yield (2-year)							
France	2870	1.032	-0.710	4.870	1.531	1.052	2.917
Italy	2870	1.921	-0.374	7.695	1.642	0.430	2.173
Germany	2870	0.862	-0.974	4.765	1.553	1.151	3.098
Spain	2870	1.916	-0.383	6.927	1.646	0.184	1.775
Sovereign bond yield (5-year)							
France	2870	1.638	-0.461	4.950	1.487	0.431	2.010
Italy	2870	2.768	0.204	7.779	1.617	0.010	2.058
Germany	2870	1.317	-0.635	4.753	1.544	0.638	2.161
Spain	2870	2.753	0.043	7.477	1.680	-0.161	1.810
Sovereign bond yield (10-year)							
France	2870	2.468	0.093	4.844	1.351	-0.113	1.687
Italy	2870	3.705	1.050	7.311	1.424	-0.248	2.124
Germany	2870	2.012	-0.215	4.671	1.415	0.211	1.749
Spain	2870	3.650	0.933	7.496	1.532	-0.205	1.948
<i>Control</i>							
HICP (Inflation) (%)							
France	2870	0.005	-12.015	1.959	0.250	-38.029	1855.792
Italy	2870	0.006	-14.423	3.351	0.357	-22.032	941.089
Germany	2870	0.006	-13.019	1.575	0.265	-41.109	2037.062
Spain	2870	0.006	-12.291	3.190	0.310	-20.940	887.904
Sovereign CDS spread (2-year)							
France	2616	22.999	2.270	142.489	24.476	2.022	7.012
Italy	2621	104.868	9.750	542.020	100.523	2.142	7.233
Germany	2616	10.629	1.030	59.230	11.517	1.879	6.077
Spain	2621	100.102	9.750	476.870	99.136	1.514	4.596
Sovereign CDS spread (5-year)							
France	2616	42.257	6.000	171.560	32.443	1.545	5.050
Italy	2621	144.122	16.375	498.660	97.479	1.616	5.169
Germany	2616	21.521	5.090	92.500	16.365	1.396	4.686
Spain	2621	130.879	16.500	492.070	101.189	1.227	3.748
Sovereign CDS spread (10-year)							
France	2616	59.783	11.025	181.360	31.884	1.180	4.684
Italy	2621	164.729	24.500	468.186	85.748	1.218	4.451
Germany	2616	31.882	8.750	91.980	15.785	1.192	4.406
Spain	2621	147.543	24.000	444.510	87.711	1.071	3.416
Market return (%)							
France (CAC40)	2870	0.013	-9.471	10.594	1.454	-0.008	9.386
Italy (FTSEMIB)	2870	-0.022	-13.331	10.877	1.670	-0.204	7.903
Germany (DAX30)	2870	0.023	-7.433	10.797	1.400	-0.009	9.238
Spain (IBEX35)	2870	0.007	-13.186	13.483	1.567	-0.074	10.069
Implied volatility							
VSTOXX implied volatility	2870	24.275	10.680	87.510	9.145	1.951	8.785

* Data was gathered for the years 2007-2017 for all variables. The number of observations may differ across variables as some variables were not always available for each selected year

Figure 1: 2-year Sovereign Bond Yields

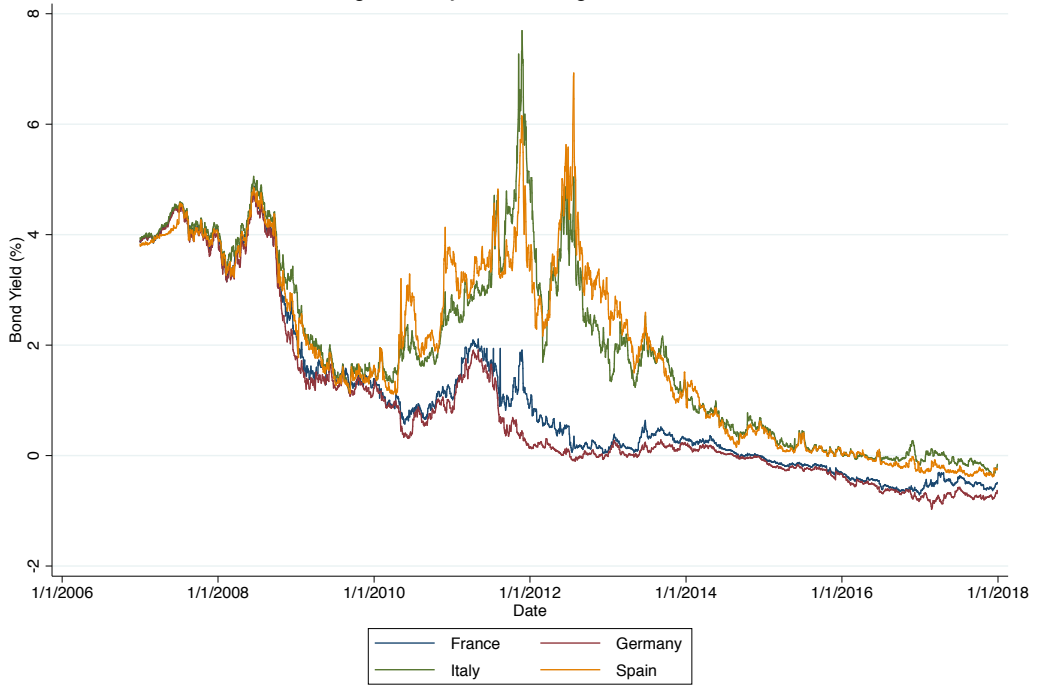


Figure 2: 5-year Sovereign Bond Yields

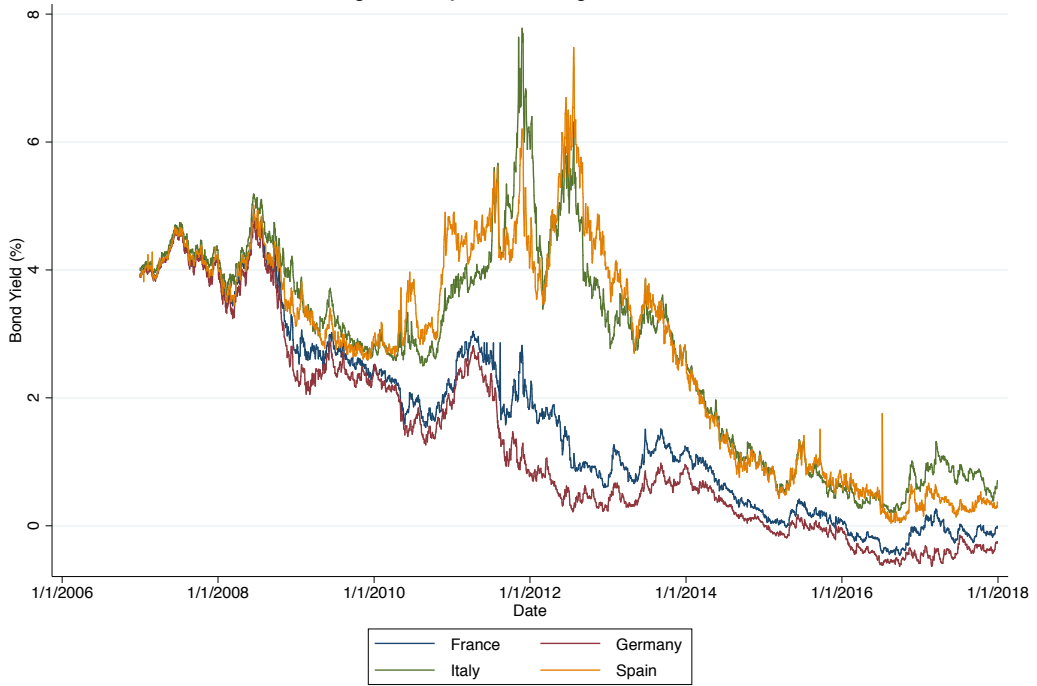
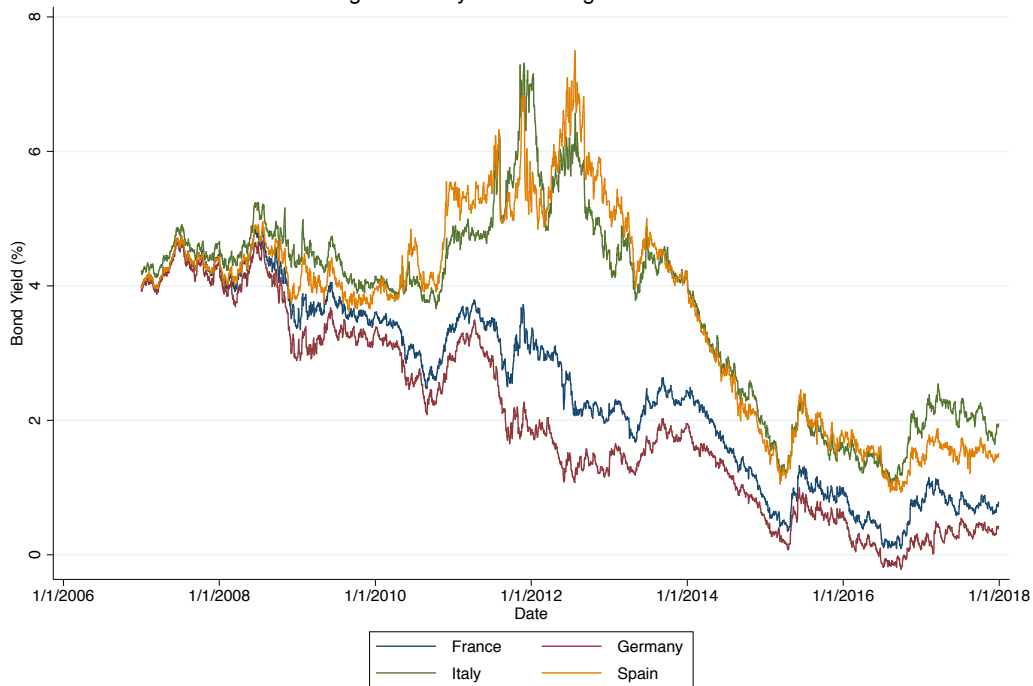


Figure 3: 10-year Sovereign Bond Yields

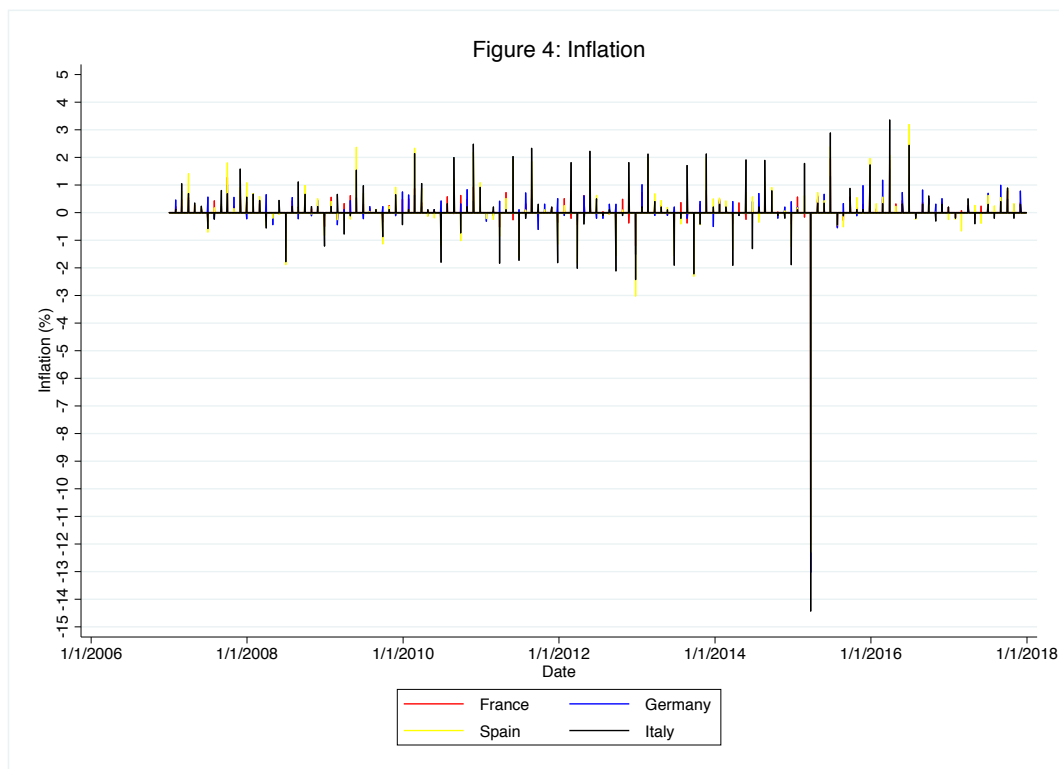


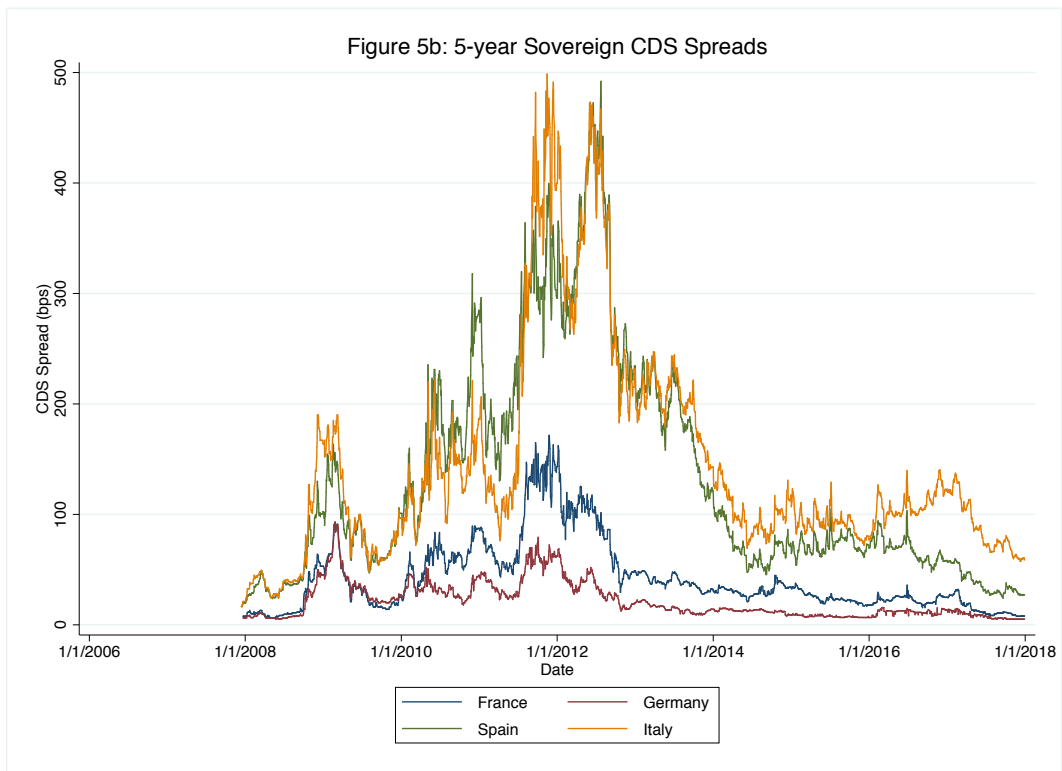
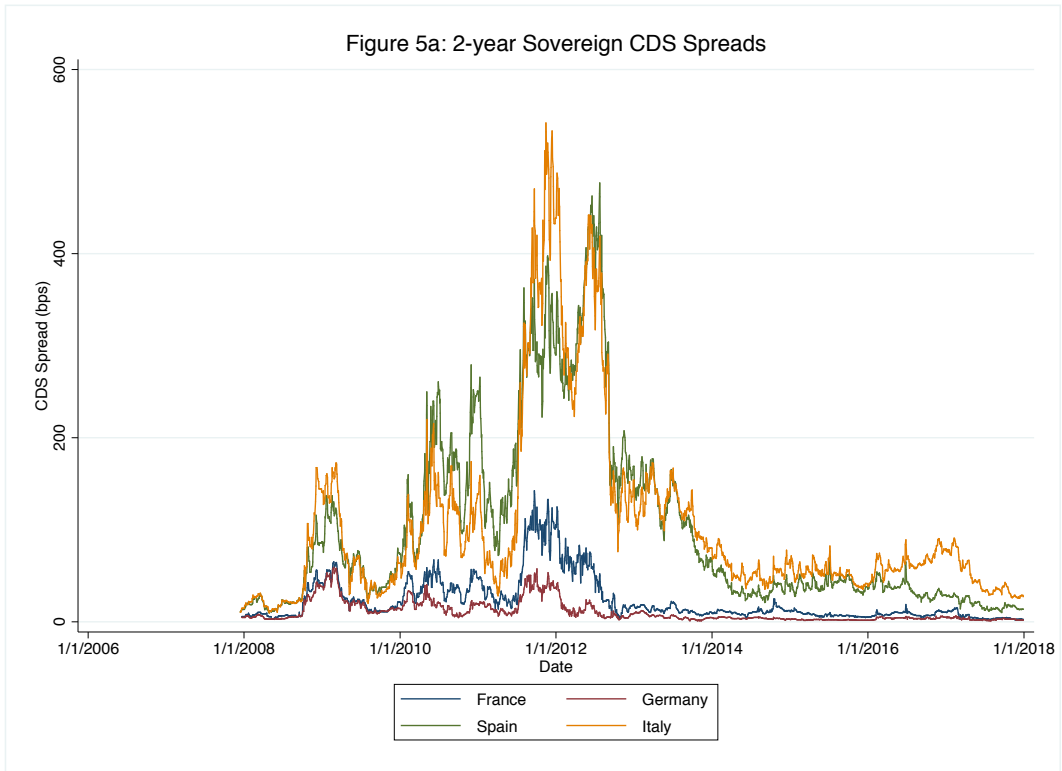
Referring to Figures 1-3, the development of different sovereign bond yields over time can be observed. 2-year sovereign bonds yields tended to increase after 2009 (financial crisis of 2007/2008), and showed to be highly volatile up to 1/1/2014. Spanish and Italian bond yields showed to be especially volatile between 2010 and 2013, mostly caused by the start of the sovereign debt crisis. The general decline in yields after 1/1/2012 coincides with the implementation of OMT and QE, while SMP and LTROs were performed before the respective period as well. As can be observed in Figures 1-3 (and Table 9), in some instances (France and Germany in 2016-2018) yields become negative. The increased demand for bonds (by the ECB) may have caused bond prices to increase so much that yields have become negative. For investors this means a guaranteed loss on their investment. Bond yields seem to be correlated across countries, with France and Germany, and Spain and Italy showing the strongest correlations.

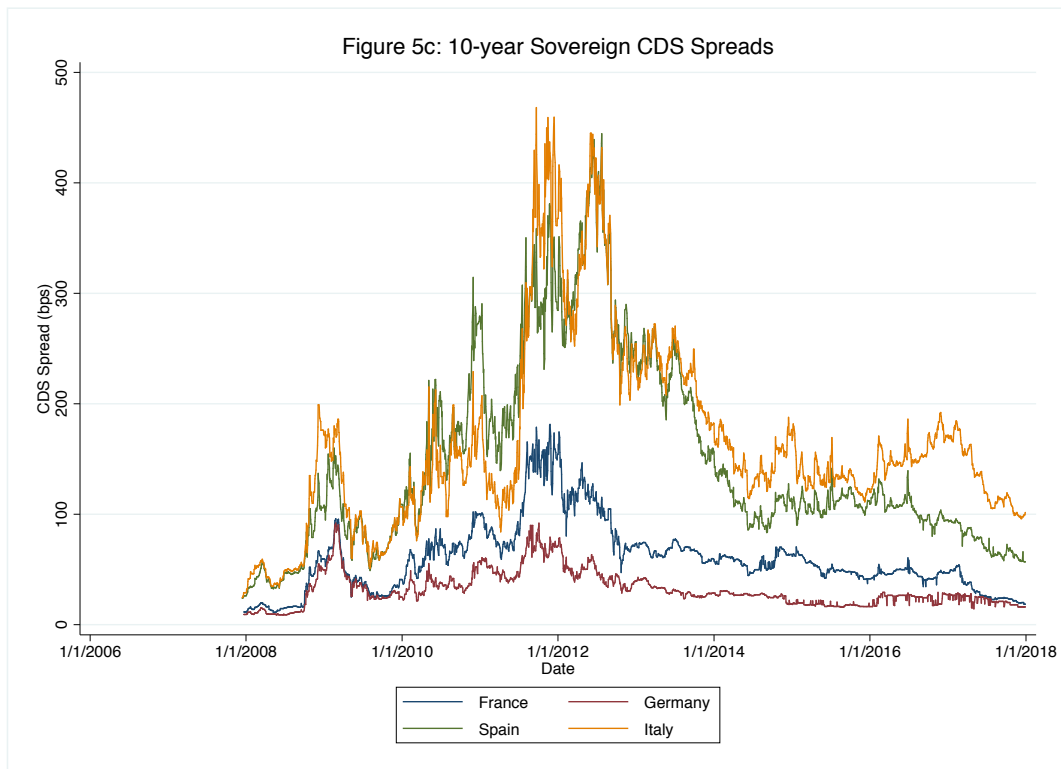
Medium-term sovereign yields largely follow the pattern found for short-term maturity bonds. Volatility in yields is high after 2010 until 2014, particularly for Spain and Italy (2012-2013). The (absolute) difference in 5-year yields between France and Germany, and on the other hand Italy and Spain seems to be larger compared to short-term yields.

10-year sovereign bond yields largely parallel movements of shorter maturity sovereign bond yields. Volatility of long-term yields is visibly lower, with (absolute) differences in yields between seemingly correlated yields (France & Germany and Italy & Spain) showing to be larger during times of high volatility.

Inflation, as proxied by the Harmonized Index of Consumer Prices (HICP), can be observed in Figure 4. Initial recovery from deflationary pressures after the financial crisis came to an abrupt end by the end of 2014/beginning of 2015. As oil prices plummeted further the Eurozone entered into a negative spiral of increased deflation. Deflation caused a delay in spending, thus lowering overall demand, that persisted until the ECB was forced to intervene through unconventional monetary policy. As the ECB engaged in large asset purchases (bonds) from the year 2015 price levels have started to recover, causing inflation levels to be largely above 0% by 2016. The more economically stable countries (France and Germany) saw smaller fluctuations in price levels. Fluctuations in price levels have remained high after the implementation of QE.



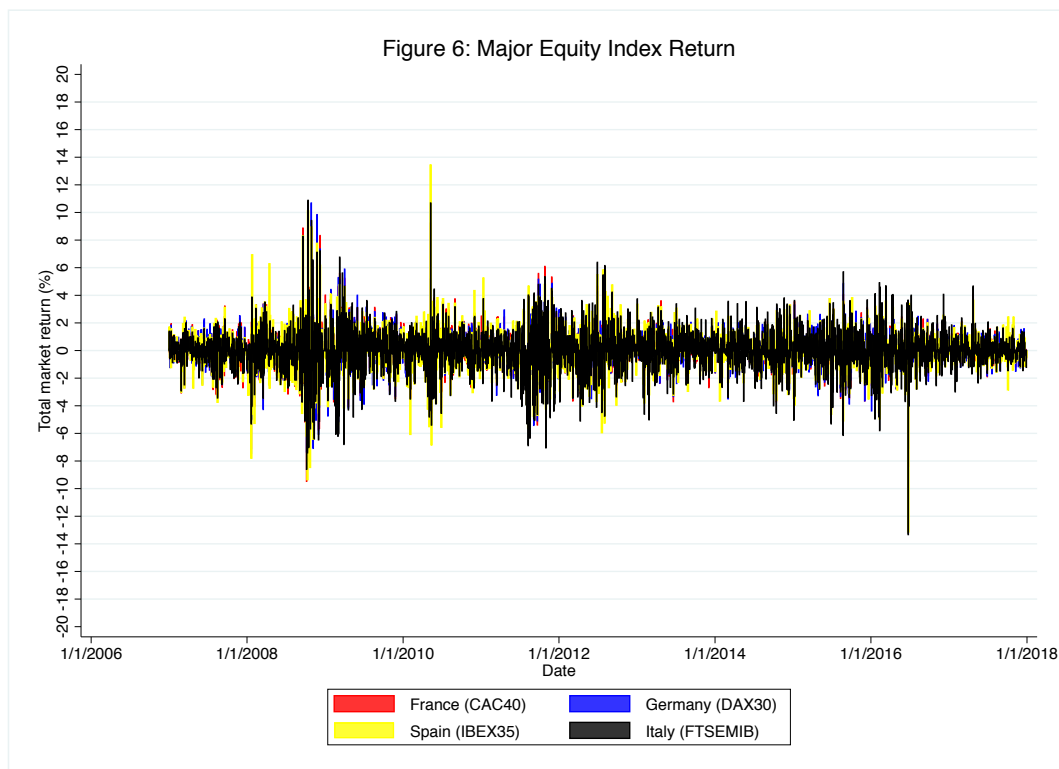




Figures 5a-5c depict spreads of sovereign Credit Default Swaps (CDS), corresponding to the investigated sovereign bonds. Spreads (premia) tend to be higher in case the probability of default is higher for the issuer of the debt (government). CDS spreads are a proxy for investor sentiment/confidence, and are high when confidence/sentiment is low/negative.

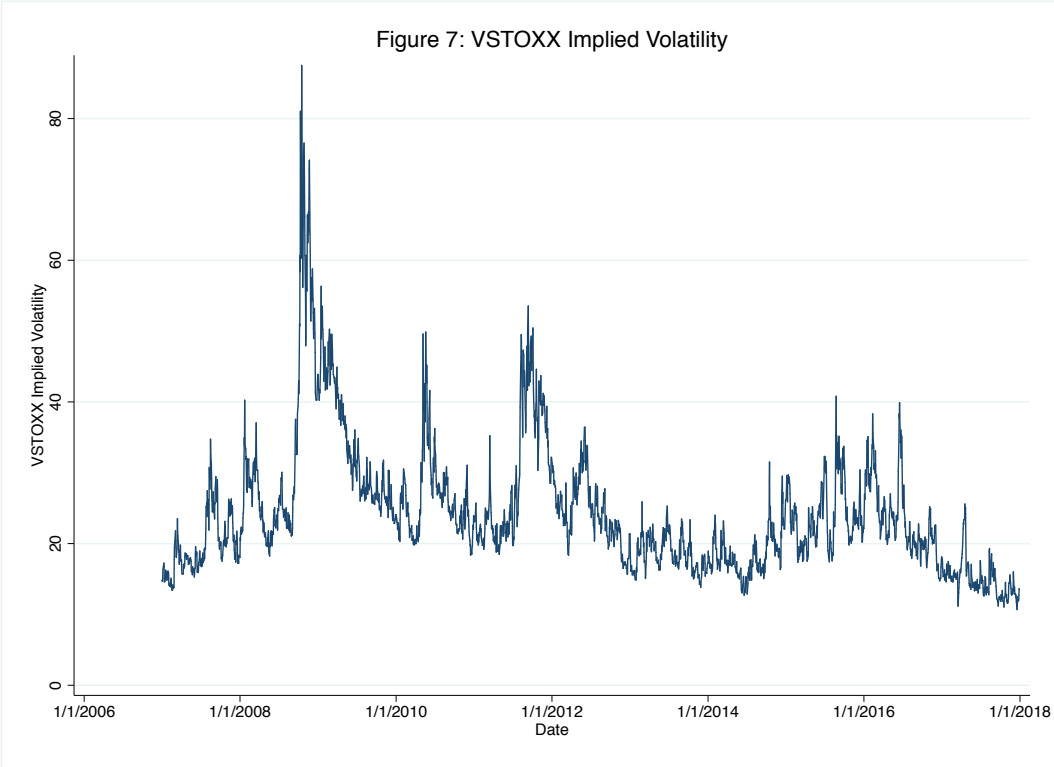
Concerning the 2-year sovereign CDS the pattern of the spread shows similarities with bond yields of similar maturity. Spanish and Italian spreads show to be more volatile, high volatilities found in yields coincide with highly volatile spreads as well. The period 2010-2013 (sovereign debt crisis), showed to be a highly volatile, and uncertain period. Investor confidence (sentiment) started to recover as the ECB announced its OMT and QE policies. Spreads are largely correlated, with France and Germany, and Italy and Spain showing the strongest degree of correlation.

Spreads and volatilities are shown to be slightly higher for longer maturities and largely mimic developments in their respective bond yields. 10-year sovereign CDS spreads and volatility levels show to be marginally higher than 5-year sovereign CDS spreads.



Equity returns are another control variable used, Figure 6 shows an overview of the total market returns of the investigated countries' major stock indices. The selected indices are the CAC40 (France), FTSEMIB (Italy), DAX30 (Germany) and IBEX35 (Spain). Market capitalizations took a hit after the financial crisis and returns remained highly volatile until 2012. When comparing the development of stock returns and bond yields in the period after 2012, these show an inverse relation. As stock- and bond markets do not compete for capital, this could be a sign of economic recovery (alongside low interest rates).

Figure 7 shows the implied volatility, implied by option prices on the EURO STOXX 50 Index, which is a representation of "super sector leaders" and all related products (50) are among those with the highest trading volumes on the Eurex. As stock prices decline the implied volatility (risk premia) usually increases, as this is deemed more risky than a bullish market. Implied volatility is thus also a proxy for investor fear and uncertainty in the market. Referring to Figure 7 volatility was especially high at the onset of the financial crisis as stock prices declined (see Figure 6). Volatility and investor fear initially declined, but as the sovereign debt crisis hit the Eurozone uncertainty returned until 2012. Volatility and market uncertainty (fear) have generally decreased after 2012, with some spikes found in 2015/2016.



4 Results

The following section is devoted to an analysis of results of the performed tests. The first section focuses on the event study used to predict bond yields during times of unconventional monetary policy announcements where a 3-day event window will apply. The section is subdivided based on the maturities of the respective bonds. Secondly, with a similar methodology a robustness analysis is performed. Using an alternative specification with a larger event window it is investigated whether effects on yields persist. Lastly, a discussion and further interpretation of findings is provided. Please refer to Tables 10-15 for an overview of results.

4.1 Short-term bond yields

The effect of unconventional monetary policy announcements by the ECB on short-term sovereign bond yields is summarized in Table 10. Two different model specifications are provided. Model (1) includes the dummy variables of all policies (LTRO, SMP, OMT and QE). Model (2) adds the control variables of inflation, 2-year sovereign CDS spreads, returns on the country-specific major equity index and the VSTOXX implied volatility to the initial specification.

Table 10: Impact of Unconventional Monetary Policy on Short-term Treasury Bond Yields (3-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on short-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 2-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	1.065*** (36.42)	4.597*** (25.99)	1.935*** (62.30)	3.813*** (18.20)	0.896*** (30.18)	4.878*** (31.22)	1.925*** (62.02)	6.969*** (34.20)
LTRO	0.326* (1.85)	-0.022 (-0.72)	0.517*** (2.76)	0.008 (0.22)	0.295* (1.65)	-0.012 (-0.40)	0.540*** (2.89)	0.079* (1.89)
SMP	-0.099 (-0.32)	-0.006 (-0.11)	1.789*** (5.43)	0.202*** (2.99)	-0.250 (-0.79)	0.037 (0.70)	2.032*** (6.17)	0.271*** (3.65)
OMT	-0.935*** (-3.07)	-0.023 (-0.45)	-0.010 (-0.03)	0.104 (1.59)	-0.918*** (-2.97)	-0.011 (-0.22)	0.467 (1.45)	0.257** (3.56)
QE	-1.425*** (-7.56)	-0.040 (-1.22)	-1.878*** (-9.37)	-0.031 (-0.74)	-1.367*** (-7.14)	-0.025 (-0.77)	-1.963*** (-9.80)	-0.030 (-0.66)
HICP (inflation)		0.007 (0.35)		-0.008 (-0.46)		-0.001 (-0.08)		-0.006 (-0.28)
2-year CDS spread		0.001** (1.96)		0.008*** (64.40)		-0.010*** (-11.96)		0.008*** (42.56)
Major equity market return		-0.016 (-1.19)		0.016*** (3.54)		-0.057*** (-4.21)		-0.091*** (-14.33)
VSTOXX implied volatility		-0.020*** (-16.46)		-0.019*** (-13.53)		-0.022*** (-18.35)		-0.041*** (-27.38)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0240	0.9586	0.0426	0.9567	0.0216	0.9582	0.0489	0.9498
Adj. R-squared	0.0226	0.9583	0.0412	0.9564	0.0202	0.9580	0.0476	0.9495

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

The initial specifications show that announcements of longer-term refinancing operations (LTROs) have caused upward pressure in short-term sovereign yields in all investigated countries. However, when considering the second specification the suggested effects are largely captured by the control variables. The impact on yields caused by LTROs is insignificant on aggregate in all countries. In Spain yields have increased by 8 basis points (bps) on average, which is statistically significant at the 10% significance level.

Previous research on LTRO has been far from conclusive, with results ranging from a decreasing impact to insignificant positive/negative impacts. Concerning the findings in this report these most closely compare to the results of Sczerbowicz (2012), with the exception of Spain.

Although it may be expected that yields would decline after LTRO announcements, the results of this event study are impacted by several factors. Many previous studies have not considered the overlap of unconventional monetary policies. This overlap may have caused insignificant impact of individual programs. In the case of LTRO, this program has overlapped with all other programs and a possible decline in yields may then be the result of another program that was launched simultaneously.

Referring to Table 10 similar effects of SMP as compared to LTRO announcements can be observed for France and Germany. SMP seems to have left short-term sovereign yields unchanged when considering the controlled specification. Concerning Spain and Italy, SMP has created significant upward pressures. The chosen controls have captured a large part of the variability in yields attributed to SMP, however (average) increases in sovereign yields of 20 bps and 27 bps are found in Italy and Spain respectively.

Findings are mostly inconsistent with previous research, which can be largely explained by the chosen announcements. Many authors (e.g. Eser & Schwaab, 2016; Sczerbowicz, 2012) have chosen to include only the most important announcement(s), which show significant negative pressures on long-term government bond yields. This report has included more announcements that may have highlighted the temporary nature of the SMP. The announcements on 04-08-11 and 03-11-11 for instance, may have caused a lack of trust in the (long-term) effectiveness of the SMP. Results could then be related to a “confidence effect” and particularly the absence of that effect. In addition, the fact that only 8% of total outstanding sovereign bond value was purchased, may have been insufficient to reverse upward pressures on yields caused by the sovereign debt crisis.

OMT’s impact on 2-year sovereign bond yields in France and Germany has been insignificant. The inclusion of control variables causes the initial negative relation to fade. The effect of OMT announcements on Italian short-term sovereign yields has remained insignificant after including the chosen control variables in the specification. Yields in Spain have increased by 26 basis points, the rise in yields is statistically significant.

Related literature finds that OMT in general have created negative pressures on short-term yields (in Italy and Spain), related to a signaling effect. However, most of these authors (e.g. Altavilla et al., 2014) have not included announcements in years 2013-2015 in which the ECB was often questioned on the legality of OMT, which may have increased yields. This explanation holds for France and Germany, please refer to Tables A1-A3 in the Appendix.

Moreover, over the course of time OMT has never officially been received by any member state. This could be another indication that the policy has not been effective (yet).

Considering the non-controlled specifications, large reductions in yields are observed for QE (announcements). Negative pressures (caused by QE) on yields remain after adding controls, however these effects are found to be insignificant. Effects are estimated to be small reductions in yields of several basis points for the investigated countries.

Although reductions are usually found to be larger for longer maturities, these results deviate from previous research (see van Lamoen et al., 2017; De Santis, 2016). Compared to the methodology of this report, the authors make use of fewer announcements. As the ECB announced to reduce its monthly purchases from 80 billion (April 2016 until March 2017) to 60 billion (April 2017 until December 2017) and ultimately to 30 billion (January 2018-September 2018) this may have impacted bond yields adversely. The lower level of purchases may have been insufficient to reduce yields significantly.

With many of the policy announcement effects having insignificant impact on sovereign yields (especially in France and Germany), it is worth analyzing the chosen control variables of the second regression specifications. Inflation is an insignificant factor in explaining variability in short-term sovereign bond yields. In theory the relation between yields and inflation should often be positive as inflation causes investors to require higher yields.

Stock returns and bond yields show to be inversely related in most countries. As equity and fixed income securities do not compete for capital, this could be a sign of mild economic growth. This leaves us with two important explanatory variables in the prediction of yields, namely the VSTOXX implied volatility and 2-year sovereign CDS spread. Evidence points at an important role for investor sentiment/confidence (spreads) and general market uncertainty (implied volatility). Higher spreads (low investor sentiment) tend to increase yields, as demand for bonds decreases¹². Greater market uncertainty causes a higher demand for sovereign bonds and yields tend to decrease significantly. This finding is strongly related to the concept of “flight to quality” as investors rebalance their portfolios towards less risky assets (in uncertain times).

¹² This finding is closely related to the sovereign debt crisis (2010) in which deteriorating investor confidence caused a lower demand for sovereign bonds and an increase in sovereign bond yields

4.2 Medium-term bond yields

Results of the performed tests on medium-term sovereign yields can be found in Table 11. Similar to the estimation of short-term yields, two models are estimated. The first model incorporates the announcements of the respective policies, the second includes the announcements as well as the control variables of inflation (HICP), spreads of 5-year sovereign CDS, the return on the country-specific major equity index and the VSTOXX implied volatility.

Table 11: Impact of Unconventional Monetary Policy on Medium-term Treasury Bond Yields (3-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on medium-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 5-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	1.672*** (59.20)	4.776*** (23.63)	2.782*** (91.47)	3.539*** (17.30)	1.352*** (45.98)	4.758*** (28.00)	2.765*** (87.72)	6.468*** (35.22)
LTRO	0.409** (2.40)	-0.044 (-1.30)	0.514*** (2.81)	-0.027 (-0.75)	0.386** (2.18)	-0.028 (-0.88)	0.550*** (2.90)	0.035 (0.97)
SMP	0.212 (0.71)	-0.026 (-0.44)	1.972*** (6.11)	0.163** (2.53)	-0.020 (-0.06)	0.025 (0.45)	2.157*** (6.45)	0.194*** (3.00)
OMT	-0.888*** (3.02)	-0.052 (-0.89)	0.353 (1.12)	0.112* (1.78)	-0.998*** (-3.26)	-0.003 (-0.05)	0.819** (2.50)	0.346** (5.47)
QE	-1.688*** (-9.27)	-0.062* (-1.70)	-2.064*** (-10.52)	-0.031 (-0.77)	-1.590** (-8.38)	-0.038 (-1.08)	-2.206*** (-10.85)	-0.036 (-0.90)
HICP (inflation)		0.015 (0.67)		0.003 (0.19)		0.006 (0.28)		0.015 (0.78)
5-year CDS spread		0.001*** (2.85)		0.008*** (57.22)		-0.005*** (-7.30)		0.008*** (40.34)
Major equity market return		-0.030* (-1.90)		0.002*** (5.42)		-0.028* (-1.88)		-0.073*** (-12.57)
VSTOXX implied volatility		-0.017*** (-12.78)		-0.015*** (-11.23)		-0.021*** (-17.09)		-0.033*** (-25.54)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0344	0.9533	0.0529	0.9636	0.0292	0.9580	0.0583	0.9667
Adj. R-squared	0.0331	0.9529	0.0516	0.9634	0.0278	0.9577	0.0570	0.9665

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

Similar to the 2-year sovereign yields, LTROs cause an initial significant upward pressure on yields for all bonds. Referring to the controlled specification, all countries show an insignificant impact on yields. Except for Spain, small negative pressures on yields are estimated.

From these results it follows that LTRO has been ineffective in impacting medium-term sovereign yields in the investigated countries. The results are comparable to findings of Sczerbowicz (2012). As mentioned earlier, previous research is far from conclusive and a possible explanation can be found in the (consideration of) overlap of LTROs with all other programs and the number of announcements chosen.

ECB's second unconventional monetary policy program, SMP, has not created the desired downward pressure on sovereign yields (5-year maturity) in both France and Germany. Yields in Italy and Spain have shown to increase during times of SMP policy announcements, with increases in yields lying just below the estimates at the 2-year maturity level. Yields in Italy and Spain have increased with 16 and 19 basis points respectively.

As was the case with earlier findings, discrepancies can be explained through the chosen announcements. Indeed SMP's main (three) announcements may have created favorable effects on yields, however this research has chosen more announcements that may have casted doubt on the (possible) effectiveness of SMP. Lastly, as mentioned before, the fact that a relatively small amount of sovereign bonds was purchased during the program may have been insufficient to create an overall decline in yields.

Confirming earlier results, OMT has merely caused insignificant impact on medium-term sovereign yields in France and Germany. OMT's impact in Italy and Spain has been (economically) significant, with yields in Italy and Spain increasing by 11 and 35 basis points respectively.

Previous literature (e.g. Sczerbowicz, 2012; Altavilla et al. 2014) has not incorporated more recent announcements regarding OMT in which the legality of OMT was often questioned. These announcements have shown to increase yields significantly in France and Germany (see Tables A1-A3 in the Appendix). In addition, as OMT has not (yet) been activated the results of this paper and the ineffectiveness may be explained. Larger increases in yields (in Spain and Italy) compared to shorter maturity bonds, may be attributed to the fact that OMT would focus on shorter maturity bonds (under three years).

Comparable to 2-year sovereign bonds the non-controlled specification shows large decreases in yields caused by QE for all countries. However, when considering the controlled specification the effect is largely captured and only an insignificant decline in yields is found¹³.

Previous research on QE has largely focused on a smaller number of announcements (particularly main announcements) that may have caused a discrepancy between their findings and this report. The announcements regarding the decline of bond purchases and the signaling in 2017 of a finite horizon of QE may have impacted yields adversely.

Similar to the models predicting short-term bonds, announcement effects have largely not been the main drivers of sovereign bond yields (particularly in France and Germany). Analyzing the chosen control variables, these largely show to have a significant impact on bond yields.

A similar insignificant impact of inflation, as compared to 2-year sovereign yields, is found for 5-year sovereign bonds. The positive, yet insignificant, relation is in line with the theoretical explanation (investors require higher yields as a result of inflation). Returns on the equity markets are negatively correlated with yields in most countries (except for Italy) meaning that prices are positively correlated. Again, a possible sign of economic recovery.

Global uncertainty, as proxied by the VSTOXX implied volatility, is an important indicator for variability in yields. Yields decrease as investor refuse to engage in (more) risky investments. Moreover, more investor confidence (smaller CDS spreads) causes a decrease in yields in most countries. In Germany more/less investor confidence does not translate into lower/higher yields.

4.3 Long-term bond yields

Referring to Table 12, two models are used to predict the movement in long-term (10-year) government bonds. Model (1) includes the dummy variables for all different programs. Model (2) predicts the yields using additional control variables, being inflation (HICP), the 10-year (sovereign) CDS spread, returns on the country-specific major equity index and the VSTOXX implied volatility.

¹³ Impact is statistically significant at the 10% significance level in France

Table 12: Impact of Unconventional Monetary Policy on Long-term Treasury Bond Yields (3-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on long-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 10-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	2.498*** (97.78)	4.773*** (22.89)	3.717*** (139.06)	3.725*** (17.94)	2.045*** (76.12)	4.708*** (27.98)	3.659*** (127.45)	6.216*** (34.66)
LTRO	0.440*** (2.86)	-0.044 (-1.29)	0.464*** (2.89)	-0.040 (-1.12)	0.415** (2.57)	-0.038 (-1.20)	0.474*** (2.74)	-0.006 (-0.16)
SMP	0.496* (1.83)	0.011 (0.18)	1.792*** (6.32)	0.138** (2.14)	0.148 (0.52)	0.013 (0.22)	2.048*** (6.72)	0.141** (2.25)
OMT	-0.748** (-2.44)	-0.051 (-0.85)	0.541* (1.95)	0.229*** (3.66)	-0.829*** (-2.97)	-0.011 (-0.21)	0.856*** (2.87)	0.291*** (4.75)
QE	-1.735*** (-10.53)	-0.056 (-1.50)	-1.893*** (-10.98)	-0.025 (-0.64)	-1.640*** (-9.47)	-0.023 (-0.66)	-2.038*** (-11.01)	-0.033 (-0.86)
HICP (inflation)		0.032 (1.45)		0.018 (1.12)		0.020 (1.04)		0.032* (1.75)
10-year CDS spread		0.000 (0.98)		0.006*** (38.51)		-0.008*** (-10.09)		0.006*** (30.45)
Major equity market return		-0.018 (-1.09)		0.022*** (5.00)		-0.011 (-0.78)		-0.062*** (-10.93)
VSTOXX implied volatility		-0.010*** (-7.32)		-0.007*** (-5.37)		-0.013*** (-10.54)		-0.025*** (-19.98)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0434	0.9482	0.0579	0.9582	0.0357	0.9558	0.0608	0.9642
Adj. R-squared	0.0421	0.9478	0.0566	0.9579	0.0344	0.9555	0.0595	0.9639

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

Longer-term refinancing operations (LTROs) have shown to increase yields of long-term bonds in all investigated countries, the effect becomes insignificant when considering the controlled specification. Comparable to shorter maturities, changes in yields of several basis points are found.

Similar to results found at shorter maturities, LTRO has been ineffective in decreasing sovereign bond yields. Literature is inconclusive in that it finds different announcement effects depending on the chosen announcements and specifications. The results of this report may be explained by the fact that overlap of respective programs may have impacted individual significance.

Referring to Table 12, results for the Securities Market Program (SMP) suggest different impacts in the investigated countries. Sovereign French and German yields have not changed around SMP announcements. The impact of SMP (announcements) on sovereign yields in Italy and Spain has been more pronounced. With yield hikes of over 10 basis points in both countries the impact of SMP has been significant.

Previous literature often highlights the negative pressures on yields that have been generated during the first three announcements. This report adds announcements (e.g. 04-08-11) that may have highlighted the temporary nature of the SMP, and a resulting loss of trust in its effectiveness. The relatively low amount of bond purchases may also play an important role.

Initial results of the impact of Outright Monetary Transactions (OMT) indicate a favorable effect on yields for both French and German government bonds. However, when applying control variables the pressure is completely captured and becomes insignificant. Similar to 2- and 5-year sovereign yields, Spanish and Italian yields have increased significantly. Effects are estimated to be an increase in yields of 23 basis points and 29 basis points for Italian and Spanish sovereign bonds respectively.

Comparing these findings with previous literature, this report finds somewhat conflicting evidence. OMT's suggested ineffectiveness could be the result of two factors. Namely, the inclusion of announcements that featured the questioning of the legality of OMT (see Tables A1-A3 in the Appendix for some evidence) and the matter that OMT has never been granted.

Referring to Table 12 the impact of QE on long-term sovereign yields can be found. Impact of QE (announcements) has been insignificant, in that it merely created small declines in yields of all investigated sovereign bonds. The uncontrolled specifications showed large decreases in yields, ranging from 164 basis points (in Germany) to a decrease in yields of 204 basis points (in Spain).

As for short- and medium-term maturity bonds, QE has been ineffective in significantly reducing bond yields in all investigated countries. The result is somewhat surprising as the effect was predicted to be larger for longer maturities (see van Lamoen et al. 2017; De Santis, 2016). These results may be in part explained through the fact that more announcements regarding the decline of purchases and the eventual termination of QE were incorporated in this report. These may have caused a drop in investor confidence, resulting in a weaker downward effect on yields.

Similar to shorter maturities, controlled specifications show that ECB policy announcements are largely not explanatory for (movements in) sovereign bond yields. Control variables capture a large part of estimated variability explained by ECB policy announcements. Inflation remains insignificant, however its suggested positive relation with yields confirms the theoretical effect between the two variables. The relationship between equity market returns and bond yields may be closely related to the general economic environment in the respective country, with bond prices and equity prices positively correlated during (initial) economic recovery. In turn, positive coefficients could signal economic expansion/decline in the respective country.

Investor confidence remains an important indicator for the size of bond yields, with greater confidence leading to a higher demand for bonds. Germany is an exception, perhaps greater confidence causes more risk taking (as yields are deemed to be too low). As for overall market uncertainty, a more uncertain environment (higher implied volatility) causes investors to invest in securities with lower risk such as sovereign bonds.

4.4 Robustness

Using a 3-day event window has the benefit of reducing the risk of other (major) events impacting the investigated bond yields. However, it does not fully incorporate the chance that news on ECB policy is incorporated in bond prices before the actual announcement, and the possible persistence of pressure on yields after the announcement is not entirely captured. Therefore, as a test for robustness, the event windows will be extended to five days, ranging from two days before the announcement until two days after the announcement.

4.4.1 Short-term bonds

Comparing the 5-day specification (Table 13) to the initial specification (Table 10), these mimic earlier found results. The control variables largely capture any effect on yields that was believed to have been caused by LTRO. Yields are left unaffected in all countries with the exception of Spain, a slight increase in yields of just under 10 basis points on average is observed.

Table 13: Impact of Unconventional Monetary Policy on Short-term Treasury Bond Yields (5-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on short-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 5-day event window, ranging from two days before until two days after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 2-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	1.085*** (36.58)	4.594*** (25.96)	1.945*** (62.12)	3.814*** (18.23)	0.917*** (30.41)	4.879*** (31.21)	1.935*** (61.88)	6.690*** (34.23)
LTRO	0.350** (2.54)	-0.012 (-0.54)	0.569*** (3.90)	0.017 (0.55)	0.312** (2.23)	-0.003 (-0.14)	0.588*** (4.04)	0.085** (2.56)
SMP	-0.079 (-0.32)	0.002 (0.06)	1.769*** (6.83)	0.213*** (3.92)	-0.240 (-0.96)	0.044 (1.03)	1.897*** (7.33)	0.230*** (3.85)
OMT	-0.960*** (-3.96)	-0.017 (-0.41)	-0.111 (-0.43)	0.115** (2.17)	-0.939*** (-3.82)	-0.004 (-0.09)	0.300 (1.18)	0.239*** (4.10)
QE	-1.441*** (-9.77)	-0.037 (-1.41)	-1.885*** (-12.11)	-0.027 (-0.80)	-1.385*** (-9.24)	-0.022 (-0.84)	-1.971*** (-12.68)	-0.025 (-0.69)
HICP (inflation)		0.007 (0.35)		-0.007 (-0.39)		-0.002 (-0.09)		-0.005 (-0.24)
2-year CDS spread		0.001** (1.97)		0.008*** (64.44)		-0.010*** (-11.94)		0.008*** (42.65)
Major equity market return		-0.016 (-1.16)		0.016*** (3.55)		-0.057*** (-4.21)		-0.091*** (-14.32)
VSTOXX implied volatility		-0.020*** (-16.44)		-0.019*** (-13.60)		-0.022*** (-18.36)		-0.041*** (-27.50)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0398	0.9586	0.0700	0.9569	0.0357	0.9582	0.0773	0.9500
Adj. R-squared	0.0385	0.9583	0.0687	0.9566	0.0344	0.9580	0.0760	0.9496

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

Again referring to Tables 10 and 13, SMP announcements do not significantly impact yields in France and Germany, and an insignificant effect on yields persists in all specified event windows. Consistent effects are also found in Spain and Italy, where yields increase significantly in both the 3- and 5-day event windows.

ECB's OMT have created a negligible impact on yields in France and Germany, effects are statistically insignificant and persist when controlling for event windows of different sizes. Upward pressures on yields in Spain and Italy persist with OMT impact now significant at the 5% level in both countries¹⁴.

¹⁴ The 3-day specification showed an insignificant effect on Italian short-term sovereign bond yields

QE announcement effects on yields for all 2-year sovereign bonds remain insignificant when considering controlled specifications and are robust against different event window specifications. Estimates generally amount to a reduction in yields of a few basis points.

4.4.2 Medium-term bonds

Policy announcement effects on 5-year sovereign bond yields can be found in Tables 11 and 14. Earlier it was observed that LTRO announcements had insignificantly impacted yields of French, German, Spanish and Italian medium-term sovereign bonds. Extending event windows largely confirm these results.

As for the case of SMP, yields are impacted marginally in both France and Germany. The announcement effect remains insignificant after expanding event windows. Significant increases in medium-term sovereign yields persist in Italy and Spain.

Outright Monetary Transactions (OMT) have an insignificant effect on bond yields in France and Germany, results are robust to a change in event window size. As for Spain a significant rise in medium-term sovereign yields persists. Previously an insignificant increase in sovereign yields was observed for Italy, the 5-day specification shows OMT announcements have caused significant upward pressures in Italian medium-term sovereign bond yields.

Comparing both specifications (Table 11 and 14), results for QE are largely similar across the different 5-year sovereign bonds. QE announcements have had an insignificant impact on bond yields, as these decline marginally around announcement dates, in Germany, Italy and Spain. Extending the event window to 5 days causes the impact of QE on medium-term sovereign bond yields in France to be significant, yields decrease by an average 6 basis points around announcement dates.

Table 14: Impact of Unconventional Monetary Policy on Medium-term Treasury Bond Yields (5-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on medium-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 5-day event window, ranging from two days before until two days after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 5-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	1.692*** (59.29)	4.769*** (23.59)	2.792*** (91.35)	3.541*** (17.34)	1.374*** (46.12)	4.755*** (27.97)	2.774*** (87.65)	6.463*** (35.26)
LTRO	0.443*** (3.34)	-0.034 (-1.28)	0.578*** (4.07)	-0.016 (-0.56)	0.408*** (2.95)	-0.023 (-0.92)	0.613*** (4.16)	0.048* (1.66)
SMP	0.242 (1.02)	-0.010 (-0.21)	1.937*** (7.66)	0.177*** (3.40)	0.004 (0.02)	0.031 (0.68)	2.031*** (7.76)	0.160*** (3.08)
OMT	-0.917*** (-3.93)	-0.041 (-0.88)	0.253 (1.01)	0.128** (2.52)	-1.018*** (-4.19)	0.008 (0.19)	0.660** (2.55)	0.322*** (6.33)
QE	-1.701*** (-11.99)	-0.060** (-2.06)	-2.067*** (-13.61)	-0.029 (-0.92)	-1.606*** (-10.85)	-0.034 (-1.21)	-2.207*** (-14.02)	-0.027 (-0.86)
HICP (inflation)		0.015 (0.68)		0.004 (0.25)		0.005 (0.28)		0.015 (0.82)
5-year CDS spread		0.001*** (2.86)		0.008*** (57.21)		-0.005*** (-7.28)		0.008*** (40.43)
Major equity market return		-0.029* (-1.86)		0.024*** (5.42)		-0.028* (-1.85)		-0.073*** (-12.55)
VSTOXX implied volatility		-0.017*** (-12.74)		-0.015*** (-11.27)		-0.021*** (-17.07)		-0.033*** (-25.64)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0573	0.9533	0.0862	0.9638	0.0483	0.9580	0.0920	0.9668
Adj. R-squared	0.0560	0.9530	0.0849	0.9635	0.0470	0.9577	0.0907	0.9666

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

4.4.3 Long-term bonds

Referring to Table 12 (3-day window) and Table 15 (5-day window) announcement effects of all policies on long-term sovereign bond yields can be observed. When comparing both event windows, results are robust to changes in event window size and the impact of LTRO remains insignificant for all investigated countries.

Increasing the size of event windows shows consistent results for the SMP. The upward trend of yields persists in Italy and Spain. The controlled specifications show an insignificant increase in yields for France in Germany, regardless of the chosen event window.

The impact of OMT (announcements) does not differ when considering larger event windows. A similar insignificant pressure on yields in France and Germany is found for the 5-day specification. The increase in sovereign yields of 10-year Spanish and Italian bonds persists, with all models showing a significant increase in yields in both event windows.

Evidence of the methodology that applied 3-day event windows showed signs of a (insignificant) downward effect on yields in all investigated countries for QE announcements. The choice of a larger event window shows a consistent pattern in results. For long-term bonds in France, Germany, Italy and Spain yields have shown to decrease marginally.

Table 15: Impact of Unconventional Monetary Policy on Long-term Treasury Bond Yields (5-day event window)

This table represents an overview of the impact of unconventional monetary policy announcements on long-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 5-day event window, ranging from two days before until two days after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 10-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables.

<i>Dependent variable:</i>	<i>France (yield)</i>		<i>Italy (yield)</i>		<i>Germany (yield)</i>		<i>Spain (yield)</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	2.516*** (97.76)	4.767*** (22.86)	3.725*** (138.92)	3.724*** (17.97)	2.064*** (76.07)	4.705*** (27.95)	3.667*** (127.32)	6.205*** (34.68)
LTRO	0.473*** (3.95)	-0.041 (-1.50)	0.519*** (4.16)	-0.025 (-1.23)	0.442*** (3.50)	-0.034 (-1.35)	0.538*** (4.01)	0.010 (0.34)
SMP	0.523** (2.46)	0.032 (0.65)	1.751*** (7.90)	0.140*** (2.70)	0.176 (0.79)	0.025 (0.55)	1.946*** (8.17)	0.117** (2.32)
OMT	-0.678*** (-3.23)	-0.036 (-0.74)	0.450** (2.06)	0.237*** (4.70)	-0.849*** (-3.83)	0.002 (0.04)	0.743*** (3.16)	0.292*** (5.92)
QE	-1.743*** (-13.63)	-0.053* (-1.78)	-1.896*** (-14.22)	-0.027 (-0.84)	-1.651*** (-12.24)	-0.020 (-0.73)	-2.040*** (-14.25)	-0.030 (-0.98)
HICP (inflation)		0.032 (1.46)		0.019 (1.17)		0.020 (1.03)		0.033* (1.78)
10-year CDS spread		0.000 (0.99)		0.006*** (38.50)		-0.008*** (-10.08)		0.006*** (30.53)
Major equity market return		-0.002 (-1.06)		0.002*** (5.02)		-0.001 (-0.76)		-0.061*** (-10.87)
VSTOXX implied volatility		-0.010*** (-7.28)		-0.007*** (-5.38)		-0.013*** (-10.51)		-0.025*** (-20.03)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2616	2616	2621	2621	2616	2616	2621	2621
R-squared	0.0721	0.9482	0.0936	0.9563	0.0592	0.9559	0.0964	0.9644
Adj. R-squared	0.0708	0.9478	0.0924	0.9560	0.0579	0.9555	0.0952	0.9641

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

4.5 Discussion and summary

The ECB's unconventional monetary policies have had differing effects on sovereign bonds, and bond yields in particular. In this section results are summarized and a further interpretation of results is provided. The section is subdivided based on respective policy and examines all countries and different sovereign bonds.

LTROs were mainly used to provide liquidity to central banks, and thereby ensuring that interbank lending would remain possible. Banks largely used sovereign bonds as collateral for these loans, and a large part of LTRO financing was used to buy "peripheral sovereign debt" (e.g. Greek- and Spanish sovereign bonds). Looking at what impact repeated interventions in the form of LTROs have had on the yields of sovereign bonds in the investigated countries, insignificant pressures on yields are observed across all maturity bonds in France, Germany and Italy. Spain is the exception, as yields increase significantly for short-term bonds¹⁵. Long-term yields have been left largely unaffected by LTRO (announcements) in all countries. All of the above-mentioned results are robust against different event window specifications.

LTROs have been ineffective in reducing yields of sovereign bonds in all investigated countries. Thereby, channels such as the wealth effect or portfolio rebalancing effect (through a change in yields) are not likely to have been utilized.

Considering that LTRO already provided (central) banks with loans with low interest rates, government borrowing costs initially declined. However, given the fact that governments make use of long-term debt (e.g. 10-year sovereign bonds), an insignificant change in yields on these particular bonds suggests that government cost of debt (financing) have not further declined. Resulting in Hypothesis (1) not being rejected.

Insignificant impact on yields through LTROs is likely to be the result of an overlap of LTROs with all other investigated ECB policies, causing individual LTROs to have insignificant impact.

The Securities Market Program (SMP) was launched to restore transmission channels (bond volatility and yields), and translated into sovereign bond purchases on the secondary markets (e.g. in Spain and Italy). This report finds consistent results for Italy and Spain across all maturities, as a significant increase in yields is found (largest for 2-year sovereign bonds).

¹⁵ When considering a 5-day specification the impact on short-term yields is significant

Yields in France and Germany were not impacted by SMP (announcements). All results are robust against a change in event window size.

SMP's impact, similar to LTRO, has not brought the desired reduction in sovereign bond yields, particularly in Spain and Italy. As long-term yields did not (significantly) decrease, government borrowing costs have not declined through SMP in all investigated countries. Holders of sovereign bonds are not likely to have witnessed any increase in price of their bonds. Wealth effects through a decline in yields are therefore unlikely, especially in Spain and Italy. Given these findings Hypothesis (2) is not rejected, while Hypothesis (3) is rejected.

As peripheral bonds were targeted by the SMP, it was expected that at least Spanish and Italian bond yields would be favorably impacted. The absence of a significant downward pressure on yields caused by SMP may be the result of two factors. Firstly, the incorporation of announcements that may have casted doubt on the effectiveness of SMP and the relatively small amount (8%) of total bond value that was purchased under SMP.

The replacement of SMP, OMT, was aimed at supporting those countries with excessively high bond yields and volatilities that complied with a certain set of requirements¹⁶. Similar to SMP this would result in (unlimited) bond purchases in the secondary market if granted. The impact of OMT in France and Germany has been similar across maturities. Insignificant announcement effects are found on average. In Spain and Italy, yields have increased significantly for most bonds¹⁷.

Borrowing costs for the French and German governments have not declined, particularly because long-term yields have not declined. Spain and Italy have witnessed (significant) increases in yields across most investigated bonds, hence borrowing costs for the respective governments have not diminished. Consequently, Hypothesis (4) is not rejected and Hypothesis (5) is rejected.

Based on these findings it can be concluded that any occurrence of wealth effects, or a shift towards more risky assets (portfolio rebalancing) is unlikely to have been caused by OMT. The ineffectiveness of OMT is suspected to be in part the result of the chosen announcements (France and Germany, see Appendix) and the fact that OMT has not been granted to any member state.

¹⁶ See Szczerbowicz (2012)

¹⁷ When considering the 5-day specifications the increase is significant for all bonds

QE, the ECB's latest unconventional policy, aimed at increased economic growth in the Eurozone while at the same time maintaining price stability. The policy has been employed in the form of large, periodic, purchases of (sovereign) bonds at pre-determined rates. As opposed to what was previously hypothesized, yields did not decline significantly in many of the investigated countries, this results holds across maturities and different event window specifications. The only exception is the French 5-year sovereign bond, yields decreased significantly when considering a 5-day event window specification.

Given that yields of long-term sovereign bonds have not significantly decreased in all investigated countries, borrowing costs of governments have not reduced through QE. Thus, Hypothesis (6) is rejected.

Although insignificant, yields are estimated to decrease (at least) slightly for all investigated sovereign bonds. This may signal that a flow-based policy is most effective in reducing yields (partly through forward guidance). Small wealth effects are a possibility for holders of sovereign bonds (particularly in France). The ineffectiveness of QE is a surprising result, however may in part be caused by announcements regarding the reduction of bond purchases and approaching termination of QE. Constant (and ever-increasing) purchases may be required to show any lasting effects.

In addition, bond purchases may simply have been insufficient to significantly reduce bond yields in countries with relatively lower capital keys. Using these capital keys causes the largest and economically strongest to receive most purchases, which are not necessarily countries that are in need of significant reductions of sovereign bond yields. Moreover, adhering to such a capital key causes, in the event of a lack of supply of bonds (e.g. in Germany), a lower amount of bonds eligible for purchase in other countries.

In contrast to ECB policy (announcements), findings suggest that the majority of chosen control variables possess great explanatory power in predicting bond yields across countries and maturities. Equity returns on the country-specific equity indices significantly impact bond yields, the relation is largely determined by the country's position in the economic cycle. Moreover, the factors of global uncertainty (proxied by VSTOXX implied volatility) and investor sentiment/confidence (proxied by sovereign CDS spreads) are important determinants of the variability in bond yields. Larger global uncertainty creates a shift towards low-risk securities such as bonds. Improved investor sentiment/confidence shows a similar effect, demand for sovereign bonds increases and yields decrease.

5 Conclusion

5.1 Conclusion

Through event study methodology policy induced effects on sovereign bond yields have been isolated and estimated in France, Germany, Italy and Spain during the ECB's unconventional monetary policy programs. Using various event windows, control variables and analyzing announcement effects on bond yields for a diverse range of bonds it is found that policy announcements have been largely ineffective in reducing yields and sovereign borrowing costs.

LTROs have left almost all yields of investigated sovereign bonds unchanged, with the exception of short-term maturity bonds in Spain. This result is most probably caused by the overlap of LTROs with all other unconventional monetary policies pursued by the ECB. The Securities Market Program (SMP) has not eased financing conditions as it caused yields to increase significantly in Spain and Italy, and left yields in France and Germany unchanged. The bond purchases performed under SMP are likely to have been insufficient to reverse the impact of the sovereign debt crisis (2010).

OMT has primarily negatively impacted government borrowing costs in Spain and Italy, while yields have changed insignificantly in France and Germany. OMT may have lost its credibility as it was often questioned on its permissibility (France and Germany) and has never been implemented. QE, surprisingly, has largely created insignificant declines in yields. Financial markets may require ever-increasing impulses to show any lasting decline in yields.

An implication of these findings is that the ECB was predominantly unable to use its desired channels of transmission of unconventional monetary policy. Any policy-signaling effects or (positive) wealth effects are unlikely. The policy that is most likely to have realized any reduction in yields, and a utilization of transmission channels, is QE that created negative, but mostly insignificant reductions in yields across all investigated bonds.

As opposed to the analyzed announcements, the control variables of major equity index returns, investor sentiment (CDS spreads) and global uncertainty (VSTOXX implied volatility) serve as important predictors of the variability in yields.

Arguably, QE has been most effective in impacting yields, and as such the ECB should continue to use a flow-based policy that credibly signals the ECB's monetary policy stance. Through applying such a policy, investor confidence/sentiment can be built, which has been shown to be a key channel in reducing sovereign bond yields. In addition to creating policies that credibly signal (an expansionary) monetary policy stance, the ECB should focus more on necessity and differences between countries in monetary policy creation. QE serves as a clear case in which a greater focus on those elements could have created a more efficient and effective allocation of sovereign bond purchases across the Eurozone's sovereign states.

5.2 Limitations

Several limitations restrict the performed analysis of this report. The event study methodology is a great tool as it reduces the risk of external factors influencing the explanatory power, but it does not fully mitigate this risk. As seen in comparison with previous research, such a study is also highly dependent upon the chosen announcements. In addition, focusing only on announcements (bond purchase data was unavailable) may bias conclusions. Although the choice for a limited number of investigated countries is justified, the inclusion of other Eurozone countries (sovereign bonds) could have added some more insights on overall effectiveness of unconventional monetary policy programs.

5.3 Future research

Future research should continue to investigate the effectiveness of (recent) unconventional monetary policies of central banks, such as the ECB, as this could be vital for current, and future decision-making regarding policy design and communication. Specifically, research should focus on channels of transmission by which real variables are potentially affected, and further investigating the impact on bond yields using different control variables as well as alternative event window specifications. As QE has been the least documented program, future research should focus on its effectiveness. Areas that could be considered are borrowing costs for corporates, SMEs and households, as well as impact on macroeconomic variables such as GDP and employment. Moreover, possible spillover effects of QE could be further investigated.

6 Bibliography

Altavilla, C., Giannone, D., & Lenza, M. (2014). The financial and macroeconomic effects of OMT announcements

Angeloni, I., Faia, E., & Duca, M. L. (2015). Monetary policy and risk taking. *Journal of Economic Dynamics and Control*, 52, 285-307.

Baumeister, C., & Benati, L. (2012). *Unconventional monetary policy and the great recession: Estimating the macroeconomic effects of a spread compression at the zero lower bound* (No. 2012-21). Bank of Canada Working Paper.

Belke, A. (2013). *3-year LTROs: A first assessment of a non-standard policy measure* (No. 13-09). ROME Discussion Paper Series.

Bowdler, C., & Radia, A. (2012). Unconventional monetary policy: the assessment. *Oxford Review of Economic Policy*, 28(4), 603-621.

Ciccarelli, M., Maddaloni, A., & Peydró, J. L. (2013). Heterogeneous transmission mechanism: monetary policy and financial fragility in the eurozone. *Economic Policy*, 28(75), 459-512.

Ciccarelli, M., Maddaloni, A., & Peydró, J. L. (2014). Trusting the bankers: A new look at the credit channel of monetary policy. *Review of Economic Dynamics*.

Chodorow-Reich, G. (2014). *Effects of unconventional monetary policy on financial institutions* (No. w20230). National Bureau of Economic Research.

Darracq Paries, M., & De Santis, R. A. (2013). A non-standard monetary policy shock: the ECB's 3-year LTROs and the shift in credit supply.

Duca, M. L., Nicoletti, G., & Martinez, A. V. (2016). Global corporate bond issuance: what role for US quantitative easing?. *Journal of International Money and Finance*, 60, 114-150.

Eser, F., & Schwaab, B. (2016). Evaluating the impact of unconventional monetary policy measures: Empirical evidence from the ECB's Securities Markets Programme. *Journal of Financial Economics*, 119(1), 147-167.

Falagiarda, M., & Reitz, S. (2015). Announcements of ECB unconventional programs: Implications for the sovereign spreads of stressed euro area countries. *Journal of International Money and Finance*, 53, 276-295.

Fawley, B. W., & Neely, C. J. (2013). Four stories of quantitative easing. *Federal Reserve Bank of St. Louis Review*, 95(1), 51-88.

Ferrando, A., Popov, A. A., & Udell, G. F. (2015). Sovereign stress, unconventional monetary policy, and SME access to finance.

Foley-Fisher, N., Ramcharan, R., & Yu, E. G. (2016). The impact of unconventional monetary policy on firm financing constraints: evidence from the maturity extension program.

Gambacorta, L., Hofmann, B., & Peersman, G. (2014). The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis. *Journal of Money, Credit and Banking*, 46(4), 615-642.

Gertler, M., & Karadi, P. (2014). *Monetary policy surprises, credit costs and economic activity* (No. w20224). National Bureau of Economic Research.

Gilchrist, S., López-Salido, D., & Zakrajšek, E. (2014). *Monetary policy and real borrowing costs at the zero lower bound* (No. w20094). National Bureau of Economic Research.

Joyce, M., Miles, D., Scott, A., & Vayanos, D. (2012). Quantitative Easing and Unconventional Monetary Policy—an Introduction*. *The Economic Journal*, 122(564), F271-F288.

Joyce, M. A. S., McLaren, N., and Young, C. (2012), 'Quantitative Easing in the United Kingdom: Evidence from Financial Markets on QE1 and QE2', *Oxford Review of Economic Policy*, 28(4), 671–701

Kapetanios, G., Mumtaz, H., Stevens, I., & Theodoridis, K. (2012). Assessing the Economy-wide Effects of Quantitative Easing*. *The Economic Journal*, 122(564), F316-F347.

Kuroda, H. (2013, April). Quantitative and Qualitative Monetary Easing. In *Speech at a Meeting Held by the Yomiuri International Economic Society in Tokyo* (Vol. 12).

van Lamoen, R., Mattheuissens, S., & Dröes, M. (2017). Quantitative easing and exuberance in government bond markets: Evidence from the ECB's expanded asset purchase program. *Tinbergen Institute Discussion Paper*, (2017-080/IV).

Lenza, M., Pill, H., & Reichlin, L. (2010). Monetary policy in exceptional times. *Economic Policy*, 25(62), 295-339.

Neely, C. J. (2015). Unconventional monetary policy had large international effects. *Journal of Banking & Finance*, 52, 101-111.

De Pooter, M., Rebecca, D., Martin, R. F., & Pruitt, S. (2015). *Cheap Talk and the Efficacy of the ECB's Securities Market Programme: Did Bond Purchases Matter?* (No. 1139).

Rogers, J. H., Scotti, C., & Wright, J. H. (2014). Evaluating asset-market effects of unconventional monetary policy: a multi-country review. *Economic Policy*, 29(80), 749-799.

Pattipeilohy, C., Van Den End, J. W., Tabbae, M., Frost, J., & De Haan, J. (2013). Unconventional monetary policy of the ECB during the financial crisis: An assessment and new evidence.

De Santis, R. A. (2016). Impact of the asset purchase programme on euro area government bond yields using market news.

Sharpe, T., & Watts, M. J. (2013). Unconventional monetary policy in the UK: a modern money critique. *Economic Issues*, 18(2), 41-63.

Szczerbowicz, U. (2012). The ECB unconventional monetary policies: have they lowered market borrowing costs for banks and governments?. *Document Du Travail, Centre D'Etudes Prospectiveset D'informations Internationales*.

Szczerbowicz, U. (2011). *Effectiveness of Unconventional Monetary Policies and their Impact on Long-Term Inflation Expectations*. na.

Urbschat, F., & Watzka, S. (2017). Quantitative Easing in the Euro Area-An Event Study Approach.

Valencia, F. (2014). Monetary policy, bank leverage, and financial stability. *Journal of Economic Dynamics and Control*, 47, 20-38.

Wu, J. C., & Xia, F. D. (2014). *Measuring the macroeconomic impact of monetary policy at the zero lower bound* (No. w20117). National Bureau of Economic Research.

7 Appendix

The tables below provide some additional analysis on the chosen announcements for the ECB's OMT program. The impact of OMT on sovereign bond yields is computed separately for the announcements of 2012, 2013-2015 and the full sample.

Table A1: Impact of Unconventional Monetary Policy on Short-term Treasury Bond Yields (different OMT announcements)
 This table represents an overview of the impact of unconventional monetary policy announcements on short-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 2-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables. Each regression specification includes either OMT announcements for the year of 2012 (1), announcements for years 2013-2015 (2) or all OMT announcements (3).

Dependent variable:	France (yield)			Italy (yield)			Germany (yield)			Spain (yield)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	4.594*** (26.02)	4.585*** (25.92)	4.597*** (25.99)	3.819*** (18.23)	3.816*** (18.21)	3.813*** (18.20)	4.879*** (31.25)	4.872*** (31.18)	4.878*** (31.22)	6.978*** (34.25)	6.984*** (34.22)	6.969*** (34.20)
LTRO	-0.022 (-0.74)	-0.021 (-0.71)	-0.022 (-0.72)	0.008 (0.20)	0.008 (0.21)	0.008 (0.22)	-0.012 (-0.42)	-0.012 (-0.39)	-0.012 (-0.40)	0.078* (1.85)	0.078* (1.86)	0.079* (1.89)
SMP	-0.008 (-0.15)	-0.005 (-0.10)	-0.006 (-0.11)	0.202*** (2.99)	0.201*** (2.97)	0.202*** (2.99)	0.035 (0.67)	0.037 (0.71)	0.037 (0.70)	0.274*** (3.69)	0.266*** (3.58)	0.271*** (3.65)
OMT	-0.179** (-2.07)	0.064 (0.98)	-0.023 (-0.45)	0.112 (1.02)	0.100 (1.22)	0.104 (1.59)	-0.149* (-1.72)	0.065 (1.01)	-0.011 (-0.22)	0.432*** (3.56)	0.161* (1.79)	0.257*** (3.56)
QE	-0.039 (-1.21)	-0.039 (-1.20)	-0.040 (-1.22)	-0.032 (-0.76)	-0.031 (-0.74)	-0.031 (-0.74)	-0.025 (-0.76)	-0.024 (-0.75)	-0.025 (-0.77)	-0.032 (-0.71)	-0.031 (-0.68)	-0.030 (-0.66)
HICP (inflation)	0.007 (0.35)	0.007 (0.34)	0.007 (0.35)	-0.008 (-0.46)	-0.008 (-0.46)	-0.008 (-0.46)	-0.002 (-0.09)	-0.001 (-0.08)	-0.001 (-0.08)	-0.006 (-0.28)	-0.006 (-0.28)	-0.006 (-0.28)
2-year CDS spread	0.001* (1.85)	0.001** (2.02)	0.001** (1.96)	0.008*** (64.36)	0.008*** (64.43)	0.008*** (64.40)	-0.011*** (-12.06)	-0.010*** (-11.94)	-0.010*** (-11.96)	0.008*** (42.33)	0.008*** (42.71)	0.008*** (42.56)
Major equity market return	-0.016 (-1.18)	-0.015 (-1.10)	-0.016 (-1.19)	0.015*** (3.51)	0.016*** (3.52)	0.016*** (3.54)	-0.057*** (-4.23)	-0.057*** (-4.16)	-0.057*** (-4.21)	-0.092*** (-14.40)	-0.092*** (-14.39)	-0.091*** (-14.33)
VSTOXX implied volatility	-0.020*** (-16.40)	-0.020*** (-16.44)	-0.020*** (-16.46)	-0.019*** (-13.53)	-0.019*** (-13.55)	-0.019*** (-13.53)	-0.022*** (-18.31)	-0.022*** (-18.36)	-0.022*** (-18.35)	-0.041*** (-27.32)	-0.041*** (-27.45)	-0.041*** (-27.38)
OMT announcements	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes
Year fixed effects	2616	2616	2616	2621	2621	2621	2616	2616	2616	2621	2621	2621
Observations	0.9587	0.9586	0.9586	0.9567	0.9567	0.9567	0.9583	0.9583	0.9582	0.9498	0.9496	0.9498
R-squared	0.9584	0.9583	0.9583	0.9564	0.9564	0.9564	0.9580	0.9580	0.9580	0.9495	0.9493	0.9495

* Significant at the 10% significance level
 ** Significant at the 5% significance level
 *** Significant at the 1% significance level

Table A2: Impact of Unconventional Monetary Policy on Medium-term Treasury Bond Yields (different OMT announcements)

This table represents an overview of the impact of unconventional monetary policy announcements on medium-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 5-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables. Each regression specification includes either OMT announcements for the year of 2012 (1), announcements for years 2013-2015 (2) or all OMT announcements (3).

Dependent variable:	France (yield)			Italy (yield)			Germany (yield)			Spain (yield)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	4.764*** (23.63)	4.757*** (23.53)	4.776*** (23.63)	3.546*** (17.33)	3.538*** (17.30)	3.539*** (17.30)	4.760*** (28.04)	4.751*** (27.97)	4.758*** (28.00)	6.481*** (35.36)	6.482*** (35.12)	6.468*** (35.22)
LTRO	-0.044 (-1.32)	-0.043 (-1.28)	-0.044 (-1.30)	-0.028 (-0.76)	-0.027 (-0.75)	-0.027 (-0.75)	-0.029 (-0.89)	-0.028 (-0.86)	-0.028 (-0.88)	0.035 (0.95)	0.034 (0.92)	0.035 (0.97)
SMP	-0.029 (-0.50)	-0.025 (-0.42)	-0.026 (-0.44)	0.162** (2.51)	0.161** (2.50)	0.163** (2.53)	0.023 (0.41)	0.025 (0.45)	0.025 (0.45)	0.199*** (3.08)	0.189*** (2.89)	0.194*** (3.00)
OMT	-0.300*** (-3.10)	0.087 (1.20)	-0.052 (-0.89)	0.059 (0.56)	0.140* (1.79)	0.112* (1.78)	-0.167* (-1.80)	0.089 (1.28)	-0.003 (-0.05)	0.664*** (6.28)	0.169** (2.15)	0.346*** (5.47)
QE	-0.062* (-1.69)	-0.061* (-1.67)	-0.062* (-1.70)	-0.032 (-0.80)	-0.030 (-0.76)	-0.031 (-0.77)	-0.037 (-1.08)	-0.037 (-1.06)	-0.038 (-1.08)	-0.039 (-0.99)	-0.037 (-0.94)	-0.036 (-0.90)
HICP (inflation)	0.015 (0.68)	0.014 (0.67)	0.015 (0.67)	0.003 (0.19)	0.003 (0.19)	0.003 (0.19)	0.005 (0.28)	0.005 (0.28)	0.006 (0.28)	0.015 (0.79)	0.015 (0.78)	0.015 (0.78)
5-year CDS spread	0.001*** (2.83)	0.001*** (2.90)	0.001*** (2.85)	0.008*** (57.17)	0.008*** (57.33)	0.008*** (57.22)	-0.005*** (-7.38)	-0.005*** (-7.28)	-0.005*** (-7.30)	0.008*** (40.06)	0.008*** (40.55)	0.008*** (40.34)
Major equity market return	-0.029* (-1.84)	-0.028* (-1.78)	-0.030* (-1.90)	0.023*** (5.38)	0.024*** (5.43)	0.002*** (5.42)	-0.028* (-1.90)	-0.027* (-1.82)	-0.028* (-1.88)	-0.074*** (-12.70)	-0.074*** (-12.59)	-0.073*** (-12.57)
VSTOXX implied volatility	-0.017*** (-12.73)	-0.017*** (-12.74)	-0.017*** (-12.78)	-0.015*** (-11.25)	-0.015*** (-11.26)	-0.015*** (-11.23)	-0.021*** (-17.07)	-0.021*** (-17.09)	-0.021*** (-17.09)	-0.033*** (-25.49)	-0.033*** (-25.58)	-0.033*** (-25.54)
OMT announcements	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes	2012 Yes	2013-2015 Yes	All Yes
Year fixed effects	2616	2616	2616	2621	2621	2621	2616	2616	2616	2621	2621	2621
Observations	0.9534	0.9533	0.9533	0.9636	0.9636	0.9636	0.9581	0.9580	0.9580	0.9668	0.9664	0.9667
Adj. R-squared	0.9531	0.9530	0.9529	0.9633	0.9633	0.9634	0.9578	0.9577	0.9577	0.9666	0.9661	0.9665

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level

Table A3: Impact of Unconventional Monetary Policy on Long-term Treasury Bond Yields (different OMT announcements)

This table represents an overview of the impact of unconventional monetary policy announcements on long-term Treasury bond yields in all investigated countries. Dummy variables are used to predict yields. "Constant" refers to a no-announcement scenario. The event study performed makes use of a 3-day event window, ranging from one day before until one day after the announcement. The country-specific Harmonized Index of Consumer Prices (HICP), 10-year country-specific sovereign CDS spread, the VSTOXX implied volatility and returns on the specific country's main equity market are used as control variables. Each regression specification includes either OMT announcements for the year of 2012 (1), announcements for years 2013-2015 (2) or all OMT announcements (3).

Dependent variable:	France (yield)			Italy (yield)			Germany (yield)			Spain (yield)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	4.760*** (22.89)	4.750*** (22.77)	4.773*** (22.89)	3.736*** (17.96)	3.727*** (17.93)	3.725*** (17.94)	4.709*** (28.02)	4.700*** (27.94)	4.708*** (27.98)	6.221*** (34.73)	6.233*** (34.64)	6.216*** (34.66)
LTRO	-0.045 (-1.31)	-0.043 (-1.26)	-0.044 (-1.29)	-0.041 (-1.14)	-0.041 (-1.13)	-0.040 (-1.12)	-0.039 (-1.22)	-0.038 (-1.19)	-0.038 (-1.20)	-0.006 (-0.18)	-0.007 (-0.20)	-0.006 (-0.16)
SMP	0.007 (0.11)	0.012 (0.20)	0.011 (0.18)	0.138** (2.14)	0.134** (2.09)	0.138** (2.14)	0.010 (0.17)	0.013 (0.22)	0.013 (0.22)	0.145** (2.30)	0.137** (2.16)	0.141** (2.25)
OMT	-0.349*** (-3.52)	0.115 (1.56)	-0.051 (-0.85)	0.253** (2.41)	0.215*** (2.75)	0.229*** (3.66)	-0.220** (-2.37)	0.104 (1.51)	-0.011 (-0.21)	0.536*** (5.23)	0.154** (2.02)	0.291*** (4.75)
QE	-0.056 (-1.49)	-0.055 (-1.46)	-0.056 (-1.50)	-0.027 (-0.69)	-0.025 (-0.64)	-0.025 (-0.64)	-0.023 (-0.65)	-0.022 (-0.69)	-0.023 (-0.66)	-0.036 (-0.93)	-0.034 (-0.89)	-0.033 (-0.86)
HICP (inflation)	0.032 (1.46)	0.032 (1.45)	0.032 (1.45)	0.018 (1.13)	0.018 (1.12)	0.018 (1.12)	0.020 (1.03)	0.020 (1.04)	0.020 (1.04)	0.033* (1.76)	0.032* (1.75)	0.032* (1.75)
10-year CDS spread	0.000 (0.96)	0.000 (1.04)	0.000 (0.98)	0.006*** (38.46)	0.006*** (38.62)	0.006*** (38.51)	-0.008*** (-10.18)	-0.008*** (-10.07)	-0.008*** (-10.09)	0.006*** (30.37)	0.007*** (30.55)	0.006*** (30.45)
Major equity market return	-0.016 (-1.02)	-0.015 (-0.96)	-0.018 (-1.09)	0.022*** (4.93)	0.022*** (4.99)	0.022*** (5.00)	-0.012 (-0.80)	-0.010 (-0.74)	-0.011 (-0.78)	-0.062*** (-10.99)	-0.062*** (-11.01)	-0.062*** (-10.93)
VSTOXX implied volatility	-0.010*** (-7.26)	-0.010*** (-7.27)	-0.010*** (-7.32)	-0.007*** (-5.38)	-0.007*** (-5.42)	-0.007*** (-5.37)	-0.013*** (-10.51)	-0.013*** (-10.54)	-0.013*** (-10.54)	-0.025*** (-19.93)	-0.025*** (-20.04)	-0.025*** (-19.98)
OMT announcements	2012	2013-2015	All	2012	2013-2015	All	2012	2013-2015	All	2012	2013-2015	All
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2616	2616	2616	2621	2621	2621	2616	2616	2616	2621	2621	2621
R-squared	0.9884	0.9482	0.9482	0.9560	0.9560	0.9582	0.9559	0.9559	0.9558	0.9643	0.9639	0.9642
Adj. R-squared	0.9480	0.9478	0.9478	0.9557	0.9557	0.9579	0.9556	0.9556	0.9555	0.9640	0.9637	0.9639

* Significant at the 10% significance level

** Significant at the 5% significance level

*** Significant at the 1% significance level