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The Impact of the European Central Bank Monetary Policy on Government Bonds After the Financial Crisis of 2008

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Resumo

Investigamos o efeito da decisão da política monetária do Banco Central Europeu em relação aos principais ajustes das taxas de juros no mercado de obrigações governamentais em vários países da União Europeia. Para obter as respostas instantâneas dos títulos do governo, é utilizado o Estudo de Eventos para avaliar o impacto das decisões através do retorno anormal médio acumulado das taxas de rendibilidade das obrigações. O estudo consegui que a política monetária do BCE teve um efeito significativo nos títulos do governo da zona do euro e não só. A maturidade de cinco anos da Alemanha revelou ser o mais sensível aos eventos entre oito países analisados. Por seu turno, o Reino Unido, país fora da zona Euro, foi aquele cujas obrigações menos reagiram. O estudo confirma um impacto mais relevante sobre as obrigações governamentais relativamente ao anúncio da decisão de 4 de setembro de 2014. A maior parte dos rendimentos das obrigações apresentou reações significativas no dia seguinte à data do anúncio, mas as obrigações a cinco anos revelaram ser mais afetadas do que as a 10 anos.

Palavras-chave: Banco Central Europeu, Estudo de Eventos, Títulos de Dívida Pública, Crise Financeira

Classificação JEL: G14, G18

Abstract

I investigate the effects of the European Central Bank monetary policy over the European government bonds market. To obtain the instantaneous reactions of government bonds, I use event studies to evaluate the impact of changes on monetary policy – the events – over the cumulative average abnormal return of bond yields. I conclude that the European Central Bank monetary policy did have significant effects on Euro-zone government bonds and other European countries. Among eight countries, the German 5-year government bonds were the most responsive to the events. On the other hand, the United Kingdom, which does not belong to the Euro-zone, was the least responsive. I also find that the event with the strongest impact on the bond markets is the announcement of 4th September 2014. Most of bond yields show significant reactions on the day after the announcement date, but the 5-year government bonds is affected much more than the 10-year government bonds.

Keywords: European Central Bank, Event Study, Government Bond Yields, Financial Crisis

JEL Classification: G14, G18

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Acronyms

ECB: the European Central Bank

EU: the Euroepan Union

EEC: the European Economic Community

Euratom: the European Atomic Energy Community

EMU: the Economic and Monetary Union

EMS: the European Monetary System

ECU: the European Currency Unit

EMI: the European Monetary Institute

MRO: the main refinancing operations rate

Fed: Federal Reserve

QE: Quantitative Easing

BOJ: the Bank of Japan

BOE: the Bank of England

M4: Explanatory Notes

CDS: Credit Default Swap

GDP: Gross Domestic Product

CAR: Cumulative Abnormal Return

AR: Average Abnormal Return

CAAR: Cumulative Average Abnormal Return

GTFRF5Y: France 5-year government bond yield

GTBEF5Y: Belgium 5-year government bond yield

GDBR5Y: Germany 5-year government bond yield

GTITL5Y: Italy 5-year government bond yield

GSPG5Y: Spain 5-year government bond yield

GSPT5Y: Portugal 5-year government bond yield

GTNL5Y: Netherlands 5-year government bond yield

UKGGBE5Y: United Kingdom 5-year government bond yield

Sig.n: Number of Government Bonds with Significant Results

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1. Introduction

In the last few years, government bond yields and macroeconomic news related to rates changes have become one of most popular topics across the global news reports, especially after the recent financial debt crisis. With the eruption of the European sovereign debt crisis, the Euro-zone suffered an unprecedented turmoil, extending to the global financial markets. In terms of the bond market, several government bonds were affected by financial contagion along with continuously increasing bond yields. In particular, the 10-year Greece government bond yields were almost up to 40%.

In the perspective of governments, bonds are issued to raise funds to finance the public deficit. Bond yields are a kind of premium that bond investors receive as a compensation for the risks they take relative to issuers defaulting on a future date. Usually higher bond yields mean higher risks that investors are exposed to. Whenever government bond yields go up, the financing cost rises in the whole economy, which restricts business investment activities and further economy development is encumbered.

Whenever justified by market financing conditions, central banks put forward certain expansionary monetary policies, for example by cutting key interest rates. However, some critics note that traditional monetary policy lacks effectiveness, and shows huge limitations for solving economic problems. At an early stage of the financial crisis, decreasing interest rates may have fundamental effects for stimulating economy and avoiding an economic downward spiral. Gambacorta, Hofmann and Peersman (2014) believe that, when reaching an extremely low level (around zero), lower interest rates are not effective to stimulate the economic activity.

There are a few articles studying European Central Bank (ECB) monetary policy's impact on European government bond markets. Most of them pay a lot of attention to stock market and corporate bond market, and are interest in researching the effects of unconventional monetary policy as a complementary method to financial market.

The objective of this paper is to investigate the effectiveness of traditional monetary policy,

namely interest rates announcements, on Euro-zone bond markets among eight European Union (EU) member states over the past six years, i.e. from 2011 to 2016. To achieve this objective, the paper uses government bonds' daily yields as indicators to measure the response of the bond market to the stimulus policies from the ECB. In order to get conclusions, I chose the event study as the evaluation method. The study analyzes the differences between the cumulative average abnormal returns after the ECB monetary policy decisions on different countries, different events, different length of windows and different bond maturities.

Inspired by prior research on this subject, the following five questions are addressed on the paper:

Q1: Were there any significant effects from European central bank monetary decision on the European government bond markets?

Q2: How did different EU member states respond to the same monetary policy, and which countries revealed to be the most and the least responsive?

Q3: What was the difference of each bond performance between different events? More specifically, in which event did they react most actively?

Q4: How did government bonds behave across various event windows? More specifically, in which stage of time period significant reactions would mostly probably appear?

Q5: What was the difference between the yields of the 5-year government bond and the 10-year government bond when it comes to rate announcements?

The results I obtain are expected to bring important references for investors, government policy-making, and financial institution who have European government bonds in their portfolios. The results are valuable to fully utilize public information for allocating funds in an optimal combination as to mitigate potential risks and maximize returns. In addition, they help governments to better understand the relationship between the monetary policy and bond markets, therefore being able to manage the economy more properly.

This paper consists of six sections besides the introduction. Section 2 contains a literature review about the background of the European Central Bank and its monetary policy, the

government bonds and the sovereign debt crisis. The data issues and variable definitions are presented in section 3. The next section introduces the event study methodology that is used in the paper. Section 5 presents an empirical analysis of the statistical results. Section 6 concludes.

2. Literature Review

In this part I introduce the European Central Bank and its monetary policy. Then, I discuss the objects of my study - government bonds and the bond yields - as variables in the event study methodology. This section also focuses on the background of the financial crisis and monetary policies among several central banks under this circumstance.

2.1. European Central Bank

2.1.1. Definition and Role

The European Central Bank (ECB) is the central bank of 19 European Union Member States which apply euro currency. It is an official European Union institution at the heart of the Eurosystem as well as the Single Supervisory Mechanism for banking supervision (ECB, 2017). Its main objective is to maintain price stability in the euro area and so preserve the purchasing power of the single currency. The ECB is responsible for the prudential supervision of credit institutions located in the euro area and participating non-euro area Member States, within the Single Supervisory Mechanism, which also comprises the national competent authorities. It thereby contributes to the safety and soundness of the banking system and the stability of the financial system within the EU and each participating Member State (Richter and Wahl, 2011).

The ECB carries out specific tasks in the areas of banking supervision, banknotes, statistics, macro-prudential policy and financial stability as well as international and European

cooperation (Israël, Jean-Marc, Patrick, Aurel, and Björn, 2013).

2.1.2. History of the European Central Bank

World War II was a devastating disaster to Europe. It ended the traditional Europe hegemony in the world, which was replaced by the United States and the Soviet Union. In the wake of the war, the desire to build a peaceful and prosperous continent became much stronger than ever before.

In 1951, six countries (France, Germany, Belgium, Italy, Luxembourg and Netherlands) signed the Treaty of Paris creating the European Coal and Steal Community governed by the third super-national body-the High Authority. Europe leaders wanted to go further. So, in 1957, the European Economic Community (EEC)[1] and the European Atomic Energy Community (Euratom)[2] were both created in the Treaty of Rome. In 1968, the prime minister of Luxembourg proposed a single currency. The Werner Report[3] published in 1970 set out three stage processes to achieve the Economic and Monetary Union (EMU)[4] within ten years (Werner Report, 1970).

Soon after, in 1971, occurred the demise of Bretton Woods System. So, instead of a monetary union, some countries in Europe introduced what was called the currency snake, which set limits on the exchange rate fluctuation both against a number of European currencies and against the dollar (Day, 1976). Between its creation, in 1972, and its demise 7 years later, the

[1] The European Economic Community (EEC) was a regional organization which aimed to bring about economic integration among its member states.

[2] The European Atomic Energy Community (EAEC or Euratom) is an international organization founded in 1957 with the purpose of creating a specialist market for nuclear power in Europe, developing nuclear energy and distributing it to its member states while selling the surplus to non-member states.

[3] Werner Plan (or Werner Report) - at the European Summit in The Hague in 1969, the Heads of State and Government of the European Community agreed to prepare a plan for economic and monetary union. The Werner Report was drawn up by a working group chaired by Pierre Werner, Luxembourg's Prime Minister and Minister for Finances, and presented in October 1970.

[4] The Economic and Monetary Union (EMU) is an umbrella term for the group of policies aimed at converging the economies of member states of the European Union at three stages. The policies cover the 19 Eurozone states, as well as non-euro European Union states.

currency snake saw a lot of exchange rate adjustments, and a veritable reviving absorbed countries joining, leaving and then rejoining again.

In 1979, the push of economic and monetary union was revived. The European Monetary System (EMS) was born and the European Currency Unit (ECU)[5] was created with the participation of all member states' currencies except the British pound. The ECU, however, was near a virtual currency unit of account[6].

Within the EMS, currency fluctuations of the member states were limited to 2.25% around the central reference rate, which were controlled through Exchange Rate Mechanism (Angelos, 2015).

The governments of member states didn't always find it easy to maintain the exchange rates of their currencies within that fluctuation band. There were 37 currencies realignments between 1979 and 1987. In 1986, the member states signed the single European act which marked the first substantial changes for the Treaty of Rome. The objective of the act was to create a true common market by 1993 based on the free circulation of goods, people, services and capitals with no non-tariff barriers. In 1988, Jacques Delors, the then president of European Commission, was pointed as chair of the committee who devoted to basis of the Maastricht treaty. Jacques Delors' report indicated three stage progression to achieve Economic and Monetary Union. Stage 1 focused on increasing cooperation among central banks and was adopted on the 1st July, 1990, when movements of capital were liberalized completely. The treaty on European Union was then signed in Madrid on 7th February, 1992. It laid out the framework and the third step for achieving the Economic and Monetary Union and making it work. The treaty established in 1994 the beginning of stage 2. This page would bring about economy convergence as well as institution and procedures needed to achieve it. The treaty set out the convergence criteria which member states had to fulfill in order to

[5] The European Currency Unit was a basket of the currencies of the European Community member states, used as the unit of account of the European Community before being replaced by the euro on 1 January 1999, at parity.

[6] The European Unit of Account (EUA) was a unit of account used in the European Communities from 1975 to 1979.

consider addressing the adoption of the single currency (Dinan, 1999).

Stage 2 saw the creation of the European Monetary Institute (EMI), which began functioning in Frankfurt on the 1st January, 1994. EMI carried out all the preparatory work which was necessary for ECB to assume responsibility for monetary policy. In May, 1998, EU leaders and finance ministers met in Brussel to decide about the stage of sufficient degree of convergence and who could participate in the monetary union. They also appointed the first president of ECB and the other members of executive board (Brown, 1998). The ECB was established on the 1st June 1998, replacing the EMI and taking over Frankfurt offices together with all the national central banks of member states of European Union. The ECB came to form European system of central bank. On the night of 13th December 1998, the Euro was born and the conversion rate of currencies participated in it became irrevocably fixed (Dinan, 1999).

Stage 3 began on the 1st January 1999, when the single currency was launched and authority over monetary policy was transferred from national central banks to the governing council of European Central Bank. Three years later, on the 1st January 2002, the new bank notes and coins were introduced to the public (ECB, 2017). During the first three years, the Euro had become confined to the official currency for banks, businesses and the financial markets, but after that its use was extended to everyone.

2.1.3. Monetary Policy of European Central Bank

The monetary policy reflects the action of a Central Bank to influence a nation's money supply and overall economy. It is also responsible for price stability, credit and debt control, financial institution expansion and creation, as well as appropriate interest rate term. In 2003, in the context of the evaluation of the monetary policy strategy, the Governing Council confirmed the quantitative definition of price stability and clarified that, in pursuing price stability, it will aim to keep the euro area inflation rate at below, but close to, 2% over the medium term (ECB, 2017).

According to Black (1975), there are three ways to influence the money supply. The first is to buy or sell government bonds through the open-market operation. If the Central Bank buys government bonds from the brokers or dealers, it will promote the currency liquidity in the market and thus interest rates tend to decrease. If it sells bonds, it will shrink the money supply and therefore interest rates increase. The second way to influence the money supply is by establishing reserve requirements, which is the amount of money that banks are required to keep in treasury; this affects the interest rates that banks charge to the public for their loans. Last, the third way is through interest rate modification with marginal lending rate, deposit facility announcement rate and main refinancing operations announcement rate. When the market is depressed, the Central Bank lowers the interest rates, thus spurring lending and other economic activity. The converse is done when the market is overheated and needs to be slowed down.

As an essential part of the Eurosystem, one of the biggest responsibilities of the ECB is defining and implementing monetary policy to maintain price stability. The objective is to achieve money growth neither too fast, which causes inflation, nor too slow, which leads to deflation. This prudential policy regime is expected to contribute to economic growth, job creation and social cohesion in the Euro zone (Issing, 2001).

The conventional monetary policies we usually talk about include expansionary monetary policy and austerity monetary policy. Expansionary monetary policy is considered as ‘easy money policy’. It would usually be put forward when perspectives on the economy are gloomy, which requires striving for economic growth by increasing money supply or decreasing the interest rate. Oppositely, an austerity monetary policy cuts down money supply in order to control economic bubbles and cool down an overheated economy. However, when it lasts too long, it could also bring about economic recession, increasing unemployment and squeezing internal consumption.

In some cases, only using conventional monetary policy is not enough to achieve its economic goal. Then, unconventional monetary policy comes out, including quantitative easing and purchasing financial assets (Gambacorta, Hofmann and Peersman, 2014).

Feldstein (2000) said that one of the major achievement that can probably be attributed to the creation of the euro is the expansion of the European commercial bond market. The ability to borrow and lend in euros and to do so without fear of exchange rate fluctuations between the borrower and the lender has facilitated substantial cross-border lending within the euro area. Whether this has had significant effects on the level of real interest rates or on economic production remains to be studied. It has undoubtedly made it easier to finance cross-border corporate takeovers, a development that has not generally been welcomed by the governments of the target companies.

In my study, I will mainly focus on the key interest rates decision, which in this paper are considered as the events. The key interest rates for the Eurozone set by the Governing Council are (European Central Bank, 2017):

- The interest rate on the main refinancing operations (MROs), which generally provides the majority of liquidity to the banking system. The Eurosystem may execute its tenders in the form of fixed rate or variable rate tenders.
- The rate on the deposit facility, which banks may use to make overnight deposits with the Eurosystem.
- The rate on the marginal lending facility, which offers overnight credit to banks from the Eurosystem.

2.2. Government Bonds

2.2.1. Definition and History

Government bonds, also named government securities, are a kind of debt security issued by national governments, which aims to collect funds for investing infrastructure, covering fiscal deficit and regulating the economy. Generally, the government promises an interest payment during a certain period and repay the principal at maturity. For countries with autonomous monetary policy and own currency, Treasury bonds are seen as the safest investment

instruments in the market. These investments are also considered as the benchmark of comparable fixed-income categories, since they are virtually risk-free.

The original government bond was created for war spending. In 1694, the Bank of England issued a bond to raise money to fund the war against France. Later, governments in Europe started issuing perpetual bonds (bonds with no maturity date) to fund wars and other government spending. The use of perpetual bonds ceased in the 20th century, and currently governments issue bonds of limited term to maturity.

2.2.2. Classification

According to the different maturities, the regular government bonds can be classified into three types:

- Treasury bills (T-bills). It is a debt obligation with a maturity below one year, which therefore has high liquidity. The government objective of issuing T-bills is to improve temporary shortage of treasury funds turnover. For investors, it is a very attractive instrument to earn extra profit with a rather low risk. People usually buy T-bills at a discount from the par and receive par value at maturity. The difference between the purchase price and par value is the interest that investors can earn.
- Treasury notes. It is a government debt security with a maturity between one and ten years. Government can make better use of the debt while investors can get higher interest because of its longer maturity.
- Treasury bonds. It is a government debt security with maturity over ten years. It offers the government a long time to utilize the fund. However, bondholder's revenue will be affected by inflation level.

All these types of bonds can be purchased in auction. In terms of competitive bid, the bidder may buy the bond at a desirable rate if his proposed rate is higher than what other bidders proposed. For the noncompetitive bid, buyers have to accept the bond whatever its set rate is. After the auction, investors can also purchase the bond in secondary market from banks, brokers or dealers, and even online (U.S. Treasury, 2017).

2.2.3. Risk Exposure

In most cases, the longer the maturity of the bond the higher risk bondholders will bear. As a compensation, when issuing new debt, bond issuers need to pay a risk premium to attract purchasers (Benczur, 2001).

Usually, for investors, government bonds imply four types of risk exposures:

- Interest rate risk. It is the risk that floating interest rates may decay the market value of issued bonds. When interest rate is higher than the existing bond's coupon rate, the bond owners have to sell it at a price lower than par value if bondholders want to redeem its securities.
- Credit risk. It is the risk that a government may fail to pay interest and repay the bond on time. Theoretically, the probability of default of a government is quite small. Therefore the interest payment, a premium to compensate the risk that bond buyers bear, is rather low.
- Currency risk. It is the risk that the value of a bond issued in another currency will decline due to the change of exchange rate between the two currencies. It is the main risk that foreigner bondholders should concern about. Take the example of a Chinese investor who purchased Portuguese government bonds at the par value of 1000 euros, and admit that at maturity the conversion rate of RMB against Euro increases. This means the 1000 euros par value is deflating compared to the beginning of the purchase.
- Inflation risk. It is the risk that the value of the currency a bond pays out will decline over time. When the supply of currency exceeds the capacity of a nation's productivity, the currency's purchasing power decreases. For a bondholder, this means the bond value decreased. Since the bond is a fixed income asset, the money he received at maturity cannot buy the same amount of products or services.

2.2.4. Bond Yields

A bond yield is the percent return the bondholder realizes on a bond at maturity. Several types of bond yields are usually mentioned about, including nominal yield, required yield, current yield and yield to maturity.

Nominal yield is the interest paid divided by the face value of the bond. It is the coupon rate that is stated on the bond (Morgenson and Harvey, 2002). Required yield refers to the amount of yield a bond issuer must offer to attract investors. Current yield equals annual interest divided by its current price. It shows how much the investor will earn if he buys the bond now and hold it for one year. Yield to maturity is the expected return the investor gets if he holds the bond until maturity, also expressed as an annual rate. It is a good reference to see the potential return of the holding bond and to compare with the other bonds in different maturities and coupons (Sharpe, Alexander and Bailey, 1999).

A government bond yield is a very important indicator to measure bond investment earnings. The short-term yield is usually used to see if a nation’s currency liquidity is adequate. When the short-term bond yield rises rapidly and deviates from the regular range, it means there is a high likelihood that the central bank will raise interest rates. Long-term government bond yields normally refer to those bonds with a maturity above then years. To some extent, it reflects a nation’s macroeconomic fundamentals (Fabozzi and Mann, 2012).

A bond's yield moves inversely to its price. A bond's yield is the discount rate (or factor) that equates the bond's cash flows to its current dollar price. When inflation expectations rise, interest rates rise, so the discount rate used to calculate the bond's price increases, making the bond's price drop. It's that simple. The opposite scenario would be true when inflation expectations fall (Thomas, 2017).

Inflation is a bond's worst enemy. Research by Crowder and Hoffman (1996) provides evidence that when inflation rise, interest rates also rise, leading bond yields to rise and bond prices to fall. To that end, bond prices/yields, or the prices/yields of bonds with different maturities are an excellent predictor of future economic activity. To see the market's

prediction of future economic activity, all you have to do is look at the yield curve.

We can forecast the monetary policy through the change of government bond yields. When short-term yields get close to long-term yields, the present economy is normally over-heated. The central bank may rise rates to cool down the market. If the long-term yield drops to near the short-term yield, the economy is probably in a recession. The central bank in this case needs to decrease rates to revive the economic growth. Furthermore, the fluctuation of interest rates has a huge impact on foreign currency trends. So, yields have indirect influence on international investment.

2.3. Macroeconomic Environment

2.3.1. European Sovereign Debt Crisis

The European sovereign debt crisis occurred during a period of time in which several European countries faced the collapse of financial institutions, high government debt default risk and rapidly rising bond yield spreads in government securities.

In October 2009, the Greek government announced a huge fiscal deficit, with 12% of Gross Domestic Product, which is four times higher than the limit of 3% determined by the European Union. In December 2009, three credit rating agencies downgraded the rating of the Greek sovereign debt, driving up the country's interest rates. The Greek debt crisis soon spread to the rest of the Eurozone, specially Ireland, Portugal and Spain. In June 2011, the crisis was deteriorated by the Italian government debt issue. With more and more countries involved in the European sovereign debt crisis, the crisis soon spread all over the world (Figures 2.1. and Figure 2.2.).

Figure 2.1. Budget Deficit and Public Debt to GDP-2009[7]

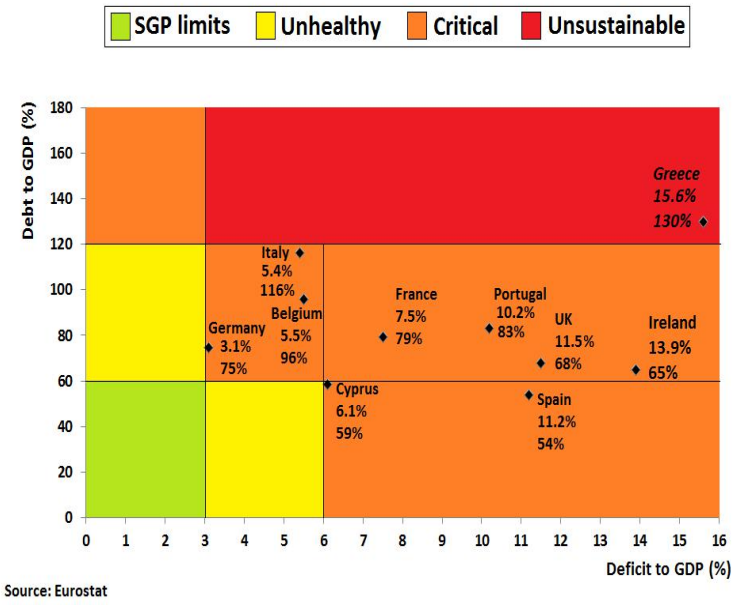
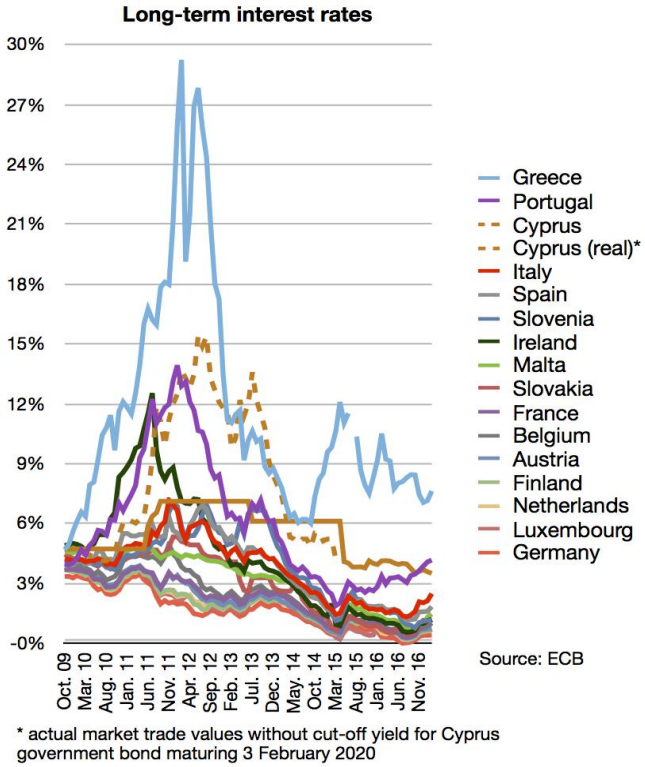


Figure 2.2. Long-term interest rate[8]



The European sovereign debt crisis resulted from a combination of complex factors. One is the contagion from the subprime crisis in 2008. Easy credit conditions and low interest rates during the 2002–2008 period encouraged high-risk lending and borrowing practices in Eurozone members, like Ireland, Portugal, and Italy. At the same time, international trade amplified imbalances of economy growth among EU member states. As the single monetary policy restricts individual member's actions, once facing default risk, EU members do not have the ability on their own to create currency for debt payoff (Arghyrou and Kontonikas, 2012).

[7] The Debt-to-GDP ratio and Budget deficit to GDP ratio have been plotted for 10 important/big EU member states in 2009. The figures indicate the fiscal health of the countries in the plot. Generally, the farther up and to the right a country goes, the higher the risk for investors.

[8] Long-term interest rate statistics (monthly averages of secondary market yields - percentages per annum - of government bonds with maturities close to ten years) for all Eurozone countries, except the three Baltic states

2.3.2. Monetary Policies among Several Central Banks since 2008

European Central Bank

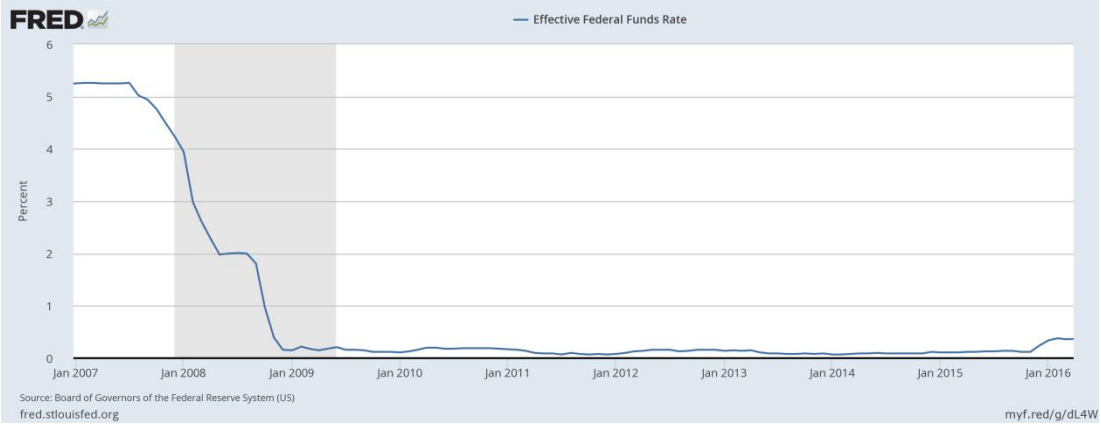
During this tough period, the ECB launched a series of loose monetary policies, in order to cope with persistent deflationary pressure and promote economic recovery. Unfortunately, the effect was not as effective as it worked in U.S.. The European Union is a regional economic union of 28 European countries, 19 of which share a common currency. Every policy-making decision is settled through a rotation system which concerns the allocation of voting rights to the members of the European Central Bank's Governing Council (ECB, 2017). Each Member State has a specific development condition, and this inequality determines that monetary decisions cannot be as effective as those by other central banks. Besides, the ECB cannot institute the uniform fiscal policy for all the member states to cooperate with their new monetary policy. So, there might be a need for new fiscal tools to deal with next economic crises, given that all monetary policies now available had been a limited effect. The ECB lowered its interest rates for a couple of times in the wake of the crisis. In 2014, it introduced a negative interest rate that only applied to bank deposits, and was intended to prevent the Euro-zone from falling into a deflationary spiral. This means the EU officially entered the negative interest rate era. Theoretically, this conduct would reduce the financing costs for companies and households, stimulating investments and consumer spending. However, the result was at the limits of what was expected for monetary policy (Ruparel, 2015). Many problems are still waiting to be solved, like the reduction of high unemployment rates and low inflation rates.

Federal Reserve

At the beginning of the subprime crisis, the Fed focused on traditional monetary policy and cut interest rates for ten times within one year (from 3.94% to 0.15%) (Trading Economics, 2009). The interest rates had already been reduced to a very low level, around zero (Figure 2.3.). Therefore, the government had no feasible course of action to stimulate the economy. In

cases like these, a quantitative easing (QE) comes in handy. This is because it acts as an additional economic policy tool and helps the central bank to mitigate crises when they happen (Forbes, 2015).

Figure 2.3. Effective Federal Funds Rates



Source: www.tradingeconomics.com|Federal Reserve

Since 16th December, 2008, unconventional monetary policy - Quantitative Easing policy - started in the wake of financial crisis. Such policy, with and increasing monetary base and purchasing government bonds, made a great contribution to the US economic recovery. Thanks to this effective policy, the U.S. finally stabilized the domestic economy with about 2% of economic annual growth rate observed during the past few years, and got rid of recession.

However, critics believe that policies such as QE are not a beneficial way to provide monetary stimulus in the long run, as it creates monetary instability which defeats the entire purpose of having a central bank. That is why Fed started to exit QE gradually since 2013.

The Fed launched three stages of QE, from the end of 2008 to October 2014, which made contribution to the economic recovery and financial system remedy. Adversely, the QE policy may increase the inflation risk and affect the market stability. In order to avoid such side-effects, the Fed gradually started to decrease the amount of securities purchased since January 2014. It had conducted security purchase cuts for seven times and this contraction would end in October 2014. After this action, the Fed focused on raising interest rates. The last time the Fed made a rate announcement took place on 16th December, 2016, with a 25 b.p.

increase (from 0.5% to 0.75%). On account of the strong economic data released recently, the stated that it will continue to conduct interest rate increases in the near future.

Bank of Japan

Sato (2009) explained that "Japan was not immune from the current global financial crisis. The financial system was severely affected by the high volatility of financial markets, including the sharp decline in the prices of equity shares held by banks. Meanwhile, the deterioration of the real economy affected banks' profitability in the form of increased credit costs, albeit on a limited scale."

Japan's financial system suffered from external contagions, not from a domestic recession. Therefore, most of the short-term policies in Japan were aimed at preventing the external injury from turning into a serious internal disease (Sato, 2009).

Similar to what other central banks did, the Bank of Japan (BoJ) also cut interest rates to a level around zero, and at the same time restarted its easing monetary policy in 2010, after the crisis erupted. The BOJ provided plenty of short-term funds to support the financial markets, improved dollar liquidity through open market operations, and reduced unsecured overnight rates twice (Sato, 2009). In December 2008, BOJ implemented some unconventional policies, like purchasing long-term government debt and corporate commercial paper. In March 2013, the former Comprehensive Monetary Easing Policies was turned into Extradimensional Quantitative Easing Policy. To date, this policy has been implemented for five years with significant changes happened during this period.

Bank of England

Unavoidably, the United Kingdom was one of the biggest victims in the financial crisis of 2008. Confronted with daily-worse economic conditions, the Bank of England (BOE) announced its asset purchase facility which was valued at 7.5 billion pounds and started in 9th April (Bank of England, 2016). The BOE attempted to stimulate demand, increase

employment and control the inflation rate, by lowering interest rates and increasing the currency supply from the asset purchase facility. Thanks to a series of stimulating monetary policies, the monetary aggregate M4 increased from 169 billion pounds, in 2008, to 203 billion pounds in 2009. In 2010, M4 had a stable upward trend after the crisis. Hitherto April 2010, M4 was up to 221 billion pounds. The 20-year government bond yields and the 91-days Treasury-bills average discount rate declined to different extents. In conclusion, although BOE‘s easing monetary policy achieved some improvement in the financial market, it didn’t change the worse conditions caused by the crisis. Furthermore, its policies drawback showed up day by day.

2.4. Related Literature on the Effects of Economic News

Several authors studied macroeconomic news and their spillover effects. Saka, Fuertes, and Kalotychou (2015) revealed significant transmission mechanism of pre-announcement news. The outcome on spreads from Spain, Italy, Belgium, France and Austria shows effects clearly dissipated on the post-announcement date. Besides, Bhanot et al. (2014) find that increases in the yield spreads were associated with negative abnormal returns on stock markets in Portugal, Spain and Netherlands. Some reasons about these abnormal returns were attributed to rating downgrades and other unfavorable news announcements about Greece.

In his research, Balli (2009) concludes that country-specific regressions of CDS spreads on systematic risk factors reveal frequent days of large adverse shocks affecting simultaneously those same Eurozone countries during the pre-announcement period.

Campbell et al. (1997) provide a very meaningful methodology to measure the impact of events on financial assets. As Peter (2001) said, “it is a standard notion to view bond yield differentials as the market’s assessment of the relative riskiness of the issuers.” In order to find an appropriate method to evaluate the bond responses, I will use idea from Peter (2001). He introduced a new approach for event studies in bonds, in which he mentioned that event impacts should be reflected in levels of yield premium, instead of the standard method using

bond returns.

Eser and Schwaab (2013) studied the yields impact of asset purchases within the ECB's Securities Markets Programme in Eurozone sovereign bond markets from 2010-11. They conclude that, in terms of macroeconomic announcements, there is an impact of around -3 b.p. for the purchasing 1/1000 of the sovereign bonds at the 5-year maturity. Bond yield volatility and tail risk were lower on intervention days for most countries with a Securities Markets Programme. Both liquidity conditions and default-risk premia had been improved, while the expectation of low interest rates did not make any contribution to it.

Guidolin and Pedio (2014) find that none of the policies can persistently lower corporate spreads, and that operation twist is the only policy capable of lowering corporate yields. This latter finding can be accounted for by the operation to flatten the riskless yield curve without generating inflationary expectations.

A related dissertation with high relevance to my work was done by Lebedeff (2014). He discussed about the market responses of Scandinavian government bonds daily yields spread and a major European corporate bond index to major macroeconomic news released from U.S. and selected European countries.

When it comes to the empirical results of Germany government bond performance, I find similar conclusions as Lebedeff (2014), specifically about the effect of the level and slope (term structure of interest rates) of German benchmark government bond yields on the government bonds during the macroeconomic news announcement days.

In line with Lebedeff (2014), I show that 21 out of the 23 macroeconomic news used in this study have statistically significant effect on at least one of the daily yields investigated. Effects vary significantly across different news and markets. The results reveal that U.S. macroeconomic news have in general more significant impact on the yields in this study than equivalent European countries' news, when investigating the spillover effect on yield changes after a news surprise. The results also reveal that Finland and Sweden government bond markets are the most responsive to the foreign macroeconomic news spillover effect. In addition, strong evidence is found that there is a negative (positive) relation between the

German government term structure of interest rates and the investigated bond spreads (yields) during the macroeconomic news announcement days.

3. Data

The data I collected refers to daily yields of government bonds from eight countries, all of them European Union Members located in the Western Europe area. This includes Germany, France, Spain, Portugal, Italy, Belgium, Netherlands and the United Kingdom. Data on bonds is relative to the last price of 8 bond yields corresponding to the above countries. The selected time period goes from 31 December 2010 to 31 December 2016, covering the eruption of the sovereign debt crisis. The experience events comprise all interest rate announcements released by ECB during the selected time period. The data on daily yields of government bonds were retrieved from Bloomberg and rate announcements were collected from ECB official website (https://www.ecb.europa.eu/).

3.1. Monetary Policy Decision with Key Rates Adjustments

The announcements on the key rates of ECB, released from 2011 to 2016, are shown on Figures 3.1 and 3.2. We can see that all three key interest rates show a downward tendency since the 13th July 2011. Specially, the deposit facility rate had been cut to zero level in 2012, and to negative value in 2014. In terms of the refinancing operation rate, it had also touched to the zero level in 2016. The marginal lending rate reached the lowest point over the past five years.

Under the circumstances of low inflation and weak GDP growth, the ECB led the deposit facility rate to a level below zero on the 11th July 2014, which means the rate officially entered a “Negative Interest Rate Era”. After this monetary policy decision, people who deposit their money in the bank would be charged a “deposit fee”. This conduct aimed to spur

domestic consumption as well as avoid more oversea capital from flowing into Euro-zone.

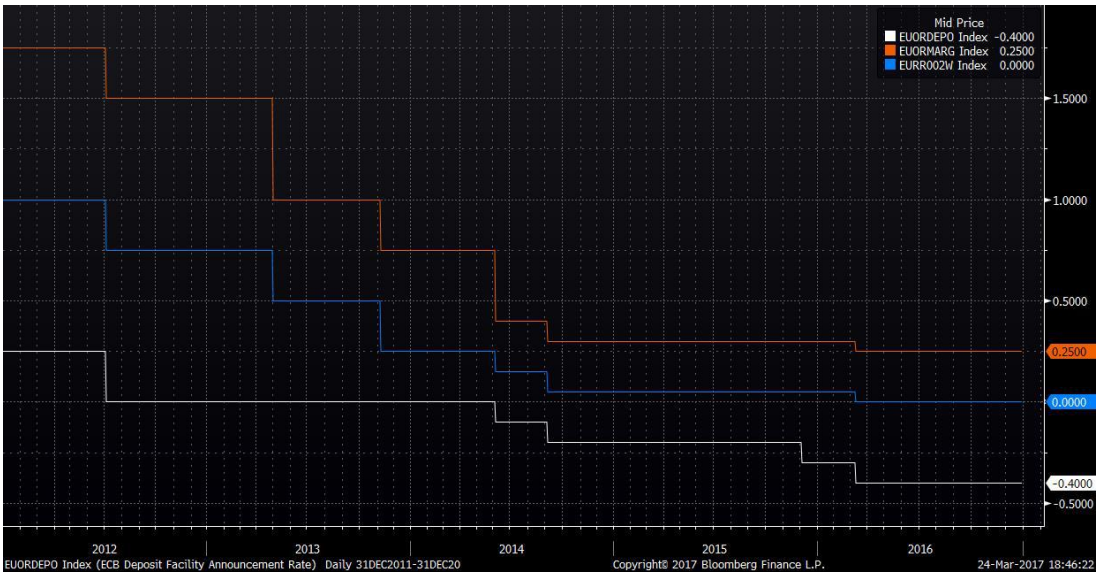
During 2011, the ECB changed the key rates more frequently than any time ever, which meant four announcements in total compared to one or two times in the later years. This corresponds to the year when the financial crisis hit more intensively the whole Europe.(details see Figure 3.1. and Figure 3.2.)

Figure 3.1. Interest Rate Levels in Percentages per annum

Date		Deposit facility	Main refinancing operations		Marginal lending facility
			Fixed rate tenders Fixed rate	Variable rate tenders Minimum bid rate	
With effect from					
2016	16 Mar.	−0.40	0.00	-	0.25
2015	9 Dec.	−0.30	0.05	-	0.30
2014	10 Sep.	−0.20	0.05	-	0.30
	11 Jun.	−0.10	0.15	-	0.40
2013	13 Nov.	0.00	0.25	-	0.75
	8 May.	0.00	0.50	-	1.00
2012	11 Jul.	0.00	0.75	-	1.50
2011	14 Dec.	0.25	1.00	-	1.75
	9 Nov.	0.50	1.25	-	2.00
	13 Jul.	0.75	1.50	-	2.25
	13 Apr.	0.50	1.25	-	2.00

Source: European Central Bank

Figure 3.2. ECB Key Interest Rates



Source: Bloomberg

One has to keep in mind that asset prices used in an event study usually are closing prices. In case we know the exact time when the news became public information, we should take this into account. If news become public information after the trading system (e.g., the stock exchange) is closed, they will be reflected in the closing price of the next trading day. If we are unable to identify the exact time of news, we should choose normally a three-day event window (starting one day before and ending one day after the identified event date) to cope with the event date uncertainty.

3.2. Government Bond Yields

I downloaded all the bond yield data that I needed on Bloomberg, including government bond daily yield of France, Belgium, Germany, Italy, Spain, Portugal, Netherlands and the United Kingdom. The data horizon covers six years, beginning on the 31st December, 2010, and ending on the 31st December, 2016. However, due to distinct national holidays, the yields for each country do not correspond necessarily to the same dates. This generates a missing data problem. In order to fix the non-coincidence of dates, I define the missing data as null value.

4. Methodology

4.1. Principles of the Event Study Methodology

In order to analyze how government bond markets respond to ECB monetary policy announcements, an event study methodology is applied in the current research. This methodology uses financial data to measure the effect of a specific event on a particular variable. Conceptually, an event study differentiates between the returns that would have been expected if the analyzed event would not have taken place (normal returns), and the returns that were caused by the respective event (abnormal returns). The general idea of this measure is to isolate the effect of the event from other general market movements. If financial markets are efficient and the event announcement is unexpected, the impact on the value of financial assets should be quick and should persist. To illustrate, if an ECB monetary policy announcement is unexpected and is believed to have an impact to government bond markets, the percentage change in bond yield should be quick and should persist.

4.2. Process

There are six steps to conduct event study methodology.

i. Define the exact event

In my study, monetary policy announcements denote the event of interest and the effects are measured as the level of percentage change in interest rates. The defined events are the changes on the three key interest rates released by ECB, i.e. the interest rate on the main refinancing operations, the rate on the deposit facility and the rate on the marginal lending facility.

ii. Define the samples and news sources

This research uses data starting on the 29th December 2010 and ending on the 29th December 2016. These six-year data is used to calculate the daily percent change on eight different European countries' daily bond yield (Germany, France, Spain, Portugal, Italy, Belgium, Netherlands, and United Kingdom).

All event dates of monetary policy decision related to key rates announcements during these six years refer to the first trading dates after the announcements were released to the public. I checked the announcement dates I collected and all are on the market trading period (table 4.1).

Table 4.1. ECB Key Interest Rates with released dates

Date	Deposit facility	Refinancing operations	Marginal lending facility
2016 10Mar.	-0.40	0.00	0.25
2015 3Dec.	-0.30	0.05	0.30
2014 4Sept.	-0.20	0.05	0.30
2014 5Jun	-0.10	0.15	0.40
2013 7Nov.	0.00	0.25	0.75
2013 2May.	0.00	0.50	1.00
2012 5Jul.	0.00	0.75	1.50
2011 8Dec.	0.25	1.00	1.75
2011 3Nov.	0.50	1.25	2.00
2011 7Jul.	0.75	1.50	2.25
2011 7Apr.	0.50	1.25	2.00

Souce: European Central Bank

iii. Select a return model to calculate the expected return

I chose the Constant Mean Return Model to achieve the expected return. The daily percentage change is divided into two parts. One is the test period, and the other is the rest of the days for non-event period. For each day during the test period, the daily abnormal percentage change is calculated. The daily abnormal percentage change is the difference between actual percentage change and the expected percentage change.

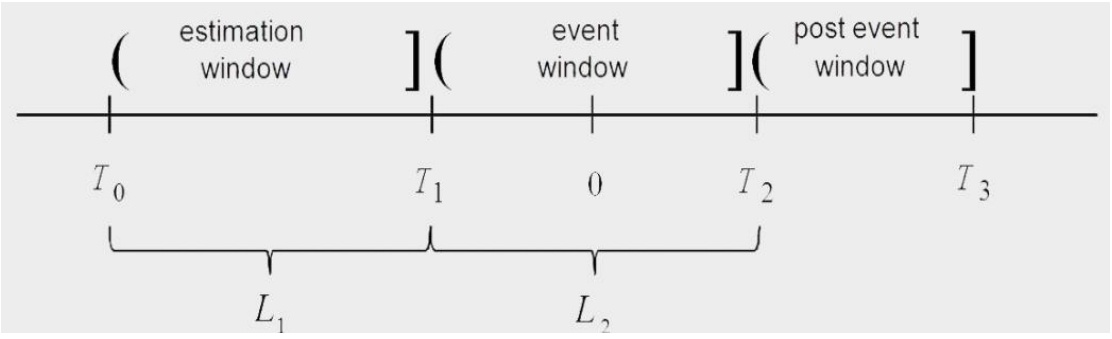
$$R_{it} = \mu_i + \varepsilon_{it}$$
$$E[\varepsilon_{it}] = 0$$
$$\text{var}[\varepsilon_{it}] = \sigma^2_{\varepsilon_i} \quad (4.1.1)$$

$$AR_i = R_{it} - E[R_{it} \mid X_t] \quad (4.1.2)$$

iv. Identify the estimation window

I define the date when the event happened as date zero. With N days before it (until time T1) and M days after it (until time T2), the time window [T1, T2] is called the event window (Figure 4.1). This is used to evaluate the performance of the financial asset when the event occurred. The period prior to the event window is considered as the estimation window, which is used for calculating the expected return. As I mentioned before, the expected return refers to the average return without the effect of event. In my study, I pick several different lengths of estimation windows and event windows to conduct the research, with the aim of identifying market anticipations, instant reactions and post-responses to the event of interests.

Figure 4.1. Windows Classification



v. Calculate cumulative (average) abnormal returns

For the purpose of analyzing the overall influence for the event of interest, the abnormal returns should be aggregated through time (Cumulative Abnormal Return, or CAR), across

Euro-zone bond markets (Average Abnormal Return, or AR), and both (Cumulative Average Abnormal Return, CAAR).

First, I calculate the abnormal return, which is the difference between actual return and expected return:

$$AR_i = R_{it} - \mathrm{E}\left[R_{it} \mid X_t\right] \qquad (4.1.2)$$

R_{it} refers to the actual return of asset i at date t, and $\mathrm{E}\left[R_{it} \mid X_t\right]$ refers to the expected return. Accumulating abnormal returns across time, the CAR is calculated as:

$$CAR_{i(T1\ T2)} = \sum_{t=T1}^{T2} AR_{i,t} \qquad (4.1.3)$$

Statistical tests of abnormal returns are commonly based on the cross-average of each measure. For cumulative abnormal returns the cross-sectional average (CAAR) is:

$$CAAR_{(T1,T2)} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i(T1,T2)} \qquad (4.1.4)$$

These two measures can be used to analyze consecutive days and sum the differences together to understand how an event affects the financial assets over time. If the same type of model is used to analyze multiple events of the same type, it can predict how bond yields typically respond to a specific event.

vi. Test for statistical significance

The cross-sectional t-test is defined as:

$$T_{cross} = \frac{CAAR_{(T1,T2)}}{\sigma_{CAAR(T1,T2)}} \qquad (4.1.5)$$

Under the null hypothesis, the cumulative average abnormal return is equal to zero. The variance estimator of this statistic is based on the cross-section of abnormal returns.

$$\hat{\sigma}^{2}_{CAAR(T1.T2)} = \frac{1}{N(N-d)}\sum_{i=1}^{N}\left[CAR_{i(T1,T2)} - CAAR_{i(T1,T2)}\right]^2 \qquad (4.1.6)$$

I applied E-views to conduct the t-test from the three perspectives as follows:

- Average Abnormal Returns and Cumulative Average Abnormal Returns and respective t-test value by countries.
- Average Abnormal Returns and Cumulative Average Abnormal Returns and respective t-test value by events.
- Average Abnormal Returns and Cumulative Average Abnormal Returns and respective t-test value by event windows.
- Average Abnormal Returns and Cumulative Average Abnormal Returns and respective t-test value by bonds with different maturities

5. Empirical Results

In this part, I discuss the empirical results in several aspects. Initially, the overall performance of government bond market is analyzed by countries, then considering all effect by events and the different kind of event windows are taken into account. In the end, I compare government bond markets with two distinct maturities.

5.1. Impact by Countries

Due to specific factors, one country's reaction to the event may differ from the reactions in other countries. Precisely, confronted with the same monetary policy announcement, some European Union members may behave more sensitively than others. However, there is no clear evidence to confirm which country is the most strongly influenced by the ECB monetary policy decision. The conclusion we can obtain is of course limited by the sample of the study, composed by eight representative EU members, namely France, Germany, Belgium, Italy, Spain, Portugal, Netherlands and the United Kingdom.

In order to conclude, we need to calculate the cumulative average abnormal returns of all eight countries selected. For a rounded analysis, I create eight event windows with different

lengths and divide them into three groups. The first group contains one day before and after the day of event, as well as one day symmetrically surrounding the event date. I extend the length around the identified event date into 5 days for lagged reactions to news in the second group. The last group includes nine trading days before and 5 trading days after event. Here I have to explain why we pick this period as our main event window to conduct the event study metric. In many cases the maximum event window includes 41 trading days symmetrically surrounding the identified event date, abbreviated [-20, 20]. According to the intervals between two event dates in my sample, this period will be a bit long, for example, there are only 24 days from 11/3/2011 to 12/8/2011. Regarding this situation, it is better to take a shorter period as event window and consider that anticipation of monetary policy decision will also affect the bond market; so we should put more weight on the horizon prior to the identified event date. Therefore I take a period of fifteen trading days (about three weeks) as my event window with nine trading days before and five trading days after the announcement date. All the event windows include the date of monetary policy announcement itself.

Table 5.1 reveals the significant effects from each monetary policy statement to eight countries respectively. Markers and yellow cells denote cumulative average abnormal returns with at least 5% significant level across the eight event windows.

Table 5.1. Significant Cumulative Average Abnormal Returns Distribution

	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016			√			√	√	√
12/3/2015	√			√	√	√		
9/4/2014	√	√	√	√	√		√	√
6/5/2014	√	√	√	√	√	√		
11/7/2013								√
5/2/2013								
7/5/2012	√	√	√		√		√	√
12/8/2011	√	√	√		√		√	
11/3/2011	√			√		√		
7/7/2011		√	√	√		√		
4/7/2011								

The legend in the table is as follows: GTFRF5Y-France 5-year government bond yield; GTBEF5Y-Belgium 5-year government bond yield; GDBR5Y-Germany 5-year government bond yield; GTITL5Y-Italy 5-year government bond yield; GSPG5Y-Spain 5-year government bond yield; GSPT5Y-Portugal 5-year government bond yield; GTNL5Y-Netherlands 5-year government bond yield; UKGGBE5Y-United Kingdom 5-year government bond yield.

As can be confirmed in the previous table, GDBR5Y index and GTFRF5Y index have the highest number of significant results during the examined period. Both achieve 6 significant results out of 11 events from 2011 to 2016. We can say Germany and France government bonds were the most responsive to ECB monetary policy announcements.

According to the table, a significant performance of GDBR5Y generally appeared in these periods, with most government bond indexes showing significant results on our specified event windows.

The German government bond market is widely considered as the benchmark for other European bond markets among market participants. It played an important role in European Union especially after the sovereign debt crisis, as Germany made a great contribution to the European economy recovery by implementing appropriate policies and reforms, which strengthened its key character in EU authority.

In fact, despite the ongoing turmoil in neighboring economies, the German economic recovery was able to succeed in the wake of the global financial crisis. Like The Economist said, “the reluctant hegemon”. With strong economic foundations rooted in export-led growth and fiscal austerity, the German economy continues to represent an anchor in the EU economy.

We observe that UKGGBE5Y behaved uniquely when it comes to the impact of announcements. The most outstanding performance happened to announcement on the 11th July 2016, leading the rejection of null hypothesis with 5% significant level for the event window of [-9, 5] and [-5, 5] (Table 5.2.), while the rest of examined countries have no significant CAARs on the same event.

Table 5.2. Cumulative Average Abnormal Returns for the Rate Announcement of 11/7/2013

11/7/2013	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y	
date	caar	caar	caar	caar	caar	caar	caar	caar	prob.
[-9, 5]	-0.150	-0.140	-0.258	-0.032	-0.073	-0.106	-0.192	-0.090	**0.048**
[-9, 0]	-0.154	-0.157	-0.244	0.010	-0.034	-0.111	-0.174	-0.039	0.298
[-5, 5]	-0.091	-0.086	-0.150	-0.120	-0.066	-0.098	-0.130	-0.077	**0.048**
[-5, 0]	-0.096	-0.103	-0.136	-0.077	-0.027	-0.103	-0.112	-0.026	0.371
[0, 5]	-0.082	-0.075	-0.138	-0.097	-0.085	-0.013	-0.103	-0.054	0.060
[-1, 1]	-0.036	-0.045	-0.053	-0.039	-0.026	-0.040	-0.046	0.004	0.836
[-1, 0]	-0.091	-0.089	-0.146	-0.044	-0.033	-0.057	-0.099	-0.009	0.577
[0, 1]	-0.031	-0.047	-0.031	-0.049	-0.040	-0.001	-0.032	0.011	0.517

Besides, on the 5th June 2014, when other six selected countries all showed active responses to the announcement, UKGGBE5Y gave no response as well as GTNLG5Y (Table 5.3).

Table 5.3. Cumulative Average Abnormal Returns for Rate Announcement of 6/5/2014

6/5/2014	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
date	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.0876	-0.1131	-0.0459	-0.2444	-0.1948	-0.1596	-0.1918	-0.0169
[-9, 0]	-0.0537	-0.0607	-0.0266	-0.1709	-0.1358	-0.0405	-0.1735	-0.0236
[-5, 5]	0.0002	-0.0083	0.0516	-0.0915	-0.0711	-0.0664	-0.1298	0.0027
[-5, 0]	0.034	0.0441	0.0709	-0.018	-0.0121	0.0528	-0.1115	-0.004
[0, 5]	-0.1431	-0.1461	-0.1337	-0.1431	-0.1212	-0.1562	-0.1033	0.0108
[-1, 1]	-0.227	-0.2345	-0.1796	-0.1972	-0.1982	-0.1181	-0.0463	-0.0166
[-1, 0]	-0.08	-0.0616	-0.0767	-0.0538	-0.0422	-0.0261	-0.099	-0.0129
[0, 1]	-0.2562	-0.2667	-0.2173	-0.2131	-0.2183	-0.129	-0.0322	0.0005

In general, GTBEF5Y and GDBR5Y hold high similarity across the examined period, except for one special case, on the 10th March 2016, when GDBR5Y has 1% level of significance to reject the null hypothesis and GTBEF5Y doesn't have any remarkable response to it. Otherwise, there is some common characteristics between the trend of GTITL5Y and GSPT5Y. What's more, UKGGBE5Y and GTNLG5Y also followed a very similar path compared to others.

One possibility of this phenomenon is due to spillover effects which occur between economies which have very close financial connections. We find that bond markets of neighboring countries usually have similar trend across all announcements. This corresponds to the finding of Forbes and Rigobon (2002), according to which the estimated correlation

amplified during stress periods but tends to be biased upwards. They conclude that a stable and elevated co-movement during both tranquil and stress times should be referred to as interdependence.

5.2. Impact by Events

I collected eleven monetary policy announcements (Table 5.4) between 2011 and 2016, to demonstrate how the government bond market responded to each event shock. In order to summarize the bond market performance, the data will be divided into three groups. Regarding to several event windows I implemented, I discuss first the difference between bond yields changes on the windows [-1, 1], [-1, 0], [0, 1].

Table 5.4. Number of Government Bonds with Significant Results on Each Event

event	*sig. n*
3/10/2016	4
12/3/2015	4
9/4/2014	7
6/5/2014	6
11/7/2013	1
5/2/2013	0
7/5/2012	6
12/8/2011	5
11/3/2011	3
7/7/2011	4
4/7/2011	0

As can be seen in Table 5.5, some events are considered as influential among the eleven events. They refer to the monetary policy decisions announced on the 9th April, 2014, 6th May, 2014, and the 7th May, 2012, all of which have six significant results of CAAR, especially in the window [0, 1]. The event of 6th May, 2014, shows no evidence of impacts on bond market related to the announcements for the window [-1, 0]. When it comes to the insignificant

results, the least influential events are those on the 11th July, 2013, 5th February, 2013 and the 11th March, 2011, none of which with any significant level of CAAR.

Table 5.5. Cumulative Average Abnormal Returns by events of [-1, 1],[-1, 0],[0, 1]

	GTFRF5Y	GTBEP5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	0.0677	0.4558	-0.3874	-0.0581	-0.1028	-0.1234	-0.3098	0.0746
[-1, 0]	-0.4613	0.0412	-0.5134	0.1033	0.0517	-0.0404	-0.4714	0.0558
[0, 1]	0.1464	0.3356	-0.2296	-0.1197	-0.1234	-0.1182	-0.1636	0.0505
12/3/2015	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-3.9384	-2.2034	-0.1189	0.5465	0.3736	0.1778	1.1426	0.0093
[-1, 0]	-3.7931	-1.9154	0.15	0.5293	0.3325	0.1317	-1.201	0.0125
[0, 1]	-4.2452	-2.2511	-0.6524	0.6142	0.4114	0.213	1.1756	0.0103
9/4/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.2276	-0.3088	0.2672	-0.1655	-0.1097	-0.1084	-0.3726	0.0026
[-1, 0]	-0.1479	-0.19	0.2815	-0.0974	-0.0054	-0.0356	-0.2457	0.006
[0, 1]	-0.2784	-0.3418	-0.2177	-0.1571	-0.1033	-0.1014	-0.431	-0.0043
6/5/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.227	-0.2345	-0.1796	-0.1972	-0.1982	-0.1181	-0.0463	-0.0166
[-1, 0]	-0.08	-0.0616	-0.0767	-0.0538	-0.0422	-0.0261	-0.099	-0.0129
[0, 1]	-0.2562	-0.2667	-0.2173	-0.2131	-0.2183	-0.129	-0.0322	0.0005
11/7/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.0358	-0.0447	-0.053	-0.039	-0.026	-0.0399	-0.0463	0.0042
[-1, 0]	-0.0906	-0.0889	-0.1457	-0.0435	-0.0326	-0.0572	-0.099	-0.0092
[0, 1]	-0.0312	-0.0473	-0.0314	-0.0493	-0.0398	-0.0008	-0.0322	0.0107
5/2/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.0442	-0.0253	0.052	-0.0359	-0.0494	-0.0365	-0.0414	-0.0169
[-1, 0]	-0.0753	-0.0508	-0.0977	-0.0529	-0.0551	-0.0019	-0.0975	-0.0366
[0, 1]	-0.0215	-0.0162	-0.0088	-0.0263	-0.0349	-0.0399	-0.0303	0.0023
7/5/2012	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.1933	-0.1071	-0.4526	0.1016	0.1379	-0.0033	-0.2453	-0.0295
[-1, 0]	-0.043	-0.0076	-0.3124	0.0827	0.1022	-0.0053	-0.1394	-0.0122
[0, 1]	-0.1946	-0.1036	-0.3233	0.0717	0.1093	-0.0002	-0.2121	-0.0334
12/8/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	0.0048	-0.0324	-0.1563	0.0985	0.0656	-0.0263	-0.1514	0.0178
[-1, 0]	0.0655	0.0374	-0.1859	0.1242	0.1056	-0.0109	-0.1309	-0.0036
[0, 1]	0.0091	-0.0442	-0.0618	0.0778	0.0399	-0.0029	-0.0827	0.021
11/3/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	0.0166	-0.0169	0.0202	0.0178	0.0175	0.0064	-0.005	0.0033
[-1, 0]	0.0411	-0.026	0.0899	-0.0284	0.0037	0.0094	0.0482	0.0056
[0, 1]	-0.0186	-0.0098	-0.0194	0.0253	0.027	0.003	-0.033	-0.0085
7/7/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-1, 1]	-0.052	-0.0057	-0.0859	0.0791	0.0328	0.2624	-0.0665	-0.0185
[-1, 0]	-0.0162	0.0064	-0.0224	0.0456	0.0245	0.2309	-0.0194	-0.0141
[0, 1]	-0.0342	-0.0129	-0.0497	0.0484	0.0046	0.0494	-0.0429	0.0031

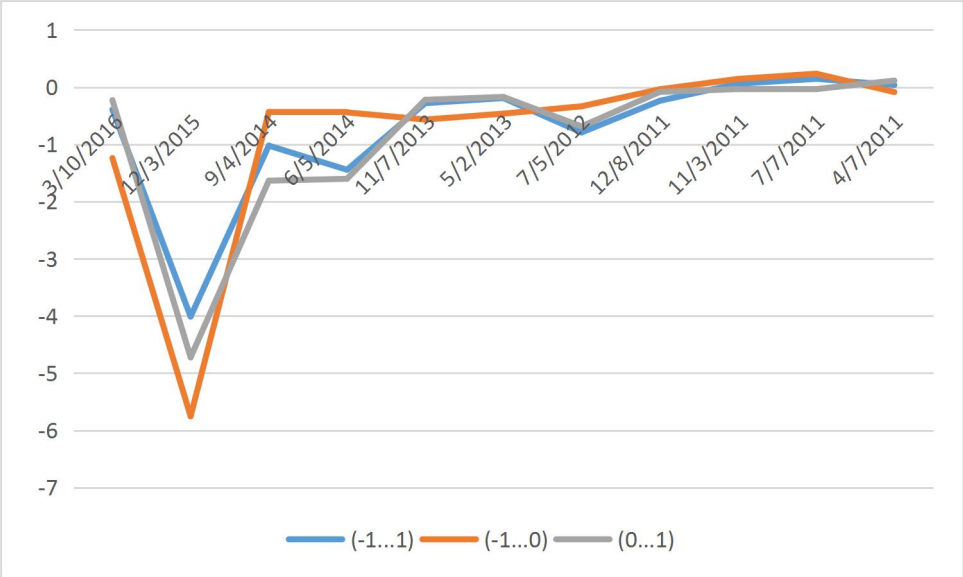
Orange highlight means 1% significance level

Yellow highlight means 5% significance level

A straight view of the CAAR evolution of different event windows is given by Figure 5.1, with the overall CAAR levels obtained from eight bond yields data. The figure reveals that the trend of CAAR in the three windows is quite similar while responding to all the announcements. However, we can still clearly see that the evolution for the window [-1, 0] (the orange line) drops in a greatest percentage during the event dates of 12/3/2015 and

9/4/2014. Then returns to near zero in the earlier events dates, which implies a greater effect to the bond market on one day before the announcements released than the day after the event date. In summary, the bond market yields decrease one day before the interest cut news is released to the public. This corresponds to the negative drop up to -6 b.p. in the line chart.

Figure 5.1. Cumulative Average Abnormal Return of all Government Bonds



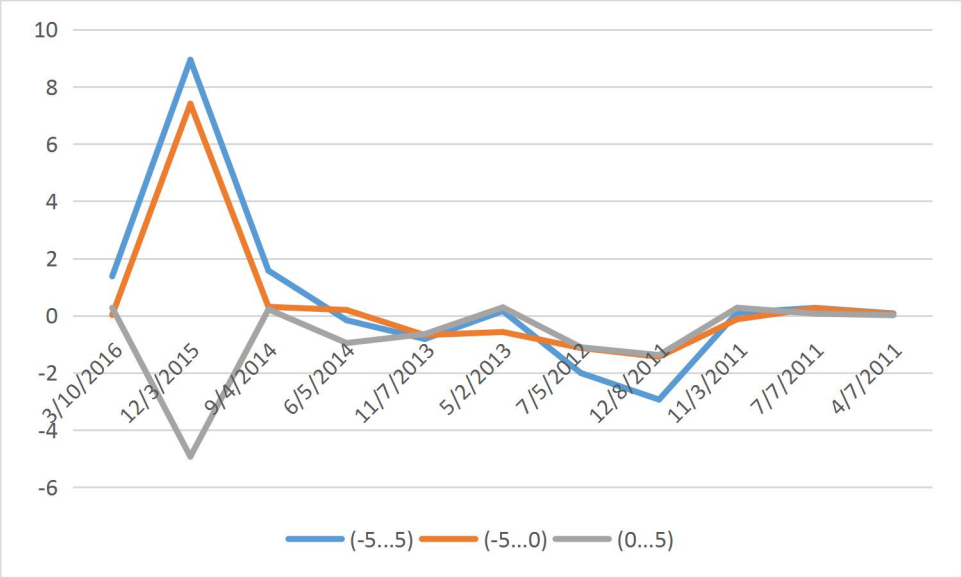
Next we are going to study the impact from announcements for the windows of [-5, 5], [-5, 0], [0, 5]. The distribution of a significant CAAR showing on Table 5.6 is completely different from Table 5.1, because it is not as concentrated as before. Generally speaking, the relevant impacts actively appear on the event dates of 7/5/2012 and 12/8/2011.

Table 5.6. Cumulative Average Abnormal Returns by events on windows [-5, 5], [-5, 0], [0, 5]

	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	0.9014	2.3641	-0.6848	-0.2202	-0.1711	-0.2784	-0.6352	0.1288
[-5, 0]	0.0417	1.0734	-0.6495	0.0364	0.0544	-0.0126	-0.6032	0.1003
[0, 5]	0.4771	1.2117	-0.391	-0.2148	-0.1944	-0.3009	-0.3573	0.0601
12/3/2015	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	6.9962	0.1862	9.7742	0.5149	0.2835	-0.0025	-8.844	0.0341
[-5, 0]	8.8609	-2.6267	1.9936	0.5771	0.3153	0.0136	-1.7689	0.0421
[0, 5]	-5.9647	0.8498	7.397	0.5348	0.3384	0.1508	-8.2431	0.0056
9/4/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	0.2405	0.1272	0.4196	0.0836	0.305	0.0991	0.2643	0.0331
[-5, 0]	-0.0128	-0.0597	0.2993	-0.0276	0.1125	0.0649	-0.1126	0.0433
[0, 5]	0.0546	-0.0361	-0.0831	0.0223	0.1935	0.0057	0.0728	-0.0111
6/5/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	0.0002	-0.0083	0.0516	-0.0915	-0.0711	-0.0664	-0.1298	0.0027
[-5, 0]	0.034	0.0441	0.0709	-0.018	-0.0121	0.0528	-0.1115	-0.004
[0, 5]	-0.1431	-0.1461	-0.1337	-0.1431	-0.1212	-0.1562	-0.1033	0.0108
11/7/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	-0.0911	-0.0862	-0.1501	-0.1201	-0.0658	-0.0978	-0.1298	-0.0768
[-5, 0]	-0.0955	-0.1032	-0.1364	-0.0773	-0.0274	-0.1029	-0.1115	-0.0257
[0, 5]	-0.0816	-0.0745	-0.1377	-0.0965	-0.0848	-0.013	-0.1033	-0.0538
5/2/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	0.0341	0.0227	0.0567	0.0738	-0.0174	0.0678	-0.0303	-0.0706
[-5, 0]	-0.0625	-0.0612	-0.1734	-0.0515	-0.0699	0.0533	-0.1382	-0.0838
[0, 5]	0.044	0.0422	0.0715	0.082	0.0119	0.0092	0.0214	-0.0042
7/5/2012	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	-0.3624	-0.3406	-0.6648	-0.0568	-0.0838	0.0164	-0.4917	-0.0242
[-5, 0]	-0.1243	-0.1333	-0.4263	-0.0806	-0.0706	-0.0195	-0.2828	0.0068
[0, 5]	-0.2824	-0.2114	-0.4216	0.0766	0.0605	0.0337	-0.3151	-0.0471
12/8/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	-0.1582	-0.5321	-0.59	-0.154	-0.4117	-0.2123	-0.6781	0.0177
[-5, 0]	0.0217	-0.2221	-0.3488	-0.0835	-0.1741	-0.1474	-0.3434	-0.0225
[0, 5]	-0.1102	-0.2844	-0.3326	0.033	-0.1577	-0.0524	-0.3968	0.0398
11/3/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	0.2058	0.0661	-0.1727	0.1904	0.0837	-0.1726	-0.092	-0.0081
[-5, 0]	0.0131	0.0281	-0.0825	0.035	0.0198	-0.0674	-0.0788	0.0069
[0, 5]	0.1986	0.019	-0.0399	0.1345	0.0771	-0.0993	0.0072	-0.0211
7/7/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	-0.0317	0.0463	-0.0765	0.1764	0.0581	0.1909	-0.1012	0.0097
[-5, 0]	0.0029	-0.0044	0.0252	0.0391	0.0019	0.197	-0.0036	0.0006
[0, 5]	-0.033	0.0499	-0.0879	0.1522	0.0524	0.0118	-0.0933	0.0165
4/7/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-5, 5]	-0.0209	-0.002	-0.0227	0.0045	0.0791	0.0674	-0.0063	-0.0215
[-5, 0]	-0.0087	-0.0165	-0.0024	-0.0029	0.0305	0.0388	0.0049	0.0117
[0, 5]	-0.0218	0.0096	-0.0309	0.0139	0.0541	0.0406	-0.0191	-0.0326

From Figure 5.2., the evolution of CAAR for these three event windows is distinct, while the trends go opposite way in the latest three announcements. It is a very interesting phenomenon that bond yields increase within 5 trading days before the announcement date. When the official announcement is released, the rate cut caused a bond yields decrease during 5 trading days after. I admit that the anticipation of an interest rate raise affects the bond yields change. However, the announcement of the rate cut leads to a yield drop in the following days.

Figure 5.2. Cumulative Average Abnormal Return of Eight Government Bonds on [-5, 5], [-5, 0], [0, 5]



[9]

In terms of earlier events, three lines follow its own unique paths with small volatility in different announcements. It is worth mentioning that there is a negative CAAR on the window [-5, 5] appearing in the event of 12/8/2011, which is also a rate cut announcement. As discussed before, the rate cut announcement on 12/3/2015 caused a positive result with high value of CAAR (about 9 b.p.). It indicates that anticipation makes a great contribution to the evolution of CAAR to some extent. Especially after a long term implementation of loose monetary policy, the market tends to hold the expectation of a rate raise. Furthermore, market expectations towards the ECB policy decision strongly affects European government bond yields compared to previous periods. When it comes to the beginning of our sample, the gaps between them shrink into almost a same level (near zero). We can say there is no obvious influence before the widespread outbreak of sovereign debt crisis.

The final event widows we would like to mention about are [-9, 5] and [-9, 0] (Table 5.7.). They are more disperse, showing that significant results don't come out like the other event windows. There is no concentrated distribution on all events, except for 12/8/2011, which has

[9] I drew the line chart by summing up cumulative average abnormal return of eight government bonds on event windows of [-5, 5], [0, 5], [-5, 0]. The vertical axis represents the overall level of cumulative average abnormal returns. The horizontal axis represents all event dates arranged from the last to the earliest.

five government bond yields change with a significant level to reject the null hypothesis. The others only show a few significant CAARs, and most of them have about 5% level of significance.

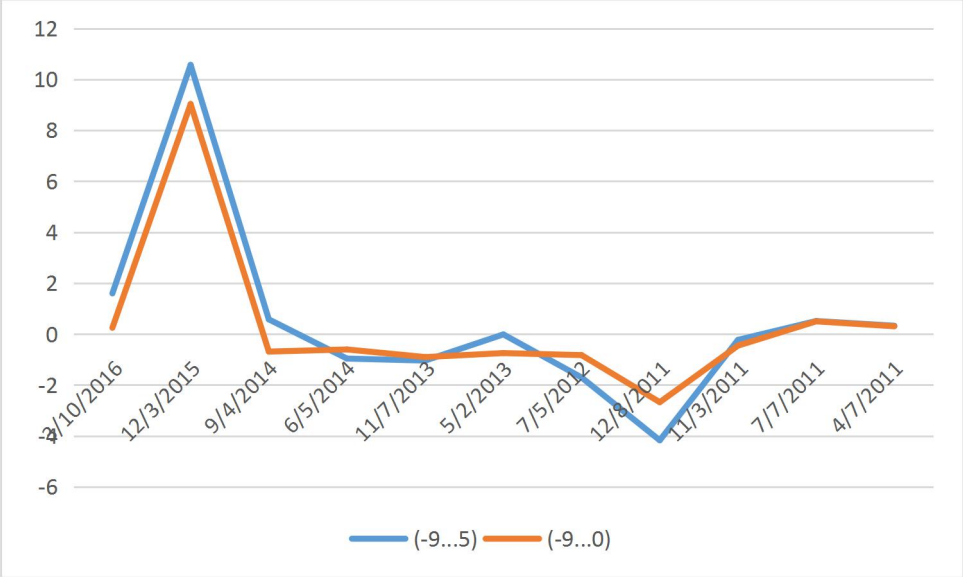
Table 5.7. Cumulative Average Abnormal Returns by events on the windows [-9, 5], [-9, 0]

	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	1.2163	3.2294	-0.8736	-0.4607	-0.3763	-0.5959	-0.7967	0.2976
[-9, 0]	0.3566	1.9386	-0.8383	-0.2041	-0.1508	-0.3301	-0.7647	0.2691
12/3/2015	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	6.7356	0.7633	11.8685	0.2724	0.0967	-0.1	-9.1463	0.079
[-9, 0]	8.6003	-2.0495	4.0879	0.3346	0.1284	-0.0839	-2.0711	0.087
9/4/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	0.0485	-0.0967	0.2527	0.0002	0.2511	0.0674	0.0341	0.0202
[-9, 0]	-0.2048	-0.2837	0.1324	-0.1111	0.0586	0.0331	-0.3427	0.0304
6/5/2014	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.0876	-0.1131	-0.0459	-0.2444	-0.1948	-0.1596	-0.1918	-0.0169
[-9, 0]	-0.0537	-0.0607	-0.0266	-0.1709	-0.1358	-0.0405	-0.1735	-0.0236
11/7/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.15	-0.1401	-0.2576	-0.0324	-0.0727	-0.1058	-0.1918	-0.0896
[-9, 0]	-0.1543	-0.1571	-0.2439	0.0103	-0.0343	-0.1109	-0.1735	-0.0385
5/2/2013	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.0137	0.0024	0.1634	-0.0095	-0.0859	0.0656	-0.0945	-0.0737
[-9, 0]	-0.1103	-0.0816	-0.0667	-0.1348	-0.1384	0.0511	-0.2024	-0.0869
7/5/2012	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.3801	-0.2791	-0.6	0.0739	-0.0138	0.0111	-0.4482	-0.0664
[-9, 0]	-0.142	-0.0718	-0.3616	0.05	-0.0007	-0.0248	-0.2394	-0.0354
12/8/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.4252	-0.9374	-0.7267	-0.1508	-0.5454	-0.1309	-0.9719	0.0125
[-9, 0]	-0.2453	-0.6274	-0.4855	-0.0803	-0.3077	-0.066	-0.6373	-0.0277
11/3/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	0.0755	-0.0116	-0.1853	0.1433	0.0487	-0.143	-0.1309	-0.0242
[-9, 0]	-0.1172	-0.0496	-0.0951	-0.0121	-0.0152	-0.0377	-0.1177	-0.0092
7/7/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	0.0365	0.0528	0.0469	0.1862	0.0434	0.1443	-0.0339	0.0382
[-9, 0]	0.0711	0.0022	0.1486	0.0489	-0.0128	0.1504	0.0637	0.0291
4/7/2011	caar	caar	caar	caar	caar	caar	caar	caar
[-9, 5]	-0.0024	0.0243	-0.0007	0.0389	0.1149	0.1492	0.0231	-0.019
[-9, 0]	0.0097	0.0098	0.0196	0.0315	0.0663	0.1206	0.0344	0.0143

From Figure 5.3, we can see the distinct tendencies of CAAR in windows [-9, 0] and [-9, 5]. They follow a very similar track with highly positive CAAR in the event of interest for 3/10/2016, 12/3/2015 and 9/4/2014. In these events, CAAR in [-9, 5] (blue line) stays above the CAAR in [-9, 0] (orange line), which implies the influence on the bond market does not only exists in the trading period prior to event date but also has significant impact in the

afterward trading days.

Figure 5.3. Cumulative Average Abnormal Return of Eight Government bonds on windows [-9, 5], [-9, 0]



5.3. Impact by Event Windows

It is important to figure out when the influence would appear during the whole event process. In order to get relative conclusions, I arrange the data based on several event windows to find out in which time period the bond market reacted actively after receiving the announcement. Appendix I shows the results of CAAR by different event windows.

Table 5.8 summarizes the results in Appendix I. From this table, we can clearly get that the event window [0, 1] has the highest number of significant CAARs (23), as well as the most CAARs with 1% significance level to reject to null hypothesis. In other words, compared to other event windows, the highest probability that bond markets have a significant reaction to the monetary policy announcement is on the day after the announcement was released.

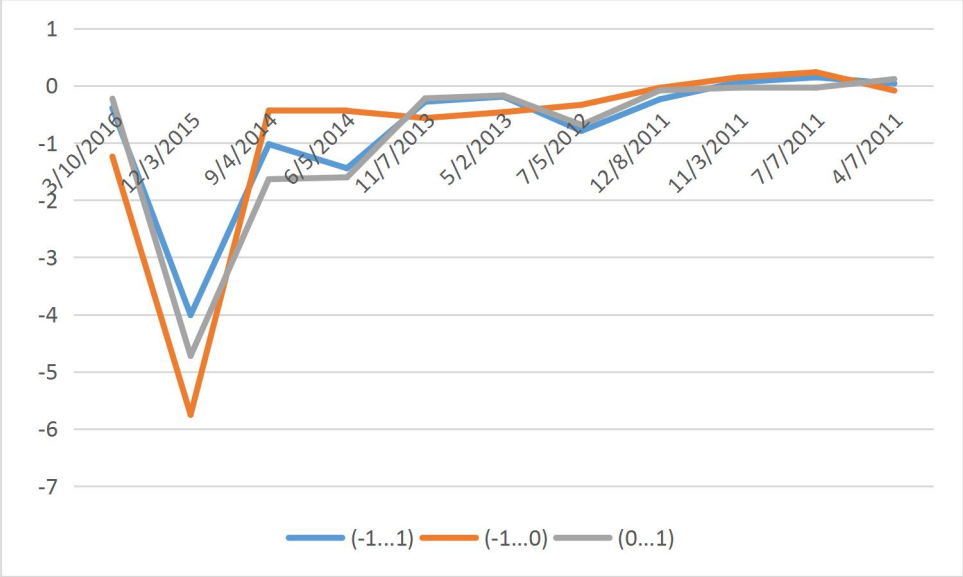
Table 5.8. Number of Significant Results on Different Event Windows

window	*sig. n*	*5%*	*1%*
[-9, 5]	16	8	8
[-9, 0]	8	4	4
[-5, 5]	16	5	11
[-5, 0]	10	4	6
[0, 5]	15	5	10
[-1, 1]	22	12	10
[-1, 0]	15	4	11
[0, 1]	23	5	18

The second most relevant window is [-1, 1], with 22 significant CAAR. From Figure 5.4, it is clear that CAARs on windows [-1, 1] and [0, 1] are quite similar. In terms of the significance level, window [0, 1] has a higher proportion of 1% significance, almost 80% of its own. However, the 1% significance has less than half of cases, with only 10 out of 22 significant CAARs. In conclusion, most of the impact happens one day symmetrically surrounded announcement released date, especially on the day after it.

Figure 5.4. Tendency of Cumulative Average Abnormal Returns of Government Bonds on

[-1, 1], [-1, 0], [0, 1]



On the other hand, window [-9, 0] has the lowest number of significant CAARs across the

whole sample, which means announcements have bare impacts on bond market during the 9 trading days before the event date.

5.4. Impact by Maturities of Bonds

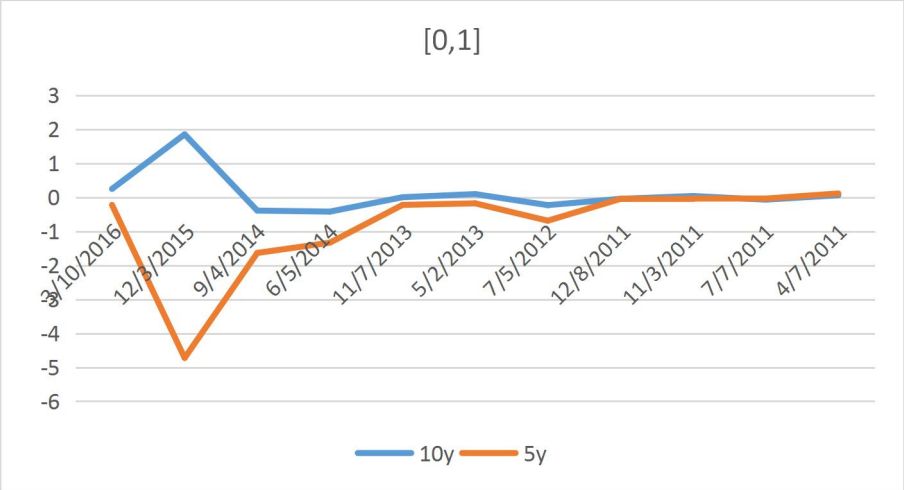
In order to know if there is any difference between the bond yields performance with different maturities when an event happened, Table 5.9 shows a comparison of bond yield with the maturities of 10 years and 5 years. Furthermore, we can also get the information about the number of CAARs with 5% significance level and 1% significance level in eight event windows. Generally speaking, most of the significant values concentrate in the windows [-1, 1], [-1, 0] and [0, 1]. Taking the significance level into account, I will mainly focus on the window [0, 1], since the majority of 1% significance level of CAAR shows up one day after the event date.

Table 5.9. Number of Significant Results of Government Bond with Different maturities on Several Event Windows

window	sig.n		5%		1%	
maturity	10y	5y	10y	5y	10y	5y
[-9, 5]	12	16	7	8	5	8
[-9, 0]	9	8	3	4	6	4
[-5, 5]	14	16	7	5	7	11
[-5, 0]	11	10	8	4	3	6
[0, 5]	9	15	7	5	2	10
[-1, 1]	6	22	3	12	3	10
[-1, 0]	19	15	6	4	13	11
[0, 1]	16	23	3	5	13	18

Figure 5.5 describes the overall CAAR value of eight selected European government bond yields. The blue line refers to 10-year government bonds and the orange line represents the 5-year maturity. All CAARs correspond to the event window [0, 1].

Figure 5.5. Tendency of Cumulative Average Abnormal Returns of Government Bonds with Different Maturities on the window [0, 1]



The figure above shows that CAARs of 5-year government bond yields have bigger fluctuation than CAARs of 10-year government bond yields. Specially, there is a sharp fall in the event of 12/3/2015, while 10-year government bond yields have an opposite trend with a positive value of CAAR, whose change is not as big as the 5-year government bond yields. It indicates that the monetary policy announcement has a bigger impact on 5-year government bond than on the 10-year government bond. In the earlier events, a bare influence to the bond market has been found generally. Both CAARs go around zero. The distinct paths may be explained by investors believing that rates have decreased into an unprecedented low level and admit the loose monetary policy will last for recent years, which leads to the increase in 5-year bond yields, but in the future this must change, as the effect of financial crisis gradually fades away. Some observers, noting that the 10-year Treasury yield has not declined on net since the inception of the LSAP programs, have argued that the LSAPs did not have a lasting effect.

6. Conclusion

This study aims to confirm the impact of European central bank monetary policy decisions

referring to interest rate changes on Euro-zone government bond. The effects are measured on the variables by percent change of daily bond yields.

Results indicate that 9 out of 11 rate announcements had significant impacts on at least one government bond yield during my tested period. We can conclude that ECB monetary policy announcement did have significant effects to Euro-zone government bonds. Bonds from eight countries (7 belonging to the Euro-zone) behaved quite differently, but still there is something in common when it comes to the same rate announcements. Germany and France government bonds are the most responsive to the ECB monetary policy announcement, both of which with 6 out of 11 significant results. In contrast, United Kingdom and Netherlands bonds are the least affected by the news disclosure. The case of UK is not a surprise, as the country does not belong to the Euro-zone. I also noticed some kind of regional characteristics about bond yields performances. Countries which are adjacent presented similar patterns in some events. They can be divided into three groups: 1) Germany, France and Belgium; 2) Italy, Spain and Portugal; 3) Netherlands and United Kingdom. In what concerns Germany and Belgium, all significant CAARs of Belgium government bonds showed up on the same events in which Germany government bonds were recorded with significant results simultaneously. I collected six significant results relatively to France and Germany government bonds, which were considered as the most responsive to the announcement shock in my sample. As for the least responsive member states, Netherlands and United Kingdom, I detected only 4 out of 11 events with significant results. Furthermore, United Kingdom had significant results on some events which most of countries showed few responses, again probably because of having an autonomous monetary policy.

The results indicate that the rate announcement released on the 4th September, 2014, had the strongest influence on government bonds with all countries showing significant results, except Portugal. However, this may not be attributed to the impact of a rate announcement, since three key rates continued to be reduced by 10 b.p. exactly like the last statement on the 5th June, 2014. On the press conference of the 4th September, 2014, the ECB announced its securities purchase programme, which could be the main shock to the government bond

market rather than the news of a rate cut. Then, we also got two rate announcements to which several government bonds reacted quite actively, with bonds of 6 members presenting significant results. One is the monetary policy decision that took place on the 5th July, 2012. The fundamental significance on government bonds may come from the shock when the deposit rate was cut to zero level. The other is the date of 5th June, 2014, which could be explained because ECB started to implement a negative deposit rate.

The results also implicate that most government bonds made react on the day after the news are released. This makes sense since all press conferences were held on a Thursday night, when trading time was over. And the financial market could only make reaction next day. That is why we can observe the event window [0, 1] has collected the highest number of total significant results, as well as the 1% significance level results among all event windows.

I also conclude that 5-year government bonds are more sensitive to rate announcements than 10-year government bonds. This phenomenon can be attributed to the inception of the LSAP programs, noting that the 10-year Treasury yield has not declined on net since they have argued that the LSAPs did not have a lasting effect.

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Appendix I

Table A1.1. Cumulative Average Abnormal Returns by events on the window [-9, 5]

[-9, 5]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	1.2163	3.2294	-0.8736	-0.4607	-0.3763	-0.5959	-0.7967	0.2976
12/3/2015	6.7356	0.7633	11.8685	0.2724	0.0967	-0.1	-9.1463	0.079
9/4/2014	0.0485	-0.0967	0.2527	0.0002	0.2511	0.0674	0.0341	0.0202
6/5/2014	-0.0876	-0.1131	-0.0459	-0.2444	-0.1948	-0.1596	-0.1918	-0.0169
11/7/2013	-0.15	-0.1401	-0.2576	-0.0324	-0.0727	-0.1058	-0.1918	-0.0896
5/2/2013	-0.0137	0.0024	0.1634	-0.0095	-0.0859	0.0656	-0.0945	-0.0737
7/5/2012	-0.3801	-0.2791	-0.6	0.0739	-0.0138	0.0111	-0.4482	-0.0664
12/8/2011	-0.4252	-0.9374	-0.7267	-0.1508	-0.5454	-0.1309	-0.9719	0.0125
11/3/2011	0.0755	-0.0116	-0.1853	0.1433	0.0487	-0.143	-0.1309	-0.0242
7/7/2011	0.0365	0.0528	0.0469	0.1862	0.0434	0.1443	-0.0339	0.0382
4/7/2011	-0.0024	0.0243	-0.0007	0.0389	0.1149	0.1492	0.0231	-0.019

Table A1.2. Cumulative Average Abnormal Returns by events on the window [-9, 0]

[-9, 0]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.3566	1.9386	-0.8383	-0.2041	-0.1508	-0.3301	-0.7647	0.2691
12/3/2015	8.6003	-2.0495	4.0879	0.3346	0.1284	-0.0839	-2.0711	0.087
9/4/2014	-0.2048	-0.2837	0.1324	-0.1111	0.0586	0.0331	-0.3427	0.0304
6/5/2014	-0.0537	-0.0607	-0.0266	-0.1709	-0.1358	-0.0405	-0.1735	-0.0236
11/7/2013	-0.1543	-0.1571	-0.2439	0.0103	-0.0343	-0.1109	-0.1735	-0.0385
5/2/2013	-0.1103	-0.0816	-0.0667	-0.1348	-0.1384	0.0511	-0.2024	-0.0869
7/5/2012	-0.142	-0.0718	-0.3616	0.05	-0.0007	-0.0248	-0.2394	-0.0354
12/8/2011	-0.2453	-0.6274	-0.4855	-0.0803	-0.3077	-0.066	-0.6373	-0.0277
11/3/2011	-0.1172	-0.0496	-0.0951	-0.0121	-0.0152	-0.0377	-0.1177	-0.0092
7/7/2011	0.0711	0.0022	0.1486	0.0489	-0.0128	0.1504	0.0637	0.0291
4/7/2011	0.0097	0.0098	0.0196	0.0315	0.0663	0.1206	0.0344	0.0143

Table A1.3. Cumulative Average Abnormal Returns by events on the window [-5, 5]

[-5, 5]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.9014	2.3641	−0.6848	−0.2202	−0.1711	−0.2784	−0.6352	0.1288
12/3/2015	6.9962	0.1862	9.7742	0.5149	0.2835	−0.0025	−8.844	0.0341
9/4/2014	0.2405	0.1272	0.4196	0.0836	0.305	0.0991	0.2643	0.0331
6/5/2014	0.0002	−0.0083	0.0516	−0.0915	−0.0711	−0.0664	−0.1298	0.0027
11/7/2013	−0.0911	−0.0862	−0.1501	−0.1201	−0.0658	−0.0978	−0.1298	−0.0768
5/2/2013	0.0341	0.0227	0.0567	0.0738	−0.0174	0.0678	−0.0303	−0.0706
7/5/2012	−0.3624	−0.3406	−0.6648	−0.0568	−0.0838	0.0164	−0.4917	−0.0242
12/8/2011	−0.1582	−0.5321	−0.59	−0.154	−0.4117	−0.2123	−0.6781	0.0177
11/3/2011	0.2058	0.0661	−0.1727	0.1904	0.0837	−0.1726	−0.092	−0.0081
7/7/2011	−0.0317	0.0463	−0.0765	0.1764	0.0581	0.1909	−0.1012	0.0097
4/7/2011	−0.0209	−0.002	−0.0227	0.0045	0.0791	0.0674	−0.0063	−0.0215

Table A1.4. Cumulative Average Abnormal Returns by events on the window [-5, 0]

[-5, 0]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.0417	1.0734	−0.6495	0.0364	0.0544	−0.0126	−0.6032	0.1003
12/3/2015	8.8609	−2.6267	1.9936	0.5771	0.3153	0.0136	−1.7689	0.0421
9/4/2014	−0.0128	−0.0597	0.2993	−0.0276	0.1125	0.0649	−0.1126	0.0433
6/5/2014	0.034	0.0441	0.0709	−0.018	−0.0121	0.0528	−0.1115	−0.004
11/7/2013	−0.0955	−0.1032	−0.1364	−0.0773	−0.0274	−0.1029	−0.1115	−0.0257
5/2/2013	−0.0625	−0.0612	−0.1734	−0.0515	−0.0699	0.0533	−0.1382	−0.0838
7/5/2012	−0.1243	−0.1333	−0.4263	−0.0806	−0.0706	−0.0195	−0.2828	0.0068
12/8/2011	0.0217	−0.2221	−0.3488	−0.0835	−0.1741	−0.1474	−0.3434	−0.0225
11/3/2011	0.0131	0.0281	−0.0825	0.035	0.0198	−0.0674	−0.0788	0.0069
7/7/2011	0.0029	−0.0044	0.0252	0.0391	0.0019	0.197	−0.0036	0.0006
4/7/2011	−0.0087	−0.0165	−0.0024	−0.0029	0.0305	0.0388	0.0049	0.0117

Table A1.5. Cumulative Average Abnormal Returns by events on the window [0, 5]

[0, 5]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.4771	1.2117	−0.391	−0.2148	−0.1944	−0.3009	−0.3573	0.0601
12/3/2015	−5.9647	0.8498	7.397	0.5348	0.3384	0.1508	−8.2431	0.0056
9/4/2014	0.0546	−0.0361	−0.0831	0.0223	0.1935	0.0057	0.0728	−0.0111
6/5/2014	−0.1431	−0.1461	−0.1337	−0.1431	−0.1212	−0.1562	−0.1033	0.0108
11/7/2013	−0.0816	−0.0745	−0.1377	−0.0965	−0.0848	−0.013	−0.1033	−0.0538
5/2/2013	0.044	0.0422	0.0715	0.082	0.0119	0.0092	0.0214	−0.0042
7/5/2012	−0.2824	−0.2114	−0.4216	0.0766	0.0605	0.0337	−0.3151	−0.0471
12/8/2011	−0.1102	−0.2844	−0.3326	0.033	−0.1577	−0.0524	−0.3968	0.0398
11/3/2011	0.1986	0.019	−0.0399	0.1345	0.0771	−0.0993	0.0072	−0.0211
7/7/2011	−0.033	0.0499	−0.0879	0.1522	0.0524	0.0118	−0.0933	0.0165
4/7/2011	−0.0218	0.0096	−0.0309	0.0139	0.0541	0.0406	−0.0191	−0.0326

Table A1.6. Cumulative Average Abnormal Returns by events on the window [-1, 1]

[-1, 1]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.0677	0.4558	-0.3874	-0.0581	-0.1028	-0.1234	-0.3098	0.0746
12/3/2015	-3.9384	-2.2034	-0.1189	0.5465	0.3736	0.1778	1.1426	0.0093
9/4/2014	-0.2276	-0.3088	0.2672	-0.1655	-0.1097	-0.1084	-0.3726	0.0026
6/5/2014	-0.227	-0.2345	-0.1796	-0.1972	-0.1982	-0.1181	-0.0463	-0.0166
11/7/2013	-0.0358	-0.0447	-0.053	-0.039	-0.026	-0.0399	-0.0463	0.0042
5/2/2013	-0.0442	-0.0253	0.052	-0.0359	-0.0494	-0.0365	-0.0414	-0.0169
7/5/2012	-0.1933	-0.1071	-0.4526	0.1016	0.1379	-0.0033	-0.2453	-0.0295
12/8/2011	0.0048	-0.0324	-0.1563	0.0985	0.0656	-0.0263	-0.1514	0.0178
11/3/2011	0.0166	-0.0169	0.0202	0.0178	0.0175	0.0064	-0.005	0.0033
7/7/2011	-0.052	-0.0057	-0.0859	0.0791	0.0328	0.2624	-0.0665	-0.0185
4/7/2011	0.0065	0.0113	0.0154	0.0112	0.0109	-0.0342	0.0209	-0.0046

Table A1.7. Cumulative Average Abnormal Returns by events on the window [-1, 0]

[-1, 0]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	-0.4613	0.0412	-0.5134	0.1033	0.0517	-0.0404	-0.4714	0.0558
12/3/2015	-3.7931	-1.9154	0.15	0.5293	0.3325	0.1317	-1.201	0.0125
9/4/2014	-0.1479	-0.19	0.2815	-0.0974	-0.0054	-0.0356	-0.2457	0.006
6/5/2014	-0.08	-0.0616	-0.0767	-0.0538	-0.0422	-0.0261	-0.099	-0.0129
11/7/2013	-0.0906	-0.0889	-0.1457	-0.0435	-0.0326	-0.0572	-0.099	-0.0092
5/2/2013	-0.0753	-0.0508	-0.0977	-0.0529	-0.0551	-0.0019	-0.0975	-0.0366
7/5/2012	-0.043	-0.0076	-0.3124	0.0827	0.1022	-0.0053	-0.1394	-0.0122
12/8/2011	0.0655	0.0374	-0.1859	0.1242	0.1056	-0.0109	-0.1309	-0.0036
11/3/2011	0.0411	-0.026	0.0899	-0.0284	0.0037	0.0094	0.0482	0.0056
7/7/2011	-0.0162	0.0064	-0.0224	0.0456	0.0245	0.2309	-0.0194	-0.0141
4/7/2011	-0.0118	-0.012	-0.0064	0.0029	-0.0041	-0.0423	-0.003	-0.009

Table A1.8. Cumulative Average Abnormal Returns by events on the window [0, 1]

[0, 1]	GTFRF5Y	GTBEF5Y	GDBR5Y	GTITL5Y	GSPG5Y	GSPT5Y	GTNLG5Y	UKGGBE5Y
3/10/2016	0.1464	0.3356	-0.2296	-0.1197	-0.1234	-0.1182	-0.1636	0.0505
12/3/2015	-4.2452	-2.2511	-0.6524	0.6142	0.4114	0.213	1.1756	0.0103
9/4/2014	-0.2784	-0.3418	-0.2177	-0.1571	-0.1033	-0.1014	-0.431	-0.0043
6/5/2014	-0.2562	-0.2667	-0.2173	-0.2131	-0.2183	-0.129	-0.0322	0.0005
11/7/2013	-0.0312	-0.0473	-0.0314	-0.0493	-0.0398	-0.0008	-0.0322	0.0107
5/2/2013	-0.0215	-0.0162	-0.0088	-0.0263	-0.0349	-0.0399	-0.0303	0.0023
7/5/2012	-0.1946	-0.1036	-0.3233	0.0717	0.1093	-0.0002	-0.2121	-0.0334
12/8/2011	0.0091	-0.0442	-0.0618	0.0778	0.0399	-0.0029	-0.0827	0.021
11/3/2011	-0.0186	-0.0098	-0.0194	0.0253	0.027	0.003	-0.033	-0.0085
7/7/2011	-0.0342	-0.0129	-0.0497	0.0484	0.0046	0.0494	-0.0429	0.0031
4/7/2011	0.0086	0.0183	0.0112	0.0148	0.0205	0.02	0.016	0.0051

Appendix II

Figure A2.1. CAAR Graph of GDBR5Y Index on 9/4/2014

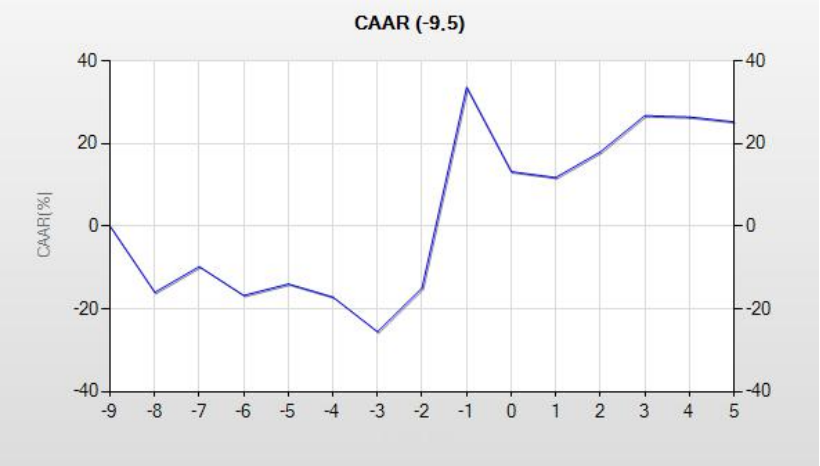


Figure A2.2. CAAR Graph of GDBR5Y Index on 6/5/2014

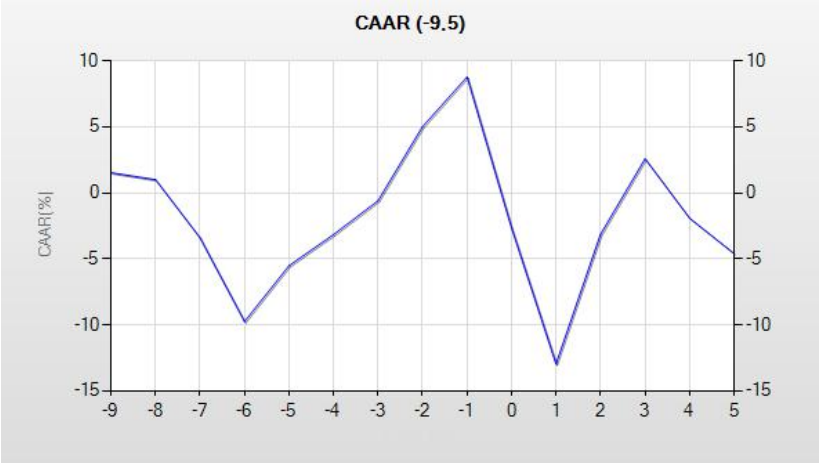


Figure A2.3. CAAR Graph of GDBR5Y Index on 12/3/2015

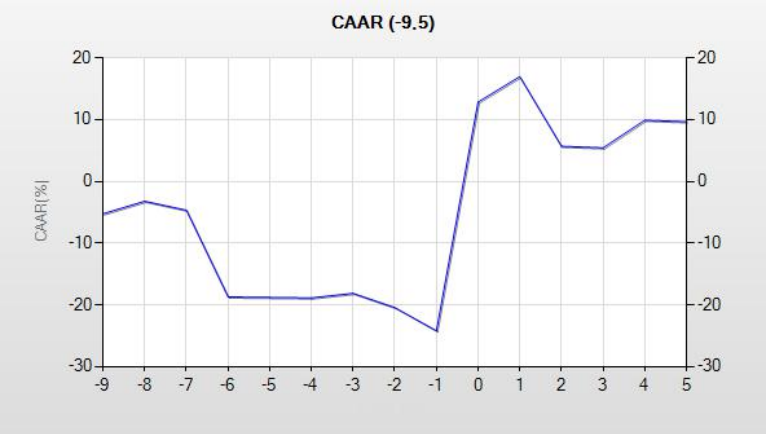


Figure A2.4. CAAR Graph of GSPG5Y Index on 9/4/2014

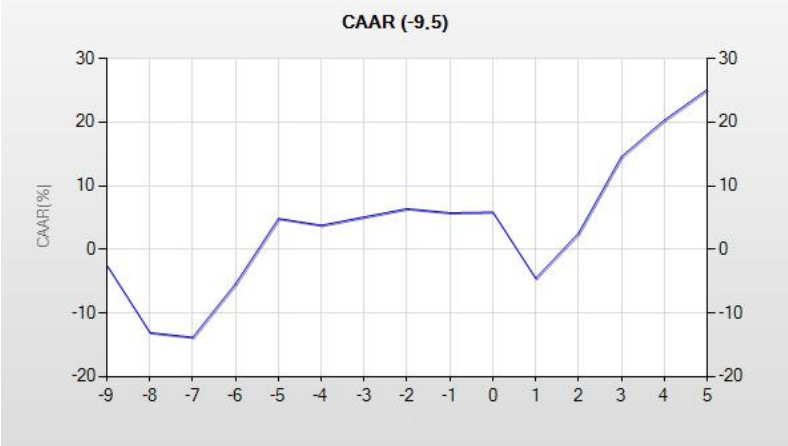


Figure A2.5. CAAR Graph of GSPG5Y Index on 7/5/2012

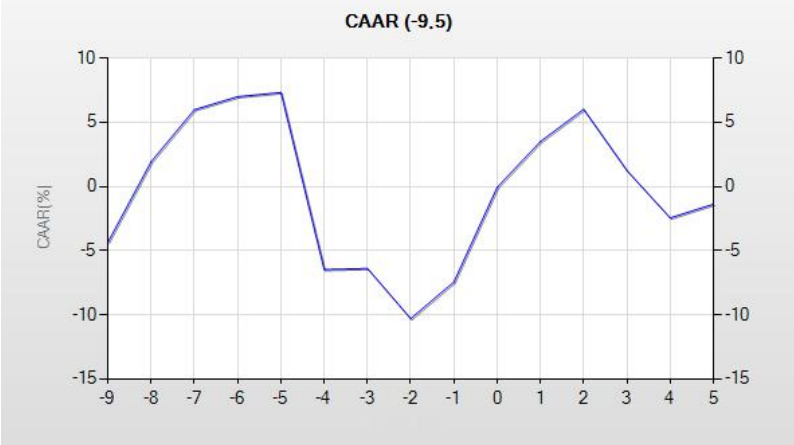


Figure A2.6. CAAR Graph of GTFRF5Y Index on 9/4/2014

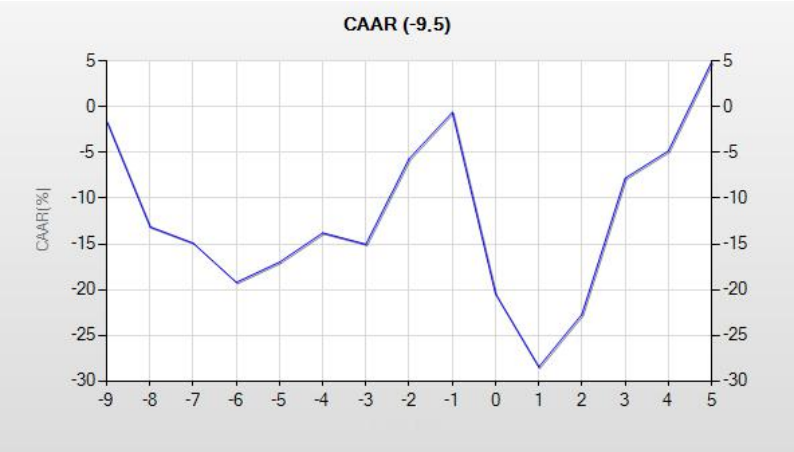


Figure A2.7. CAAR Graph of GTFRF5Y Index on 6/5/2014

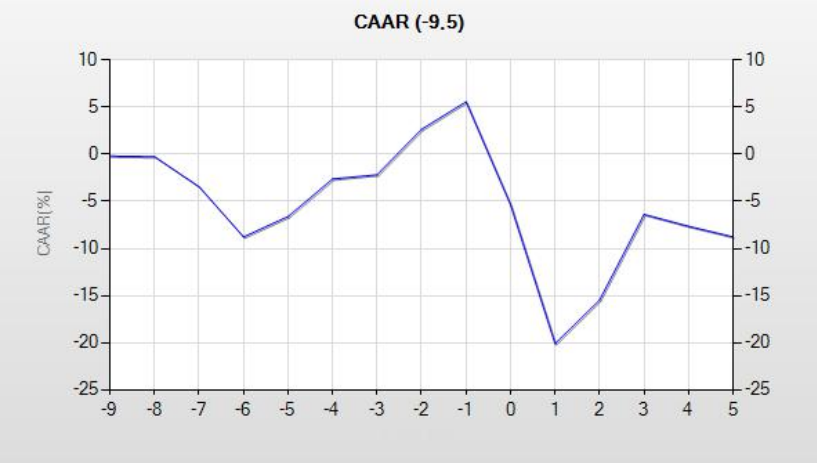


Figure A2.8. CAAR Graph of GTITL5Y Index on 12/3/2016

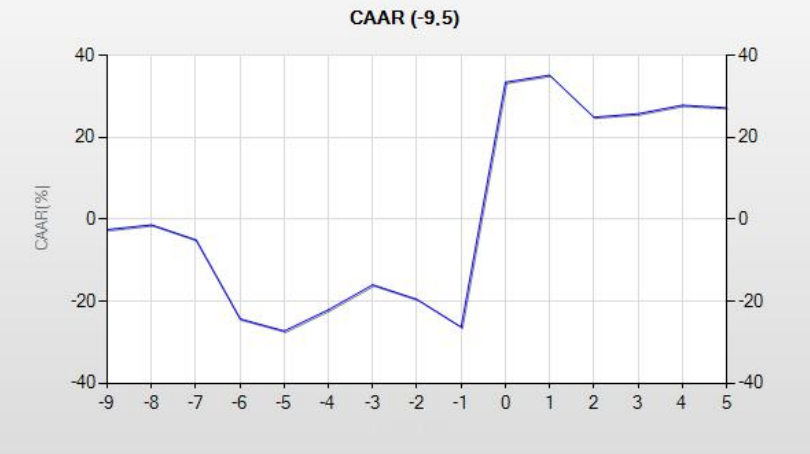


Figure A2.9. CAAR Graph of GTITL5Y Index on 11/3/2011

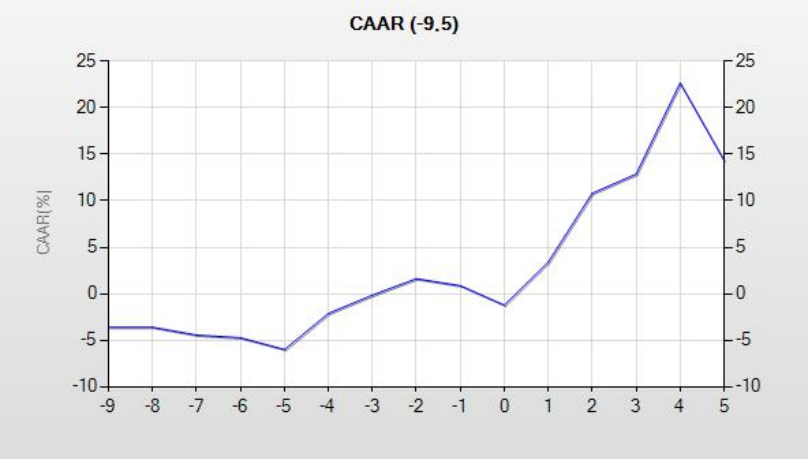


Figure A2.10. CAAR Graph of GTITL5Y Index on 7/7/2011

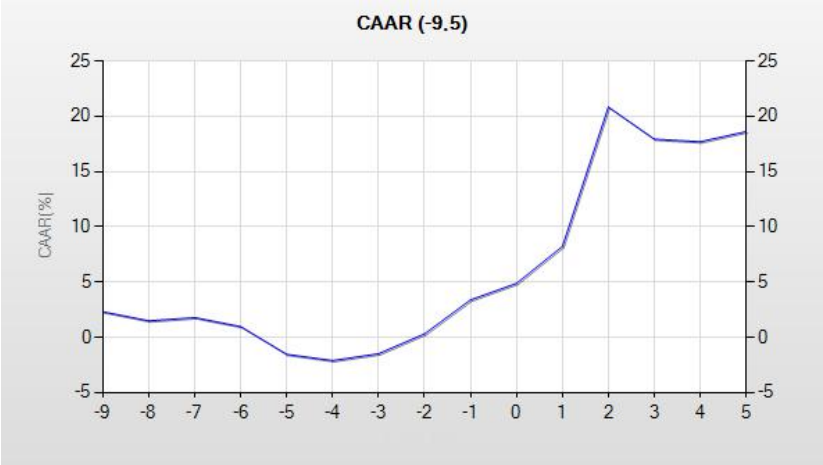


Figure A2.11. Decision-making bodies of ECB

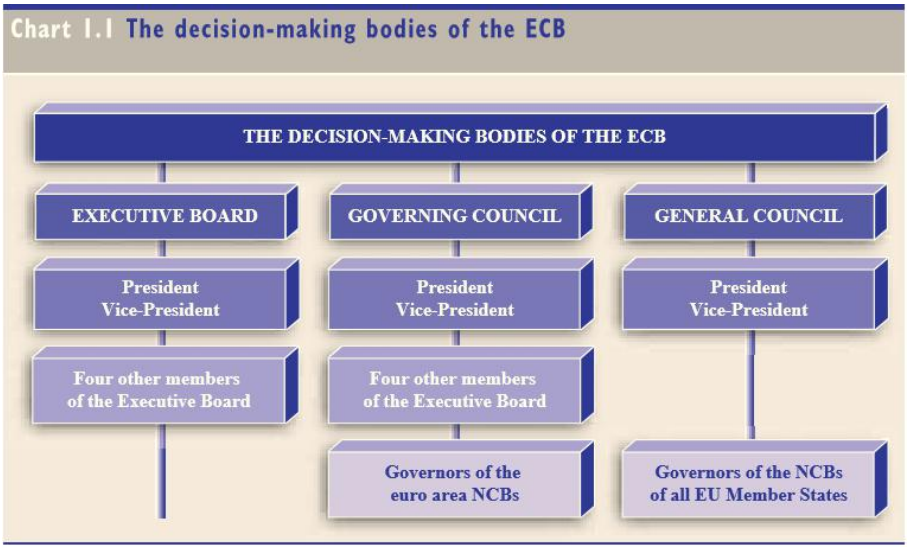
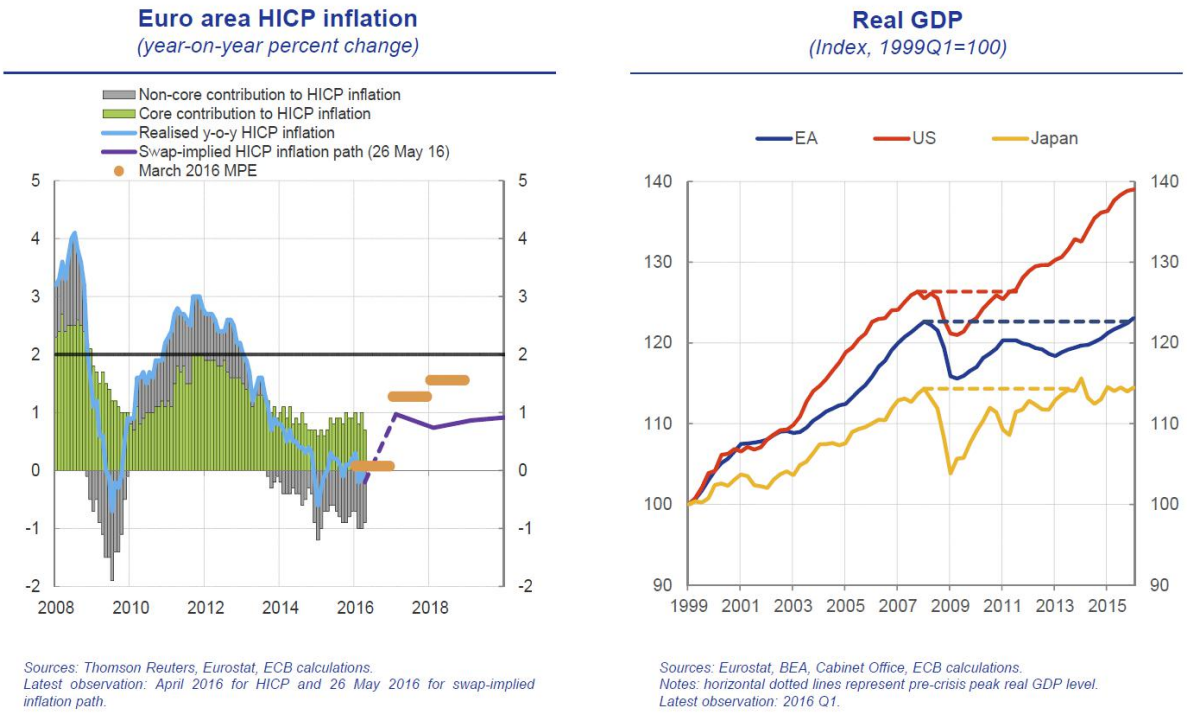


Figure A2.12. Euro area HICP inflation and Real GDP



Sources: Thomson Reuters, Eurostat, ECB calculations.
Latest observation: April 2016 for HICP and 26 May 2016 for swap-implied inflation path.

Sources: Eurostat, BEA, Cabinet Office, ECB calculations.
Notes: horizontal dotted lines represent pre-crisis peak real GDP level.
Latest observation: 2016 Q1.