EFFECTIVENESS OF NON-CONVENTIONAL MONETARY POLICY TOOL: EVENT-STUDY ANALYSIS OF MAJOR EUROZONE ECONOMIES

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Abstract:

This study examines the effectiveness of European Central Bank asset purchase program (quantitative easing) on the long-term interest rates. In particular, the study evaluates the effectiveness or influence of the European Central Bank's non-conventional monetary policy tool, quantitative easing (also known as asset purchase program) on the yield of 5-year sovereign government bonds of Eurozone economies. The main objective and the motivation for this study is to provide the compact effects or influence of the quantitative easing in the Eurozone economies, as the current literature on quantitative easing insufficiently covers the effects of quantitative easing in the euro area. The duration of the quantitative easing or asset purchase program is from the end of 2014 until the first quarter of 2017; however, the currently available literature only studies the effects of the asset purchase program until mid of 2016. Very few researches are published after the completion of the quantitative program that estimates or evaluate the complete influence of the program on the long-term interest rates and economic indicators. Whereas, this research provides a complete solution to the literature gap by studying the influence of all the quantitative easing related announcements made by ECB from June 2014 to January 2017, or the whole period of extended asset purchase program conducted by ECB.

The research questions that the study aims to answer is that if the ECB announcements related to quantitative easing influence the long-term interest rates via influencing the 5-year government bonds. If the impact on the 5-year government bond yield is only influenced by those ECB announcements that contain new information related to asset purchase program. If the impact of quantitative easing or asset purchase program is larger on the weaker Eurozone economies namely Spain and Italy, as compared to the impact of the same program on stronger Eurozone economies including Germany and France

This research uses the event-study analysis methodology. Under the event study method, the research first estimates the abnormal variation in the yield of 5-year government bonds of the four largest Eurozone economies around the announcements made by European Central Bank regarding the quantitative easing or asset purchase program in the monetary policy statement. Later the study evaluates if abnormal variation in 5-year government bond yield around such announcements has statistical and economic significance. The sample of four 5-year government bonds of the four largest economies of Eurozone, namely Germany, France, Spain, and Italy, are considered for the research..

The research made key contributions to the literature on the subject of quantitative easing focused on the euro area. The statistical results of the research conclude that the ECB announcements negatively (decrease) influence the 5-year government bond yields. While the event-study results and the hypothesis revolve around measuring the effectiveness and influence of the non-conventional monetary policy tools used by ECB, the study also discovered a key pattern that the influence of such asset purchase program is much larger on weaker economies of the dataset like Spain and Italy, as compared to strong candidates i.e. Germany and France. The study also discovered that the abnormal variations in yields only occur around those central bank announcement that has a surprise element or that has a new information related the monetary policy.

The results of the study also show economic significance. The results show that at the initiation of the asset purchase program or quantitative easing, the inflation rates across Europe were between -1% to 0.8%, which is far below the optimal inflation rate of 2%. However, at the end of asset purchase program in the first quarter of 2017, the monthly inflation rates in Germany, France, Spain and Italy has increased to 2%, 1.4%, 2.6% and 2% respectively. At the beginning of the asset purchase program the quarterly GDP growth rate in sample countries was between -0.2% to 0.4%, whereas, at the end of the asset purchase program or quantitative easing in the second quarter of 2017, the quarterly GDP growth rate of Germany, France, Spain and Italy increased to 0.6%, 0.5%, 0.9% and 0.4% respectively. Hence all the results derived from the event-study analysis are consistent with the hypothesis proposed under this research.

JEL: E31, E4, E5

Keywords: quantitative easing, ECB, QE, event study, money market, bond, euro bond market

List of Abbreviations

ABS   : Asset-Backed Securities
ABSPP : Asset-Backed Securities Purchase Program
APP   : Asset Purchase Program
BoE   : Bank of England
BoJ   : Bank of Japan
CBPP   : Covered Bond Purchase Program
CSPP   : Corporate Sector Securities Purchase Program
EAPP   : Extended Asset Purchase Program
ECB   : European Central Bank
EC   : European Commission
EU   : European Union
FED   : Federal Reserve
LTRO   : Long-Term Refinancing Operation
MPS   : Monetary Policy Statement
MPC   : Monetary Policy Committee
OMO   : Open Market Operation
PSPP   : Public Sector Securities Purchase Program
QE   : Quantitative Easing
Yr   : Year
ZLB   : Zero Lower Bound

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1. Introduction

After the financial crises of 2008 and the great depression, the global economies slowed and the most advanced economies like the U.S, U.K. Japan, and European economies took the biggest hit. The inflation was lowest, deflation in some countries, aggregate demand was sluggish, unemployment was highest, and the public was losing trust in the global financial system. It was the job of the financial institutions to take significant measures to revive the global economy. Many economies already took measures to increase consumption, production, investment, and inflation in the economy by lowering the interest rate to the lowest level. However, once the interest rate becomes zero, the conventional monetary tools of central banks become ineffective. Hence, the central banks resort to non-conventional monetary tools like quantitative easing and credit easing.

This study also focuses on the same subject, it measures the effectiveness of European central bank's non-conventional monetary policy tools. Thought the United States' Federal Reserve, Bank of Japan, and Bank of England used such non-conventional monetary policy, however, the focus of the study is based on European central bank and European economies. On January 22, 2015, the ECB introduced initiated the asset purchase program or the quantitative easing program focusing to empower the Eurozone economy. Be that as it may, there has been a severe

contradiction between ECB member countries regarding monetary strategy's part since the monetary crisis of 2007-2008 (Olson & Wohar, 2016).

In following chapters, as it is discussed under the background heading of the research, why central banks were in dire need of such drastic measures like non-conventional monetary policy tools. Throughout the study, the term quantitative easing and asset purchase program is used interchangeably. The research aims to test the hypothesis to measure whether the non-conventional tool, particularly quantitative easing, is effective in controlling the monetary policy or not. The research is focused on the the largest economies of Eurozone, which collectively constitute more than 70% of the Eurozone GDP. The research uses the event-study methodology to test the effectiveness of ECB asset purchase program announcement or effectiveness of ECB's asset purchase program via signaling and communication channel. In the study tests the hypothesis for the statistical significance as well as the economic significance.

1.1 Background

The financial crises that begin after the bankruptcy of Lehman Brothers in 2008, one of the America's largest investment banks, brought the financial system of the whole world to halt. The most developed and most connected economies were the most severely affected. Trading in the U.S. stock markets was standstill (Wouter J. Den Haan, 2016). In order to calm down markets, the central banks around the world lowered the policy rate and took many measures but none of them could fully absorb the effects of the crisis. The central bank, conventionally, has three monetary tools to operate its monetary policy or change its interest rates (policy rates and interest rates are used interchangeably). These tools are discussed in detail in the following chapter. Central banks have two types of monetary policies, contractionary and expansionary. The decrease in policy rates mostly affects the short-term interest rates, but since the institutional investments take longer period it is necessary to change long-term interest rates as well. In the aftermath of financial crisis, there was dire need of expansionary monetary policy to stimulate the growth and bring the inflation to nominal rate. In expansionary monetary policy, the central bank decreases the rates to make the finance cheaper for institutions and household so the institutions can acquire cheap financing to expand their businesses and households can get cheap loans to increase spending activity which will stimulate the GDP and will have the trickle-down effect of inflation and employment. The decrease in policy rate is carried out by central banks by purchasing government securities from banks. Since it is difficult to lower the interest rate below zero, central banks' monetary policy is restricted by zero lowered bound (ZLB). This severity of financial crises and the inability of conventional monetary policy tools forced central banks to resort to unconventional monetary tools like quantitative easing (QE) or Large-scale asset purchase programs (LSAPs). The Bank of Japan used QE during 2001-2006, followed by Federal Reserve (FED) and Bank of England (BoE) in

2008 and 2009, respectively (Christensen & Krogstrup, A Portfolio Model of Quantitative Easing, 2016).

As Europe was severely hit by the crises and the conventional measures did not help it to fully recover, therefore, the European Central Bank's (ECB) QE program was necessary given the slow growth and the uncomfortably weak inflation in the euro area (Levy, 2014). However, the European economies were growing at a slower rate, but the aggregate demand was too low to facilitate healthy real growth.

In the Eurozone's real GDP growth outlook is demonstrated in Figure 1, the GDP Growth rate fell from 3.0% in 2007 to -4.4% in 2009 in the aftermath of financial crisis. Since 2007, Eurozone GDP has taken double dips below the 0% GDP growth rate. The second dip of Eurozone's double-dip recession occurred in 2012 with the GDP growth rate of -0.5%, since then the GDP has grown moderately with the peak of 2.2% in 2015, which is far below the nominal GDP growth rate. The latest forecast shows a drop in GDP growth to 1.7% in the third quarter of 2016.

Figure 1: GDP Growth Rate of Eurozone

P*= Forecast Source: (EUROSTAT, 2017)

The inflation has also fallen from the level of 2.6% in the first quarter of 2012 to -0.5% in first quarter of 2015. Eurozone's inflation jumped to 0.13% in the second quarter of 2015, a month after the ECB's Asset Purchase Program. According to the latest data, the Eurozone Inflation was recorded at 0.3% in the third quarter of 2016, which is again less than the desired inflation level of around but below 2%.

With slow growth and low inflation in Eurozone economies, there was strong need of quantitative easing or LSAPs. The Quantitative easing as unconventional monetary policy tool works in a very different manner than conventional tools. First of all, where conventional tools affect short-term interest rate through buying and selling of short-term government securities, the quantitative easing affects long-term interest rate by buying long-term government bonds, mortgage back securities and in some cases even corporate bonds (Greenwood & Vayanos, 2015). Secondly, these purchases are a very large scale as compared to the conventional tool. For instance, since the

beginning of QE in the United States in 2008 the assets size of Federal Reserve has more than tripled (Fawley & Neely, 2013) (Briciu & Lisi, 2015). Thirdly, the quantitative easing works through different channels of transmission, some of these channels are Signaling Channel, which means when central banks purchases assets with QE to lower the long-term interest rates, it sends a signal of lower future long-term interest rates (Christensen & Rudebusch, 2012). The second channel is Supply Channel, in which central bank decreases the supply of securities with long-term maturities by acquiring them in QE hence it increase their price and lower its rates (Gagnon & Raskin et al, 2011).

This research is aimed to find the evidence if the QE actually decreased long-term interest rate. The research will use the event-study methodology to calculate the decrease in the interest rate on important event dates. Literature provides very little evidence of an empirical study that gauges the effectiveness of QE. The studies of Greenwood & Vayanos (2008); Gagnon, Raskin, Remache, & Brian Sack (2011); Krishnamurthy & Vissing-Jorgens (2011); Bauer & Neely (2012); D'Amico & King (2013) and Christensen & Rudebusch (2016) uses event-study methodology to measure the impact of unconventional monetary tool used by Federal Reserve, these studies provide the evidence of between of 45 to 55 basis points decrease in 10-year US Government bond yield with the purchase of assets equaling 10% of GDP (Gagnon, 2016).

Whereas, in Eurozone, there has been comparatively less research to gauge the effectiveness of unconventional monetary tool i.e. QE. One of the reasons for this insufficient studies is that the ECB's asset purchase program started later in 2015. According to Middeldorp (2015) ECB's asset purchase program with the assets equal to 10% of the GDP can decrease the interest rate on 10-Years government bond by 45 to 130 basis points, Altavilla, Carboni, & Motto (2016) suggests the decrease of 44 basis points and as per the study conducted by Andrade, Breckenfelder, De Fiore, Karadi, & Tristani (2016) the 10-year government bond yield dropped 20 basis point due to ECB's asset purchase program.

1.2 Research aim and objectives

This paper will make a significant contribution to the scarce literature on the subject of non-conventional monetary policy tools, also known as Quantitative Easing. Using an event-study approach, this study provides an impact analysis of European Central Bank's asset purchase programme (APP) on the yields of European government bond with long-term maturities. The ECB's APPs were announced on 22nd January 2015 (ECB, 2015) and initiated on 9th March 2015, since the program has been recently initiated, there have been a small amount of the literature or studies published on the impact of ECB's QE. Therefore, the paper empirically analyzes *the Effectiveness of ECB's unconventional monetary policy tool in major Euro economies.*

The aim of this study is to identify and estimate the impact on the yields of long-term government bond on the announcement date. This paper also aims shed some light on the impact of long-term yield curve on macroeconomic variables in Eurozone economies.

1.3 Research Question

Like every study and research is based on either exploring a new concept or validating the existing theory, the research is also based on the theory that already exists, however, the effectiveness of the theory is not researched or studied sufficiently. The study aims to evaluate the effectiveness of the non-conventional monetary tools such as quantitative easy while studying its influence on the European economy. In other words, it analyses the effectiveness of European Central Bank's asset purchase program (quantitative easing) and its effects on long-term interest rates. This research will answer the following questions:

- *Does the non-conventional monetary policy tool like quantitative easy used by ECB, influence the long-term interest rates or yield through its announcement (communication mechanism)?*
- *Does the bond the yield only influenced by the ECB announcements that contain surprises or no new information?*
- *Do the non-conventional monetary tools have same effects or influence on the bond yields across Europe or it affects each economy differently?*

1.4 Hypothesis

Following are the hypothesis that the research intends to test based on the research questions

Hypothesis 1

H1: The ECB announcement (events) does not influence the yields of government bond with 5-year maturity

H_a 1: The ECB announcement (events) influence the yields of government bond with 5-year maturity

Hypothesis 2

H2: The bond yields are influenced by ECB announcements that only contain new information

H_a 2: The bond yields are influenced by ECB announcements that contain only new information

Hypothesis 3

H3: The impact of ECB announcements on the bond yields of the weaker economies like Spain and Italy is same as the impact on the bond yields of stronger economies like Germany and France.

H_a 3: The impact of ECB announcements on the bond yields of the weaker economies like Spain and Italy is larger than the impact on the bond yields of stronger economies like Germany and France.

1.5 Data

The dataset used for this research is composed of daily yields data of 5-Year Government Bonds, covering the period from September 2014 to 2017. The research focuses on four major Eurozone economies i.e. Germany, France, Spain and Italy for the research because these four specific countries as these countries represent 75% of Eurozone GDP. The research has selected the 5-Year maturity bond yields for the analysis. Past studies done on QE program in the U.S and APPs in Eurozone has, mostly, focused on the 2-year to 10-year maturity bracket, with the 5-year maturity in the middle of that spectrum (Gagnon, Raskin, Remache, & Sack, The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases, 2011) (Falagiarda & Reitz, 2015). That being said, as they the 5-year bond is the 'midpoint' of the yield curve, the research selects the-the daily change in yield data of bonds with 5-year maturity for the analysis.

While reading the literature on the similar subject, it was discovered that there is no detailed and updated study available that evaluate the affected of ECB announcements on government bond yields until 2017. Therefore, this study covers all the significant asset purchase program-related announcements from 5th of June 2014 to 19th of January 2017. The study considers all the monetary policy announcements, including those that did not carry any surprise announcement or any news related to changes in ongoing conventional and unconventional monetary policy stance

1.6 Methodology: Event Study

This paper uses event study methodology to measure the effect caused by the ECB's APP-related announcement on the yields of bonds issued by the government of four major Eurozone countries. For the purpose of impact analysis of ECB's asset purchase programme (APP) on the yields of European government bond with long-term maturities, the method of choice is event study. Event-study analysis method was first proposed by Fama, Fisher, Jensen and Roll in their paper published in 1969 (Fama, Fisher, Jensen, & Roll, 1969). Their paper was focused examined the effect of the event (or announcement) of a stock split on stock returns around the event date (or event window).

First, the Abnormal Variations in the Yield of 5-year government bond around the selected Event or ECB announcement dates is calculated. Once the abnormal variation is calculated, it is then tested for statistical significance. If the abnormal variation has statistical significance, it can be concluded that the event under the sample

had a statistically significant effect on the yields of government bonds of selected Eurozone economies.

1.7 Research limitations

One of the limitations of the study is that the direct influence of QE can only be seen on Long-term interest rate (Greenwood & Vayanos, 2015), all other economic variables have transition effects of Q.E. Therefore, the direct impact of Q.E on other macroeconomic factors like Household consumption, institution investment, employment, housing prices, and CPI cannot be established. As there are other factors that, influence these variables. In addition, the macroeconomic data is published on monthly basis and in some cases weekly, while the study focuses to estimate the impact of QE announcement on daily variations in the yield curve.

Lastly, as per my knowledge, there has been very small amount of event study researchers on the announcement of the QE program of the ECB. Therefore, the results could not be compared to other studies for validation. However, the studies conducted by the Bank of Japan, the Fed in the US and the Bank of England on the subject of the asset purchase program are available.

1.8 Outline of the thesis

The outline of the study provides a snapshot of all the chapters included in the paper. The study has four chapters in total. The paper begins (**Chapter 1**) with an overview of the current economic situation in Eurozone and ECB's initiatives to coup with the current situation. The chapter also briefly discusses the conventional and unconventional monetary tools available to the central bank and lastly, mentions the aims, objectives, and limitations of the study. **Chapter 2** provides a description of the ECB's conventional and unconventional monetary policy tool. Later, it will discuss the detailed technical aspects of the recently announced QE programme by ECB. **Chapter 3** will discuss everything about event-study methodology; the chapter will begin with the description of the rationale behind selecting the event-study methodology and its implications. The second part of Chapter 3 will discuss the sample size, sample data and the motivation behind the selection of sample data. The results of event study are discussed in the last part of chapter 3. The **Chapter 4** of the paper provides the conclusion of the whole research and translates the empirical results of a study into economic rationale. **Chapter 5 & 6** includes discussion analysis and conclusion, which will also discuss the impact of ECB's asset purchase program on macroeconomic variables and asset prices.

2. Literature Review

2.1 Conventional Monetary policy Tools

Monetary policy refers to actions of a central bank with regards to determining or influencing the quantity of money in circulation and credit within the economy or money supply. Also, one of the major objectives of the policy is to ensure financial stability and price stability.

The central banks around the world traditionally use quite a number of instruments to accomplish its objectives. Some of them include bank rate variation policy, open market operations, changes in reserve ratios, and selective credit controls. The following are the three main tools used by the central banks to implement monetary policies:

2.1.1 The Central Bank's Policy Rate

The interest rate or what is also called the bank rate is the most used tool of the central bank to express its policy intentions to the commercial banks, to the entire financial system and to the economy in general. Normally, the central banks only transact with the commercial banks and other financial institution. Therefore, when an interest rate is announced by the central bank, it is letting the public know at what rate it is willing to lend to the commercial banks. When the central bank wishes to reduce the amount of money in circulation (money supply) within an economy, it could increase its interest rate (policy rate or bank rate). When the interest is increased, the commercial bank would have to reduce their lending (loans) because if the commercial banks run short of fund they will have to borrow from the central bank at the interest rate set by the central bank. Similarly, the central bank would reduce its interest rate if it wished to increase the amount of money in circulation within the economy.

2.1.2 Open Market Operation

The open market operation is another widely used tool that refers to a case where the central bank buys and sells securities in the money market. When there is a price rise (inflation), the central bank sells securities. The commercial bank's reserves are decreased and, therefore, cannot be in a position to lend more to the business community. This leads to a decline in investments and prices are restrained from rising. On the other hand, when recessionary forces decrease the prices, the central bank purchases securities in order to increase the commercial banks' reserves. This enables commercial banks to lend more to businesses which in turn increase their investments and prices in general economy.

2.1.3 Reserve Requirement

The law requires commercial banks to keep a certain percentage of their total deposit as a reserve and also a certain percentage with the central bank. When there is a price rise or inflation in the economy, the central bank raises the reserve ratios and, therefore, commercial banks are left with less money to lend the businesses. When businesses have less money to invest it will decrease the demand and eventually, the prices will fall. The opposite is also true. In other words, the higher the reserve requirement, the less money the commercial banks can create hence if the central bank wants to reduce the money creation power of the commercial banks, it could easily increase the commercial bank's reserve requirements.

2.2 Unconventional monetary policy tools

2.2.1 Quantitative easing

Quantitative easing comprises of purchasing different sorts of financial assets by central banks, e.g. long-maturity government bonds or loan sponsored securities, with the goal of increasing the money supply in the economy (beginning with an expansion in the fiscal base) and decreasing the yields on less-risky assets, which ought to be useful for a definitive objective of reigniting financial development (Armstrong, Caselli, Chadha, & Den Ha, 2015).

Quantitative easing is expansionary monetary policy stance of the central bank. It involves the purchase of a large number of assets or an open market operation on a larger scale. The central bank, under QE, increases the liquidity or money supply in the economy through purchasing financial assets from its member banks. These assets are not limited to government securities.

In other words, when at some point when the central bank chooses to increase its balance sheet, it needs to pick which assets it can purchase. In principle, it could buy any asset from any institution, but in case of quantitative easing, it is centred around purchasing longer-term government bonds from banks. The central bank's activity of purchasing these assets has twin benefits: Firstly, when the central bank acquires sovereign bonds, whose yields fill in as a benchmark for evaluating less secure corporate securities, the yields on risky corporate securities decrease in along with the government securities' yields. Secondly, the decrease in long-term interest rates stimulates longer-term investments and aggregate demand (Smaghi, 2009).

2.2.2 Credit easing

Credit easing is another non-conventional monetary policy tool used by central banks to increase liquidity or ease the credit conditions in the economy through purchasing private-sector securities from its member banks. The purpose of credit easing is to

expand the liquidity in the problematic economy and encourage banks to lend and invest more.

The example of credit easing can be seen in the United States in the aftermath of 2009 credit crisis when the central bank of the United States (Fed) started purchasing mortgage-backed securities from its too big to fail banks, whereas in Europe and the U. K. the ECB and BoK started acquiring corporate debt from its financial institutions.

2.2.3 Forward guidance

Forward guidance is another important but infrequently used non-conventional monetary policy tool, it operates through a strategy where the central bank shows or depicts its sentiments or willingness to keep the interest rates at a particular level for a certain period of time. The goal of this non-conventional tool i.e. forward guidance is to navigate the long-term interest rates and market expectations.

2.3 European Central Bank's Unconventional Monetary Policy Tools

The non-conventional monetary policy tool is commonly known as quantitative easing in the United States and the United Kingdom, but in Europe, the European Central Bank prefers to call it Extended Asset purchase program (EAPP). The ECB's extended asset purchase programme has the following backbones named as Asset-Backed Securities Purchase Program (ABSPP), Covered Bond Purchase Program (CBPP3), the Public Sector Purchase Program (PSPP) and the Corporate Sector Purchase Program (CSPP) (ECB, 2017).

2.3.1 Asset-Backed Securities Purchase Program (ABSPP)

The key purpose of launching the Asset-Backed Securities Purchase Program (ABSPP) was to enhance the transmission of monetary policy, increasing the level of credit to the central European economies and to create a soft and acceptable image to other markets. Thus the result was that the European Central Bank's monetary policy take a marvellous position, as it helped the ECB to increase the Eurozone inflation to the target level of 2% (Jäger & Grigoriadis, 2017). The ABSP program facilitates the banks to diversify their funding sources and motivates them to issue new securities. Asset-backed securities (ABS) enable banks to contribute to the expansion in the economy by providing finances and funds to the different sectors of the economy which help the economy to grow. Through ABS banks can securitize its outstanding loans and sell it to central banks, and the funds received in return from central banks enhance the bank's capacity to lend more funds.

The purchase of asset-backed securities under the ABSPP program is conducted through the central bank of each country or each member economy of Eurozone. Following are some of the largest and most important central banks of Eurozone that

were designated to perform the purchase under the program, the Central Bank of Germany (Deutsche Bundesbank), National bank of Belgium (Nationale Bank van Belgique), central bank of Spain (Banco de España), the central bank of Italy (Banca d'Italia), the national bank of France (Banque de France), and the bank of Netherland (De Nederlandsche Bank). These banks were responsible for allocation and securities selection under the ABSPP.

The ABSPP was launched at the end of 2014, at the time when it was needed the most. It is considered one of the most significant ECB's asset purchase programmes that helped in kicking the inflation and growth of Eurozone economy. (Claeys, Leanardo, & Mandara, 2015).

2.3.2 Corporate Sector Purchase Program (CSPP)

By the mid of 2016, the European Central Bank (ECB) prepared an execution plan and decided to establish a new program named as Corporate Sector Purchase Program (CSPP) to buy euro-denominated AAA-rated bonds, usually issued by non-financial institutions that were effectively established in the Eurozone. In the return of implementing this program and collaboration with the other non-standard monetary measures in place, the CSPP was targeted to deliver additional monetary policy development and facilitate the inflation rates to reach close to, 2% in the near term (ECB, 2017).

Only those financial assets and securities were purchased under CSPP program that fulfilled the requirement of Eurosystem framework for collateral. The securities issued by financial institutions and the organizations whose parent company is a financial institution, particularly a bank, are excluded from the eligible assets to be purchased under the program.

2.3.3 Public Sector Purchase Program (PSPP)

In December 2015, the European Central Bank also decided to establish the public sector purchase programme (PSPP) under the terms and conditions established by the member states. The assets eligible to be acquired under the PSPP are comprised of the nominal and inflation-adjusted sovereign bonds that were usually distributed by familiar agencies, regional and local governments, global organizations and multinational development banks which were headquartered in the euro area (ECB, 2017).

2.3.4 Long-Term Refinancing Operation (LTROs)

The European economists and central bankers coined the term LTRO in the aftermath of 2008 financial crisis. The abbreviation of the LTRO is "Long-term refinancing operation". LTRO is a monetary policy tool used by European Central Bank. The

purpose of LTRO is to provide funds to the ECB member banks at a very low or zero interest rates in the euro area.

All the banks that are the member of ECB or EU and willing to participate in LTRO may do so. The Banks take part in this as long as the banks deliver competent security as the collateral against the funds borrowed under LTRO. There are hard and fast rules for the securities that qualify for collateral, however, the banks can only place A-rated securities as collateral. The procedure of conducting LTRO is well established, electronic and automated.

ECB directly accepts and reserve collateral securities at its headquarters, otherwise, to the central national bank of the country of the borrowing member bank, as a "provisional solution." For Instance, Spanish banks are able to access LTRO funding by pledging securities to the Central Bank of Spain rather than directly to the ECB (Babecka Kucharcukova, Claeys, & Vasidek, 2016).

ECB increases the money supply in the member economies through lending funds to the member bank against the collateral. ECB disburse these funds on monthly basis and are normally repaid annually, semi-annually, and quarterly (Armstrong, Caselli, Chadha, & Den Ha, 2015).

2.3.5 The LTROs are structured to have a two-fold impression
There are two main benefits attached to LTROs as discussed below:
A. The declined yield on government bonds
By placing the own government-issued debts as a collateral under LTRO program, the member countries can increase the demand for their local bonds and thus decrease the yield on these bonds.
B. Increased liquidity
The funds that member banks receive under LTRO, increase the lending capacity of the member banks thus increasing the money supply and liquidity in the economy. The higher money supply will enable banks to lend more, that will help increase the consumption, expenditure, aggregate demand and at last, the economic activity in the economy. The lower yields and greater money supply will also motivate corporations to invest in more risky projects and asset with the motivation of earning higher profits, thus accelerating the activity in general economy.

2.4 Theoretical Fundamentals of Quantitative Easing
During the financial crises of 2008, some of the world's largest financial institutions, including investment banks and insurance companies, failed that brought the financial system of the whole world to halt. The most advanced economies were the most severely affected. The capital markets and banking activities in many of the world's largest economies were a standstill. In order to calm down markets, the central banks

around resorted to conventional monetary policy tools lowered the policy rate and took many measures but no avail. Even their most radical and strong policy structure seemed unsuccessful to stop the slowdown in economic activity and decreasing prices. In addition, the short-term nominal interest rates fell to zero percent or even below than zero percent. The Central banks initiated to implement numerous eccentric and alternative monetary policies as there was no choice left behind to handle the short-term nominal interest rate. The first choice of the central banks from the arena of non-conventional monetary tools was "Quantitative easing (QE)" as it was previously tested and successfully applied in the Japanese economy in 2001 by the Bank of Japan. The United States central bank (Fed) conducted the QE in 2008, the Bank of England (BoE) in 2009, the Bank of Japan (BOJ) in 2013, and lastly the European Central Bank in 2015.

In no time, QE has accomplished the noticeable result, although that was not necessarily sufficient to make up for the damage done by the crisis. Academics understanding, though fairly short, demonstrate that it takes quite long for QE to have noticeable effects. Thus, it can be stated that the central banks that formed QE early in the global financial crisis appear to have effective paybacks from the policy, while the others that delayed implementing QE would have to wait to reap its fruit. The complex mechanism of quantitative easing has reserved attention of a large number of researchers, economists and central bankers, however, there has been no milestone development in theoretical working behind the QE mechanism, as the former Federal Reserve Chairman Ben Bernanke during his memorable speech said, "The problem with QE is it works in practice but it doesn't work in theory" (2014). As the matter of fact, standard theoretical models appeared to reject the efficiency and impact of QE altogether or to estimate it at most quite inadequate. For instance, (Eggertsson & Woodford, 2003) recommended the inappropriateness intention, which states that a growth in base money has no effects on the economy when the policy interest rate has hit the zero (Christensen & Rudebusch, 2012).

The asset that is purchased by central banks in QE usually can either be of government bonds (or bills) or it may be the assets issued by the private sector. The purchasing of assets is quite different with the scenario where decisions about a target of a policy statement, are made on the basis of explicitly about quantities. (Ambler & Rumler, 2017).

Some of the important researchers on the subject of quantitative easing have based on the questions like what is the mechanism by which the real cost and accessibility of loans to the private sector are most affected? How can QE accelerate demand in the economy? Is it only acquisitions of private sector assets that affect the asset prices? Or can acquisitions of sovereign bonds and bills also have an effect on it? How does the combination of assets procured by the central bank affect debt securities?

Sargent & Wallace (1984) were the first to answer some of these questions regarding the difference of the effect of private sector securities and public sector securities. The principal outcome of their study concluded that the government debt securities purchased under quantitative easing will have a lasting effect on the interest rate or yield of private sector assets are based on the benchmark i.e. government securities. Andrade et. al, (2016) represented a model with the inadequate participation of banks in financial markets fixed in a DSGE model with distinguished preferences for securities. In the above-mentioned model, purchases made by the central bank shows that some types of asset purchases by the central bank can affect demand, supply and output differently (Cúrdia & Woodford, 2011).

Before the financial crisis, the researches done the subject of asset purchase programs of quantitative easing has focused on it influence or impact on capital markets. Most of the researchers study the programs conducted by BoE or Fed. Gagnon et al published a significant research which is considered as the milestone and a key contribution to the literature on quantitative easing. The study is also aligned with the framework introduced by Gagnon. He studied the Fed's large-scale asset purchases (LSAPs) during 2008. Using both of statistical event, studies around key announcements by Fed regarding the program and time series regressions relating risk premia of government bonds, he concluded his research with the key finding that quantitative easing program reduced the interest rate or yield on 10-year U.S sovereign debt by approximately 1%. A variety of succeeding research has also established that the Fed's QE programs were successful in reducing medium and long-term interest rates, comprising those by (D'Amico & King, 2013), (Krishnamurthy & Vissing-Jorgens, 2011), (Hamilton & Wu, 2012), (Swanson, Reichlin, & Wright, 2011) used the modern event study methodology on the previously conducted asset purchase programs by the United States in 1961 has the similar successful effects on Treasury yields as LSAP1 and LSAP2.

Their study also brought forward key findings that the Fed's asset purchase program not only affected U.S debt securities but it also has a spillover effect on international debt markets and also influences the exchange rate against U.S Dollar. Joyce & Tong (2012) initiates the similar study based on the case of the United Kingdom or Bank of England's asset purchase program and they also found out that BoE program has significant effects on the yields of U.K government bonds, also known as gilt.

Based on the statistical evidence derived from event study methodology, Joyce & Tong concluded that the primary asset purchase related announcements made by Bank of England negatively influenced the U.K government bond yields by 35–60 basis points with short-term maturities as compared to the 1% drop in the yields of medium or long-term government bonds issued by the U.K. They also used 2-days window

around the Bank of England announcements regarding asset purchase program in the sample period of 2009 to 2010. Their findings also established that there was a decline in the yield of the corporate bond as well due to the BoE asset purchased. They also noticed some influence on the valuation of the sterling against its major pairs. The scope of these findings was approximately in line with the calculations of portfolio choice models projected over the period before the financial crisis of 2008-9, which also established that asset purchase program may have a positive impact on equity assets.

Event study methodology is a most suitable method of analysis on the subject of evaluation of the effectiveness of asset purchase program or quantitative easing. The most critical decision that researchers take while using event study methodology is the selection of appropriate event window, or the selection of the number of days before and after the event, that are appropriate to reflect the impact of the event on the yield or return. As an example of this, Joyce et al. (2012) emphasized that selecting a one-day instead of a two-day window to find the impact of United Kingdom quantitative easing events. Joyce and Tong (2012) observe the suitable window length on the basis of a comprehensive description of the events following each of the Bank of England's QE related event (announcement) they analyze. They concluded that the U.K bond market quickly reflected the news related to the quantitative easing in the bond prices, which is why one-day event window is sufficient to evaluate the majority of the impact or influence of QE related announcement on the U.K bond yields or Gilt yields.

Despite the fact that there are quite different estimations by the academics but all of them conclude that there is a sufficient evidence in the literature that proves that central bank asset purchase program has economically significant effects, at least on government bond yields. Nevertheless, this subject demands more research and studies that can appropriately study the true mechanism that influences the asset prices by the purchase of assets by central banks, particularly it requires to emphasize on the transmission channel of asset purchase program. The studies by D'Amico and King, (2010), Gagnon et al., (2011), Joyce et al., (2011) are a consensus that the central bank's asset purchase program surely influences the asset prices, particularly bond yields.

Another notable research by Krishnamurthy and Vissing-Jorgensen (2011), underlined the comparative status of signalling effects and what they term a 'safety channel' in enlightening the influence of the central bank's asset purchase program through the event study analysis. Christensen and Rudebusch (2012) conclude that the Fed's LSAPs primarily worked through a signalling channel, though their outcomes recommend the portfolio balance channel was more imperative in clarifying the decline in United Kingdom yields in response to Quantitative Easing.

Wright (2011), in his research, studied the effects of United States' monetary policy on economic indicators throughout the financial crisis by using an auto-regression model, which showed that the fluctuation or variation in indicators are

larger on the days the monetary policy statement contained any new information regarding asset purchase or QE program, The key outcome from the analysis is that although the unconventional policy has substantial effects on financial variables beyond Treasury yields, those effects disappear very quickly, with a half-life of a few months.

3. Research Methodology

3.1 Event Study

For the purpose of impact analysis of ECB's asset purchase programme (APP) on the yields of European government bond with long-term maturities, the method of choice is event study. Event study analysis methodology was initially coined by Fama, Fisher, Jensen and Roll in their paper published in 1969 (Fama, Fisher, Jensen, & Roll, 1969). Their paper was focused examined the effect of the announcement (or event) of a stock split on stock returns around the event date (or event window). This paper revolutionized the research methodology in the field of accounting, finance, and economics. Later, Mackinley (1997) suggested that the most robust method to investigate the impact of an event on stock market returns is the event study methodology, which differentiates the pre -and post event dynamics in security prices or returns, in other words, it compares the normal security returns prior to an event with the post event's return. This difference between normal (actual) behaviour and expected behaviour is known as "abnormal" return. In current date, the event study methodology is being greatly used in the numerous disciplines to evaluate the behavior of security or asset's prices and returns around events such as new regulations, ratings, changes in accounting rule, merger & acquisition announcements, earnings announcements, monetary policy announcements and the announcement related to important economic variables such as interest rates, CPI, payroll, GDP growth etc. (Binder, 1998). In post-financial crisis and after the introduction and implementation of unconventional monetary policy tools i.e quantitative easing or asset purchase programme, the use of event study methodology has gained increasing attention of researchers and institutes evaluating the effect of such unconventional tools on the yield curve of long-maturity assets.

Some notable event studies that have been recently conducted to evaluate announcement effects of policy measures are done by Swanson that measured the impact of six announcements related to Operation Twist and QE3 on the on longer-term Treasury Yield (Swanson, Reichlin, & Wright, 2011). Daniel L. Thornton conducted an event study of QE announcements on the yields of long-term U.S treasury bonds (Thornton, 2013). The event study methodology has become the standard methodology of measuring security returns and price reaction to some influential event or announcement.

3.1.1 Econometric methodology

This paper uses event study methodology to measure the effect caused by the ECB's APP-related announcement on the yields of bonds issued by the government of four major Eurozone countries. The event study method was first used to evaluate events like M&A transactions, issuance new debt or equity, or announcements related to macroeconomic indicators, on firm value by estimating the abnormal variations in asset prices around the event or announcement. The original basic model measures of normal and abnormal returns. The normal return is defined as $E[R]$ that is the expected return assuming that the event did not take place. While, R represents the return for firm at a given time. On the other hand, the abnormal return, is defined as the return earned in addition of the actual return at a given time, given the certain event has occurred.

$$A[R] = R - E[R]$$

In the models used for estimated abnormal returns, researchers estimated the expected return or market return using different models, these models include simple mean considering the mean return of security is constant, market model i.e CAPM or Capital Asset Pricing Model and multi-factor market models. Once the abnormal variation is calculated, it is then tested for statistical significance. If the abnormal variation has statistical significance, it can be concluded that the event under the sample had a statistically significant effect on the yields of government bonds of selected Eurozone economies.

The research is measuring the "abnormal variation" or changes in the yields of Eurozone government bonds instead of the "abnormal return". Therefore, using the word "return" and denoting it with R in the equation is inconsistent and incorrect. To correct this misleading error, the "V" is used for measuring the variation in the yield. Thus the formula for measuring the abnormal variation in the yields of Eurozone government bond is

Equation 1: Abnormal Variation

$$A[V] = V_{CE,T} - \mu[V_{CE,T-30}]$$

where A[V] stands for Abnormal variation in yield, $V_{CE,T}$ stands for variation in the yield of the bond of country C during the event E at time T, and the $\mu[V_{CE,T-30}]$ stands for the 30 days average variation prior the event announcement in the yield of the bond of country C around the event E at 30 days prior time T.

The variation in the yield of the bond of country C during the event E at time T is calculated as

Equation 2: Variation in Bond Yield

$$V_{CE,T} = Y_{CE,T} - Y_{CE,T-1}$$

Where, $Y_{CE,T}$ is the yield of the bond of country C during the event E at time T and $Y_{CE,T-1}$ is the yield of the bond of country C during the event E at time $T-1$ or one previous period. This methodology of estimating abnormal variation in the yield curve is consistent with the methods provided by Swanson et. al (2011) and Gagnon et. al (2011). The study uses high-frequency event study data to find significant abnormal changes in yields around the events or announcements.

Once the abnormal variation in the yield is estimated around the event or announcement, the graphical charts are used to analyze the extent of variation around the event. The event or announcement timeline will be presented on the x-axis with "0" denoting the event, "-1" denoting the one-day prior the announcement and "+1" one-day post announcement of the event.

The second part of the research methodology is to measure the statistical significance of the abnormal variation around the announcement date (Gagnon, Raskin, Remache, & Sack, 2011). Using the hypothesis testing approach provided by Gagnon (2011), the hypothesis related to the statistical significance of abnormal variation in bond yield around each announcement are tested. The *Null Hypothesis* assumes that there are no abnormal variations in the bond yield around announcement date. Whereas, the *Alternative Hypothesis* assumes that there is abnormal variation in bond yield around each announcement or event.

Therefore;

$$H_0: A[V] = 0$$
$$H_a: A[V] \neq 0$$

Since the expected variation is the average of past 30 days variation in yield curve or the sample of 30 days variation, T-1=30-1= 29 degrees of freedom and 95% confidence interval are used. As it is a two-tailed test, the research uses student T-table to derive the critical value for hypothesis testing. The critical value of 29 degrees of freedom at 95% confidence interval is -2.045 and +2.045. Thus the rule of hypothesis testing is set to reject the null hypothesis if the t-statistic falls above the 2.045 or below -2.045 critical value, and accept the alternative hypothesis that there is abnormal variation in bond yield around each announcement or event.

Another crucial part of the study is the estimation of t-statistic for the hypothesis testing of significance of abnormal variation in yields around the announcement dates. To test whether that independent variable i.e. announcements or events explain the variation in a dependent variable i.e. bond yields (or statistically significant), the hypothesis that is tested is whether the true slope is zero, therefore, $V_O = 0$. The study uses following formula for calculating t-statistics

$$\text{T-statistic} = \frac{V_{CE,T} - V_O}{Sd_{CE,T}}$$

Where, $V_{CE,T}$ stands for variation in the yield of the bond of country C during the event E at time T, V_O equals some hypothesized value which in this case is zero ($V_O = 0$), and $Sd_{CE,T}$ stands for standard deviation of variations in the bond yields of the country C during the event E at time T. As it discussed earlier the variation in the yield of the bond of country C during the event E at time T is calculated as $V_{CE,T} = Y_{CE,T} - Y_{CE,T-1}$. The formula for calculation of the standard deviation is follow

$$Sd_{CE,T} = \frac{\sqrt{\sum_{T=1}^{n}(V_{CE,T} - \overline{V_{CE,T}})^2}}{T-1}$$

Here, T is equal to 30 days variation. This approach of testing the significance of variation in bond yields due to ECB announcements or event is in consensus with the approaches introduced by Gagnon, et al., (2011) Swanson, et al., (2011) and Krishnamurthy & Vissing-Jorgens, (2011)

Hence, the decision rule for the rejection of null hypothesis that the variation in bond yields is not explained or impacted by the announcement is

Reject H$_O$ if *t-statistic > + t-critical* value **OR** Reject H$_O$ if *t-statistic < - t-critical value*

3.1.2 Event window

This high-frequency data approach i.e. calculating one-day variation, was first used by Swanson (2011) for the Operation Twist. He used this method to find significant results that Modigliani & Sutch (1966) was unable to find in his event study of Operation Twist using quarterly data. Swanson used 1- or 2- day variations in yield of government bonds, considering that this window is sufficed for evaluating the influence of a specific announcement or event on the yield curve, the same approach is used for this research. This approach is consistent with the Efficient Market Hypothesis (EMH) that assumes that the current price reflects the expectation and market sentiments of investors about the economy. As a result, all the relevant information disseminated in relevant announcements is already reflected in security prices.

On the footprints of Swanson's (2011), the research uses the one-day window to evaluate the variation in yields of bonds of economies under the sample.

3.1.3 Past Studies

Following is the list of past studies conducted to evaluate and examine the impact or effect of events or announcements by ECB and ECB officials related to the unconventional monetary tools and asset purchase programs. Some of the studies are conducted by some notable economists, scholars and higher rank officials from European Central Bank.

Many of the studies are conducted using the event study methodology, which motivated us to use the same methodology. However, most of the studies cover the announcements until the end of 2015 or the beginning of 2016, whereas, this research presents the latest findings, as it covers the most recent data related to ECB announcements i.e. until the beginning of 2017.

Table 1 presents some of the significant studies conducted on ECB's non-conventional monetary tools

Table 1: Past Studies on Non-conventional Monetary Policy Tools based on Eurozone

No.	Study	Sample Countries	Sample Time	Sample Instruments	Methodology
1	(Schwaab & Eser, 2013)	Austria, Belgium, Germany, Spain, France, Greece, Ireland, Italy, Netherlands and Portugal	2008-2011	5-year & 10-year bonds	Event Study
2	(Rivolta, 2014)	Austria, Italy, Belgium, Finland, Netherlands, France, Germany, Greece, Portugal and Spain	2007-2012	Government securities with 3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years, 10 years, 15 years, 20 years and 30 years maturities	Event Study
3	(Altavilla, Carboni, & Motto, 2016)	Germany, France, Italy, and Spain	2014-2015	5-year & 10-year bonds	Event Study
4	(Krishnamurthy, Nagel, & Vissing-Jorgensen, 2014)	Italy, Spain, Ireland, Greece and Portugal	2010-2013	6-months, 2-years, 5-years, 10-years government bonds	Event Study
5	(SZCZERBOWICZ, 2014)	Germany, France, Greece, Ireland, Italy, Portugal, and Spain	2007-2012	Bond spreads	Event-based regression

6	(Bluwstein & Canova, 2016)	Czech Republic, Hungary, Poland, Romania, Denmark, Belgium, Sweden, Norway and Switzerland	2008-2014	Economic Variables	Structural Vector Autoregressive
7	(Watfe, 2015)	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Portugal, and Spain	2008-2015	5-year Government bonds	Event Study & GARCH Model
8	(Falagiarda & Reitz, 2015)	Event Study	2008-2012	Long-term bond yields	Event Study
9	(De Santis, 2016)	Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain	2004-2015	5-year & 10-year bonds	Event Study
10	(D'Amico, Discussion of "The Financial and Macroeconomic Effects of the OMT Announcements., 2016)	Germany, France, Italy, and Spain	2008-2012	Long-term bond yields	Event Study
11	(Ambler & Rumler, 2017)	Germany, France, Italy, and Spain	2008-2016	2-year, 5-year, 10-year Government Bonds	Event Study
12	(Markmann & Zietz, 2017)	Germany, France, Spain, Ireland, and the United Kingdom	2006-2015	Bond indices and spreads	Time series

3.2 Data

The dataset used for this research is composed of daily data covering the period from September 2014 to 2017. The four major Eurozone economies i.e. Germany, France, Spain and Italy are used for the research. These four countries are selected as they represent 75% of Eurozone GDP. Past studies done on QE program in the U.S and APPs in Eurozone has, mostly, focused on the 2-year to 10-year maturity bracket, with the 5-year maturity in the middle of that spectrum (Gagnon, Raskin, Remache, & Sack, The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases, 2011) (Falagiarda & Reitz, 2015). That being said, as they have found 5-year 'midpoint' of the

yield curve, the study uses daily change in yield data of bonds with 5-year maturity for analysis.

3.2.1 Sources of Data

The main source of data is European Central Bank's data warehouse, which has the formal responsibility of collecting all the bond yields and prices related data. Some of the data related to economic indicator were taken from Eurostat, European Union;s official website and OECD. The author personally visit ECB and Frankfurt stock exchange to seek the guidance of responsible person working there in data warehouse department.

3.3 Motivation of input choices (Data Selection)

The main motivation for focusing the research on the government bonds yields Germany, France, Spain and Italy is their share in GDP as well as the nature of ECB's asset purchase program. After the exit of U.K from Eurozone in the result of the referendum conducted on 23rd of June 2016, the GDP share of Germany, France, Spain and Italy has increased to as much as 65% of the total GDP of EU.

Another motivation for the selection is the scale and selection of bonds purchased under ECB's asset purchase program. As per the latest APP, ECB decided to purchase assets worth of Euro 60 billion on monthly basis. Assets under this program include asset-backed securities and covered bonds, the debt of supranational institutions located in the euro area and denominated in euros, and sovereign debt securities ranging within the maturities of 2-year to 30-years. As shown in the figure 2 given below, out of the sovereign debt securities category, purchases of sovereign securities from Germany, France, Spain and Italy will make up to 76% of total sovereign debt securities purchased and 56% of total assets purchased under the program (Claeys, Leanardo, & Mandara, 2015).

Figure 2: Share of each Euro Area member in APP
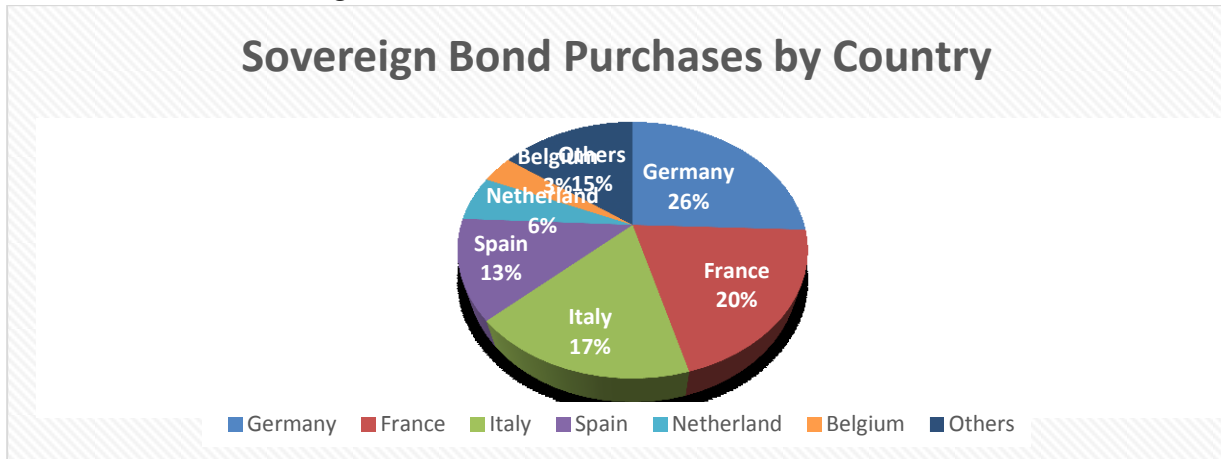
Source: Bruegel, ECB, Eurostat.

3.3.1 Selected ECB Announcements (Events)

While going through the literature on the subject, it was discovered that there is no detailed and updated study available that evaluate the affected of ECB announcements on government bond yields until 2017. Therefore, the research covers all the significant asset purchase program-related announcements from 5th of June 2014 to 19th of January 2017. The research also included those monetary policy announcements that did not carry any surprise announcement or any news related to changes in ongoing conventional and unconventional monetary policy stance to check if all the announcements made by ECB influence the bond yield. Table below shows the selected announcements to be studied in the research

Table 2: Selected ECB announcements

No.	Announcement Date	Program	Description
1	5-Jun-2014	TLTRO1	Decided to conduct a series of targeted longer-term refinancing operations (TLTROs) with for 4-years maturity, borrowing available for counterparty up to 30% of their loan
2	4-Sep-2014	ABSPP	Intended for at least 2 years, starting in Q4 2014
		CBPP3	Bond Purchases to begin in Oct 2014
3	22-Jan-2015	APP1, ABSPP, CBPP, PSPP	Asset purchases of € 60 billion per month to begin from Sept. 2016
4	3-Dec-2015	APP2	Extension of Asset purchase program until March 2017
5	10-Mar-2016	APP3	Expansion of asset purchase program from € 60 bn to € 80 bn per month (Corporate Bonds CSPP)
		TLTRO2	New series of LTRO with 4-years maturity, borrowing available for counterparty up to 30% of their loan

6	21-Apr-2016	CSPP	Corporate sector purchase programme (CSPP) will start from June 2016
7	8-Dec-2016	CBPP3, ABSPP, PSPP or CSPP	From April 2017, the net asset purchases are intended to continue at a monthly pace of €80 billion
8	15-Dec-2016	ABSPP	Asset-Backed Securities Purchase Programme (ABSPP) should be fully implemented by national central banks
9	19-Jan-2017	CBPP3, ABSPP, PSPP or CSPP	No purchases below the deposit facility rate will be conducted under (CBPP3, ABSPP, PSPP or CSPP).

Source: ECB

4. Empirical Results

The empirical results obtained from the Event-study model based on the method provided by Gagnon, et al., (2011) are presented in the following. There is no suitable code or software program readily available till to date, which simplifies the testing and implementation of event-study methodology, therefore, an event-study model in Microsoft Excel was created. The documentation of codes and formulas used in methodology are provided in Excel file.

4.1 Graphical Evaluation

The graphical evaluation results of variation in yield curves of 5-Year Government bonds of Germany, France, Spain, and Italy are presented here. The graphs are categorized on the basis of different events or announcement date. Each graph presents a different event and each graph has four trend lines representing the variation in yield of 5-Year government bond of each country.

The graphs show the impact of each announcement on the yields that can allow us to evaluate which country's debt yields are influenced in what direction and to what extent. European Central Bank announces collective monetary policy stance for all Eurozone economies, however, the stance influences each economy differently (Olson & Wohar, 2016). As mentioned early, the asset purchase program has a different share for each economy, in other words, the assets of each country, under asset purchase program of ECB, will be purchased in different ratios, the impact of the APP will be different on each economy. The influence of ECB announcements regarding APP also depends on the market yields presents at the time of the announcement, which will be explained in detail later in this chapter.

Following figures present a graph for each event or announcement date. The trend lines in each graph are present each economy or country under the sample data, i.e Germany, France, Spain & Italy are presented by Blue, Orange, Grey and Yellow trend line, respectively. The Y-axis or Vertical scale presents variations in yields of 5-Year government bond of each economy under sample, while, X-axis or horizontal scale denotes the number of days before and after the announcement date. 0 indicates the event or announcement date, whereas, -1 and +1 denotes one day before the event and one day after the announcement, respectively.
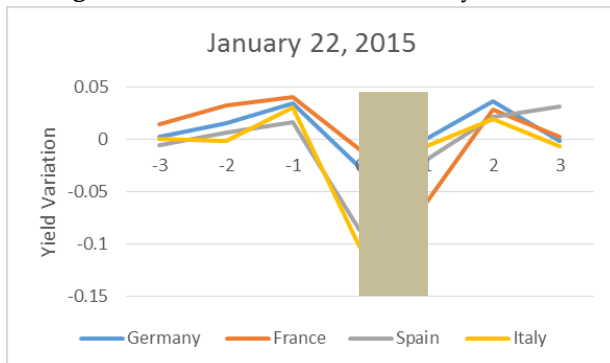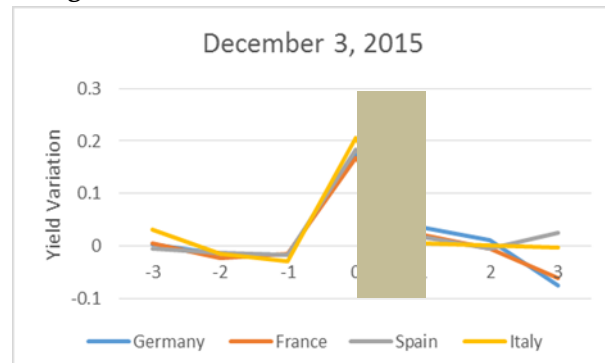
Figure 3: Yield Variation on June 5, 2014
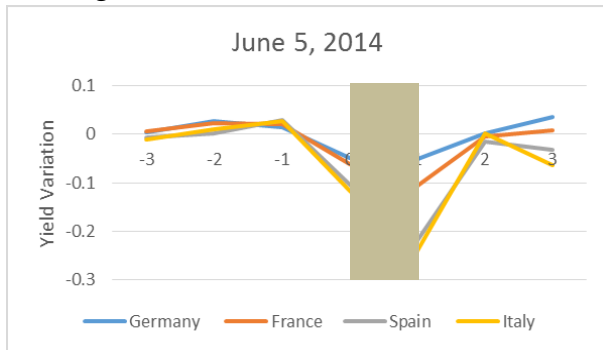
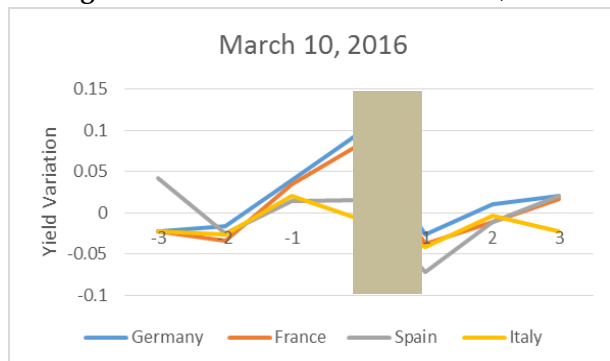**Figure 4:** Yield Variation on September 4, 2014
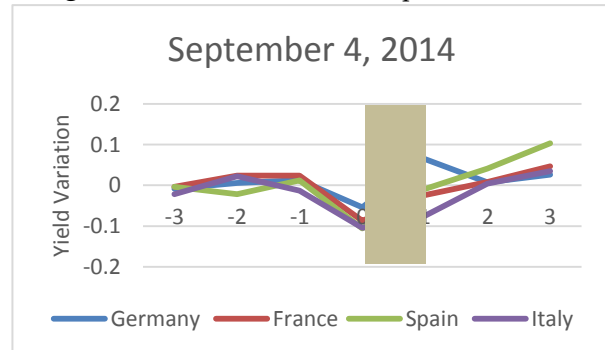
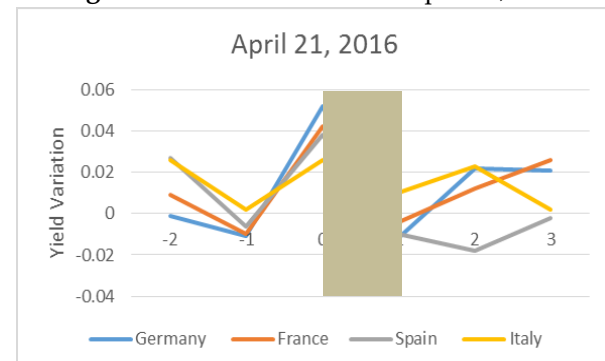**Figure 3:** Yield Variation on January 22, 2015

Figure 4: Yield Variation on December 3, 2015
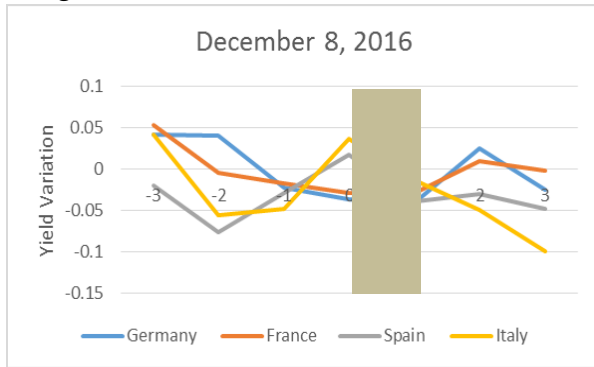

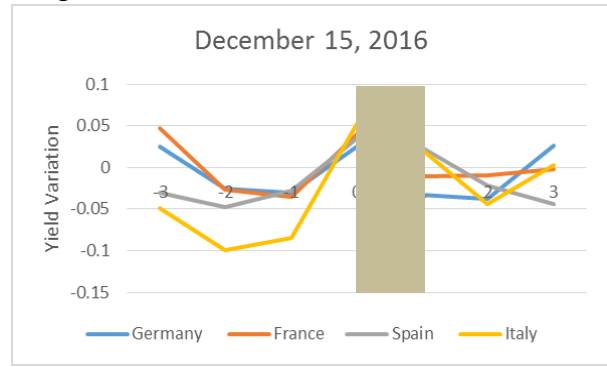**Figure 5:** Yield Variation on March 10, 2016

Figure 6: Yield Variation on April 21, 2016

Figure 7: Yield Variation on December 8, 2016

Figure 8: Yield Variation on December 15, 2016

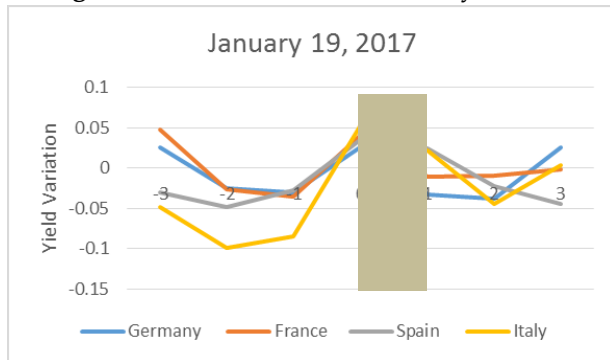**Figure 9:** Yield Variation on January 19, 2017

Figure 3 presents the variation in yield of 5-Year bond on the first event or ECB announcement date of June 5, 2014. As it can be seen the variation in the yield is negative at time 0, the event and yield decrease after time 0. This shows that the ECB's announcement of June 5, 2015, regarding the asset purchase program, decreased the yield of 5-year government bonds of European economies in the sample. The event of June 5, 2014, contains two elements, the ECB cut the deposit rate from 0% to -1%, and the other element, which is more relevant to the study, is that ECB introduced its plan regarding Targeted longer-term refinancing operations (TLTROs) under which the ECB will acquire/purchase the assets from banks to increase liquidity and increase inflation through decreasing yield on government bond. As a result, the yields decreased after the announcement at time 0, which is consistent with the hypothesis under study.

Graphical analysis help solves the Hypothesis 3.

Hypothesis H3: The impact of ECB announcements on the bond yields of the weaker economies like Spain and Italy is larger than the impact on the bond yields of stronger economies like Germany and France.

The graphical evaluation supports the hypothesis that the impact of ECB's asset purchase program is higher on the bond yields of Spain and Italy, while the ECB's decision has decreased the bond yield of Germany and France with a smaller margin. The event or the ECB announcement decreased the 5-year bond yield of Spain and Italy by approximately 10 and 12 basis points, respectively. While the 5-Year yield on

German and French government bond decreased only by approximately 5 and 6 basis point, respectively. The decreased in basis points around the announcement date is provided in Appendix. The larger decrease in the Spain and Italy bond yield is due to the higher negative inflation rates in both the countries.

Figure 4 presents the variation in yield of 5-Year bond on the first event or ECB announcement date of September 4, 2014. It is observed in the graph that the 5-year government bond yield has decreased at time 0 or event date from its previous level at a time -1. This ECB announcement contained further cuts in deposit rate, but the more relevant information to the research is that ECB announced its operational plan for conducting TLROs. It also added that unlike United State FED's QE, ECB will not only be buying government bonds but also corporate bonds, this information caused a slight increase in the yield after the event date due to the selling of government bonds done by bond vigilantes.

Figure 5 to 11 shows a similar trend in bond yields. The 5-year government bond yield of sample European economies fell or decreased at and after the event denoted with "0" on the x-axis or the ECB announcements regarding its asset purchase programs, this pattern is consistent and in line with the literature provided by American and European researchers. Another pattern that the research proposed to evaluate is the similarities in the movement of interest rates or yield in different economies. To evaluate this pattern, two stronger and two weaker European economies are taken in the sample. It can be observed in the Graph A, C, E, F, G, H, and I that the bond yield (interest rates) of strong European economies presented by Germany and France moves in similar trend, which is different from the movement in the yields presented by weaker European economies such as Spain and Italy. The trend is evaluated by observing that the Blue and Orange trend line presenting Germany and France, respectively, demonstrate similar yield movement around the ECB announcement.

Whereas the Yellow and Gray trend line denoting Spain and Italy shows a similar pattern in its yields, however, the yield pattern is different from that of stronger European economies. The graphs also conclude that the impact on bond yields or interest rates is more severe in weaker European economies than it is on the bond yield of stronger European economies that is due to the difference in the state of economies in all the countries. This argument has further discussed the heading of Economic Significance Analysis.

4.2 Event Study Results

Based on this guideline, individual event studies according to MacKinlay (1997) and Rivolta (2014) were performed using the 5-year government bond yield of Germany, France, Spain and Italy around the 9 ECB announcements i.e. the events of the study.

The event study analysis is used as the methodology to test the following hypothesis:

Hypothesis H1: The ECB announcement (events) influence the 5-year government bond yields

Hypothesis H2: The bond yield is only influenced by the ECB announcements that contain new information.

Table 3 presented below provides the support for the hypothesis under evaluation.

Table 3: Results of Event Study Analysis

Results of 1-Day variation in the Yield 5-Year Government Bonds					
Event/ Date		**Germany**	**France**	**Spain**	**Italy**
Thursday, June 5, 2014	1-Day Yield Variation	-0.0480	-0.0620	-0.1040	-0.1170
ECB Announcement with new info.	*P-Value*	0.0516	0.0271	0.0702	0.0506
Thursday, September 4, 2014	1-Day Yield Variation	-0.0540	-0.0870	-0.1060	-0.1040
ECB Announcement with new info.	*P-Value*	0.0099	0.0005	0.0222	0.0093
Thursday, January 22, 2015	1-Day Yield Variation	-0.0160	-0.0600	-0.0860	-0.1150
ECB Announcement with new info.	*P-Value*	0.4939	0.0136	0.0604	0.0006
Thursday, December 3, 2015	1-Day Yield Variation	0.1760	0.1680	0.1840	0.2070
ECB Announcement with new info.	*P-Value*	0.0000	0.0000	0.0000	0.0000
Thursday, March 10, 2016	1-Day Yield Variation	0.0960	0.0820	-0.0720	-0.0070
ECB Announcement with new info.	*P-Value*	0.0309	0.0004	0.2341	0.9446
Thursday, April 21, 2016	1-Day Yield Variation	0.0520	0.0420	0.0380	0.0260
ECB Announcement with no new info.	*P-Value*	0.2219	0.0003	0.1247	0.3819
Thursday, December 8, 2016	1-Day Yield Variation	-0.0360	-0.0290	0.0170	0.0370
ECB Announcement with no new info.	*P-Value*	0.1863	0.4013	0.8063	0.6367
Thursday, December 15, 2016	1-Day Yield Variation	0.0250	-0.0580	-0.0310	0.0520
ECB Announcement with no new info.	*P-Value*	0.3663	0.0263	0.2325	0.4758
Thursday, January 19, 2017	1-Day Yield Variation	0.0230	0.0320	0.0330	0.0310
ECB Announcement with no new info.	*P-Value*	0.2519	0.0878	0.2813	0.3834

0.05	*Significant at 5% Level of Significance as the p-value is less than or equal to 0.05*
0.051	*Significant at 10% Level of Significance as the p-value is between 0.05 and 0.10*

The first hypothesis is to test if the ECB announcements impact or influence the interest rates via influencing 5-year government bond yields of major Eurozone economies. The hypothesis below presents the alternative hypothesis

Hypothesis 1

H 1: The ECB announcement (events) does not influence the yields of government bond with 5-year maturity

H$_a$ 1: The ECB announcement (events) influence the yields of government bond with 5-year maturity

The event study results in Table shows that the ECB announcements (events) have influenced the 5-year bond yields of the sample Eurozone economies i.e. Germany, France, Spain and Italy.

The event or the announcement of ECB dated June 5, 2014, in which ECB introduced the targeted long-term refinancing operation (TLROs), decreased the 5-year

bond yield of Germany, France, Spain & Italy by approximately 5 bps, 6 bps, 10, bps and 12 bps, respectively. The ECB made an announcement on September 5, 2014, that revealed the operation plans of execution of asset purchase program, which negatively influenced the 5-year bond yield of Germany, France, Spain & Italy by approximately 6 bps, 9 bps, 11, bps and 11 bps, respectively. On January 22nd, 2015, after Monetary policy committee (MPC) meeting of ECB, ECB announced the plan to purchase $60 billion of assets each month, this announcement decreased the yield on 5-year German bond by 2 bps, French bond by 6 bps, Spanish bond by 9bps and Italian bond by 12 bps.

The largest impact of ECB announcement is observed around the announcement made on the 3rd December 2015. On this date, ECB announced the introduction of a new program under asset purchase program and also announced the extension of the program until March 2017. The event decreased yield on the 5-year government bond of Germany, France, Spain and Italy by 18 bps, 17 bps, 19 bps and 21 bps, respectively. Hence the null hypothesis that ECB announcement has no impact on bond yields is rejected, and the alternative hypothesis that the ECB announcements have a significant influence on the government bond yield (interest rates) is supported.

Hypothesis 2

H 2: The bond yields are not influenced by ECB announcements that only contain new information

H_a 2: The bond yields are influenced by ECB announcements that contain only new information

Table 3 also provides evidence that the only those events or ECB announcements influence the interest rates or bond yields that contain new information regarding asset purchase program of the monetary policy for that matter. The sample has 9 announcements (events) out of which 5 ECB announcement contains new information and initiative related to rate cut and asset purchase programs, while 4 announcement does not contain any new information but only the information about the support of decisions made in previous ECB announcement. As it can be seen in the Table above the events or announcements that took place from 5th to June 2014 to 10th March 2016, which contain new information regarding the asset purchase program, significantly influence the yield on 5-year government bonds of the sample economies i.e. Germany, France, Spain and Italy.

The green and the blue highlighted area shows the variation in yield curve on the announcement date that has statistical significance, while the non-highlighted area shows no significant variation in yield of 5-year government bond around the announcement date. The Yield variation around the announcement made between the 5th of June 2014 to 10th March 2016, which contained new information, has a statistically significant influence on the yields as highlighted with green and blue. Whereas the announcement made on the 21st April 2016 to 19th January 2017, which contained no

new information, has no statistically significant influence on the yields of 5-year government bonds of Germany, France, Spain and Italy. Therefore, the null hypothesis that interest rate or the yields on bonds are not influenced by announcements that contain only the new information is rejected, and the alternative hypothesis that only those ECB announcements have a significant influence on the bond yields that contains new information regarding asset purchase programs are accepted.

4.3 Statistical Significance

Following section talks about the statistical significance of the results obtained from event study methodology formulated by MacKinlay (1997), and later used by Gagnon & Raskin et al (2011), Swanson, et al. (2011) and Krishnamurthy & Vissing-Jorgens (2011) for the purpose of analysis of impact of central bank announcements (events) on the term structure of interest rates. Therefore, this research also uses the event-study methodology to measure the effectiveness of the ECB announcements and its influence on the interest rates via yields. The results of event-study are presented in the Table above. The table presents the variation in yield curve; the variation in the bond yield is measured according to the modified formula of abnormal variations provided by Rivolta i.e

$$V_{CE,T} = Y_{CE,T} - Y_{CE,T-1}$$

Where, $Y_{CE,T}$ is the yield of the bond of country C during the event E at time T and $Y_{CE,T-1}$ is the yield of the bond of country C during the event E at time $T-1$ or one previous period.

The p-value in the chart shows the statistical significance of the variation observed around the specific event. According to the Golden rule of hypothesis testing, Reject the null hypothesis and accept the alternative hypothesis if the p-value is less than the alpha (level of significance) (Bentler & Douglas, 1980). The yield variation and p-value that is highlighted in green shows that the variation in bond yields around the announcement date has statistical significance at 5% level of significance, as the p-value of the green highlighted area is less than 0.05 (alpha or 5% level of significance. Meanwhile, the area highlighted with blue denotes that the variation in the bond yield is significant at 10% level of significance as the p-value is above 0.05 but below 0.10. All the variations in the bond yield related to the announcement or event 1 to 5 are significant.

Hence, it proves that the Hypothesis 1 that measures the influence of events on the variation in the bond yield due to ECB announcements has statistical significance. Announcement or event 6 to 9 that measures the variation in the bond yield around the ECB announcements that do not contain any new information has no statistical

significance, Hence the second hypothesis is rejected that the variation in yield curve is due not only due to new information, and the alternative hypothesis that says the variation in yield curve is due to announcements that contain new information is selected.

5. Discussion & Analysis

The statistical results and empirical findings are discussed in the following in the context of the existing effectiveness of unconventional monetary policy tools and the current state of economic indicators in the euro area. While statistical significance analysis provides the basis for the findings, economic significance analysis provides a more realistic understanding of the hypothesis under study. The ECB's unconventional monetary policy tools and its impact on the path of government bond and its role in triggering the inflation in the euro area, which was the main purpose for this policy at first place, is discussed below in terms of each country. These analysis shows interesting results as mentioned below.

5.1 Economic Significance

The economic significance of asset purchase program or quantitative easing can only measure while analyzing real-world economic indicators and its long-term effects on the general economy. As mentioned earlier the central banks resort to quantitative easing or asset purchase programs (non-conventional monetary policy tools) when the conventional monetary policy tools are restricted by zero interest rates. The central bank's actions are limited by 0% lower bound as central banks cannot reduce the interest rates below zero.

Therefore, central bank use quantitative easing to purchase the less risky assets from the banks driving the yields on these safe-haven investments lower and motivating people to save less and invest more into riskier assets, this behavior of general public will increase the consumption and expenditure in economy, thus increasing the inflation, which is the ultimate goal of ECB with regard to current economic conditions in Eurozone.

5.1.1 Germany

Germany has the largest contribution in the combined GDP of Eurozone and it also has the largest share of assets, as much as 26%, purchased an asset purchase program or quantitative easing program of ECB. Germany is one of the stronger economies from the sample, therefore, the condition of its economic indicators was not as bad as the economy of Spain and Italy. However, before the introduction of asset purchase

program, the inflation in Germany was around 1% which is well below the 2% target inflation proposed by Taylor (1993) as the steady-state inflation growth rule.

Figure 10: Inflation vs. 5-Year Government Bond Yield in Germany
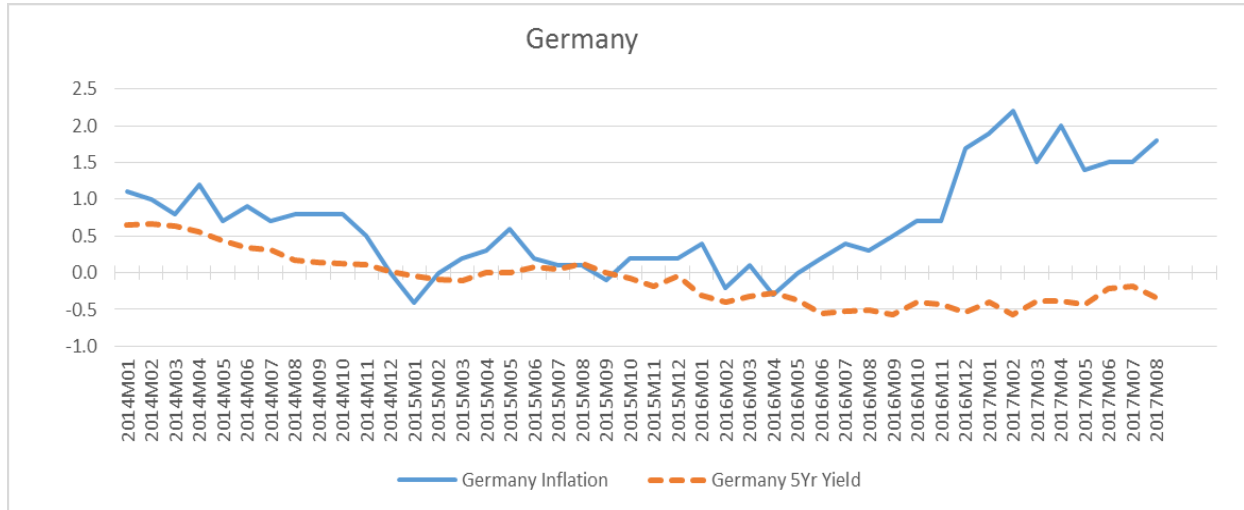
Source: (EUROSTAT, 2017) (ECB, 2017)

The figure 12 shows that the before the introduction of asset purchase program in June 2014 the inflation is approximately 0.8 % which is alarming as it poses the fear of falling below 0% or deflation. After the announcement of asset purchase, the inflation started picking up its pace. It can be observed that the asset purchase program successfully declined the long-term interest rates or yield on 5-year government German bond which forced the consumers to invest in risky assets, due to lower returns and unavailability of safer bonds that resulted in increased consumption and increased inflation.

As the yield decreased from 0.633% in 2014 to -0.4% in the first quarter of 2017, the inflation increased from 0.8% in first quarter of 2014 to 1.5% in the first quarter of 2017, hence the economic significance of the program is consistent with the results found in the empirical study.

5.1.2 France

France is another stronger candidate in the sample as it is the second largest contributor to combined GDP of Eurozone and it also has dedicated a share of 20% of the assets purchased under the ECB's asset purchase program. France had a similar situation as compared to Germany. The Inflation in France was around 0.6%, however, the growth rate and other economic indicators like production and aggregate demand were weaker as compared to Germany. At the time of the announcement related to the introduction of asset purchase program by ECB in June 2014, the long-term interest rates or 5-yr bond yield was around 1% which was higher than that of Germany as investors considered German bonds safer as compared to French (Galariotis, Makrichoriti, &

Spyrou, 2017). The figure 13 shows that after the introduction of the program the 5-year bond yield decreased from approximately 1% in the first quarter of 2014 to -0.15% in the first quarter of 2017, whereas, the inflation increased from 0.7% in first quarter of 2014 to 1.4% in the first quarter of 2017. These findings show that the empirical results are consistent with the significant economic realities.

**Figure 11:** Inflation vs. 5-Year Government Bond Yield in France
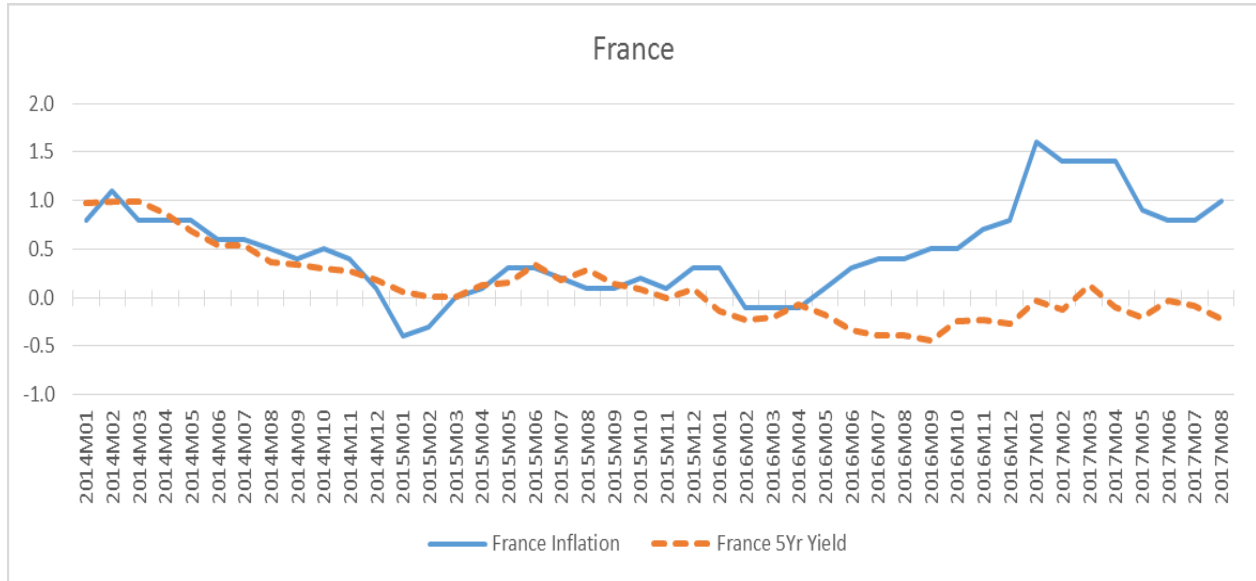
Source: (EUROSTAT, 2017) (ECB, 2017)

5.1.3 Spain

Spain is the third candidate in the sample economies under observation, it is one of the largest contributors to combined GDP of Eurozone and it also has dedicated a share of 13% of the assets purchased under the ECB's asset purchase program, which is below the 17% share of Italy. Spain had a weaker economy and far bigger problem as compared to Germany & France. Spain witnessed deflation for 3 quarters consistently until the effects of asset purchases program finally kicked in. The Inflation in Spain was around 0% which alarming fell below zero in following quarters. At the time of the announcement related to the introduction of asset purchase program by ECB in June 2014, the long-term interest rates or 5-yr bond yield was around 1.55% which was higher than that of Germany and France, as investors considered Spanish bonds much riskier.

Figure 12: Inflation vs. 5-Year Government Bond Yield in Spain
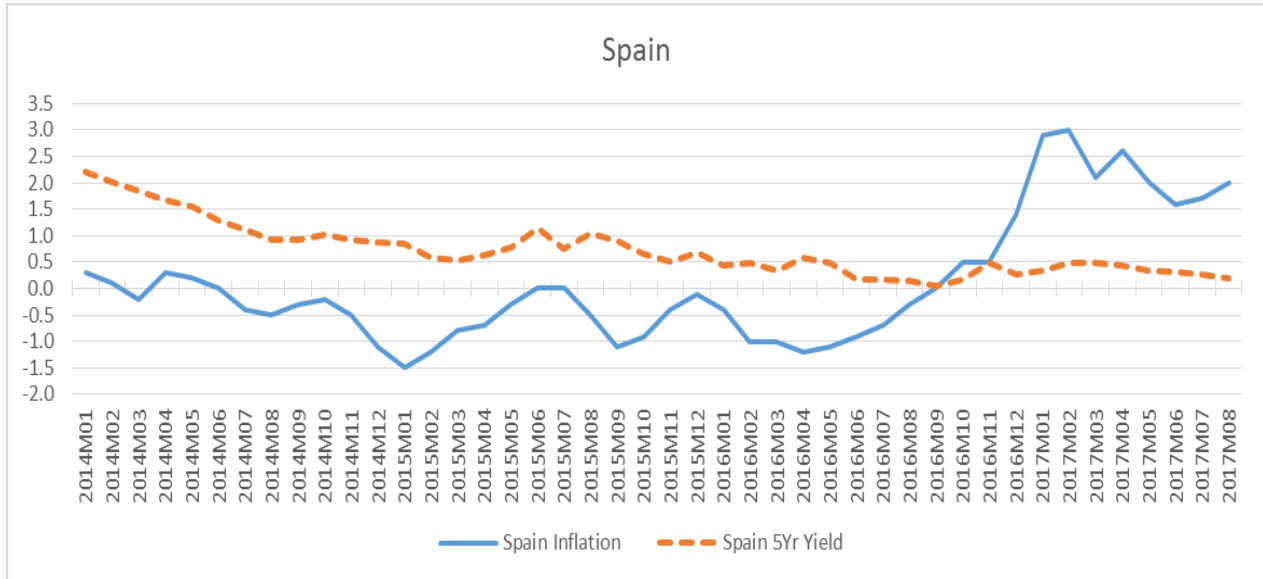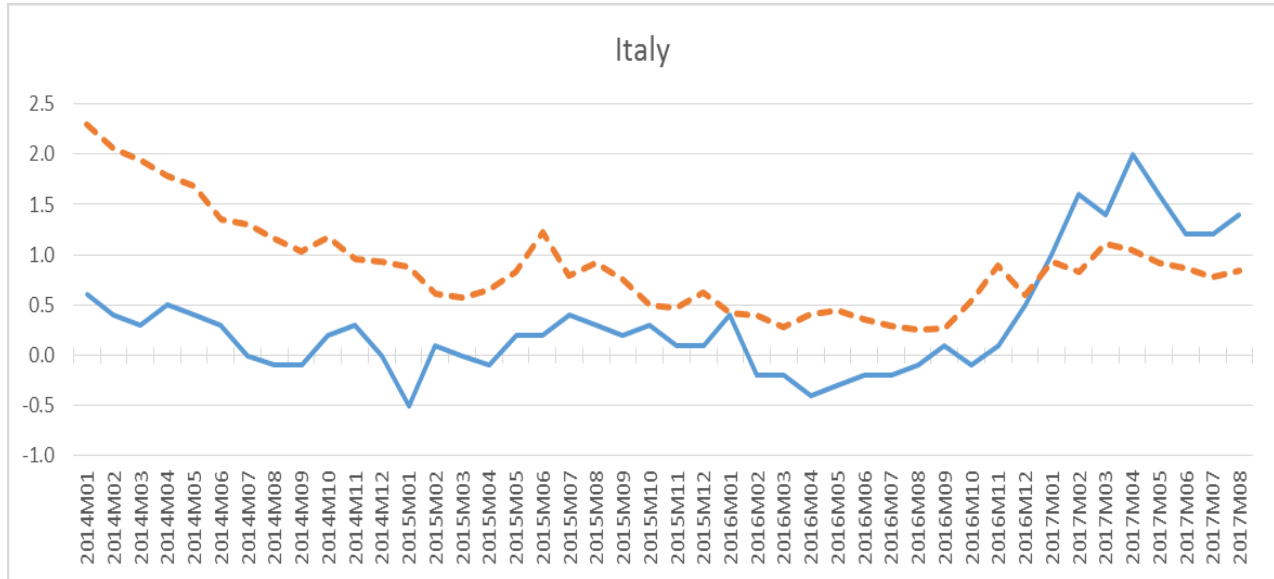

Source: (EUROSTAT, 2017) (ECB, 2017)

Figure 14 shows that after the introduction of the program the 5-year bond yield decreased from approximately 1.55% in first quarter of 2014 to 0.5% in the first quarter of 2017, whereas, the inflation increased from 0% in first quarter of 2014 to 2.1% in first quarter of 2017, which approximately equal to the ECB target inflation. Thus it is safe to conclude here that the empirical results are in line with the economic outcomes of the asset purchase program.

5.1.4 Italy

Italy is the last candidate in the study on the effectiveness of quantitative easing or asset purchase program of ECB. The combined GDP share of Germany, France, Spain and Italy has increased to as much as 65% of the total GDP of EU. Italy has its special significance in the asset purchase program of ECB. The share of Italian assets to be purchased under the asset purchase program is 17% which is larger than Spain and small than Germany and France. Italy had much larger and severe problems than other European countries. In 2013, the public debt in Italy stood over € 2 trillion and its debt to GDP ratio was about 130% which was more than twice than that in Germany and France. The Italian government also received a bailout before the announcement of asset purchase program which only improved a little. The weaker demand and decreasing industrial production posed severe consequences for Eurozone as Italy was the third largest GDP in Europe. At the time of the announcement related to the introduction of asset purchase program by ECB in June 2014, the long-term interest rates or 5-yr bond yield was approximately 2% which was higher than that of Germany, France and Spain, as investors considered Italian economy much riskier.

Figure 13: Inflation vs. 5-Year Government Bond Yield in Italy

Source: (EUROSTAT, 2017) (ECB, 2017)

Figure 15 shows that after the introduction of the program the 5-year bond yield decreased from approximately 2% in first quarter of 2014 to approximately 1% in first quarter of 2017, whereas, the inflation increased from 0.3% in first quarter of 2014 to 1.4% in first quarter of 2017, which approximately equal to the ECB target inflation. Hence, the findings of the event study analysis not only have statistical significance but also the economic importance as well.

Another key finding of the study shows that the weaker economies like Spain and Italy have gained greater good from the ECB's asset purchase program as compared to the Germany and France, the stronger counterparts, as it is reflected in the impact of asset purchase program on the inflation (Olson & Wohar, 2016).

6. Conclusion

As initially stated under the research objectives and research question headings, the study evaluates the effectiveness of the ECB's non-conventional monetary policy tool i.e. quantitative easing or asset purchase program by evaluating its impact on key economic indicator i.e yield and inflation precisely. The research uses event-study methodology introduced by MacKinlay (1997) and modified and used for the evaluation of the effectiveness of asset purchase programs or quantitative easing by Gagnon & Raskin et al (2011), SWANSON, et al. (2011) and Krishnamurthy & Vissing-Jorgens (2011).

6.1 Summary of Findings

The research found important results through event-study methodology related to the impact of ECB announcements (events) on the 5-year government bond yield that is statistically significant and economic substance or validated. It is proven that monetary policy announcements that contain new information regarding asset purchase program initiated by ECB have a significant impact on long-term interest via bond yields (Drakos & Kouretas, 2015).

It was also proven that the weaker economies like Spain and Italy have a larger effect of asset purchase programs related announcements as compared to countries like Germany and France with stronger economies where the economy is already operating at its maximum capacity and there is very little room for improvements.

The table 4 presents the hypothesis of the research and the results of the hypothesis tested through event study analysis.

**Table 4:** Summary of Results of Hypothesis Testing

Hypothesis	Result & Analysis
H1: The ECB announcement (events) influence yields of European government bond with 5-year maturity	Supported
H2: The bond yields are influenced by ECB announcements that contain only new information	Supported
H3: The impact of ECB announcements on the bond yields of the weaker economies like Spain and Italy is larger than the impact on the bond yields of stronger economies like Germany and France	Supported

6.2 Concluding Remarks

Considering the significant findings of the study and its economic validation in the real world, it is concluded that non-conventional monetary policy tools effectively influence the monetary policy or interest rates when the conventional monetary policy is restricted due to zero bound interest rates. The objective and the outcomes of the non-conventional policy tool is same as the objective of conventional monetary policy that is to bring interest rates to equilibrium stabilize the exchange rate, control unemployment, stabilize inflation to the target level and finally, more realistic objective, to kick-start the GDP growth. As it is discussed earlier in section 5.1, the study found out that that interest rates and inflation have a negative correlation. The asset purchase program used by ECB has managed to decrease the yield and increase the inflation to approximately target inflation rate of 2%. These two mechanisms have resulted in increasing the overall GDP growth in Eurozone.

Figure 14: Comparison of GDP Growth Rate
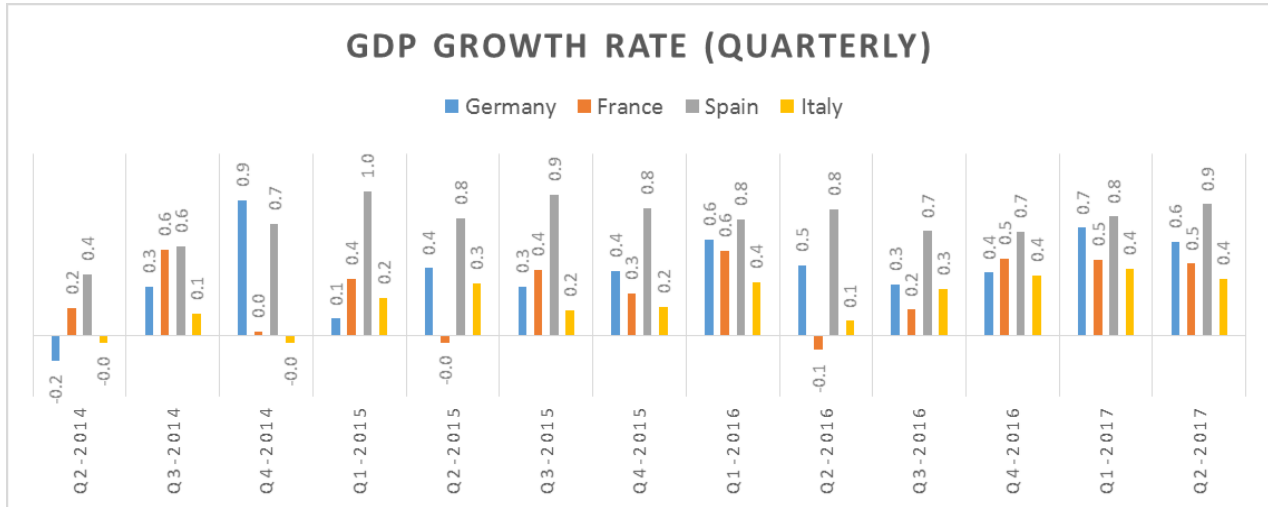
Source: OECD (2017)

Figure 16 shows that the quarterly GDP growth rate has increased from after the introduction of asset purchase program in the second quarter of 2014 till to-date. In the second quarter of 2014 the quarterly GDP growth rate in Germany, France, Spain and Italy was -0.2%, 0.2%, 0.4% and -0.2% respectively, but due to the introduction and successful operation of asset purchase program conducted by ECB (quantitative easing) the quarterly GDP growth rate picked up to the higher levels 0.6%, 0.5%, 0.9% and 0.4% in Germany, France, Spain and Italy, respectively.

6.3 Limitation & Future areas of research

There is a vast literature on the monetary policy and its tools but the literature related to non-conventional monetary policy tools especially quantitative easing is scarce. Since non-conventional tools are not used frequently, the research done on this subject is limited. However, the financial crisis of 2008 and the quantitative easing measures used by the Federal Reserve, Bank of England, and Bank of Japan, this subject has gained the interest of the researchers and central bankers around the world.

As I have personally visited European Central Bank headquarters in Frankfurt, Germany and interviewed some key personnel at the ECB, I have developed the detailed understanding and interest in this subject, which is why I would like to pursue this subject for my Ph. D studies in future. In the current study I have analyzed the influence of the non-conventional monetary tools, but in my future research, I would like to develop a model that can help measure the exact quantifiable effect of a number of assets purchased under the quantitative easing on the long-term interest rates.

Acknowledgement

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Appendix A

Monthly Inflation Rate in Percentage Terms

GEO/TIME	Germany Inflation	France Inflation	Spain Inflation	Italy Inflation
2014M01	1.10	0.80	0.30	0.60
2014M02	1.00	1.10	0.10	0.40
2014M03	0.80	0.80	-0.20	0.30
2014M04	1.20	0.80	0.30	0.50
2014M05	0.70	0.80	0.20	0.40
2014M06	0.90	0.60	0.00	0.30
2014M07	0.70	0.60	-0.40	0.00
2014M08	0.80	0.50	-0.50	-0.10
2014M09	0.80	0.40	-0.30	-0.10
2014M10	0.80	0.50	-0.20	0.20
2014M11	0.50	0.40	-0.50	0.30
2014M12	0.00	0.10	-1.10	0.00
2015M01	-0.40	-0.40	-1.50	-0.50
2015M02	0.00	-0.30	-1.20	0.10
2015M03	0.20	0.00	-0.80	0.00
2015M04	0.30	0.10	-0.70	-0.10
2015M05	0.60	0.30	-0.30	0.20
2015M06	0.20	0.30	0.00	0.20
2015M07	0.10	0.20	0.00	0.40
2015M08	0.10	0.10	-0.50	0.30
2015M09	-0.10	0.10	-1.10	0.20
2015M10	0.20	0.20	-0.90	0.30
2015M11	0.20	0.10	-0.40	0.10
2015M12	0.20	0.30	-0.10	0.10
2016M01	0.40	0.30	-0.40	0.40
2016M02	-0.20	-0.10	-1.00	-0.20
2016M03	0.10	-0.10	-1.00	-0.20
2016M04	-0.30	-0.10	-1.20	-0.40
2016M05	0.00	0.10	-1.10	-0.30

2016M06	0.20	0.30	-0.90	-0.20
2016M07	0.40	0.40	-0.70	-0.20
2016M08	0.30	0.40	-0.30	-0.10
2016M09	0.50	0.50	0.00	0.10
2016M10	0.70	0.50	0.50	-0.10
2016M11	0.70	0.70	0.50	0.10
2016M12	1.70	0.80	1.40	0.50
2017M01	1.90	1.60	2.90	1.00
2017M02	2.20	1.40	3.00	1.60
2017M03	1.50	1.40	2.10	1.40
2017M04	2.00	1.40	2.60	2.00
2017M05	1.40	0.90	2.00	1.60
2017M06	1.50	0.80	1.60	1.20
2017M07	1.50	0.80	1.70	1.20
2017M08	1.80	1.00	2.00	1.40

Source: (EUROSTAT, 2017)

Appendix B

Quarterly GDP Growth Rates of Sample Economies

Period	Germany	France	Spain	Italy
Q1-2014	0.9	0.1	0.4	0.0
Q2-2014	-0.2	0.2	0.4	-0.0
Q3-2014	0.3	0.6	0.6	0.1
Q4-2014	0.9	0.0	0.7	-0.0
Q1-2015	0.1	0.4	1.0	0.2
Q2-2015	0.4	-0.0	0.8	0.3
Q3-2015	0.3	0.4	0.9	0.2
Q4-2015	0.4	0.3	0.8	0.2
Q1-2016	0.6	0.6	0.8	0.4
Q2-2016	0.5	-0.1	0.8	0.1
Q3-2016	0.3	0.2	0.7	0.3
Q4-2016	0.4	0.5	0.7	0.4
Q1-2017	0.7	0.5	0.8	0.4
Q2-2017	0.6	0.5	0.9	0.4

Source: (OECD, 2017)