"Quantitative easing announcements and the impact on sovereign bond yields"

An event study investigating how bond yields react in three different markets

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Abstract

Assessing and comparing the impact of the Quantitative Easing announcements of the Asset Purchasing Programs (APP) by the European Central Bank (ECB) on euro area sovereign bond yields, Federal Reserve System (FED) LSAP on Treasury bond yields and the Bank of England on GILT yields is challenging, because the monetary policy announcements differ in a range of aspects. Mainly because all tree markets present distinct characteristics, in terms of scale and financial activity but also because the asset purchase programs were concerned with different amounts of capital available for the sovereign bonds purchase in each case. Therefore, to identify the level of success of those programs as well as how financial markets adaptiveness developed to such unconventional monetary tools over the years, we rely on the abnormal volatility bond yields present after the respective announcements and their persistence. The econometric results suggest that the impact on long-term sovereign yields is negative and sizeable. Most of the impact was realized before the actual purchases took place ,mainly on the announcement dates showing immediate impact on the economy, albeit the long term effects of the monetary interventions are controversial.

Keywords: Quantitative easing, APP, Sovereign yields.

Contents

1. Introduction

No one can argue that the year of 2016 has been politically and economically controversial, both at a global scale but more particularly for Great Britain. That is mainly due to the Brexit referendum campaign period officially starting on April 15th and ending on the national declaration date of the referendum result, on June 24th (Ruth Lea, 2016) .As expected, following the Brexit vote, the Bank of England governors obliged to act on the results to avoid if possible a damaging slowdown of the economy, decided on some monetary changes. This monetary stimulus was the quantitative easing program announced in August aiming to reverse the Brexit vote effects. The purpose of my paper is to investigate the volatility impact the Quantitative Easing announcement had on gilt returns and its persistence, as the markets incorporated the new macroeconomic information. This will be the milestone to compare similar quantitative easing announcements in the past coming from other two central banks, the Federal Reserve and the European Central Bank as well to compare the most recent quantitative easing extension with the QE recent history of the UK. Do the bond market effects in response to the quantitative easing announcements comply with the effectiveness of the monetary policy? Another interesting thing to observe regarding the volatility effects of such monetary tools is the persistence and if it has changed as financial markets evolve by time.

1.1 QE: What it means and how it works

Quantitative easing was first introduced in times of high financial destress when the Bank of Japan attempted to stimulate the stagnating economy, back in the year of 2001 (Alan J. Auerbach and Maurice Obstfeld, 2004) . Since then it is one of the most commonly used unconventional monetary policies by mostly all banks worldwide especially following the financial crisis of 2007-2008. By unconventional, it is defined the nature of the monetary policy, when a central bank expands it's balance sheet purchasing government bonds and other securities in order to achieve lower interest rates and inject money to the economy.

"The problem with QE is that it works in practice, but it doesn't work in theory." Ben Bernanke stated in 2014, aiming to emphasize the fact that the channels through which a quantitative easing program works are debatable both in theory and practice. Normally, the transmission mechanism for QE consists of an expansion of the central bank's balance sheet so the reserves are used to purchase short term bill (Theodoridis & others 2015) [1], and a maturity extension program that dictates swapping the bills for longer term bonds (Krishnamurthy &Vissing-Jorgensen ,2011). Although due to the majority of macroeconomic models neither practices have a direct effect in the economy, in practice such programs appear to have an impact
(Matthew & others, 2010). More particularly, monetary policy operates though certain channels such as monetary policy signaling, as a QE conveys extra information about future short-term interest rates, portfolio rebalancing, liquidity effects and exchange rate effects [2]. It is worth mentioning that for all those channels to be effective there must be some frictions or imperfections in the functioning of financial markets (Joyce & others, 2012).

[1] http://www.bankofengland.co.uk/monetarypolicy/Pages/qe/qe_faqs.aspx
[2] https://www.managementstudyguide.com/quantitative-easing-and-bond-market.htm

The reason why sovereign bonds are of such interest is origins to the fact that in all three markets they are considered as the safest asset an investor can rely on (Zhiguo He& others, 2016). In the same sense they are widely considered to be the world's safe store of value and being a large fraction of safe asset portfolios, such as the portfolios of many central banks or pension funds. In general, the structure and insurance that they provide to the beholder due to high demand leads to low yields. Outstandingly in periods of economic turmoil, government bond yield drop even further. Strikingly though, even if government debts have risen substantially in the recent past years, the bonds yields haven't been influenced.

1.2 Identification

In the existing economic literature and empirical evidence, the effects of the respective monetary announcements are perceived to have in average large impact mainly in long term bond yields regardless the effectiveness of the actual program. In most cases the monetary tool does not substantially influence the real economy, especially long term, despite that it is the primary reason it is imposed .Looking briefly into basic QE packages and the yield volatility after the correspondent announcements can depict this consensus (Papadimos,2003). Moreover, the effectiveness seems to vary both across countries and time, notably when disturbance conquers the financial markets (A. Haldane & others, 2016).

1.3 Channels of transmission of an asset purchase program

When assessing the effects of an asset purchase policy, one has to perfectly understand the casual impact it has on an economy, which even nowadays it is still not the case. Actually, a prominent view on modern macro monetary economics sets asset purchase programs fruitless alone (Wallace, 1981; Eggertsson and Woodford, 2003; Curdia and Woodford, 2011). This stance comes from the fact that monetary policy can be determined completely by the current and future level of short term policy interest rates. As these rates are calculated in regard with all future contingencies, then the prices of the financial instruments such as bonds or real assets will be adjusted accordingly to reflect the present value of the future cash flows form owing the assets. In direct sense, the relocation of such assets from the private sector and individual investors to the central bank's balance sheet given the discounting does not alter the present value of returns. Thus, any expansion of the central bank's balance sheet through reserves could not be considered relevant. Thus, the reasoning leads to the conclusion that the effects of such monetary policy could only be produced indirectly, given the fact that the term structure of future interest rates will drop accordingly in comparison with what has been anticipated until the event date. As such signaling would dictate the market prices would change in accordance with their changes stream of cash flows. This argument combined with the interpolation of the quantitative easing itself brings up the subject of credibility. In a sense that credibility might be higher due to the large scale buys of long term financial instruments exposes the central's bank balance sheet to the risk of short term rates increasing. Reassures the markets that the central bank has an incentive to maintain the policy rates at low levels.
Bhattari, Eggertsson and Gafarov, 2015; Jeanne and Svensson, 2007).

By the consensus that only a change in the term structure of interest policy rates can affect asset prices and yields we rely to the assumption of the marginal investor risk preferences being

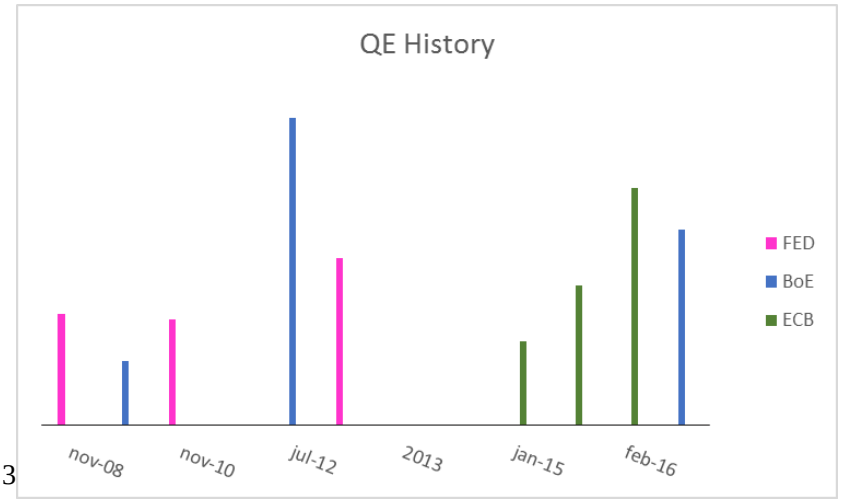
not variant to purchases. Hence, there is duration risk as a channel of influence, to emphasize the importance of acquiring longer maturity bonds. Moreover, there is "capital relief channel" pumping asset prices and yields due to the cash injection to the economy for leverage constrained institutions. Lastly, it is would be naive to neglect "portfolio rebalancing channel", that underlines that asset prices could lead to a change in optimal portfolio percentage held of the shares of those assets.

2. Brief history

The three central Banks

Every country works with its own means, with different economic structure and as a result the monetary tools available to central banks did not present the same impact. Primarily because the monetary policy effectiveness is strongly relying on the relationship between the financial system and the monetary authority and that interaction changes from country to country, so does the implementation of the quantitative easing which directly affects the comparison of the markets to the respective announcements. Still, in every case one characteristic was common, Central Banks expanded their balance sheet and policy rates sharply dropped.

Graph 1



[3]

Graph 1 depicts the amounts of money that where involved in the Quantitative easing programs imposed by the three Central Banks the analysis is concerned with as well as the respective timeline. Hence, the reader can have a clear view on the events examined.

2.1 Asset repurchase program incentives and characteristics

In this section we will briefly give a preview of the monetary police outline and capital involved for each case.

[3] Source of data used for the graph , Bank of England working paper " The story so far" by Andrew G Haldane, Matt Roberts-Sklar, Tomasz Wieladek and Chris Young, October 2016

2.1.1 The Bank of England

On principal, the Bank of England when announcing a quantitative easing program, the main focus was on buying large amounts of government GILTS. In 2009 , the HM Treasury announced the recruitment of a board that would constitute the Asset Purchase Facility (APF)[4].

The first two episodes took place on January 2009 and January 2010 when the monetary institution purchased 200 billion pounds worth of government bonds, mostly medium to long maturity. The second program began in October 2011 and continued until July 2012, expanding the existing credit monetary policy up to £375 billion. Moreover, the central bank had the authority to obtain from the private sector up to £10 billion assets, an amount that equaled 30% of the GILTS outstanding at the time and accounted for the 14% annual nominal GDP [5]. In this regard, expanding that much the Bank's balance sheet was an aim to boost the economy. All the money that was available after the GILTS purchase in coordination with the new at that time regulatory rules regarding the commercial banks liquidity served that exact purpose, increase consumer spending while the asset prices would rise (Joyce, Tong and Woods-2011) .

Since the second QE in October , BoE took multiple measures related to unconventional monetary policy, primarily to increase the money supply and the growth rate of the economy, and reach the inflation target. So literature and reviewers of the British economy do not officially register a third pronounce quantitative easing program , hence a date for the announcement . But ,this analysis considers as a third episode to be the last credit easing announcement followed by the Brexit vote in the 4rth of August 2016, due to its particular interest and controversy regarding the effectiveness[6].

2.1.2 The Fed

The Federal Reserve institution never had adopted these kind of monetary practices until the financial crisis outbreak. As the crisis worsen by the September 2008 , the American economy was trembling ready to collapse at any moment[7] . After imposing strictly traditional monetary tools ,the Fed board decided to follow the unconventional path in order to save the fragile economy and the Large Scale Asset Purchase Programs (LSAPs) started in December 2008 [8]. At these period

[4] HM Treasury Budget 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416330/47881_Budget_2015_Web_Accessible.pdf

[5] Quarterly Bulletin 2012 Q4 | Volume 52 No. 4 Bank of England

[6] http://www.bankofengland.co.uk/publications/Pages/news/2016/008.aspx
https://www.theguardian.com/business/live/2016/aug/10/uk-gilt-yields-hit-record-lows-after-bank-of-england-bond-buying-failure-business-live
http://www.telegraph.co.uk/business/2016/08/04/super-thursday-markets-brace-for-bank-of-england-interest-rate-c/

[7] Why Does the Economy Fall to Pieces after a Financial Crisis? Robert E. Hall
Journal of Economic Perspectives—Volume 24, Number 4—Fall 2010
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.378.8518&rep=rep1&type=pdf

[8] BIS Working Papers No 570 Unconventional monetary policies: a re-appraisal by Claudio Borio and Anna Zabai

the central bank had a target policy rate (Federal Fund Rate) close to zero. That announcement on the 25th of November was the LSAP that included a 100$ billion purchase of GSE debt and another 500$ billion in MBS .The main goal was to reduce risk while increasing the availability of credit , in order for the housing market to be supported . An extension of that program , which we have not included as an event in our study was followed in March 2009, and it was concerned with 750$ billion of agency MBS along with 100$ billion of GSE debt and $300 billion of long term Treasury securities. In this regard as the figures in the Appendix section show the bond rates continued decreasing as the credit easing was extended by the central Bank. Finally between from December 2008 until the extension in March 2010 the majority of Treasury securities had been bought from the private sector and the larger percent was closely linked with the housing industry once again[9].

The next episode , which we take into account as an event in the study as it is officially recorded as a new QE scheme, took palace on the 3rd of November, 2010, when the Fed officially announced a second round of credit easing maintaining the same pace of extensively purchasing GSE debt and MBS into longer-term Treasuries. The act was to promote a quicker recovery to the economy and boost inflation into desirable levels [10]. But, this QE announcement differed from the first one mainly because markets participants already had been anticipating it , as surveys conducted then showed[11], leaving the only uncertainty to be the scale of the program. Hence , the reaction was discounted before the actual announcement , diminishing the impact of the easing on asset prices as well as long term interest rates .

In 2011 the economy was not performing as anticipated with a weak recovery from the prior crisis, the Fed reacted with the objective to pressure down long term rates and relief the private sector from long term duration risk. This outcome is often referred to as the "Operation Twist," [12] . Despite the already existing credit extension and the central bank's efforts to boost the economy, the administration decided to also announce a third round of credit easing on September 13th 2012 . This date is considered as the third event in the study , QE 3. The markets reacted positively to this open end signaling of continues purchases of sovereign assets and MBS securities.

In this regard, in the years following , while the economy was recovering until the end of 2013 when the purchase rate was slowed down and the final round of purchases took place in October 2014 (Baily and Bosworth, 2013).

2.1.3 The European Central Bank

The last central bank to engage these unconventional policies was the European Central Bank. In particular ECB announced the first Expanded Asset Purchase Program (EAPP),on the 22nd of January, 2015. The central bank's main concern was the negative inflation at the time. I general the Public Asset Purchase Programs were considered an extra addition to the measures taken against the ongoing financial crisis (Duarte and others, 2015). On one hand the goals of PSPP programs were on average the same with the other credit easing schemes, the implementation and the structure differs a lot due to the legal framework regulating the central bank as well as the interaction with each fiscal institutions , in every country in the currency area. In this regard, the

Monetary and Economic Department July 2016

[9] Expectations of Large-Scale Asset Purchases By Andrew Foerster and Guangye Cao

[10] https://www.federalreserve.gov/monetarypolicy/bsd-monetary-policy-tools-201411.htm

[11] https://www.cnbc.com/2013/12/16/fed-taper-expected-sooner-cnbc-survey.html

[12] http://www.frbsf.org/economic-research/publications/economic-letter/2011/april/operation-twist-effect-large-scale-asset-purchases/

first policy included a purchase of a 50€ billion sovereign securities every month , which in combination with the preexistent programs made a total of 60 € billion thrown into the European economy on a monthly basis[13] .

Even though there not much research investigating the success of the ECB macroeconomic decisions since all programs are that recent .In general the markets seemed to respond positively to the first episode in 2015. But that effect did not last for long primarily because the market participants were expecting an extension of the first program within the same year , something that never happened. Hence , the head of the central bank , Mario Draghi , announced the second quantitative easing on the 10th of March 2016, which resulted in an even further drop in the rates of 0.4 percent and the decision for 80€ billion of purchases per month was made (Bernoth & others, 2016). Finally , the last recorded credit announcement[14] by the European Central Banks is an unchartered territory (Gambetti & Musso,2017) . Even though long term impact is not yet to be known, the facts present about 40% of the EU sovereign bonds currently having negative yields (Petersen ,2017)[15]

3. Data and Method

In this section of the paper will analyze the data collection as well as the econometric approach and equations behind the regression tables.

3.1 The Data

This paper uses one data source, Datastream, to obtain the yields for the sovereign bonds of three markets. Firstly since the topic was stimulated by the after Brexit quantitative easing announcement by the Bank of England, the yields of the sovereign bonds, GILTS, of 5 year , 10 year and 20 year maturity were downloaded among with the deposit 6 month interest rate from the year 2007 until the end of March 2017. Moving on, the same was applied to the US market, the Treasury bond yields of 5 year, 10 year and 20 year maturity as well as the deposit, 6 month interest rate for the exact period of time. Lastly, regarding the Eurozone, to asses and compare the effects of the recent quantitative easing announcements, the markets that were chosen are Germany, with 5 year, 10 year and 20 year maturity BUNDS, France , with the respective sovereign bonds OATS, and Italy with BTPS of the same maturity. Since they all belong to the same market the interest rate was the same for all three. This choice was based on primarily the fact that these three are the largest European economies and all respective monetary programs were consisted of large purchases of BUNDS, OATS and BPTS.

Using the official information regarding the announcements by the central bank institutions, we create three dummy variables equal to 1 when it is the announcement date and 0 for all other dates. Those dates at each dataset are quite random so there is no need for correcting for autocorrelation. Under the assumptions that prices and yields do respond immediately and

[13] https://www.ecb.europa.eu/press/key/date/2015/html/index.en.html
[14] https://www.ecb.europa.eu/press/pr/date/2016/html/pr161208.en.html
[15] file:///C:/Users/u472296/Downloads/QE+Monitor_May+2015_e%20(2).pdf

rationally to new macroeconomic information, it is doubtful that there are no other reasons apart from past values or interest rates that may affect bond yields and create an abnormality. Although the factors like random changes in liquidity or small shocks may prevent perfect incorporation of the news into the yields, we assume that to be of zero probability in this analysis. Still even if that is applied, further assumptions need to be made such as the rationality of the investors composing the financial markets, so we are not concerned by distortion of news and over-under reaction effects. In addition, the regressions include extra dummies for the days of the week the financial markets operate, from Monday to Friday, to capture the Day of the week effect, and lastly dummies that equal 1 for the following three days of the events, in order to observe any persistence of the incoming information. As the event study method this paper follows, focuses on the reaction of the market quoted yields over a fairly narrow interval on the quantitative easing announcement date, the timeline is structure as follows:

- The estimation window before every QE announcement is 3 months, after we leave out a moth for a gab in between the estimation window and the event window
- The event window is quite narrow, the event date and the three days following, that are used to check for any persistence
- The post event window varies for each case as the QE announcements differ

The judgement on how large should the interval window be so our comparison is not biased is subjective. In the case that it is too short we risk losing the full market reaction, as sometimes the financial markets need time evaluate new information. On the other hand, if it is too long, our results are contaminated by other factors.

3.2 The method

For the needs of our analysis , we chose to follow SUR approach and estimate the equations as a linear regression model (SUR). As proposed by Arnold Zellner in 1962, in econometrics , a seemingly unrelated regression model consisted of multiple equations that appear to be unrelated and different. Each equation has its own dependent variable and potentially altered sets of exogenous variables . The important element of this method that we also adopt in this analysis is that each equation constitutes a valid linear regression on its own , hence we can estimate it separately from the others.

Continuing , the next step of our analysis constitutes of a series of seemingly unrelated regressions with slightly different depended variables, same structure and exogenous explanatory variables. . Each equation is a valid linear regression on its own and can be estimated separately. Although it appears that none of the endogenous variables are related with the dependent variables of other equations in the system, or being both explanatory in one equation and dependent in another, econometrically and statistically there is interaction through the random error. Even they are jointly related, they produce extra information when the individual equations are considered separately .

Having decided the method next we adopt a two-stage approach for all the incidents in our event study that requires a constant mean model. Once we have retrieved the sovereign bond yields

for every event ,we have only the realized returns. Yet we need to find the abnormal rates to attribute to the events of interest. In this regard, as a first stage in order to be able to calculate the abnormal yields to test if there is a correlation with the event, we first have to approximate the *expected normal yields*. To do so we calculated the *average of the estimation window*. Hence the abnormal yields are computed as follows:

$$AR_{it} = R_{it} - E(it|xt)$$

Where, $ARit\ Rit$, and $E(it|xt)$ are the abnormal, actual, and expected normal returns of the i bond yield at time t. With creating the abnormal returns, our time series becomes stationary ,(we run a Dickey Fuller test and it is most of the times for 5% and 10%,one example is given in the Appendixes section), something that enables us to use ordinary least squares (OLS) so the market parameters will be estimated as the abnormal return observations will be aggregated along one dimension which is time, but we do it for every security. Every series in our data set is a time series computing squares and the excess abnormal yields makes the series more linear and stationary. Hence, we deduct the respective 6 month deposit rate from each dataset. It is worth explaining that using excess abnormal yields is a way of controlling for interest rate and for that purpose the interest rate chosen is the 6 month deposit interest rate for each market , for the reason that is widely used for fixed income derivatives calculations and it presents accurately the near future of interest rates. In addition it is more suitable since the dataset this analysis is dealing with is *daily* and the event window narrow to let us consider another category of interest rate .As mentioned, the regressions are estimated using daily realized yields from the beginning of 2007 to the middle of 2017 for every security. [16]

General structure of the regression[4]

$$y_t = \sum_{i}^{n} x_{it}\beta_{it} \quad + \sum_{i}^{n} Contrlos_i + \quad e_t$$

- y_t is the dependent variable
- QE_{it} are the dummies for the announcement dates
- $Contrlos_i$ are extra dummies that might be necessary to make the model more accurate
- $e_t$is the residual of the regression model

Benchmark model

Next we construct the benchmark model. This benchmark model is a simplified way to test the papers main question, how much of the abnormal yields we can be attributed to each quantitative easing announcement. We regress the already the endogenous variables on the three dummies of QE events and the dummy variables for every day of the working week. Judging from the R squared and the simplistic approach , we next add more variables to the regression until the

[16] Every security except the Italian OATS with maturity 20 years because it was not issued the first years that we examine

final one is the following [17]:

$$AR_t = a_1 QE_1 + a_2 QE_2 + a_3 QE_3 + \beta_{1t} D_{1t} + \beta_{2t} D_{2t} + \beta_{3t} D_{3t} + \beta_{4t} D_{4t} + \beta_{5t} D_{5t} + u_t$$

- Abnormal Returns, Excess Abnormal Returns , Absolute Excess Abnormal Returns or Squared Excess Abnormal Returns are the dependent variables each time
- QE_{it} are the dummies for the announcement dates
- And the day to day dummies are $Contrlos_i$ that might be necessary to make the model more accurate
- u_t is the residual of the regression model

Vector Auto regression Model

It is well known that when dealing with time series the vector auto regression (VAR) model is one of the most appropriate and flexible to use[18]. Adding the lags in our case is essential[19]. Especially for a multivariate dynamic time series. Accordingly , we construct a multivariate VAR(p) model for more accurate results, where p is the number of lags included. The equation is formed as follows :

Let the $Y_t = (y_{1t}, y_{2t}, \dots y_{nt})$ denote an (Nx1) vector of time series variables , which in our case is a vector of the N=5 sovereign bonds realized yields.

$$Y_t = c + \sum_{i}^{p} \Pi_i Y_{t-i} + \varepsilon_t$$ [20]

Π_i are the coefficient matrices and ε_t the non-observable white noise process , which is serially uncorrelated and independent with the other matrix. In addition, the $cov(\varepsilon_{1t}, \varepsilon_{2t}) = 0$, just as every other covariance in the data set. As mentioned before, the VAR(3) model is just a seemingly unrelated model since it constitutes of the same regressors and same lagged values.

Final regression

$$AR_{it} = a_1 QE_{i1} + a_2 QE_{i2} + a_3 QE_{i3} + \beta_{1t} D_{1t} + \beta_{2t} D_{2t} + \beta_{3t} D_{3t} + \beta_{4t} D_{4t} + \beta_{5t} D_{5t} + \gamma_1 P_{i1} + \gamma_2 P_{i2} + \gamma_3 P_{i3} + \delta_1 AR_{i,t-1} + \delta_2 AR_{i,t-2} + \delta_3 AR_{i,t-3} + u_{it}$$

- Abnormal Returns, Excess Abnormal Returns , Absolute Excess Abnormal Returns or Squared Excess Abnormal Returns are the dependent variables each time
- QE_{it} are the dummies for the announcement dates

[17] Noted that for the needs of the regression we use the non-constant command in Stata program, so the results do not include a constant neither does the model

[18] file:///C:/Users/u472296/Downloads/varModels.pdf

[19] http://www.reed.edu/economics/parker/312/tschapters/S13_Ch_1.pdf

[20] The equation does include a constant , but in our analysis the regressions will be run with a no constant command

- And the day to day dummies are $Contrlos_i$ that might be necessary to make the model more accurate
- P_{it} is the dummy variable that takes the value 1 the three consecutive days after the announcement day of the event in order to capture the persistence, and zero on every other date
- $AR_{i,t-1}$are the lags of the endogenous variables

When estimating Benchmark model and the more complexed ones that result from the addition of mandatory variables for every security i , each time we compute the coefficients for a_1, a_2 , a_3, that reveal the impact of the first quantitative easing announcement QE_1, the second QE_2, and the third QE_3 respectively. The QE dummy variables equal 1 in the case that it is one of the three announcement dates . As it is already demonstrated above, those dates differ for each currency area. The next thing the regression checks is whether the day to day effects have any influence on the abnormal returns released . In this sense we isolate better the true effect of the announcements . Hence, the β_{1t}, β_{2t}, β_{3t}, β_{4t}, β_{5t} are the coefficients for each working day of the week and the dummies are D_{1t} for Monday, D_{2t} for Tuesday, $D_{3t}$for Wednesday , D_{4t} for Thursday and D_{5t} for Friday. Moving on, a simple way to check if the announcement effect persists for a period of time is to create another set of dummy variables that take the value 1 the three days following the macro announcement. Those dummies in our case are P_{i1}, P_{i2}, P_{i3} for the QE_1, QE_2 and QE_3 respectively. After checking a wider persistence window, we observed that in all case after day three, the γ_1, γ_2 and γ_3 were statistically insignificant. Finally, in the regression we quantify the lags' impact on the excess abnormal returns by calculating δ_1, δ_2 and δ_3 for the first lag $AR_{i,t-1}$, meaning the value of the previous day, the second lag $AR_{i,t-2}$which is the value of two days prior to the announcement and the third lag $AR_{i,t-3}$ counting back three days before the news hit the market . Lastly , every regression produces some residuals , which in our case are presented by u_{it}.

As previously mentioned , the abnormal yields AR_{it} are not the only dependent variable that we run the final regression on. In the process we changed the left side of the equation into the Excess Abnormal Yields, the Absolute Abnormal Excess yields and Abnormal Excess Squared yields, that are other stationary time series producing extra information regarding our case.

Accordingly , for the next equations we use the abnormal returns but the absolute value and the squared value and run the same variables again. That was thought to be necessary to investigate since some returns where negative and it would state our result as a linear regression.

3.3 Assumptions

- No other major announcement takes place on that day that would influence bond yields in any direction significantly.
- Efficient market theory holds as new information becomes available to the market, prices adjust accurately and accordingly.
- We assume that the amount of capital related with the sovereign bond purchase from the

private sector or any other securities in every quantitative easing program in our case is irrelevant to the response of the bond yields

- For the comparison needs, we do not take into consideration the different scale of each market
- In a similar way, we do not take into account any other different characteristics of the economies
- Lastly, we assume that the dummy variable P (for persistence) captures the short term persistence of the event expressed by the abnormal returns

4. Empirical Results

In this section of the analysis the empirical results will be presented and described. The relative tables are located in the appendix section of the paper. We will comment of the result both from a statistical point of view but will also interpret the economic significance of our findings .

4.1 A general view on the realized returns

To have a general idea of how the bond returns moved through the examined period, we first create the graphs for each currency area to depict the realized yields. In Figure 1, the US Treasury bonds are presented. As expected and due to theory, the longer the maturity of a bond the higher the return would be (Veronesi, 2010).

[Figure 1]

In this regard, we observe the 5-year maturity Treasury bonds to have the smallest yield of the three (light blue color line). Long term bonds, like the 10-years (the navy-blue line) of the 20-year T-bonds provide higher compensation to the holder compared to the short maturity one, with the 20-year maturity being the riskier one (the darkest blue line). In is worth mentioning that even without the trendline (the light blue non-continues straight line), it is easy for someone to observe a clear trend form the beginning of 2007 until the current year. All bond yields have decreased substantially in the period of 10 years. That could be attributed to multiple reasons, a pronounce one being the monetary policy imposed by the Fed, and especially unconventional monetary policy like quantitative easing . By taking a closer look at the year to year bounce of the yields, we can distinct some occasions where the yields have dropped and bounced back to the original almost values after a relative small period of time. Those dates are correlated by either QE announcements and introduction of such programs or extension on existing ones. More specifically, for the American market according to the graph that time was in early 2008, the beginning of 2009 and for a larger period starting from the beginning of 2012 until the end of 2013. The dates are not

irrelevant with the quantitative easing schemes followed then, with the main ones as mentioned before to be on November 2008, November 2010 and September 2012.

Accordingly, when we examine Figure 2 that describes the movement of the GILT yields for the exact period and we identify the same traits with Figure 1.

[Figure 2]

As it is demonstrated, all maturity sovereign bonds have been following the same pattern since the beginning of the year 2007. Again, the facts show that the rates have been diminishing steadily and reached record low values in the middle of 2016. Also in the yields are lower for the 5-year GILTS, larger for the 10-year ones and the largest for the longer term 20-year maturity GILTS. Although as a general deduction we can state that the level of yields for Treasury bonds are lower compared to the UK sovereign bonds, something that reveals mainly the difference in risk in between the two economies. Moreover, one can correlate as before some pronounce declines of the yields with the known macroeconomic policy changes. Those dates are linked to our study and are for instance on March 2009, July 2012 and August 2016.

Moving on to the euro area, the largest and strongest economy of the Eurozone both in terms of GDP and endurance, is the German economy [21]. When comparing to the US Treasury bond yields, the BUNDS yields are lower, especially during the latest years as when comparing with the UK GILTS yields. That can be concluded from Figure 3 that presents the levels the BUND yields we are concerned with.

[Figure 3]

Similarly with the previous graphs, the smallest returns account for the 5-year maturity BUND, and according to maturity and risk the largest belong to the 20-year BUND. It is worth to notice that although as expected there is volatility in all three graph lines, the changes are obviously smaller than the other graphs where the yields have been more volatile, meaning the reaction of the German sovereign bonds is smaller to external news or macroeconomic policy and returns follow a pattern closer the mean.

The second European country to be involved to such monetary programs is France. In this regard, Figure 4 presents the historic values for the OATS returns, the sovereign bond of France. Once again, the maturities are 5-year bonds, 10-year bond and 20-year bonds.

[Figure 4]

The level of returns seems to be similar to the German sovereign bonds ones, with the only difference that the France bonds present more pronounce spikes throughout the examined period. Lastly, the trend is also down sloping. One can clearly observe the down turn the yields have taken the past decade, even reaching the level zero, like the German ones.

[21] https://www.weforum.org/agenda/2015/09/the-top-10-most-competitive-economies-in-europe/

Lastly, the last economy in the euro area that we will conclude in our research is Italy, as it is the third largest economy following the previous two and the one to receive the third largest amount of money in the form of sovereign bond purchases in every quantitative easing program the ECB has imposed.

[Figure 5]

The sovereign bonds of Italy, also called and BPTS [22], decreased in general from the beginning of the year of 2007, as the trend line shows in Figure 5, but the ratio is not as sharp as the one from the other economies. Another point of interest in the graph is the intense jump of the yields during 2012 that can be attributed to political and economic uncertainty at the time [23].

4.2 Econometric & economic significance

In this section there will be a description of the tables , an explanation on the statistical results as well as an commentary on their economic significance.

4.2.1 The benchmark model

The estimated coefficients for the original regression of the first stage are not reported in the draft since the approach was too simplified and the results could not be interpreted correctly. By trying with multiple other versions and controls we reach the final version of the regression which is way more accurate and comprehensive compared to the benchmark model. That was clear from numbers like the *R squared that was less than 10% in the first attempt, the Akaike's information criterion and Bayesian information criterion that were also much smaller*. Those numbers reveal that the former model could not explain the real world with accuracy compared to the later one.

4.2.2 The final Regression

After multiple attempts , the final regression was created and econometrically speaking the results present a more than decent goodness of fit . More particularly, as mentioned already the date being non stationary at 5% and 10% enable us to test it directly without further process using OLS . The results are reported at the Appendixes section. What we are looking to detect in this section is econometrically if the results comply with a) similar event studies in the existing literature and b) answer the main questions of the paper. We regress the Abnormal Yields, the Excess Abnormal Yields and the Squared Abnormal yields resulting from the sovereign bond realized yields on the QE dummies for the three announcement events on the ,the days if the week (Monday until Friday), the persistence dummy variables that we created to capture whether the

[22] The BPTS with the 20 year maturity was introduced later than the smaller maturity ones, hence the there are no values for the respective dates.

[23] https://www.easybourse.com/international/news/944727/berlusconi-urged-to-quit-as-bond-yields-climb.html https://www.cnbc.com/2017/06/27/reuters-america-update-1-euro-zone-bond-yields-jump-as-draghi-opens-door-to-policy-tweak.html

effect persist after announcing the news and lastly since we deal with time series we included as mentioned before the three first lags of the dependent variable of each regression. The estimated coefficients are exhibited in the appendix section.

The Treasury Bond market

In Table 1, we exhibit the estimated coefficients for the 5-year Treasury bond issued by the Fed. We observe that regardless of the dependent variables, whether it Is just the abnormal yields or a computation of the previous, all events are significant at 1% confidence level. In additions, as expected by macroeconomic theory the announcements are negatively correlated with the bond yields (Crump & others,2016) , meaning as the bank institution announced the monetary program , the respective yields dropped due to the announcement [24]. In addition, when looking more closely to the corresponding coefficients, it is easy to observe a decrease in the absolute value as the time passes. Particularly, the first QE on the 25th of November, 2008, influenced more the yields of the 5-year T-bonds , the yields dropped 18.1% due to the first program and around 5% in the next ones on the on the 3rd of November 2010 and the 13t of September 2012. [25]

[Table 1]

Moreover, there is no seasonality in our time series since there is no day of the week effect, all the coefficients are statistically insignificant for all the regressions regardless of the dependent variable. The economic interpretation reflects the irrelevance of the day when it comes to the abnormal yields that we computed. Another observation agrees with the previous deduction that among the three programs the one having the most impact in the sovereign bonds returns was the first Quantitative easing. Looking at the persistence dummy variables we see at least for the abnormal yields that the coefficient is statistically significant at 1% confidence level, while the other QE announcements seem not to have a lasting effect after the announcement date. This fact maybe coincides with the perspective that the financial markets are becoming more efficient over the years and adapt quicker to new information [26] . Hence, the statistical difference. Although, we notice that the last event in (date of QE3 US) effected the dependent variables in 10% confidence level, only after controlling for interest rate, meaning the Excess Abnormal Yields, the Absolut Excess Abnormal Yields and the Squared Excess Abnormal Yields. Moving on, as expected in all cases the lags play a role in the abnormal results, though the statistical significance varies along the regressions. The first and third lag are statistically significant for the Abnormal Yields, to 1% and 10% respectively but the second lag is not. All three lags of the Excess Abnormal Yields are statistically significant in 10% and 5% confidence level. In the same way the lags are important for the Absolute in contrast with the Squared Abnormal Yields, where only the first lag is

[24] There is aa exception where the QE2 and QE2 has a positive effect to the endogenous variable Excess abnormal Yields, a fact that we attribute to the deduction of the deposit interest rate

[25] Although each Quantitative easing policy bared its own characteristics regarding the capital injection into the economy and the sovereign asset repurchase . Hence the result is not absolute, but should be weight adjusted.

[26] https://hbr.org/2011/07/adaptability-the-new-competitive-advantage

statistically significant (Wooldridge, 2012) . In addition, the respective coefficients in all cases are larger for the Lag 1 and lower for the other two lags. Lastly, for a sample of 2,715 observations, the three R-squared values are very satisfactory , around 99%, meaning that the regression explains well financial reality.

Next two tables are concerned again with the US bond market , only now we are testing the long term sovereign bonds , the 10-year T-bonds and the 20-year T-bonds.

[Table 2]

[Table 3]

Following the same process, we find in both cases statistically significant all announcement dates for all dependent variables regarding the longer maturity bonds[27]. Again, we have no seasonality effect, days are not significant 99% of the time in both tables. Moving on, in the same way as for the 5-year T-bond, the longer maturity ones seem to follow the same pattern when it comes to persistence of the announcement effect since only the first event is significant for every equation in the tables. Something that can be interpreted as mentioned before as markets becoming more efficient and adapting to monetary policy quicker. Finally, the lags are important and impact the abnormal yields and their derivatives, in most cases the first and second lag are significant in 10% confidence level. Last thing to check is the R-squared that in both Table 2 and Table 3 is approximately 99%. Comparing the 5-year Treasury bond with longer maturity 10-year and 20-year we find that they match and the bonds had similar reaction to the events.

Next Tables exhibit the results for the UK market. Where Table 4 presents the regressions for the 5-year maturity GILT.

[Table 4]

First thing to specify is that all announcements by the Bank of England are statistically significant in 1% confidence level but in contrast with the US case the coefficients are large both in the first event on the 5th of march 2009 and the third one on the 4th of August 21016. The last quantitative easing announcement by the Central Bank of the UK was for a monetary program of great importance and the amount of capital thrown in the economy was not trivial too[28] .As expected and proven by our results as well that effected greatly the sovereign bonds as well, all QE dummy coefficients are SS at 1% confidence level. Just like before, there is no day of the week effect in the table since the corresponding coefficients are not statistically significant. Notice that in Table 4 the persistence coefficients are in all cases statistically insignificant which can be interpreted into the events effect being non-lasting after the event date [29]. Notice that the lags are not all three statistically significant for each equation. The abnormal yields first lag is statistically significant in 1% confidence level and so is the first lag of the squared excess abnormal yields. In the excess

[27] With the exception of the QE 3 in Table 3, where it seems it had no effect on the abnormal yields.

[28] https://www.economist.com/news/britain/21704762-how-misunderstanding-about-qe-led-lots-misleading-headlines-bank-englands-new

[29] Any deduction is solely based on the assumptions that the persistence dummies capture the lasting effect the news might have on the bond yields.

abnormal and absolute excess abnormal yields, the second lag is also statistically significant. In neither regressions the third lag plays any role in the formation of the endogenous variable. Lastly, once again the R-squared is satisfactory high [30] and accounts for 99,7% in every equation.

Table 5 illustrates the long term GILT of 10-years maturity which follows the same pattern as the 5-year GILT from the previous table.

[Table 5]

The long maturity bonds dropped in the incoming news of a quantitative easing each time, with the most pronounced decrease to be for the first event in March 2009 since the coefficient is the largest compared with the others in all equations. Days of the week seem trivial, and so does the persistence of the news. Almost all coefficient corresponding to the Persistence dummy variables are statistically insignificant As for the lags, in this case in the excess abnormal and absolute excess and the yields influence the dependent variable. More particularly almost all are statistically significant in 1% confidence level. Although he simple abnormal returns do not seem to be affected by the previously realized values of the time series, only the first lag is SS for both abnormal yields and squared ones. Finally, the R-squared as in the previous tables accounts for 99%.

Last Table concerned with the UK quantitative announcements is Table 6

[Table 6]

The 20-year GILTS were negatively affected by the policy announcements, as all three QE coefficients are statistically significant in 1% confidence level, with the larger one being the first of 2009 .The days of the week do not seem to have any impact. Notice that the first two announcements did not influenced the yields for more than one day but the third on did, in fact for the Excess Abnormal Yields and the Absolute Excess the respective coefficients are statistically significant at 1% confidence level and approximate 5%, meaning that the following three days the news decreased the bond yields by 5% on average. In addition, all the lags in each equation are SS with the first one being more important and influensive. Once again the R-squared is 99% for every regression letting us assume the accuracy of the model.

In the Eurozone, the three representative countries, as mentioned before, that we applied the model are Germany, France and Italy with respect to the capital allocated in each monetary program.

Starting with the 5-year maturity bonds, also called BUNDS, we examine the results in Table 7.

[Table 7]

Among the three incidents , BUND yields seem to have suffered a loss only to the second one on the 10th of March 2016 , in contrast with the other two which appears to benefit the bond holders increasing the yields [31]. Moving one, the results show that Tuesday decreases the yields as well ,

[30] This is partly due to the inclusion of Lags, although even before the R-squared was high as well.
[31] https://www.ft.com/content/f297129a-ee7b-11e4-88e3-00144feab7de

although any other day is insignificant. None of the events had a lasting effect after the announcement date, hence the persistence coefficients are insignificant in all case. Once more, the lags are important in the regressions, especially the first and second which appear to be statistically significant, and the R-squared confirms that the model fits the German reality too, as it is around 99%.

[Table 8]

[Table 9]

The longer maturity BUNDS as well do not exhibit same reaction with the other markets to the events. The QE coefficient are positive and statistically significant for every regression at 1% confidence level, something that goes against economic and macroeconomic theory. The persistence coefficients are negative but statistically insignificant except for the third QE persistence dummy coefficient that is positive for all equations and statistically significant at 1%confidence level of the 10-year and 20-year maturity BUNDS. That outcome might be attributed to the negative interest rates that existed in the German market[32]. Next, the lags on both tables are SS, mostly the firs and the second one and the R-squared is again around 99%.

France us the second largest European economy, ranked by GDP, and accordingly the capital allocated when monetary policies are imposed is of same importance. Tables 10, 11 and 12 demonstrate the reaction of the OATS, the sovereign French bonds to the incoming macroeconomic news.

[Table 10]

[Table 11]

[Table 12]

The 5-year maturity OATS exhibit same characteristics with the German sovereign bonds. They are positively influenced by the QE announcements, the respective coefficients are positive and statistically significant, and the persistence coefficients are positive as well when SS. There is a correlations between the bond yields being negative and close to zero at the time and the positive reaction to the event, such as the 5-year OATS. In the same way, the lags are SS for 1% confidence level in most cases the first one and second ones with the exception of the simple abnormal returns, where the second lag is trivial.

Although longer maturity French sovereign bonds react negatively to the episodes. All coefficients corresponding to the event are statistically significant and negative , with the most pronounce one with the largest coefficients being the second QE dated in March 2016. On the other hand ,persistence dummies reveal that the markets relapsed the following three days rising yields again as the coefficients of the second and third event are positive and statistically

http://www.marketwatch.com/story/treasury-yields-rise-after-draghi-dismisses-factors-holding-down-inflation-as-temporary-2017-06-27

[32] https://www.cnbc.com/2016/07/13/germany-becomes-second-g7-nation-to-issue-10-year-bond-with-a-negative-yield.html

significant in 10% and 1% confidence level. The lags present the same picture as all previous tables have and the R-squared is around 99% in all regressions. In the same way, the longer maturity 20- year OATS react negatively to the policy news with again the second event being the one with the most impact. Almost all coefficients are negative and statistically significant . The only persistence coefficient that we take into account it the QE3 one that is SS in 10% confidence level and shows that during the 3 days followed by the event the yields increased . Lastly , the first two lags of all equations play some role as expected for every equation and the R-square accounts for 99% in most cases.

For concluding the analysis regarding the ECB monetary policies, we included Italy, since the country is the third biggest in Europe in terms of GDP[33] and the amounts allocated to Italian sovereign securities in each program are the third largest after Germany and France. As the Table 13 shows, the 5-year maturity BTPS reacted negatively to each event as all coefficient are negative.

[Table 13]

Though , the first credit easing seems no to affect the yields at all as the respective coefficients are statistically insignificant after controlling for the interest rate of that time. Besides this , the other two episodes decreased the yields in all equations and the coefficients are statistically significant in 1% confidence level. Moving on, days of the week seem not to matter in our sample and the following days the impact of the announcements was not pronounce since the corresponding coefficients are not SS. When we run the first regression checking the simple abnormal returns , the first two lags came out SS in contrast with the next three regressions where only the values of a day before influenced the dependent variable. Lastly, the R-squared is found to be approximately 99%.

The following tables, Table 14 and Table 15 , are concerned with long term BPTS of 10-ear and 20-year maturity and share the same characteristics.

[Table 14]

[Table 15]

Every endogenous variable had a negative reaction to the three episodes. All the respective coefficients are negative but the results agree with the previous table when it comes to the firs credit easing announcement , where the coefficients are statistically insignificant showing that the markets did not react immediately decreasing the long term rates due to the ECB's announcement. Although, by the QE 1 Persistence dummy we can conclude that the three following days, the markets decreased as well with a time lag the long term yields due to its sign which is negative and statistical significance. Once again, in both tables and all regressions the previous day of the event lag plays a role but the other two do not contribute to the abnormal yields . Finally , the R-squared is around 99% in both tables and all equations.

[33] http://statisticstimes.com/economy/european-countries-by-gdp.php

4.2.3 Findings and existing literature

The Fed : LSAPs

Taking into account the existing literature there is a controversy whether such credit easing programs are actually effective and whether this kind of interference with the economy and the financial markets should continue. As it is quite a challenge to quantify the real impact of unconventional monetary tools in order for wiser future policy making[34].More specifically, if the programs concerned were successful achieving the initial goals, always in regard with our concern which is the sovereign bond rates.

Regarding the Fed and the LSAP programs taken into consideration in the analysis , the majority of the researchers point out the effectiveness of the programs in diminishing the long term yields in the successive rounds of credit easing. Particularly the first QE1 and the second QE 2 imposed by the Fed are found generally successful in that way (Gagnon et al. (2010), Zhu (2011), Krishnamurthy and Vissing-Jorgensen (2012)). Although there is a controversy as different researchers apply different event study approaches. In that sense, Nellis (2013) characterized QE1 and QE2 as fruitless as the impact on the securities and rates was not pronounced enough reaching the goal , in contrast with the third one QE3 which was found more successful [35].

Comparing our findings

In the same regard the papers findings agree with the majority of the literature that all of the events are statistically significant and effective in reducing the long term interest yields. As shown in Tables 1,2 and 3 the coefficients are SS and negative for the QE dummies .As the reduction of long term rates is the immediate goal . Hence , we can interpret the drop as a positive impact of the programs to decrease rates as well as diminishing risk so investor could turn to the private sector and boost the real economy.

BoE : APP

A review of the main surveys conducted on the asset purchase programs in UK revealed the following . To start with the main goal, just like for the other central banks as well, was to stabilize the finance structure rather than chase a stable inflation rate. In this way, with the large purchases of GILTS from the private sector , the central bank made an effort to affect the yields and provide in a second level more liquidity .The studies have shown a great decrease in the long long term yields , 10-year maturity GILTS by 107 basis points and a smaller in the short term (Glick and Leluc (2011). The anticipation of the second episode in 2011 , seems to have a larger effect on the yields as they diminish by 125 basis points (Joyce et al – Q3 2011). Although, the success of the British QE program sequence is under discussion with many arguing that I failed to deliver on its

[34] https://workspace.imperial.ac.uk/business-school/Public/people/dmiles/Analytical_6616470_1.PDF

[35] However, given the number of assumptions necessary to model the impact of an LSAP program on the macroeconomy, the numbers have a degree of imprecision

task, which was to boost the growth rate despite the logical deduction coming from the facts: lowered yields and long term interest rates have a positive impact on the economy channeling capital to the stock and private security market (Joyce, Miles, Scott, Vayanos - 2012). That was mainly because another important factor playing a role to the success of those policies is the willingness of the financial and pension institutions to turn their resources to riskier assets. That was the problem with the last episode of the study , in August 2016 [36]. While the BoE was pursuing the large purchase program, institutions and individual investor were holding on to the sovereign securities and were unwilling to sell.

Comparing our findings

From a yields point of view, studying the Tables 4, 5 and 6 reveal that the events had the desirable results suppressing the long term yields. All coefficients are negative and statistically significant in 1% confidence level confirming what is already said. Although judging from the size of the coefficients the second credit easing had not that pronounced impact in all maturity GILTS , a fact not already emphasized by other studies. As much as the last episode is concerned, we find similar results with the first QE announcement in 2009 , which is considered successful in decreasing long term rates and that is also what the tables show.

ECB : APP

Due to the fact that all credit schemes introduced by the ECB date in 2015 and 2016, the long term economic effects and have not already been examined . Although , short term financial markets reactions have been monitored concerning the sovereign bond yields .All sovereign instruments , especially the German , French and Italian ones we investigate, except Greece sovereign bonds, have reached record low levels and by the end of 2015 30% of the government bonds had negative yields[37]. That is a sign of a prospect future growth as low yields aid reduced financing cost as well as credit expansion.

Comparing our findings

In general the tables show an immediate reaction to the ECB announcements that agrees with the existing literature , as the markets perceive the sovereign bonds as more secure ,bearing less future risk and the yields fall instantly. Although the persistence of the credit easing effect seeds to exist after one day , long term rates drop noticeably . Hence, using only one simple factor to evaluate the ECB credit easing schemes one could deduct that on average they reached the goal of the lower financing rates in order to boost the real economy .

[36] https://www.theguardian.com/business/2016/aug/10/why-the-banks-bond-buying-failure-may-not-be-just-a-blip

[37] http://www.ciis.org.cn/english/2016-08/19/content_8974973.htm

5. Conclusion

The quantification of the impact of policy measures relative to Quantitative Easing programs as well as the respective announcements on asset prices just like the sovereign bonds, is often observed over a small time window close to the policy announcement . Some identifications of such events are even harder and more challenging due to prior announcements of QEs and communications with the market for more extensions. Therefore , to be reassured that the study's assumptions are correct regarding the timeline of the policy announcements, we cross checked the empirical results using the Datastream database with different finance news press sites such as Bloomberg News and Financial Times.

By running the same regression for each country and bond type , the results suggest that in each case the macroeconomic policy announcements affects negatively the bond yields as expected and the announcements are statistical significant. The econometric test reveals how important and effective still is a monetary policy that sizable as those under scope, by even just monitoring one basic fixed income instrument. But as far are the effectiveness and market reaction towards the program are concerned , we can observe a small decline in the absolute values of the coefficients accompanying the QE dummies and almost no persistence after every episode. A fact maybe suggesting the evolution of the markets through time as well as their improved efficiency making monetary policy fruitless.

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Appendices

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. dfuller Abnormalyields, regress lag(0)

Dickey-Fuller test for unit root                   Number of obs   =      2717

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -3.462           -3.430            -2.860           -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0090
```

D. Abnormalyields	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Abnormalyields L1.	-.0077584	.0022408	-3.46	0.001	-.0121522	-.0033647
_cons	.0000168	.0000151	1.11	0.268	-.0000129	.0000464

Figure 1

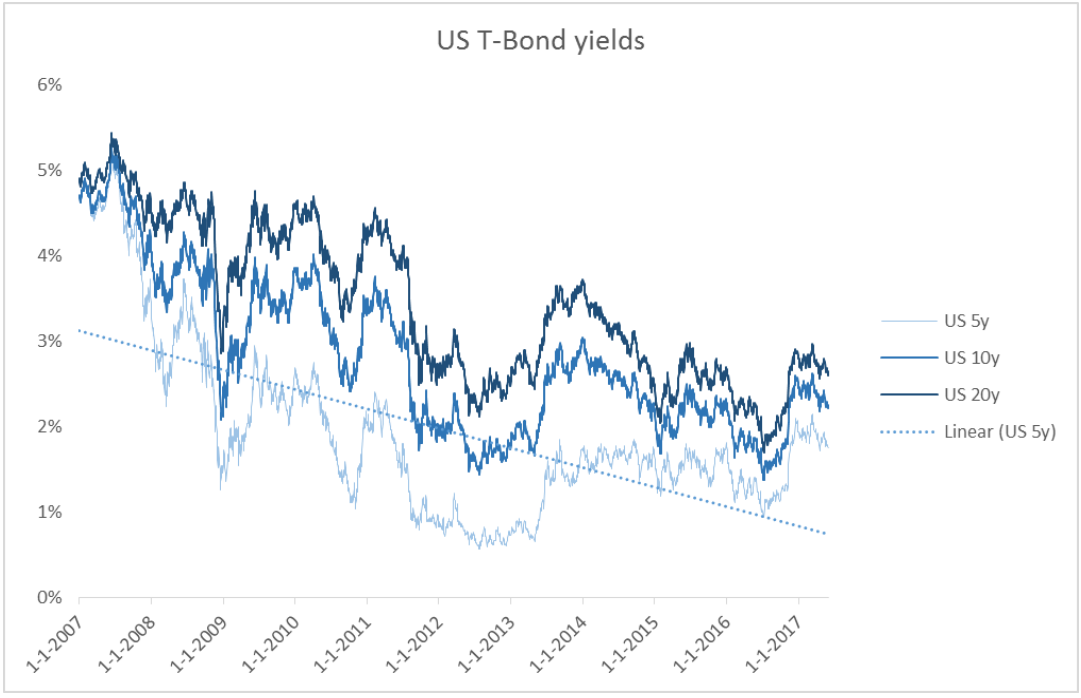

Figure 2

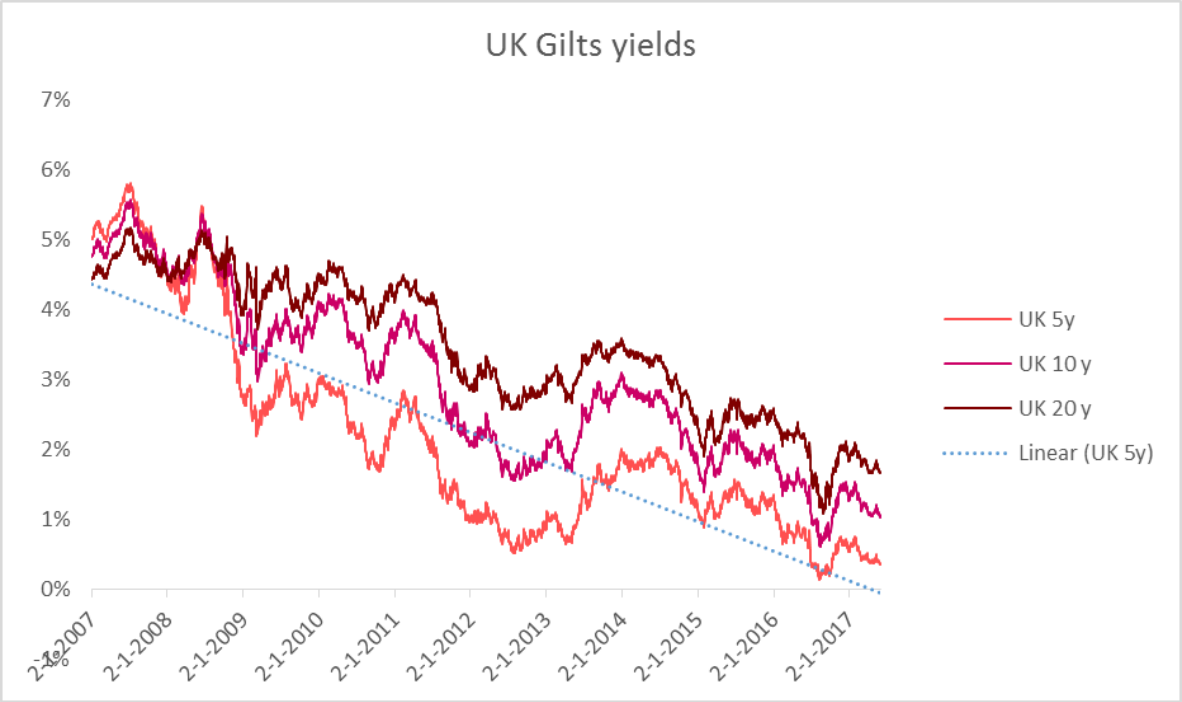

Figure 3

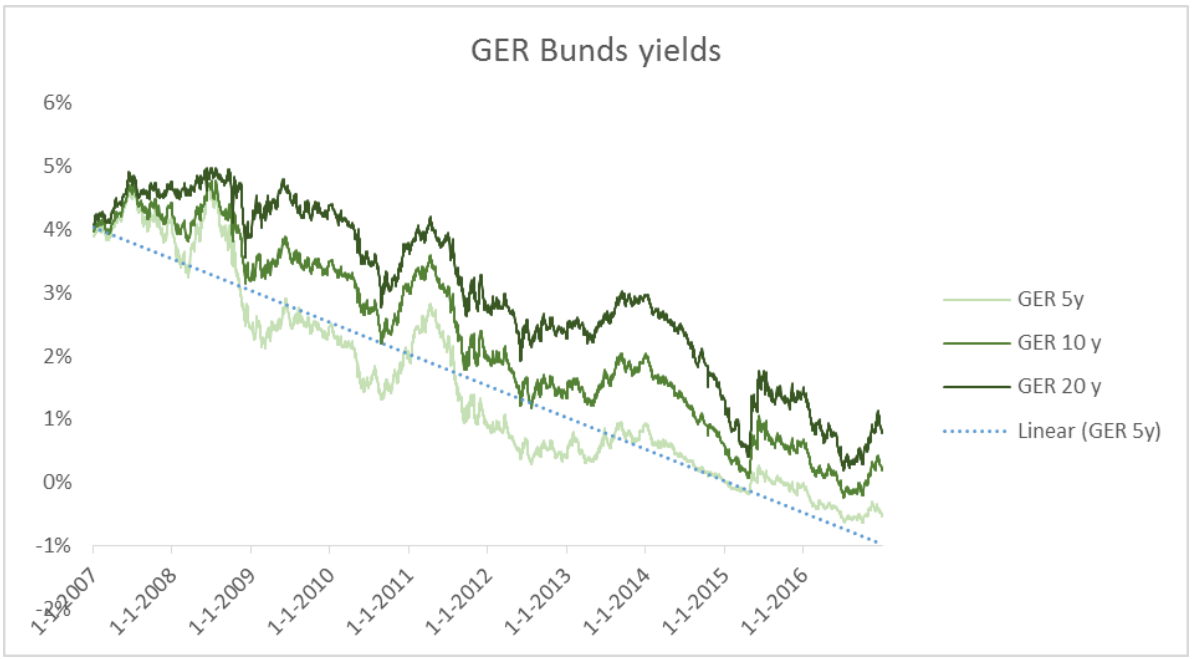

Figure 4

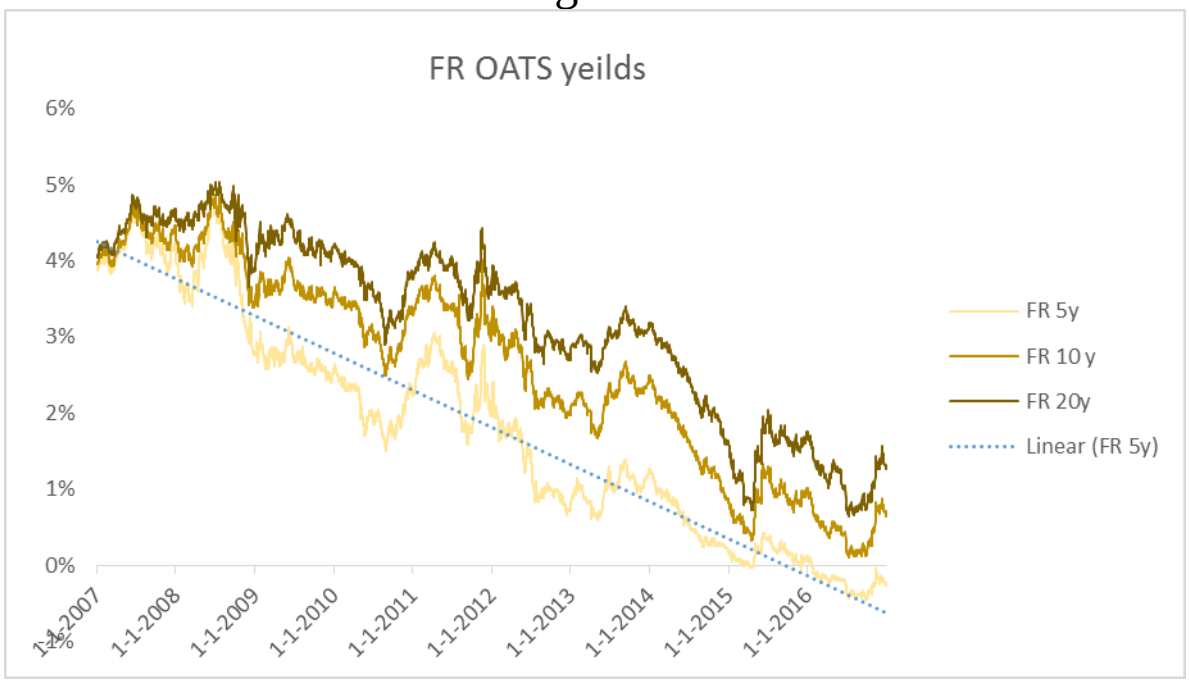

Figure 5

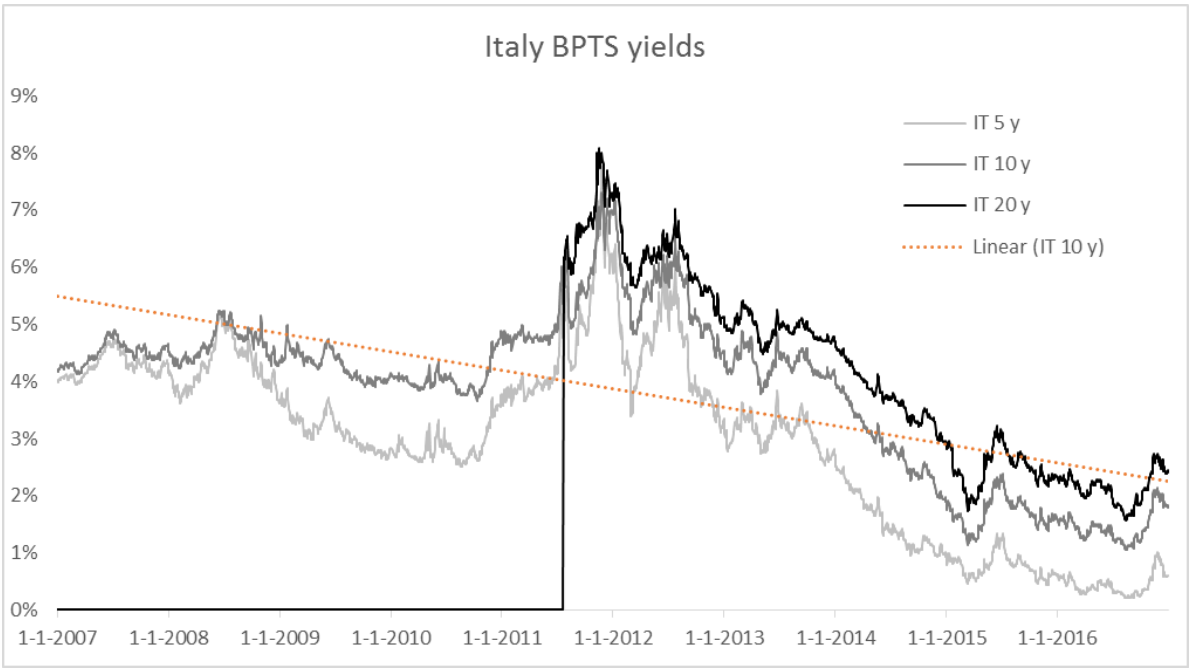

Table 1 US Treasury Bonds 5 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abnormal
QE 1	-0.181***	-0.145***	0.143***	0.0130***
	(0.00888)	(0.0114)	(0.0117)	(0.00120)
QE 2	-0.0460***	0.0434***	-0.0414***	-0.00146***
	(0.00350)	(0.00721)	(0.00731)	(0.000273)
QE 3	-0.0558***	0.0711***	-0.0748***	-0.000815***
	(0.00465)	(0.00557)	(0.00544)	(0.000211)
Monday	-0.00156	-0.00727	0.00345	7.50e-05
	(0.00319)	(0.00492)	(0.00484)	(0.000170)
Tuesday	0.000272	-0.00198	0.00509	0.000160
	(0.00302)	(0.00558)	(0.00556)	(0.000168)
Wednesday	0.00283	-0.00746	0.00622	0.000152
	(0.00295)	(0.00499)	(0.00492)	(0.000198)
Thursday	0.00647	0.00164	0.00226	-6.47e-05
	(0.00434)	(0.00534)	(0.00521)	(0.000205)
Friday	0.00109	-0.00112	0.00385	7.99e-05
	(0.00288)	(0.00519)	(0.00519)	(0.000169)
Persistence QE 1	-0.0548***	-0.0698	0.0697	0.00421
	(0.0169)	(0.0496)	(0.0492)	(0.00398)
Persistence QE 2	-0.00110	0.0263	-0.0271	-0.000308
	(0.0336)	(0.0419)	(0.0431)	(0.000861)
Persistence QE 3	0.0210	0.0427*	-0.0432*	-0.000433*
	(0.0210)	(0.0225)	(0.0226)	(0.000255)
Lag 1 Abnormal	0.988***			
	(0.0279)			
Lag 2 Abnormal	-0.0435			
	(0.0356)			
Lag 3 Abnormal	0.0478**			
	(0.0222)			
Lag 1 Excess Abn		0.686***		
		(0.0369)		
Lag 2 Excess Abn		0.253***		
		(0.0317)		
Lag 3 Excess Abn		0.0567**		
		(0.0254)		
Lag 1 ABS excess			0.683***	
			(0.0385)	
Lag 2 ABS excess			0.256***	
			(0.0329)	
Lag 3 ABS excess			0.0568**	
			(0.0262)	
Lag 1 Squared				0.872***

				(0.0730)
Lag 2 Squared				0.130
				(0.0835)
Lag 3 Squared				-0.00642
				(0.0584)
Observations	2,715	2,715	2,715	2,715
R-squared	0.989	0.996	0.996	0.994

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 Treasury Bonds 10 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abnormal
QE 1	-0.240***	-0.224***	0.219***	0.0170***
	(0.00709)	(0.00846)	(0.00837)	(0.000838)
QE 2	0.0350***	0.122***	-0.119***	-0.00223***
	(0.00316)	(0.00661)	(0.00659)	(0.000234)
QE 3	-0.0241***	0.114***	-0.117***	-0.000918***
	(0.00444)	(0.00578)	(0.00569)	(0.000197)
Monday	-0.00114	-0.00666	0.00592	9.82e-05
	(0.00336)	(0.00505)	(0.00507)	(0.000159)
Tuesday	-5.07e-05	-0.00198	0.00808	0.000175
	(0.00305)	(0.00558)	(0.00552)	(0.000153)
Wednesday	0.00462	-0.00566	0.00432	7.43e-05
	(0.00289)	(0.00480)	(0.00478)	(0.000185)
Thursday	0.00619*	0.00208	0.000440	-9.19e-05
	(0.00376)	(0.00516)	(0.00506)	(0.000184)
Friday	0.00111	-0.000958	0.000588	-7.18e-06
	(0.00285)	(0.00506)	(0.00513)	(0.000151)
Persistence QE 1	-0.0733***	-0.103***	0.105***	0.00516*
	(0.0252)	(0.0329)	(0.0335)	(0.00287)
Persistence QE 2	-0.0285	-0.00303	0.00245	0.000221
	(0.0496)	(0.0419)	(0.0413)	(0.000655)
Persistence QE 3	0.0271	0.0541	-0.0561	-0.000339
	(0.0431)	(0.0458)	(0.0447)	(0.000317)
Lag 1 Abnormal	0.989***			
	(0.0274)			
Lag 2 Abnormal	-0.0304			
	(0.0370)			
Lag 3 Abnormal	0.0329			

	(0.0251)			
Lag 1 Excess		0.689***		
		(0.0323)		
Lag 2 Excess		0.250***		
		(0.0301)		
Lag 3 Excess		0.0574**		
		(0.0243)		
Lag 1 ABS			0.681***	
			(0.0330)	
Lag 2 ABS			0.257***	
			(0.0306)	
Lag 3 ABS			0.0580**	
			(0.0249)	
Lag 1 Squared				0.911***
				(0.0754)
Lag 2 Squared				0.103
				(0.0836)
Lag 3 Squared				-0.0182
				(0.0541)
Observations	2,715	2,715	2,715	2,715
R-squared	0.987	0.996	0.996	0.997

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 Treasury Bonds 20 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abnormal
QE 1	-0.162***	-0.171***	0.163***	0.0120***
	(0.00505)	(0.00652)	(0.00624)	(0.000479)
QE 2	0.124***	0.199***	-0.197***	-0.00256***
	(0.00323)	(0.00806)	(0.00789)	(0.000237)
QE 3	0.00600	0.143***	-0.143***	-0.000988***
	(0.00418)	(0.00571)	(0.00563)	(0.000177)
Monday	-0.00203	-0.00848*	0.00865*	0.000148
	(0.00337)	(0.00498)	(0.00495)	(0.000155)
Tuesday	-0.000102	-0.00247	0.00934*	0.000172
	(0.00298)	(0.00541)	(0.00535)	(0.000146)
Wednesday	0.00554**	-0.00255	0.00469	-1.83e-05
	(0.00269)	(0.00456)	(0.00450)	(0.000178)
Thursday	0.00665*	0.00291	-0.00430	-0.000118
	(0.00352)	(0.00507)	(0.00498)	(0.000175)

Friday	0.000203	-0.000102	-0.00124	-3.02e-06
	(0.00274)	(0.00519)	(0.00504)	(0.000147)
Persistence QE 1	-0.0578***	-0.0740*	0.0771*	0.00366
	(0.0185)	(0.0404)	(0.0402)	(0.00315)
Persistence QE 2	-0.00411	0.0320	-0.0335	-4.83e-05
	(0.0401)	(0.0470)	(0.0462)	(0.000352)
Persistence QE 3	0.0315	0.0570	-0.0611	-0.000274
	(0.0499)	(0.0535)	(0.0523)	(0.000272)
Lag 1 Abnormal	0.982***			
	(0.0260)			
Lag 2 Abnormal	-0.00620			
	(0.0371)			
Lag 3 Abnormal	0.0164			
	(0.0266)			
Lag 1 Excess		0.722***		
		(0.0339)		
Lag 2 Excess		0.251***		
		(0.0323)		
Lag 3 Excess		0.0233		
		(0.0244)		
Lag 1 ABS			0.701***	
			(0.0335)	
Lag 2 ABS			0.265***	
			(0.0324)	
Lag 3 ABS			0.0299	
			(0.0248)	
Lag 1 Squared				0.944***
				(0.0812)
Lag 2 Squared				0.112
				(0.0900)
Lag 3 Squared				-0.0586
				(0.0557)
Observations	2,715	2,715	2,715	2,715
R-squared	0.987	0.997	0.997	0.997

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

UK

Table 4 UK GILTS 5 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn

QE 1	-0.175***	-0.112***	0.108***	0.613***
	(0.00328)	(0.00498)	(0.00499)	(0.0222)
QE 2	-0.0438***	-0.0353***	0.0289***	0.0568***
	(0.00270)	(0.00509)	(0.00509)	(0.0169)
QE 3	-0.147***	-0.162***	0.155***	0.421***
	(0.00291)	(0.00430)	(0.00392)	(0.0139)
Monday	-0.000997	-0.00277	0.00418	0.0137
	(0.00253)	(0.00476)	(0.00511)	(0.0183)
Tuesday	0.00257	-0.00887**	-0.000720	0.00163
	(0.00234)	(0.00429)	(0.00462)	(0.0173)
Wednesday	0.000549	0.00323	0.00523	0.00279
	(0.00242)	(0.00469)	(0.00453)	(0.0177)
Thursday	3.20e-05	2.92e-05	0.00610	0.0147
	(0.00256)	(0.00442)	(0.00456)	(0.0179)
Friday	0.00469	0.00206	-0.00333	-0.00725
	(0.00499)	(0.00563)	(0.00576)	(0.0193)
Persistence QE1	-0.0333	-0.0327	0.0394	0.0864
	(0.0642)	(0.0709)	(0.0701)	(0.435)
Persistence QE2	-0.0115	-0.0165	0.0161	0.0283
	(0.0177)	(0.0138)	(0.0122)	(0.0492)
Persistence QE3	-0.0102	-0.0224	0.0280*	0.0135
	(0.0183)	(0.0161)	(0.0148)	(0.0641)
Lag 1 Abnormal	1.013***			
	(0.0181)			
Lag 2 Abnormal	-0.0244			
	(0.0296)			
Lag 3 Abnormal	0.00850			
	(0.0210)			
Lag 1 .Excess		0.775***		
		(0.0427)		
Lag 2 Excess		0.179***		
		(0.0479)		
Lag 3 Excess		0.0439		
		(0.0415)		
Lag 1 Absolute			0.762***	
			(0.0444)	
Lag 2 Absolute			0.168***	
			(0.0451)	
Lag 3 Absolute			0.0671*	
			(0.0349)	
Lag 1 Squared				1.023***
				(0.0434)
Lag 2 Squared				0.0120
				(0.0477)
Lag 3 Squared				-0.0373
				(0.0623)

Observations	2,715	2,715	2,715	2,715
R-squared	0.997	0.997	0.997	0.997

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 UK GILTS 10 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.292***	-0.219***	0.209***	1.087***
	(0.00285)	(0.00468)	(0.00482)	(0.0186)
QE 2	-0.0303***	-0.0183***	0.0110**	0.00746
	(0.00295)	(0.00490)	(0.00487)	(0.0175)
QE 3	-0.171***	-0.192***	0.182***	0.547***
	(0.00391)	(0.00535)	(0.00511)	(0.0156)
Monday	-0.00184	-0.00317	4.92e-05	0.00500
	(0.00243)	(0.00454)	(0.00480)	(0.0161)
Tuesday	0.00276	-0.00885**	0.000808	0.000253
	(0.00247)	(0.00420)	(0.00444)	(0.0153)
Wednesday	0.00160	0.00433	0.00421	-0.00217
	(0.00244)	(0.00469)	(0.00457)	(0.0200)
Thursday	0.00274	0.00313	0.00682	0.00903
	(0.00248)	(0.00423)	(0.00435)	(0.0159)
Friday	0.00361	0.00215	-0.00588	-0.0131
	(0.00453)	(0.00541)	(0.00547)	(0.0177)
Persistence QE1	-0.104	-0.131	0.140	0.450
	(0.0969)	(0.107)	(0.105)	(0.604)
Persistence QE2	-0.00323	-0.00498	0.00466	0.00318
	(0.0204)	(0.0110)	(0.00801)	(0.0368)
Persistence QE3	-0.0291	-0.0450**	0.0516**	0.0849
	(0.0294)	(0.0223)	(0.0224)	(0.0942)
Lag 1 Abnormal	1.003***			
	(0.0176)			
Lag 2 Abnormal	-0.0431			
	(0.0316)			
Lag 3 Abnormal	0.0365			
	(0.0255)			
Lag 1 Excess		0.758***		
		(0.0381)		

Lag 2 Excess		0.173***		
		(0.0461)		
Lag 3 Excess		0.0673		
		(0.0418)		
Lag 1 Abs			0.754***	
			(0.0387)	
Lag 2 Abs			0.162***	
			(0.0474)	
Lag 3 Abs			0.0824*	
			(0.0435)	
Lag 1 Squared				0.956***
				(0.0296)
Lag 2 Squared				0.0805
				(0.0501)
Lag 3 Squared				-0.0379
				(0.0545)
Observations	2,715	2,715	2,715	2,715
R-squared	0.996	0.998	0.998	0.998

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 UK GILTS 20 year maturity

Variable	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.347***	-0.246***	0.241***	1.186***
	(0.00395)	(0.00734)	(0.00763)	(0.0309)
QE 2	-0.0275***	-0.0135***	0.00321	-0.00377
	(0.00271)	(0.00456)	(0.00454)	(0.0182)
QE 3	-0.148***	-0.162***	0.156***	0.482***
	(0.00273)	(0.00385)	(0.00382)	(0.0156)
Monday	-0.00122	-0.00243	0.000304	0.00239
	(0.00214)	(0.00436)	(0.00443)	(0.0155)
Tuesday	0.00299	-0.00837**	9.95e-05	0.000419
	(0.00221)	(0.00416)	(0.00402)	(0.0145)
Wednesday	0.00328	0.00619	0.00347	-0.0128
	(0.00212)	(0.00450)	(0.00435)	(0.0219)
Thursday	0.00200	0.00317	0.00339	0.00301
	(0.00214)	(0.00405)	(0.00403)	(0.0152)

Friday	0.00213	0.00107	-0.00596	-0.00988
	(0.00375)	(0.00505)	(0.00495)	(0.0165)
Persistence QE 1	-0.114	-0.160	0.162	0.450
	(0.128)	(0.140)	(0.141)	(0.736)
Persistence QE 2	0.00820	0.00902	-0.00892	-0.0361
	(0.0149)	(0.0163)	(0.0135)	(0.0561)
Persistence QE 3	-0.0367	-0.0482***	0.0524***	0.111
	(0.0250)	(0.0170)	(0.0183)	(0.0867)
Lag 1 Abnormal	1.012***			
	(0.0212)			
Lag 2 Abnormal	-0.0671*			
	(0.0359)			
Lag 3 Abnormal	0.0501*			
	(0.0281)			
Lag 1 Excess		0.730***		
		(0.0377)		
Lag 2 Excess		0.183***		
		(0.0451)		
Lag 3 Excess		0.0853**		
		(0.0413)		
Lag 1 Abs			0.735***	
			(0.0384)	
Lag 2 Abs			0.192***	
			(0.0463)	
Lag 3 Abs			0.0711*	
			(0.0423)	
Lag 1 Squared				0.958***
				(0.0365)
Lag 2 Squared				0.0774*
				(0.0449)
Lag 3 Squared				-0.0370
				(0.0501)
Observations	2,715	2,715	2,715	2,715
R-squared	0.993	0.999	0.999	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

EU AREA

GERMANY

Table 7 Germany BUND 5 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	0.0129***	0.0510***	-0.0275***	-0.00293
	(0.00388)	(0.00751)	(0.00765)	(0.00979)
QE 2	-0.00882**	0.00412	-0.00639	0.00375
	(0.00448)	(0.00389)	(0.00402)	(0.00968)
QE 3	0.0181***	0.0224***	0.0235***	-0.0343***
	(0.00259)	(0.00386)	(0.00377)	(0.00970)
Monday	0.00261	0.00321	-0.00428	0.0172**
	(0.00329)	(0.00426)	(0.00401)	(0.00854)
Tuesday	-0.00381**	-0.00603*	0.00607*	-0.0101
	(0.00188)	(0.00328)	(0.00328)	(0.0100)
Wednesday	0.00158	0.00425	-0.00232	-0.0160
	(0.00207)	(0.00322)	(0.00316)	(0.0124)
Thursday	0.00459	0.000249	-0.000826	0.0142
	(0.00298)	(0.00380)	(0.00377)	(0.00968)
Friday	-0.00620**	-0.00627*	0.00632*	-0.0148
	(0.00263)	(0.00365)	(0.00359)	(0.0109)
Persistence QE1	-0.0138	-0.0229	0.0126	0.000790
	(0.0207)	(0.0377)	(0.0313)	(0.0106)
Persistence QE2	0.0323	0.0665	0.0509	0.0128
	(0.0305)	(0.0454)	(0.0413)	(0.0200)
Persistence QE3	-0.0184	-0.0227	-0.0284	0.00101
	(0.0176)	(0.0151)	(0.0181)	(0.0100)
Lag 1 Abnormal	0.981***			
	(0.0192)			
Lag 2 Abnormal	0.00706			
	(0.0196)			
Lag 3 Abnormal	-0.00547			
	(0.00733)			
Lag 1 Excess		0.789***		
		(0.0331)		
Lag 2 Excess		0.202***		
		(0.0346)		
Lag 3 Excess		0.00565		
		(0.0127)		
Lag 1 Abs			0.793***	

			(0.0357)	
Lag 2 Abs			0.196***	
			(0.0372)	
Lag 3 Abs			0.00807	
			(0.0135)	
Lag 1 Squared				0.954***
				(0.0402)
Lag 2 Squared				0.0549
				(0.0531)
Lag 3 Squared				-0.0116
				(0.0379)
Observations	2,715	2,715	2,715	2,715
R-squared	0.966	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 Germany BUND 10 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	0.0317***	0.0660***	-0.0614***	0.0226**
	(0.00335)	(0.00654)	(0.00703)	(0.0106)
QE 2	0.0122***	0.0142***	-0.0128***	0.0110
	(0.00320)	(0.00412)	(0.00422)	(0.00897)
QE 3	0.0139***	0.0177***	0.0142***	0.0466***
	(0.00267)	(0.00361)	(0.00331)	(0.00892)
Monday	-0.00381	-0.00101	-0.000469	0.00464
	(0.00307)	(0.00404)	(0.00366)	(0.00881)
Tuesday	-0.00195	-0.00508	0.00409	0.000748
	(0.00222)	(0.00343)	(0.00343)	(0.00975)
Wednesday	-0.00159	0.00167	0.000370	0.00282
	(0.00227)	(0.00334)	(0.00328)	(0.00993)
Thursday	0.00204	-0.00257	0.000702	-0.0217**
	(0.00228)	(0.00343)	(0.00336)	(0.00897)

Friday	0.00351	0.00326	0.00135	0.00153
	(0.00237)	(0.00348)	(0.00337)	(0.00907)
Persistence QE1	-0.0455	-0.0517*	0.0500*	0.0285*
	(0.0480)	(0.0282)	(0.0299)	(0.0169)
Persistence QE2	0.0126	0.0485	-0.0363	-0.000989
	(0.0216)	(0.0528)	(0.0291)	(0.00651)
Persistence QE3	0.0336***	0.0332***	0.0307***	0.00544
	(0.00301)	(0.00406)	(0.00246)	(0.0136)
Lag 1 Abnormal	0.983***			
	(0.0192)			
Lag 2 Abnormal	0.00951			
	(0.0200)			
Lag 3 Abnormal	-0.00817			
	(0.00782)			
Lag 1 Excess		0.790***		
		(0.0312)		
Lag 2 Excess		0.196***		
		(0.0330)		
Lag 3 Excess		0.0106		
		(0.0139)		
Lag 1 Abs			0.800***	
			(0.0344)	
Lag 2 Abs			0.175***	
			(0.0373)	
Lag 3 Abs			0.0214	
			(0.0185)	
Lag 1 Squared				0.917***
				(0.0461)
Lag 2 Squared				0.0968*
				(0.0532)
Lag 3 Squared				-0.0165
				(0.0412)
Observations	2,715	2,715	2,715	2,715
R-squared	0.971	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 German BUND 20 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	0.0200***	0.0522***	-0.0505***	-0.00180
	(0.00357)	(0.00649)	(0.00671)	(0.0122)

QE 2	0.0236***	0.0286***	-0.0242***	0.0104
	(0.00299)	(0.00418)	(0.00415)	(0.00945)
QE 3	0.0362***	0.0372***	0.0318***	0.0530***
	(0.00294)	(0.00369)	(0.00345)	(0.00941)
Monday	-0.00537*	-0.00227	0.00160	0.00518
	(0.00311)	(0.00408)	(0.00392)	(0.00875)
Tuesday	-0.00316	-0.00646*	0.00631*	-0.00191
	(0.00240)	(0.00359)	(0.00357)	(0.00999)
Wednesday	-0.000542	0.00270	-2.35e-05	0.00540
	(0.00257)	(0.00364)	(0.00360)	(0.00932)
Thursday	0.000228	-0.00425	0.00107	-0.0234**
	(0.00233)	(0.00355)	(0.00351)	(0.00942)
Friday	0.00535*	0.00496	-0.00137	0.00337
	(0.00278)	(0.00378)	(0.00372)	(0.00913)
Persistence QE 1	-0.0586	-0.0646	0.0638	0.0748
	(0.0718)	(0.0497)	(0.0508)	(0.0488)
Persistence QE 2	-0.00117	0.0311	-0.0296	-0.00444
	(0.0148)	(0.0477)	(0.0271)	(0.00529)
Persistence QE 3	0.0712***	0.0762***	0.0738***	0.0340
	(0.0221)	(0.0209)	(0.0187)	(0.0473)
Lag 1 Abnormal	0.991***			
	(0.0244)			
Lag 2 Abnormal	0.00471			
	(0.0251)			
Lag 3 Abnormal	-0.0110			
	(0.0108)			
Lag 1 Excess		0.821***		
		(0.0309)		
Lag 2 Excess		0.171***		
		(0.0318)		
Lag 3 Excess		0.00431		
		(0.0123)		
Lag 1 Abs			0.809***	
			(0.0322)	
Lag 2 Abs			0.175***	
			(0.0333)	
Lag 3 Abs			0.0126	
			(0.0143)	
Lag 1 Squared				0.917***
				(0.0428)
Lag 2 Squared				0.0952**
				(0.0480)
Lag 3 Squared				-0.0151
				(0.0368)
Observations	2,715	2,715	2,715	2,715

R-squared	0.973	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

France

Table 10 France OATS 5 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	0.0633***	0.0938***	-0.0880***	0.0202**
	(0.00403)	(0.00676)	(0.00709)	(0.0101)
QE 2	0.0128***	0.0174***	-0.00889**	0.0214**
	(0.00412)	(0.00459)	(0.00443)	(0.00982)
QE 3	0.00223	0.00492	0.000483	0.0276***
	(0.00244)	(0.00377)	(0.00366)	(0.00980)
Monday	-0.00312	-0.00136	0.00241	0.00781
	(0.00354)	(0.00445)	(0.00371)	(0.00965)
Tuesday	-0.000669	-0.00407	0.00457	-0.00838
	(0.00232)	(0.00344)	(0.00341)	(0.0100)
Wednesday	0.000687	0.00395	-0.00221	0.00271
	(0.00215)	(0.00328)	(0.00325)	(0.0115)
Thursday	0.00209	-0.00254	0.00206	-0.0190*
	(0.00292)	(0.00373)	(0.00368)	(0.00981)
Friday	0.000106	-0.000384	-0.00118	0.00627
	(0.00256)	(0.00369)	(0.00363)	(0.0104)
Persistence QE 1	-0.0260	-0.0295***	0.0266***	5.24e-05
	(0.0190)	(0.00939)	(0.00830)	(0.00624)
Persistence QE 2	0.00988	0.0435	0.0391	0.0120
	(0.0283)	(0.0558)	(0.0564)	(0.0210)
Persistence QE 3	0.00216	-0.00312	-0.00711	-0.00728
	(0.0225)	(0.0212)	(0.0210)	(0.0100)
Lag 1 Abnormal	0.987***			
	(0.0198)			
Lag 2 Abnormal	0.00406			
	(0.0226)			
Lag 3 Abnormal	-0.0136			
	(0.0102)			
Lag 1 Excess		0.821***		
		(0.0317)		
Lag 2 Excess		0.173***		
		(0.0331)		
Lag 3 Excess		0.00327		
		(0.0135)		

Lag 1 Abs			0.805***	
			(0.0334)	
Lag 2 Abs			0.180***	
			(0.0356)	
Lag 3 Abs			0.0116	
			(0.0162)	
Lag 1 Squared				0.934***
				(0.0467)
Lag 2 Squared				0.0491
				(0.0573)
Lag 3 Squared				0.0144
				(0.0422)
Observations	2,715	2,715	2,715	2,715
R-squared	0.957	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 France OATS 10 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.00122	0.0347***	-0.0323***	0.0162
	(0.00351)	(0.00617)	(0.00634)	(0.0102)
QE 2	-0.0667***	-0.0604***	0.0618***	-0.00708
	(0.00269)	(0.00363)	(0.00378)	(0.00937)
QE 3	-0.0135***	-0.0163***	-0.0194***	0.0191**
	(0.00270)	(0.00336)	(0.00328)	(0.00936)
Monday	0.00559*	0.00784*	-0.00325	0.0148
	(0.00322)	(0.00423)	(0.00356)	(0.00909)
Tuesday	-0.00779***	-0.00890**	0.00933**	-0.00341
	(0.00242)	(0.00370)	(0.00363)	(0.00996)
Wednesday	-0.000972	0.00117	-0.000909	0.000836
	(0.00269)	(0.00372)	(0.00359)	(0.00934)
Thursday	0.00170	-0.00274	0.000142	-0.00170
	(0.00217)	(0.00325)	(0.00326)	(0.00934)
Friday	0.000307	5.44e-05	0.00188	-0.0240***
	(0.00215)	(0.00346)	(0.00343)	(0.00910)
Persistence QE 1	-0.0405	-0.0359	0.0329	0.0452
	(0.0568)	(0.0508)	(0.0516)	(0.0349)
Persistence QE 2	0.0147*	0.0424*	-0.0385***	0.00335
	(0.00844)	(0.0257)	(0.0105)	(0.0104)

Persistence QE 3	0.0357***	0.0292**	0.0264***	0.0449***
	(0.0134)	(0.0142)	(0.00804)	(0.00700)
Lag 1 Abnormal	0.980***			
	(0.0303)			
Lag 2 Abnormal	-0.00933			
	(0.0327)			
Lag 3 Abnormal	0.0117			
	(0.0110)			
Lag 1 Excess		0.776***		
		(0.0314)		
Lag 2 Excess		0.204***		
		(0.0343)		
Lag 3 Excess		0.0173		
		(0.0168)		
Lag 1 Abs			0.764***	
			(0.0320)	
Lag 2 Abs			0.203***	
			(0.0366)	
Lag 3 Abs			0.0294	
			(0.0205)	
Lag 1 Squared				0.864***
				(0.0559)
Lag 2 Squared				0.126*
				(0.0654)
Lag 3 Squared				0.00730
				(0.0387)
Observations	2,715	2,715	2,715	2,715
R-squared	0.966	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12 France OATS 20 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.000452	0.0381***	-0.0370***	0.0241**
	(0.00332)	(0.00647)	(0.00670)	(0.0119)
QE 2	-0.0546***	-0.0484***	0.0443***	0.000907
	(0.00235)	(0.00351)	(0.00338)	(0.00992)
QE	-0.0224***	-0.0270***	-0.0338***	0.0220**
	(0.00289)	(0.00332)	(0.00312)	(0.00955)
Monday	0.00442	0.00694*	-0.00455	0.0132
	(0.00274)	(0.00391)	(0.00355)	(0.00915)

Tuesday	-0.00741***	-0.00852**	0.00816**	-0.00793
	(0.00230)	(0.00370)	(0.00361)	(0.0100)
Wednesday	-6.95e-05	0.00223	-0.000453	0.0109
	(0.00274)	(0.00375)	(0.00373)	(0.00913)
Thursday	0.000301	-0.00379	0.00288	-0.00690
	(0.00213)	(0.00319)	(0.00316)	(0.00984)
Friday	0.000465	6.27e-05	0.00123	-0.0230**
	(0.00244)	(0.00362)	(0.00358)	(0.00924)
Persistence QE 1	-0.0559	-0.0494	0.0477	0.0832
	(0.0723)	(0.0654)	(0.0659)	(0.0654)
Persistence QE 2	0.00618	0.0326	-0.0256	0.00566
	(0.00672)	(0.0304)	(0.0215)	(0.0110)
Persistence QE 3	0.0616**	0.0567*	0.0547**	0.0963***
	(0.0260)	(0.0289)	(0.0238)	(0.0179)
Lag 1 Abnormal	1.004***			
	(0.0229)			
Lag 2 Abnormal	-0.0171			
	(0.0251)			
Lag 3 Abnormal	-0.00264			
	(0.00956)			
Lag 1 Excess		0.782***		
		(0.0303)		
Lag 2 Excess		0.210***		
		(0.0333)		
Lag 3 Excess		0.00533		
		(0.0120)		
Lag 1 Abs			0.772***	
			(0.0316)	
Lag 2 Abs			0.209***	
			(0.0350)	
Lag 3 Abs			0.0155	
			(0.0146)	
Lag 1 Squared				0.857***
				(0.0615)
Lag 2 Squared				0.121*
				(0.0723)
Lag 3 Squared				0.0193
				(0.0351)
Observations	2,715	2,715	2,715	2,715
R-squared	0.971	0.998	0.998	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Italy

Table 13 Italy BPTS 5 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.00925**	-0.0107	0.000122	0.00424
	(0.00450)	(0.00687)	(0.00671)	(0.0128)
QE 2	-0.0318***	-0.0126**	-0.0269***	0.00767
	(0.00446)	(0.00598)	(0.00531)	(0.0127)
QE 3	-0.0541***	-0.0533***	-0.0644***	-0.0401***
	(0.00740)	(0.00609)	(0.00570)	(0.0131)
Monday	-0.00501	-0.00533	-0.000123	0.00300
	(0.00549)	(0.00667)	(0.00638)	(0.0129)
Tuesday	-0.00159	-0.00682	0.00187	-0.00132
	(0.00463)	(0.00576)	(0.00518)	(0.0120)
Wednesday	0.00528	0.00760	0.00255	0.0167
	(0.00508)	(0.00602)	(0.00493)	(0.0133)
Thursday	0.00384	-0.00287	0.00972*	-0.000394
	(0.00436)	(0.00546)	(0.00502)	(0.0127)
Friday	-0.00311	-0.00418	0.00561	-0.0156
	(0.00355)	(0.00465)	(0.00434)	(0.0192)
Persistence QE 1	-0.0253	-0.0262	0.0301*	0.0133
	(0.0335)	(0.0165)	(0.0167)	(0.0124)
Persistence QE 2	-0.0109	0.0110	0.00411	0.00501
	(0.0152)	(0.0487)	(0.0487)	(0.0163)
Persistence QE 3	0.00703	-0.00276	-0.0110	-0.00254
	(0.0203)	(0.0194)	(0.0203)	(0.0218)
Lag 1 Abnormal	1.087***			
	(0.0352)			
Lag 2 Abnormal	-0.137***			
	(0.0425)			
Lag 3 Abnormal	0.0254			
	(0.0220)			
Lag 1 Excess		1.003***		
		(0.0291)		
Lag 2 Excess		-0.0318		
		(0.0358)		
Lag 3 Excess		0.0241		
		(0.0224)		
Lag 1 Abs			0.979***	
			(0.0310)	
Lag 2 Abs			-0.00833	
			(0.0381)	
Lag 3 Abs			0.0245	
			(0.0241)	
Lag 1 Squared				1.010***

				(0.0541)
Lag 2 Squared				-0.0473
				(0.0682)
Lag 3 Squared				0.0339
				(0.0455)
Observations	2,715	2,715	2,715	2,715
R-squared	0.955	0.996	0.996	0.998

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14 Italy BPTS 10 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.00626	0.00452	-0.0102	0.0378***
	(0.00422)	(0.00614)	(0.00653)	(0.0108)
QE 2	-0.0325***	-0.0205***	-0.0343***	0.0140
	(0.00299)	(0.00475)	(0.00453)	(0.00971)
QE 3	-0.0444***	-0.0365***	-0.0453***	-0.0504***
	(0.00660)	(0.00568)	(0.00564)	(0.0106)
Monday	-0.00333	-0.00230	0.000962	0.00935
	(0.00441)	(0.00543)	(0.00523)	(0.0105)
Tuesday	-0.00321	-0.00704	0.00393	-0.00720
	(0.00383)	(0.00496)	(0.00454)	(0.0101)
Wednesday	0.00657	0.00968*	0.000529	0.00937
	(0.00421)	(0.00512)	(0.00451)	(0.00892)
Thursday	-0.000493	-0.00540	0.00607	-0.00674
	(0.00300)	(0.00422)	(0.00400)	(0.00969)
Friday	-0.00123	-0.00170	0.00208	-0.0137
	(0.00297)	(0.00405)	(0.00396)	(0.0135)
Persistence QE 1	-0.0636*	-0.0636***	0.0666***	0.0844***
	(0.0365)	(0.0163)	(0.0170)	(0.0155)
Persistence QE 2	-0.0310	-0.0101	-0.0148	0.00166
	(0.0340)	(0.0677)	(0.0687)	(0.0274)
Persistence QE 3	0.0417	0.0329	0.0272	0.0463
	(0.0365)	(0.0361)	(0.0357)	(0.0377)
Lag 1 Abnormal	1.070***			
	(0.0292)			
Lag 2 Abnormal	-0.119***			
	(0.0350)			
Lag 3 Abnormal	0.0275*			
	(0.0161)			
Lag 1 Excess		0.947***		

		(0.0291)		
Lag 2 Excess		0.0194		
		(0.0328)		
Lag 3 Excess		0.0298*		
		(0.0176)		
Lag 1 Abs			0.910***	
			(0.0316)	
Lag 2 Abs			0.0473	
			(0.0362)	
Lag 3 Abs			0.0386*	
			(0.0213)	
Lag 1 Squared				0.959***
				(0.0403)
Lag 2 Squared				0.00956
				(0.0500)
Lag 3 Squared				0.0291
				(0.0329)
Observations	2,715	2,715	2,715	2,715
R-squared	0.962	0.997	0.997	0.999

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.

Table 15 Italy BPTS 20 year maturity

Variables	Abnormal Yields	Excess Abnormal Yields	Absolute Excess Abn	Squared Excess Abn
QE 1	-0.00351	-0.00238	-0.00762	0.00569
	(0.00493)	(0.00738)	(0.00758)	(0.00650)
QE 2	-0.0310***	-0.0152**	-0.0360***	-0.00252
	(0.00443)	(0.00604)	(0.00519)	(0.00573)
QE 3	-0.0603***	-0.0377***	-0.0496***	-0.0685***
	(0.00792)	(0.00839)	(0.00711)	(0.00700)
Monday	0.000155	-0.00563	0.0224***	0.00343
	(0.00556)	(0.00619)	(0.00693)	(0.00569)
Tuesday	-0.00703	-0.00853	0.00995**	0.000188
	(0.00623)	(0.00669)	(0.00503)	(0.00642)
Wednesday	0.00888	0.00941	0.00962	0.0129**
	(0.00590)	(0.00625)	(0.00618)	(0.00611)
Thursday	-0.00196	-0.00556	0.0172***	0.0100*
	(0.00413)	(0.00529)	(0.00612)	(0.00596)
Friday	-0.00503	-0.00664	0.0161***	0.0156**
	(0.00395)	(0.00495)	(0.00605)	(0.00704)
Persistence QE 1	-0.105*	-0.117***	0.116***	0.198***

	(0.0591)	(0.0377)	(0.0390)	(0.0361)
Persistence QE 2	-0.0335	-0.00888	-0.0279	-0.00692
	(0.0250)	(0.0611)	(0.0579)	(0.0233)
Persistence QE 3	0.0461	0.0524	0.0372	0.0647***
	(0.0438)	(0.0477)	(0.0473)	(0.0222)
Lag 1 Abnormal	1.083***			
	(0.0331)			
Lag 2 Abnormal	-0.156***			
	(0.0472)			
Lag 3 Abnormal	0.0536*			
	(0.0308)			
Lag 1 Excess		0.947***		
		(0.0272)		
Lag 2 Excess		0.0361		
		(0.0369)		
Lag 3 Excess		-0.00771		
		(0.0258)		
Lag 1 Abs			0.901***	
			(0.0331)	
Lag 2 Abs			0.0633	
			(0.0433)	
Lag 3 Abs			-0.00501	
			(0.0308)	
Lag 1 Squared				0.988***
				(0.0535)
Lag 2 Squared				-0.0695
				(0.0622)
Lag 3 Squared				0.0412
				(0.0375)
Observations	1,416	1,416	1,416	1,416
R-squared	0.968	0.962	0.970	0.952

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1