MASTER IN
MONETARY AND FINANCIAL ECONOMICS

MASTER'S FINAL WORK
DISSERTATION

THE EFFECT OF QUANTITATIVE EASING PROGRAMMES ON LONG-TERM GOVERNMENT BONDS

TERESA GASPAR SILVA

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SUPERVISION:

PROFESSOR ANTÓNIO AFONSO

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THE EFFECT OF QUANTITATIVE EASING PROGRAMMES ON LONG-TERM GOVERNMENT BONDS

Teresa Gaspar Silva

Abstract: The aim of this dissertation is to clarify the Quantitative Easing programmes employed by the United States of America, United Kingdom, Euro Area and Japan during the financial crisis of 2007-2009 and assess its impact into the variation of the long-term Government bond yield, using monthly and quarterly based data. The empirical analysis consisted in four equations for each timeframe using an OLS estimator. It was found evidence supporting that QE diminishes the variation of the long-term Government bond yield in the US. On the UK case, it was found evidence that QE measures reduces the explained variable but with modest strength. In the EA and in Japan the results were ambiguous and one cannot be assertive about the impact of QE policies for both economies.

Key Words: Quantitative Easing, Government Bonds, Monetary Policy, Unconventional Monetary Policy, Long-term Government Bond Yield

THE EFFECT OF QUANTITATIVE EASING PROGRAMMES ON LONG-TERM GOVERNMENT BOND YIELDS

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Resumo: O objectivo desta dissertação é apresentar os programas de Quantitative Easing levados a cabo nos Estados Unidos da América, Reino Unido, Zona Euro e no Japão durante a Crise Financeira de 2007-2009 e avaliar o seu impacto na variação das taxas de juro de longo prazo para títulos do Governo, usando dados mensais e trimestrais. A analise empírica consistiu em quatro equações para cada frequência temporal usando um estimador OLS. No caso dos USA, foi encontrado suporte de que as politicas de QE diminuem a taxa de juro de longo prazo para títulos do Governo. A mesma relação foi encontrada para o Reino Unido, no entanto com menos assertividade. Os resultados para a Zona Euro e para o Japão foram ambíguos e não foi possível determinar o impacto das medidas de QE para estes países.

Palavras-Chave: Quantitative Easing, Política Monetária, Política Monetária Não Convencional, Taxa de Juro de Longo Prazo Titulos do Governo; Títulos do Governo.

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1. Introduction

On September 2009, the Lehman Brothers announced bankruptcy marking the beginning of what became the "Great Recession". After this episode, the financial markets became dysfunctional, credit conditions constricted, consumption and investment decreased and overall, the economic indicators deteriorated. Aiming for a recovery of consumption and the economy in general, Central Banks opted to loosen their monetary policy. One of the first actions taken was the decrease of the instrumental rate. The interest rates approached levels close to zero (Zero Lower Bound (ZLB) theory) and financial markets remained dysfunctional. At this point, the conventional monetary policy was worn out so the Central Bank needed a new action plan – the so-called unconventional monetary policies. There are several ways of implementing unconventional monetary policies; this study focuses on the Quantitative Easing measures. Quantitative Easing (QE) is a mechanism where the Central Bank creates new money (electronically) and employs the increasing of monetary base on financial asset purchases, such as government bonds. Before the Financial Crisis of 2007-2009, QE related research was not abundant. After 2008, the amount of studies about the effects of QE skyrocketed. Regarding the US, Gagnon *et al.* (2011), Chung *et al.* (2010) and Baumeister and Benati (2010) represent the most cited studies about the effect of QE measures in the American economy. Joyce *et al.* (2011) and Joyce, Tong and Woods (2011) are relevant essays about the QE programmes lead by the Bank of England (BOE). Some literature on the European case was performed by Attinasi *et al.* (2009), Gambacorta *et al.* (2012) and Afonso and Kazemi (2017). The new wave of Japanese QE policies was studied by Rogers *et al.* (2014) and Gambacorta et al. (2012).

Fawley and Neely (2013), Rogers *et al.* (2014) and Gambacorta *et al.* (2012) are rare examples of studies that portray and compare the four major QE programmes.

Most of the empirical analysis on the topic uses high-frequency financial data and does not include more than one or two economies. Therefore, there is a lack of literature that describes and compares QE programmes, across Central Banks, especially with theoretical and empirical analysis of its own.

Inspired by the gap on the literature, the aim of this dissertation is to assess the motivations the lead the Federal Reserve System (Fed), the Bank of England (BOE), the European Central Bank (ECB) and the Bank of Japan (BOJ) to consider the use of QE; to portray the peculiarities of each economy and programme and, finally, assess the impact of the announcement and asset purchases under QE policies into the long-term Government bond yield.

The thesis is organized as follows: the following section presents an overview on the relevant literature; section three presents the path through conventional monetary policy to unconventional monetary policy, in particular Quantitative Easing measures; section four describes the model, the data used and the methodology employed for each economy; section five reports the outputs of the empirical analysis and discussion; the conclusion and further research is on section six.

2. Literature Review

The literature on evaluating the impacts of the quantitative easing (QE) programmes has usually obtained its results using high-frequency data. Event-studies and structural vector autoregression (VAR) models are the most used approaches in assessing the impact of unconventional monetary policy. It is worth mentioning the

scarcity of studies evaluating the programmes of the United States of America (US), United Kingdom (UK), Euro area (EA) and Japan (JP) with an empirical analysis on their own, and even less studies employing monthly or quarterly data, in order to assess the long-term outcomes of those programmes.

Fawley and Neely (2013) portray the circumstances and motivations that led the Fed (Federal Reserve System of the US), European Central Bank (ECB), Bank of England (BOE) and Bank of Japan (BOJ) to implement QE programmes. A list of the most important announcements made in the scope of QE and a timeline of its purchases is provided. Was concluded that not all QE programmes were implemented with the same goal or tools. The Fed and the BOE chose to expand their monetary bases by purchasing bonds while the ECB and BOJ opted to focus on direct lending to banks. The different type of economy of the countries justifies these differences. The paper presents a valuable conjectural resume of the four major QE programmes using available empirical investigation of the most remarkable literature.

Gambacorta *et al.* (2012) aimed to measure the effectiveness of unconventional monetary policy at the zero lower bound in eight countries, including Canada, Japan, US and Norway. Using panel VAR with monthly data from 2008 to 2011, it was concluded that the exogenous rise in Central Bank (CB) balance sheets at the zero lower bound leads to a momentary increase in economic activity and consumer prices; in consequence the estimated output effects were qualitatively comparable to the ones found in the literature on the effects of conventional monetary policy, while the impact on the price level is weaker and less persistent; the unconventional measures had a similar macroeconomic effect across countries. Last but not least, the authors assessed

that is needed an immense expansion of the CB's balance sheet to achieve a strong monetary stimulus.

Rogers *et al.* (2014) used common methodologies in order to report the outcomes of unconventional monetary policy on stock prices, bond yields and exchange rates for the BOE, Fed, ECB and BOJ. The methodology used was an ordinary least squares (OLS) estimator with intraday data and a structural VAR model with daily data. The research concluded that the policies applied were effective, even in the zero lower bound scenarios, improving broad financial conditions. These policies worked mainly through the reduction of the term premia. They observed spill over effects between countries although it was not in the same magnitude for all economies. The authors did not only found good news, the influence of bond yields into assets prices appeared to have a higher effect on the US than in other economies and with the recovery that will be needed after the end of unconventional monetary policies it is likely that the long-term yields will increase.

Joyce, Tong and Woods (2011) evaluate the motivation of the large-scale asset programmes held by the Bank of England and portray how it was executed. The aim is to verify the impact of the asset purchases that began in 2009 had on the economy, specifically in the financial markets. Thus, this paper contributes with a synopsis about the design, operation and impact of the quantitative easing programme of the United Kingdom. The authors emphasise that the scale and speed of the asset purchases indicate that they were made with the intention of reversing the fall in confidence and the risk of rise of inflation falling sharply below target. The architecture of the programme was intended to target purchases of medium to long-term gilts from the non-bank financial sector. The impact was obvious on asset prices. Moreover, it was

analysed a variety of approaches used by the BOE's research to quantify the possible influence of those asset price variances on output and inflation. Although there is no certainty about the exact magnitude of the impact, the evidence suggests that the policy had positive and significant economic effects.

On the same note, Joyce *et al.* (2011) portray the unconventional monetary measures that the BOE adopted to battle the financial crisis. The study analysed the key transmission channels that affect the financial markets. For this, it was used an event-study analysis and survey data. The authors scrutinize the instantaneous response of asset prices to QE announcements and assign it into separated channels. The assets studied were the gilts, corporate bonds, equities and the Sterling. The majority of the impact of QE on gilt yields happens when the purchases are announced and not when the purchases truly happen. The main results of this study indicate that the QE purchases programs had a noteworthy effect on financial markets and predominantly on gilt yields.

The main goal of Baumeister and Benati (2010) was to analyse the macroeconomics consequences of a reduction in the long-term bond yield spread when the short-term interest rates are constrained by the zero lower bound within the Great Recession (2007-2009) timeframe in US and UK. Their research is guided by two main questions: first, how effective CBs' unconventional monetary policy actions in the form of government-bonds purchases were in counteracting the recessionary shocks of the 2007-2009 financial crisis; and secondly, how powerful central bank interventions are during the zero lower bound. To answer this question, the article proposes the creation of a counterfactual recreation of how output, inflation and unemployment would have developed if the asset purchases programs did not take place. The research concluded

that a reduction in the long-term yield spread employs a prevailing effect on both inflation and output when in a zero lower bound situation, as in the case of the US and the UK.

The focus of Driffill (2016) was the unconventional monetary policy in the Euro zone but it also debates the policies implemented by the Fed and the BOE. The objective was to provide lessons to the Euro area using the information available about the other two programmes. It was noted that, in comparison with the programmes held by the Fed and the BOE, the ECB's programme had a much smaller effect on bond yields and thus the effects on output and inflation could be less puissant. The good news are that the most common dangers of QE, i.e. the creation of asset prices bubbles, allowing zombie firms and banks to survive, higher levels of future inflation and the deceleration of the adjustment processes, do not appear to be a concern for EA. The ECB's efforts seemed to contribute on the reduction of costs of debt service that could ease the fiscal situation of member states.

The main contribution for the literature about QE given by Krishnamurthy and Vissing-Jorgensen (2011) was the enlightenment about how different transmissions channels for QE1 in 2008–2009 and QE2 in 2010–2011 led by the Fed influenced the interest rates and their implications in policymaking. The methodology chosen consists in an event-study using intraday data, which allowed the authors to distinguish the various transmissions channels. The methodology used consists in a difference-in-differences approach. The signalling effect, long-term safety channel and the inflation channel were the primary transmissions channels that influenced both QE1 and QE2. The channels that were only relevant during QE1 were the Mortgage-backed Securities (MBS) risk premium, default risk premium and the liquidity channel. Based on these

results three main policy implications were derived: it is not appropriate that the spotlight of CBs' policy rate to be the Treasury rate; QE has a higher benign effect on mortgage and lower-grade corporate rates whenever the Federal Reserve's asset purchases include non-Treasury assets; and as a Treasury-only policy, such as QE2, is transmitted mainly by a signalling channel, it will make the markets lower the expectation level of future federal funds rates.

Gagnon *et al.* (2011) clarifies how the Federal Reserve's large-scale asset purchases (LSAP) were employed and debates the mechanisms through which the asset purchases could affect the economy. The authors quickly examined the experiences of Japan and the UK to compare the results. To assess the effect of LSAP on market interest rates two different approaches were used: an event-study and a time-series analysis. The event-study analysis consisted in the study of eight major announcements using a one-day window frame and it was possible to observe that all interest rates suffered a significant decrease. The event-study and the time-series analysis came to the same conclusions, even using different information in the tests. It was found that the market functioning effect was stronger at the beginning of the LSAP and the portfolio balance effect was probably responsible for the long-term effects; and that the LSAP resulted in long-lasting reductions in the long-run interest rates on a diverse range of securities even those that were not part of the purchases, indicating a spillover effect.

Wright (2012) opted for a high-frequency event-study and a structural VAR within the period of November 2008 to December 2010, using daily data, in order to measure the impact of the Federal Open Market Committee (FOMC) meetings and announcements related to monetary policy on several long-term interest rates for the US. The conclusions of this work were: monetary policy shocks affect long-run

Treasury and Corporate bonds but its effect fades quite fast, in a period of about two months; and the impact of monetary policy shocks were stronger in longer-term interest rates than in short-term interest rates.

Chung *et al.* (2010) incorporated expectations on the modelling of the impact on macroeconomic variables made by the LSAPs using a forecasting model used by the Federal Reserve Board, from 2009 to 2016. The model made it possible to observe an improvement of real economy conditions that were led by changes in financial conditions, such as lower foreign exchange value of the dollar and higher stock market valuations; LSAPs led to an increase in Gross Domestic Product (GDP), lower unemployment rate and also contributed on price stability, as long-term inflationary consequences of the programme were not a likely scenario anymore. Overall, the study reflects that agents have confidence in the FOMC's actions.

Attinasi *et al.* (2009) aim was to discover the determinants of the increase in the sovereign bond yield spread of selected EA countries vis-à-vis Germany. It was done via a dynamic panel regression containing data from several European countries between July 2007 and March 2009. It was observed that announcements of bank rescue packages steered a revision of sovereign credit risk by the investors; and when comparing to Germany, countries with greater expected budget deficits or/and greater government debt ratios had higher government bond yields spreads.

De Grauwe and Ji (2014) scrutinized the changes in Eurozone spreads. The focuses were on outlining how much of the downturn is merited to improving fundamentals and determining how much could be attributed to optimistic market sentiments sparked by the announcement of Outright Monetary Transactions (OMT) in the third quarter of 2012. After analysing nine countries of the EA between the first quarter of 2000 and the

third quarter of 2013, the following conclusions derives: throughout 2010-2012 periphery countries suffered an increase in their spread that could not be justified by changes in the fundamentals, such as debt-to-GDP ratio, but by negative market sentiments; after the third quarter of 2012 the spreads of periphery countries have declined and, as before, this occurrence could not be attributed to changes in fundamentals but with the improvement of market sentiments, which coincide exactly with the OMT announcement by the ECB. Thus, market sentiments are not always in line with the fundamentals what could prevent the market from considering the actuals risks.

Studying the relation between banking and sovereign risk in the Euro area was the proposition of Gerlach *et al.* (2010). In order to do so, the authors questioned what factors have been influencing the spread in the Euro zone after the introduction of the Euro, focusing on the banking sector and sovereign risk. Employing a dynamic panel model with data from nine euro area countries between 1999 and 2009, it was observed that sovereign spreads diminish with bigger equity ratios; the size of the banking sector, proxy by aggregate balance sheet to GDP ratio, was an essential factor of sovereign risk spread relative to Germany in the Euro area; if and when readings of aggregate risk raised, yields increased more rapidly in economies with large banking sectors but the rising in aggregate risk was in itself increasing banking risk. Thus, variations of global risk perception could affect, in size and speed, sovereign risk spreads.

Klepsch and Wollmershäuser (2011) incorporated literature previously mentioned, Attinasi *et al.* (2009) and Gerlach *et al.* (2010), on their work about "How the Financial Crisis has Helped Investors to Rediscover Risk" - an analysis of yields spreads on European Monetary Union (EMU) government bonds from 2000 to 2010. The authors

used a dynamic panel regression. They observed that spreads converged with the introduction of the Euro and abruptly diverged with the financial crisis of 2007. It is important to note that before the crisis, some spreads' determinants were being ignored by the investors and after the crisis investors gave more attention to countries' credit risk. Therefore, risk aversion in the markets became more important. Consequently, during the crisis, the fundamentals turn out to be more important for investors leading to an increase in spreads. As also concluded by Gerlach *et al.* (2010), sovereign risk is manipulated by equity ratios of banks. At last, the authors additionally concluded that high forecast debt levels have a higher impact on yield spreads than the expected GDP growth rates.

Fawley and Neely (2013), Gambacorta *et al.* (2012) and Rogers *et al.* (2014) scrutinize and compare various programmes of unconventional monetary policy. The first study states that purchase of bonds were the main tools used by the Fed and the BOE, while the BOJ and ECB focus on direct lending to banks. Gambacorta *et al.* (2012) found evidence that the macroeconomic effects were similar among countries and that an immense expansion of the CB's balance sheet was needed to achieve a strong monetary stimulus. Rogers *et al.* (2014) observe a higher effect on the US economy than in the others studied and Driffill (2016) argued that the policies of the Fed and the BOE were more effective than the policies of the ECB.

Gagnon *et al.* (2011) and Wright (2012) agree that QE measures have a greater impact on long-term interest rates comparing with short-term rates.

De Grauwe and Ji (2014) and Klepsch and Wollmershäuser (2011) noticed that fundamentals and spread determinants were being ignored before the financial crises.

Krishnamurthy and Vissing-Jorgensen (2011), Gagnon *et al.* (2011) and Chung *et al.* (2010) stressed the importance of the confident on the monetary authorities when employing unconventional monetary policies. In the same line of thought, Joyce *et al.* (2011) concluded that most of the impact on gilts by the QE programmes were at the time of the announcements rather than at the time of the actual purchases.

The entire literature mentioned above is summarized in Table I with results and specific details regarding the methodology and the sample size.

3. The Path from Conventional Monetary Policy to Unconventional Monetary Policy

Central banks are one of the key agents in every economy. They are responsible for the currency/monetary issuance, supervision of the monetary system and definition and conduction of monetary policy. Different CBs have distinct mandates and so the goal of their monetary policy will be different from one another. In general, the goals of monetary policy (MP) can be price stability, high employment, economic growth, financial market stability, interest rate stability and foreign exchange market stability.

Thus, monetary policy provides ample monetary stimulus to the economy during downturns offers inflationary tension during upturns and eases the sound functioning of money markets.

Although the CB sets the goals for the monetary policy, it is unable to influence it directly. Hence, CBs use their MP tools to manipulate operating targets (such as: banking liquidity, monetary market interest rates) and those targets will influence

intermediate targets. These mechanisms will act through transmission channels and will manipulate the final goals of the monetary policy. (Abreu *et al.*, 2012)

The usual action of the CBs is setting target for the overnight interest rate in the interbank money market by adjusting the money supply through open market operations. (Smaghi, 2009) By doing so, the central bank is not involved in direct lending to the Government or the private sector. Therefore, the risk of exposure of the CB's balance sheet is lessened; the fact that all the transactions that are made to provide liquidity are reverse transactions against a list of eligible collateral also contributes to the low risk incurred in the process. (Smaghi, 2009) As such, CBs conduct the liquidity conditions in the money markets and work on its mandate objectives, piloting key interest rates. (Smaghi, 2009)

Standard and non-standard policies affect the economy through several main transmission channels. The topic will be resumed later through this chapter.

Tension started to build up on American financial markets at the beginning of 2007. In 2008, financial institutions such as Lehman Brothers, one of the biggest investment banks in the world, go bankrupt. As a result, the transmission mechanics of monetary policy stopped working properly as the general risk level went up, resulting in liquidity sinking. Capital flows between countries went to minimum records and the financial crisis rapidly disseminated to Europe and emerging economies.

When the economy suffers a powerful shock the interest rate may be brought to zero or the transmission process of MP may no longer work, even when interest rate different from zero (Smaghi, 2009).[1]

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[1] Keynes coined the term Liquidity Trap in 1936 in order to define a situation where the short-term nominal interest rate is, or really close to, zero, also known as the zero lower bound (ZLB).

When faced with a scenario where traditional tools are no longer effective, as it happened in the financial crisis of 2007, the policy-makers are challenged with a number of questions. Monetary policy-makers should visibly delineate the objectives of the unconventional measures and then pick the best measures to pursue those objectives. They should also be aware of the possible side effects of those policies, such as the influence on the financial soundness of the CB's balance sheet and avoiding the blockage of market recovery to normal functioning with unconventional measures. (Smaghi, 2009)

Unconventional monetary policies consist in actions that directly aim the accessibility and cost of external finance to banks, non-financial companies and households. These policies can be funded by CB liquidity, loans, fixed-income securities and equity. (Smaghi, 2009)

The type of shock, the state of the banking system and the differences on institutional peculiarities influence the selection of tools used by the CBs to endure with the atypical scenario in interbank markets and economy in general. (Smaghi, 2009)

In the US, the need for unconventional monetary policy arrived when the economy faced a ZLB situation and the normal status quo was no longer effective. In this case, the unconventional monetary policy substituted the conventional monetary policy.

In the EA, the unconventional monetary policy ensured the transmission of monetary policy in the face of financial market malfunctioning, as a complement of the conventional policies. In the case of ZLB, the CB may decide to influence medium to long-term interest rate expectations, change the composition and/or expand of the CB's balance sheet. When a transmission tool is not working, the CB may bring the short-

term nominal interest rates to zero and step in precisely on the transmission mechanism causing problems using unconventional policies.

Bernanke *et al.* (2004) found evidence supporting that different financial assets are not perfect substitutes, making variations in the composition of the CB's balance sheet an effective unconventional monetary policy.

Communication and credibility of the monetary authorities are key aspects to have in consideration when in a ZLB situation. If the CB commits to maintain interest rate at a low level and maintain it at a lower level for longer than previously expected, it should diminish longer-term rates, support other asset prices and stimulate aggregate demand. (Bernanke *et al.* (2004)

There are several ways of applying unconventional monetary policy, such as credit easing, quantitative easing (QE) and manipulations of the exchange rate.

Credit easing aims to reduce specific interest rates and/or rebuild market failures; when the result is the expansion of the money supply it can be taken as a not pure form of QE. (Smaghi, 2009) This instrument can be used when the interest rate is above zero. (Smaghi, 2009) The objective of credit easing is the purchase of certain type of securities as to lower interest rates in specific credit markets, thus the CB hopes to improve the functioning of credit markets and ease the transmissions to the real economy. (Söderström and Westermark, 2009)

Therefore, policies that unusually increase the money base, embracing lending programmes and asset purchases, are called QE measures. Credit easing, which eases credit facilities, can be taken as a special form of QE programme if it increases the monetary base.

An alternative way of uplifting the economy is through the depreciation of the exchange rate. The CB could purchase foreign securities and currency, instead of purchasing domestic securities. (Söderström and Westermark, 2009) It is relevant to note that because the exchange rate and inflation expectations are linked, a lower exchange rate will lead to higher inflation expectations and thus lower real interest rates. (Söderström and Westermark, 2009)

Quantitative easing is a measure taken by the CBs with the aim of expanding money supply that affects the liability side of the central bank's asset side. (Fawley and Neely, 2013) This measure should be only applied when the interest rate is zero or close to it. (Smaghi, 2009)

A quantitative monetary policy aims to influence the money supply. Often described as the central bank balance sheet effects on the asset side. (Söderström and Westermark, 2009)

In order to do so the monetary authority creates money and uses it to purchase financial assets from private investors such as insurance companies, banks and pension funds. Money is created without the need of printing and it is simply achieved by an increase of credit on the central bank's account. (Delivorias, 2015)

As CBs purchase large amounts of assets, prices rise, thus decreasing by definition the interest rate associated with them. Lower interest rates decrease borrowing costs, increasing investment and consumption. Therefore, it is relevant to understand how the main transmission mechanisms work on affecting asset prices, interest rates and the real economy. (Joyce *et al.*, 2011)

As agents should believe in long-term low policy rates as to lower their expectations of the interest rates, quantitative easing purchases can help those

expectations become credible. When the CB buys long-term government bonds it affects the long-term sovereign bond yields and longer-term rates in general, giving a sign that the short-term interest rate will, in fact, be lower in the future. (Söderström and Westermark, 2009)

As seen before, there are several factors influencing how unconventional monetary policy should be executed and how it affects the economy.

As mentioned before, the way through which monetary policy affects the various elements of the economy is called the transmission mechanism and it works across different channels.

The research of how the monetary institutions can manipulate the economy, how the markets react to those actions and what channels allow the standard and non-standard policies to reach the targets settled by the CBs is not a new topic in the economic literature. These topics are again in vogue due to the recent unconventional monetary policies.

The literature is not consensual in which are the most important channels. Below, the channels most seen in the literature will be presented, namely the policy-signalling channel, the portfolio balance channel and the liquidity premia. (Joyce *et al.*, 2011)

The macro/policy news, also known as the signalling channel, denotes to the knowledge that economic agents obtain with announcements of QE and incorporate it into their decisions. This channel can have an ambiguous effect on yields because QE can indicate lower policy rates in the short-run but can signal higher inflation in the long run. (Joyce *et al.*, 2011)

The portfolio balance channel results from the actions that agents do to remodel their portfolio in response to asset purchases made through QE programmes. Another

effect of this channel is the increase in the wealth of the agents when the monetary authority buys their assets. (Joyce, Tong and Woods, 2011) Assuming imperfect substitution between assets, a variation of quantity of a specific asset will lead, *ceteris paribus*, to a variation in its relative expect rate of return. (Joyce *et al.*, 2011) Thus, asset purchases made through QE programmes are expected to decrease bond yields and drive investors to raise their demand on additional long run assets.

Therefore, QE purchases have two main effects through this channel: the increase in assets prices, by diminishing yields that will decrease the cost of borrowing; and an increase in consumption as higher asset prices increase the agents' wealth. This channel is argued to influence the markets right after the QE announcement and throughout time, as investors need time to rebalance their portfolios. (Joyce *et al.*, 2011)

Assuming that a longer-term asset is riskier than a short-term one, agents ask for a compensation, which is reflected in the price, for holding a long-term asset – the so-called term premium. When the monetary authorities buy this kind of assets, investors will ask for less compensation for holding these assets and term premium will thus fall. A reduction on term premium leads to a reduction of the long-term real rates. (Fawley and Neely, 2013)

The signalling channel affects expected policy rates and the portfolio balance channel reduces the term premium – spreads of long-run interest rates over expected policy rate - and the risk premia – the asked return on riskier assets relative to riskless assets. (Joyce, Tong and Woods, 2011)

A scenario defines a liquid market where there are enough assets for "normal" transactions without shortage, i.e. no difficulty in exchanges. When markets are under stress, they can become illiquid and the liquidity premium – the value asked in order to

compensate the agent because of the risk of holding a less liquid asset - may rise. (Joyce *et al.*, 2011) Thus, QE purchases may act through the liquidity premia channel because those purchases may ease and diminish the cost of selling assets that investors face. It is worth mentioning that this channel may only be active during the asset purchases lead by the CB. (Joyce, Tong and Woods, 2011)

As the reader could notice, these mechanisms, although they were analysed separately, produce their outcomes simultaneously. Their strength depends on the economic and financial structure of each economy.

As the aim of this dissertation is to study the effect of unconventional monetary policies into the long-term bond yields, it is relevant to understand the elements of such yield and the mechanisms that may influence it.

Prospects of future policy interest rate variations affect longer-term market interest rates, because these are constructed via the expectations of short-term rates. The impact of market rate variations on rates of long-term maturities (i.e., long-term banking lending rates, 10-year Government bond yields) is less direct than in shorter maturities.

Accordingly, the liquidity premium theory indicates that assets with different maturities are not perfect substitutes. Uncertainty and risk aversion are factors that lead investors to prefer more liquid assets. Risk adverse agents prefer short-run investments as these types of assets have a limited exposure to risk and their capital is stationary for a shorter period. Thus, the long-term interest rate is constructed by the average of the actual and the expected short-run interest rates and the liquidity premium. The liquidity premium is the compensation in return asked by the investors in order to bear the risk of possessing a longer-term and, probably, a less liquid asset. (Abreu *et al.*, 2012)

The study of the behaviour of long-term sovereign bond yields has been an important field in the economic world for a long period. Authors have found that its behaviour usually depends on the time span that it is studied, because of economic scenarios.

The credit risk, liquidity risk and the overall risk aversion of agents are factors that Klepsch and Wollmershäuser (2011) refer as relevant for long-term sovereign yields. While Afonso and Rault (2010) studied the role of government balance-to-GDP ratio, the debt-to-GDP ratio, the current account balance ratio, inflation surprises, the real effective exchange rate and a liquidity measure as determinants of long-run sovereign bond yields.

When a country is not in a sound situation and its probability of default is high, investors will demand a higher credit risk premium to reimburse them from holding that risk. Government default risk is considered to result from the fiscal condition of the country because it is usually measured by the debt-to-GDP and deficit-to-GDP ratios. (Klepsch and Wollmershäuser, 2011) In the occurrence of a weakening of the sovereign current account balance, the long-run interest rates might increase. (Afonso and Rault, 2010)

Unconventional measures that are directed at, for example, sovereign bonds will increase the available funds for governments, which will decrease their probability of default. Thus, non-standard policies might decrease long-term bond yields through the reduction of the credit risk.

If an investor suspects that a security will have low demand in poor market conditions, the demanded yield needs to be higher because the agent will require a liquidity premium in order to buy the asset. Thus, mismatches of wills on the financial

markets increase transaction costs and will increase the asked yield. (Klepsch and Wollmershäuser, 2011) Generally, a better fiscal position reduces the real long-term interest rate, however, Afonso and Rault (2010) have found that an increase in stocks of government debt diminishes the real interest yield in some countries. Other literature has reached the same conclusions and there might be two reasons for such event: the market may be having a mispricing behaviour, or the market may be welcoming the increase in liquidity. Thus, QE purchases directed at long-term Government bonds may decrease the long-term bond yield. (Afonso and Rault, 2010)

It is worth mentioning that there is not a consensus about the weight of deficit and Government debt on long-term interest rates.

Risk aversion portrays the attitude of investors towards risk. When in times of uncertainty investors tend to be more risk averse. (Klepsch and Wollmershäuser, 2011) Literature usually uses equity market volatility as a proxy for investors' risk aversion.

Inflation and real exchange rate may be an indicator of monetary authorities' activity. Sovereign risk may rise in the occurrence of high or expected high inflation. In the study of Afonso and Rault (2010) inflation had a negative relation to real long-term sovereign yields. The real exchange rate also had a negative relation with the long-term bond yield in the majority of the countries analysed.

It is clear that the study of long-term sovereign bond yields has mapped various scenarios, not all consensual.

Unconventional monetary policies are multifactorial, depending not only on the type of shock that happened but also on the approach led by the monetary authorities, the specifications of the economy and the motivations behind the QE programmes. In the next section, each programme will be explained in particular.

4. Data and Methodology

The scope of this dissertation is to evaluate the effects of the announcements and the purchases of quantitative easing on the variation of the long-term bond interest rates in the four main economies under quantitative easing measures - United States of America, Japan, United Kingdom and Euro Zone. Expectations are not inside the scope of this dissertation. The period analysed was from 1999 to 2016 for all countries using monthly and quarterly frequency, exceptions may occur.

In this chapter, the general model is presented and design of the QE policies and the methodology will be explained separately by country.

4.1. The Model

To obtain the answers proposed by this study it was decided to employ a regression using the target variable, the factors that influence it and QE specific variables. After analysing the literature on the determinants of the yields and the yields spreads, it was possible to compile the most important elements used for the analysis.

Several authors have shown that the main determinants of the long-term Government bond interest yields are the credit risk and the investors' risk aversion. Besides those determinants, other factors must be taken in consideration when measuring the effect of unconventional monetary policies into the variation of the yields, such as international risk, the economic cycle, the stance of monetary policy, real effective exchange rate and last but not least, the announcements and actions of outstanding monetary measures. In order to measure these determinants and actions one must use proxies. Below follows

the explanation for the specific variables used, concluding with a general model that serves as a base for the country-by-country analysis showed afterwards in this chapter.

The chosen dependent variable is the variation of the long-run Government bond yield with 10 years of maturity. The dependent variable and the lagged level of the long-term Government bond yield are included in the left-hand side of the regression. As a representation on the stance for conventional monetary policy, the instrumental rate for each economy is used.

The credit risk, as explained on the ECB monthly report of May 2014 (ECB, 2014), is classically related with country ratings and default risk of a specific country. Debt and deficit-to-GDP ratio, structure of debt maturity, interest expenditure-to-GDP or interest expenditure-to-tax revenue ratios usually measure it. In the model it will be used the Debt-to-GDP ratio in order to measure sovereign's credit risk. During the tests, manipulations of this indicator were used, such as the growth rate and the variation comparing with the previous period analysed.

The aggregate banking assets-to-GDP ratio and the banking equity-to-assets ratio which together represent the total assets held by the financial sector are the variables used by (Gerlach *et al.* (2010) and Klepsch and Wollmershäuser (2011) in order to assess the impact of the sovereign risk channel into the long-term interest rate. When possible these variables will be used in addiction of the typical debt-to-GDP ratio.

Several proxies are used to evaluate the investors' risk aversion. Klepsch and Wollmershäuser (2011) explain that corporate bonds spreads and equity market volatility are used to size investors' risk aversion. In the same line of thought, the ECB (2014) specifies that US corporate bond spreads and US stock market implied volatility

(VIX) are both valid proxies. Gambacorta *et al.* (2012) explain that the VIX is an indicator of financial turmoil and economic risk and adds that it should capture uncertainty shocks that may have affected the "macro financial dynamics" throughout the crisis. Thus, the variable chosen was the VIX index, which weights the volatility of the US equity market.

As a control variable to regulate for economic cycles, the industrial production index (INDPRO) is used because it proxies output. (Peersman, 2011) During the tests, manipulations of this indicator were used, such as the growth rate and the variation comparing with the previous period analysed.

Afonso and Kazemi (2017) found evidence that the effective exchange rate is a determinant of the long-term sovereign yield in the Euro area. Thus, it is be included in the study as to observe if it is also a determinant on the other economies studied.

Last but not least, the announcements related with QE and the respective purchases are the variables used to measure the unconventional monetary policy in study, i.e. Quantitative Easing. Therefore, a dummy is created, called ANN that will take the value 1 when CBs make announcements of QE programmes in that month and 0 otherwise. The variable QE will take the value of the asset purchases made by CBs in the months that the actual purchases occurred in the respective currency of the economy being treated at the time. Tables VI, VII, VIII and IX scrutinize the announcements considered for the empirical analysis.

For a full list of the variables used, their time series name, database and nomenclature on EViews, consult tables II, III, IV and V in the appendix.

Placing together the variables mentioned above in a regression equation and taking into consideration the high persistence of financial time-series, the following regression is used to assess the effect of Quantitative Easing into the variation of long-run Government bond interest yields:

$$\Delta \ (LR \ Gov \ bond \ Yield)_t = \alpha + \beta_1 \ (LR \ Gov \ bond \ Yield)_t + \beta_2 \ Policy \ Rate_t$$

$$+ \ \beta_3 \ \frac{DEBT}{GDP}_t + \beta_4 \ \frac{Aggregate \ Baking \ Assets}{GDP}_t + \beta_5 \ \frac{Banking \ Equity}{Total \ Banking \ Assets}_t + \beta_6 \ VIX_t$$

$$+ \ \beta_7 \ INDPRO_t + \beta_8 \ REER_t + \beta_8 \ ANN_t + \beta_9 \ QE_t + \varepsilon_t \ ,$$

with t = 1, …, 204 denoting the monthly time dimension or t = 1, …, 68 denoting the quarterly time dimension depending on the time period being analysed. Including α that denotes the constant and ε denoting the error term for all models.

The econometric tests were conducted using the statistics software EViews 9. For all the estimations, an OLS regression was employed with HAC correction for standard errors and covariance.

4.2. Methodology

The model was built crossing references about the determinants of the long-term Government bond yield and QE policies and so there is not a framework to strictly follow. The goal is to find the most significant explanatory variables for the variation of the long-term Government bond yield on the time spans used, which can lead to different variables employed for different countries. Thus not resulting in a uniform model but in the most explanatory model possible given the economy and period analysed. In order to do so, sub-time samples are employed and all the explanatory

variables are tested (including lags, growth rates, variations) and then selected in order to find the determinants that compose the best the variation of the long-run Government bond yield.

Four models specifications compose the analysis:

- Entire time sample: 1999/2000 to 2015/2016;

- Time sample: 1999/2000 to 2007;

- Time sample: 2007 to 2015/2016;

- Time sample: 2007 to 2015/2016 – only QE related variables.

On the appendix is presented the mandate of the CB in question, some of the roots for the crisis, a timeline of the QE measures and the four regressions resulting from the empirical analysis, for the four economies feathered in this essay.

5. Results and Discussion

In this section, the results for each group will be presented and discussed. From here the coefficients are present with three decimal places. The exact numbers are in the related tables of each economy in the attachment sections of this dissertation.

5.1. United States

In the current section it is presented the results of the empirical analysis and discussion for the US economy. In order facilitate the interpretation, the following categorization will be used to address the regressions used:

- 1M: 1999 M04 – 2007 M12

- 2M: 2008 M01 – 2015 M12

- 3M (QE only): 2008 M01 – 2015 M12

- 4M: 1999 M03 – 2015 M12

- 1Q: 1999 Q3 – 2007 Q4

- 2Q: 2008 Q1 – 2015 Q4

- 3Q (QE only): 2008 Q1 – 2015 Q4

- 4Q: 1999 Q3 – 2015 Q4

Across all regressions of both time frequencies the LRYield(-1) presents a negative coefficient, which can be explain by the construction of the VLRYield itself: VLRYield = LRYield − LRYield(-1). The value of the coefficient ranges between -0.449 and -0.088.

The variation of the instrumental rate (VDiscountR = DiscountR − DiscountR(-1)) has a negative coefficient for the regression 1M (*VDiscountR(-1)* = -0.189; *VDiscountR(-2)* = -0.228) and 4M (*VDiscountR(-1)* = -0.103) and a positive coefficient for the regression 3M (*VDiscountR(-1)* = 0.305). A different variable used in the literature as a proxy for the stance of MP is the effective federal funds rate. However, as it was not statically significant (SS) in the regressions tested and it was removed from the analysis. This happened because, although the Fed sets a target on the EFFR, the DiscountR is the tool used by the Fed to manipulate the money supply and achieve the EFFR target.

As explained before, ABAY, EQTA, and Debt/GDP are measures for sovereign's credit risk. The size of the banking sector within a country, ABAY, has a statistically significant and positive coefficient on equation 2Q (0.060) and 4Q (0.043) and a statistically significant and negative coefficient on equation 1M (-0.023). VABAY presents a negative coefficient on equation 2M (-0.034) and 4M (-0.024), while in the other equations, it was not statistically significant and thus it was removed from those

regressions. EQTA presented a positive coefficient on 1M (7.309) and a negative coefficient on 2M (-0.345), 4M (-0.131) and 4Q (-0.267); in the other equations, it was not statistically significant. One possible explanation for the positive coefficients for the size of the banking sector within a country and the banking equity-to-banking assets ratio is that the recovery of the banking system improved the yields and consequently the VLRYield. (Klepsch and Wollmershäuser, 2011) On the other hand, a negative coefficient may represent that a higher-sized banking system or a decrease of equity regarding the banking assets indicates a more fragile banking sector with a higher risk of bank default and as bank rescue packages have a negative impact in the economy, the VLRYield increases.

The Debt/GDP represents the Government's default risk. A higher value indicates a higher probability of default, which, in theory, leads to an increase of the VLRYield. (Klepsch and Wollmershäuser, 2011) Debt/GDP has only retrieved a SS positive coefficient on equation 1M (0.111), while VDebt/GDP has a negative coefficient on 1Q (-0.214).

The indicator for financial turmoil presents negative coefficients in all equations (between -0.011 and -0.034), although not being statistically significant on 4M. A negative relation between VIX and VLRYield may indicate that investors prefer long-run instruments when financial markets are not sound.

The real exchange rate was statistically significant through monthly and quarterly analysis, with the exception of equation 4M. On the monthly analysis, the coefficient was positive (in 1M: 0.034 and in 2M: 0.009), while in the quarterly analysis it presents a negative coefficient (in 1Q: -4.731, 2Q: -7.369 and in 4Q: -5.194). The signal of the coefficient for REER is not consensual through the literature. For example, Afonso and

Rault (2010) obtained positive and negative relations between these variables, mostly negative for the countries analysed. In this study, the REER was significant in more expressions using quarterly data than with monthly data and the coefficients were higher.

The variables used to measure output (INDPRO and VGR_INDPRO) were always SS, displaying a positive relation with the dependent variable. The positive relation reflects the increase on LRYields due to the improvement of the overall economy measured by the industrial production index. The VGR_INDPRO (between 11.330 and 4.201) has a much higher coefficient than INDPRO (between 0.069 and 0.004), which may be explained by the lag between the announcement of the indicator and the necessity of adapting expectations by the agents on the VLRYield.

Across the monthly and the quarterly analysis, two variables were used to assess the impact of the announcement of QE: ANN_QE and ANN_QE(-2). ANN_QE gave a SS negative relation in equation 3M (-0.100), 4M (-0.050), 2Q (-0.370), 3Q (-0.336) and 4Q (-0.318), while *ANN_QE(-2)* was only significant and negative on the quarterly equations 2Q (-0.183) and 4Q (-0.318). Although it did not retrieve the expected signal on 3Q, it was not statistically significant. Overall, the announcement of QE policies decreased the VLRYield, as seek by the authorities.

The variables used to represent the purchases made under the QE policies were: QE_ST, QE_ST(-1), QE_CT and QE_CT(-1). As both variations gave the same coefficients, QE_ST and QE_ST(-1) were chosen as they produced better outputs in term of overcoming auto-correlation problems. QE_ST had a positive coefficient on 3M ($1.85E^{-06}$), 4M ($1.27E^{-06}$ but not SS), 2Q ($4.89E^{-06}$), 3Q ($6.19E^{-06}$) and 4Q ($4.83E^{-06}$). The QE_ST(-1) was only SS in 2M with a small positive coefficient equal to $2.89E^{-06}$.

In the US's case, the estimations made under the quarterly frequency performed better than the ones made on the monthly basis as they presented a higher R^2 and Durbin-Watson statistics closer to two.

Reviewing the results, the effect of QE policies on the *VLRYield* was not clear in sign and presented modest coefficients.

The results for the United States are presented in table X.

5.2. United Kingdom

The results of the empirical analysis and discussion for the UK are presented in this section. For ease of reading, the following nomenclature will be used to address the regressions executed:

- 1M: 2000 M03 – 2007 M12
- 2M: 2008 M01 – 2016 M05
- 3M (QE only): 2008 M01 – 2015 M12
- 4M: 1999 M06 – 2015 M01

- 1Q: 2000 Q2 – 2007 Q4
- 2Q: 2008 Q1 – 2016 Q1
- 3Q (QE only): 2008 Q1 – 2017 Q1
- 4Q: 2000 Q2 – 2016 Q2

The LRYield(-1) presents a negative and statistically significant coefficient on 4M (-0.085) and 2Q (-0.246); and LRYield(-2) in 1Q (-0.244) and 4Q (-0.233). This can be explain by the construction of the VLRYield itself: VLRYield = LRYield – LRYield(-1). The VLRYield(-1) has a positive relation with the dependent variable and it was only statistically significant on 1M (0.219) and 2M (0.284). The VLRYield(-2) presents a negative coefficient of -0.176 significant at the 10% level. The variation of the LRYield was not statistically significant on the quarterly basis analysis and thus it was removed from the estimations.

The variation of the instrumental rate in UK's case is the bank rate (VBankRate = BankRate – BankRate(-1)). The first lag of this variation is SS and has a negative coefficient for the regression 1M (-0.317), 1Q (-0.487) and 4Q (-0.173); while the second lag has a negative relation with the dependent variable on equation 2M (-0.234) and 2Q (-0.232). Therefore, this variable does not present the expected relation with the VLRYield, as the CB decreases the BankRate (= VBankRate) in order to decrease the long-term interest rates and consequently the LRYield and the VLRYield.

The indicators for sovereign risk used were VDebt/GDP, VDebt/GDP(-1) and VDebt/GDP(-2). VDebt/GDP was the only statistically significant variable, presenting a positive relation with the dependent variable on equation 1Q of 0.127: an increase/decrease on VDebt/GDP leads to an increase/decrease on VLRYield.

The VIX retrieved a negative coefficient in all the equations, although not SS on 1Q. The coefficient was rather small: varying from -0.006 to -0.032. As seen before on the US case, a negative relation may hint that investors swift their demand from short-term riskier assets to safer assets such as the Government bonds, thus increasing the liquidity of Government bond assets and lowering its yield.

The real effective exchange rate (REER) was not statistically significant in any regression across both time frequencies.

The proxy for output INDPRO presents a positive (and SS) relation with the VLRYield on equations 4M (0.011) and 1Q (0.081). The VGR_INDPRO has a SS negative coefficient of -0.808 when analysed for the period 2000-2007 on a quarterly basis. Some literature about the determinants of the long-term Government bond yields, such as Gerlach et al. (2010), found evidence that in the period previous to the financial

crisis (2000 − 2007), the fundamentals were being underrated by the investors, which can explain the negative relation between the VGR_INDPRO and the VLRYield on 1Q.

In order to appraise the impact of the QE policies on the VLRYield, the following variables were used: ANN_QE (t=0,-1,-2,-3) and AFP (t=0,-1,-2,-3). Regarding the announcements of QE: ANN_QE presented a negative coefficient, which was not statistically significant. Only ANN_QE(-1) presented a SS positive coefficient of 0.22 on 2Q and 0.31 on 3Q. The variables used to measure the effective purchases of assets under QE measures did not present homogenous signals for the coefficients. The AFP showed a positive SS coefficient, although small, of $-1.91E^{-06}$ on equation 1Q. The AFP(-1) has a small but positive SS coefficient on 3M ($1.58E^{-07}$) and 2Q ($1.32E^{-06}$). The AFP(-2) presents a SS negative coefficient of $-6.61E^{-08}$ on 2M and of $-1.04E^{-07}$ on 4M. Last but not least, the AFP(-3) has a SS positive and small coefficient on 3M of $-1.75E^{-07}$.

The effect of QE policies on the VLRYield is not clear due to its small coefficients and opposite signs throughout the estimations.

In the UK's case, the estimations made under the quarterly frequency performed better than the ones made on the monthly basis as they presented a higher R^2 and Durbin-Watson statistics closer to two. However, it was not possible to obtain more statically significant variables than in the monthly analysis.

The results for the United Kingdom are presented in table XI.

5.3. Euro Area

In this section, the outputs from the regressions about the EA are presented.

To facilitate the reading, the following cipher will be used to address the regressions executed:

- 1M: 2000 M02 – 2007 M12
- 2M: 2008 M01 – 2016 M12
- 3M (QE only): 2008 M01 – 2017 M02
- 4M: 1999 M04 – 2017 M01

- 1Q: 2000 Q1 – 2007 Q4
- 2Q: 2008 Q1 – 2016 Q4
- 3Q (QE only): 2008 Q1 – 2017 Q1
- 4Q: 2000 Q3 – 2016 Q4

The first variables analysed were the LRYield in its lagged (t = -3) form, and the VLRYield (t = -2 and t = -3). The LRYield(-3) has a negative but not statistically significant coefficient on 1M, while the VLRYield(-1) displays a negative relation on 1Q and a positive on 1M and 2M, though never presenting SS coefficients for these equations. This variable presented SS positive coefficients on 4M (0.140), 2Q (0.213) and 4Q (0.25). The VLRYield(-2) has a negative, but not SS, coefficient on 1Q and a negative relation (-0.164) significant at the 10% level.

The instrumental rate – the main refinancing operations rate (mro) – retrieved outputs with opposite signs, but when comparing their magnitudes it resulted in an overall positive relation: a decrease/increase on the policy rate leads to a decrease/increase on the VLRYield. The mro(-3) has a positive (0.245) SS relation with the dependent variable. The VMRO delivered a positive non-SS coefficient on 4M and a SS negative coefficient (-0.208) on 1M; while VMRO(-1) displayed a negative but not SS coefficient on 2M and a SS positive coefficient (0.357) on 2Q.

Conventional theory indicates that higher levels of Debt/GDP increase a country's default probability leading to investors requiring a term premium in order to buy Government bonds, which further leads to higher rates for these instruments. Recent literature about the influence of the fundamentals on the process of expectations of the financial agent has sparked after the financial crisis in 2007-2009. Gerlach et al. (2010) and Klepsch and Wollmershäuser (2011) found evidence that agents may have under

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looked the impact of Debt/GDP on periods previous to the crisis. The results found in this essay support that theory for the EA. The Debt/GDP(-1) presented a negative SS coefficient (-0.077) on 1Q (2000 Q2 – 2007 Q4) with the VLRYield, while VDebt/GDP presented a positive SS relation (0.084) on 4Q (2000 Q3 – 2016 Q4); and GR_Debt/GDP presented a positive SS coefficient of 12.299 when analysed for the 2008 Q1 – 2016 Q4 timeframe.

The VIX presented a negative relation in all equations which was only SS on 2M, 1Q, 2Q and 4Q with coefficients ranging from -0.003 to -0.028.

The analysis of the impact of the real effective exchange rate (REER) on the VLRYield revealed a negative influence on the period before the crisis (1M and 1Q) and a positive relation when analysed from 2008 to 2016 (2M and 2Q). Supporting that REER is a determinant of the sovereign yields in the EA, as found by Afonso and Kazemi (2017).

Overall, the INDPRO variables displayed a positive relation on the periods before the crisis (1M and 1Q): an increase/decrease of the industrial production index leads to an increase/decrease on the variation of the long-term Government bond yields (VLRYield). In particular, the GR_INDPRO has a strong coefficient of 14.399 significant at a 5% level.

Finally, the QE measures are represented by: ANN_QE(t = 0, -1, -2 and -3) and APP(t = 0, -1, -2 and -4). On a monthly basis, ANN_QE(-1) displays a negative SS relation with the dependent variable (-0.096);ANN_QE(-2) also has a negative coefficient of -0.151 on 2M and -0.141 on 4M. On a quarterly basis, only the ANN_QE(-2) is SS with a positive coefficient of 0.299 on 4Q.

The asset purchases under QE programmes generated coefficients with opposite signs across the empirical analysis. The APP(-1) has a small positive SS coefficient on 2M. The APP(-2) also has small positive coefficients, which are SS on 3M and 4M. The APP(-4) was the only variable of this group to provide a negative SS coefficient on the estimations – it has a negative coefficient of $-4.16E^{-06}$ on 3M and of $-6.34E^{-06}$ on 4M. On a quarterly basis, the APP(-4) is the only variable with a statistically significant coefficient. It displayed a negative coefficient of $-1.47E^{-06}$ on 4Q.

The equation exclusively with QE related variables on a monthly basis – 3M – have only two statistically significant variables with opposite directions and similar magnitudes: APP(-2) and APP(-4). No QE related variables were statistically significant on the homologous equation on a quarterly basis (3Q).

In the Eurozone's case the quarterly regressions provided better R^2 and Durbin-Watson statistics than the regressions tested on a monthly basis.

The results for the Euro Area are presented in table XII.

5.4. Japan

In this section, it is presented the results and discussion from the empirical study regarding the Japanese case.

For ease of reading, the following nomenclature will be used to address the regressions executed:

- 1M: 1999 M05 – 2007 M12

- 2M: 2008 M01 – 2015 M12

- 3M (QE only): 2008 M01 – 2015 M02

- 1Q: 2000 Q2 – 2007 Q4

- 2Q: 2008 Q1 – 2015 Q4

- 3Q (QE only): 2008 Q1 – 2015 Q4

- 4M: 1999 M06 – 2015 M01
- 4Q: 1999 Q4 – 2015 Q4

The variables regarding the LRYield were only statistically significant on equation 2Q. The LRYield(-2) presents a negative coefficient of -0.956 significant at 1% level. While LRYield(-3) has a positive coefficient around 0.178 at a 10% significance level. Overall, the effect of the lags LRYield on the dependent variable is negative, as expected due to the construction of the VLRYield itself: VLRYield = LRYield − LRYield(-1).

The VLRYield(-2) displays a negative relation (-0.185) on 4M at 1% significance level (-0.167) on 4Q at 5% significance level. The VLRYield(-4) has a negative coefficient on 4M (-0.145) significant at the 5% level. The lags of the dependent variable were not SS in any other regression.

The instrumental rate used by the BOJ is the DiscountR. A decrease/increase of the DiscountR should decrease/increase the LRYield. Thus, a decrease/increase of the VDiscountR should decrease/increase the VLRYield. The VDiscountR(-2) has a negative coefficient of -0.367 on 4Q and is SS at the 5% level, while on 2M it presents a positive relation (0.812) with a significance level of 1%. The VDiscountR(-1) has a SS positive coefficient on 2Q and the VDiscountR(-3) has a SS positive on 1M. By analysing the magnitudes and the signs of the variables, it can be concluded that the VDiscountR evolves in the same direction as VLRYield, indicating that the monetary policies may have an impact on the long-term Government bond yield.

A lower Debt/GDP ratio indicates sound public finances and a lower LRYield. In theory, the variables Debt/GDP, VDebt/GDP and GR_Debt/GDP should evolve in the same direction as the variable in study. Statistically significant and negative relations

were found on 1M (VDebt/GDP(-1): -0.443), on 2M (VDebt/GDP: -0.898) and on 2Q (Debt/GDP: -0.015). The GR_Debt/GDP variables display a strong positive relation on the dependent variable: equation 1M (GR_Debt/GDP(-1): 67.421), equation 2M (GR_Debt/GDP: 177.937) and on equation 4M (GR_Debt/GDP(-1): 15.874). The study of the Japanese public debt is, however, outside the scope of this essay.

The VIX presents a negative relation in all the equations used and is statistically significant in every equation except for 2Q.

The REER was SS on 2M and 2Q, displaying positive coefficients. As noted before, the literature is not consensual about the relation of the real effective exchange rate with the long-term bond yields.

The INDPRO related variables were only statistically significant on a quarterly basis (1Q and 2Q). The variable INDPRO(-3) has a negative coefficient of -0.004 on 2Q, while VGR_INDPRO has a positive coefficient of 3.453 on 1Q. In general, there is evidence that an increase/decrease in output leads to an increase/decrease in the VLRYield.

The variables concerning the announcements of QE policies were SS on 2Q and 3Q. The ANN has negative coefficients for 2Q (-0.094) and 3Q (-0.081), while the ANN(-1) presented a positive coefficient on 3Q (0.095). Combining the three statistically significative coefficients, ANN indicated a negative relation with the VLRYield: the announcements related with QE policies decreased the long-run Government bond yield.

The asset purchases under QE measures revealed to be statistically significant on 3M (QE(-1) = $7.98E^{-07}$), 4M (QE(-5) = $-5.16E^{-07}$) and 4Q (QE = $-3.35E^{-07}$). Comparing

the magnitude of the coefficients, QE has a slight negative relation with the dependent variable.

In the Japanese case, the quarterly based regressions presented higher R^2 and Durbin-Watson statistics closer to two than the monthly-based regressions.

Overall, the results obtained indicate that QE policies may affect and reduce the VLRYield, although the magnitude and the signs of the coefficients do not allow definitive and "crystal clear" deductions.

The results for Japan are presented in Table XIII.

6. Conclusion

The aim of this dissertation was to assess the impact of Quantitative Easing policies employed during the financial crisis of 2007-2009 into the long-term Government bond interest rate of the United States of America, United Kingdom, Euro Area and Japan. By studying this relationship, the objective was to verify if QE measures have decreased the variation of the long-term Government bond yield using similar methodologies with monthly and quarterly data.

In order to do so, the main problems for each economy were mapped out and, consequently, the aim and construction of each QE programme was described and empirically analysed on a monthly and on a quarterly basis. Several databases were needed to collect the data – data platforms, international data warehouses, as well as national sources. The dummy representing the announcement of QE required an extensive analysis of every press release about the topic for the four economies studied.

In the United States of America case, it was observed that the announcements related to QE reduced the dependent variable. On the other hand, the Large Scale Asset

Purchases presented positive but negligible coefficients. Overall, this study provides support for the use of QE policies in the US, as the QE measures decreased the variation of the long-term Government bond yield.

The announcements of the BOE's QE programme presented positive outputs, which were only statistically significant on two out of eight regressions. Most of the statistically significant coefficients of the asset purchases under the Asset Facility Programme indicate a decrease on the explained variable. It is thus not possible to be assertive of the impact of QE measures on the variation of the long-term Government bond yield for the United Kingdom case.

The outputs of the empirical analysis for the Euro Area and Japan were the most ambiguous of the group. Overall, the announcements of ECB's QE supported the use of QE as a way of influencing and decreasing the variable in study. For the asset purchase under the Asset Purchase Programme it was not possible to assess if it reduced or augmented the variation of the long-term Government bond yield as all coefficients have negligible magnitudes.

In the Japanese study, the announcements fashioned conflicting coefficients. When analysing the magnitude of the coefficients, there may be supporting evidence for the use of such policies. The asset purchases followed the same tendency but with much smaller coefficients than the announcements.

Across all regressions within the economies studied, the equations with quarterly data presented better outputs (higher R^2 and Durbin-Watson statistics closer to two).

It is worth mentioning that, although it is outside of the scope for this essay, evidence was found supporting some of the literature previous mentioned: the determinants of the long-term Government bond yields may differ according to the time

span analysed, after and during the crisis, and the same determinant may influence the long-term bond yield with opposite signs depending on the time span in case. In addition, this essay found evidence supporting that bank and sovereign risk has become more and more interconnected.

Although the results about the effect of QE measures on the variation of the long-term Government bond yields were not always perceptible, this study remains meaningful, since it provides an overview of the design, operations and empirical assessment of the impact of the unconventional asset purchase programmes conducted by Central Banks in response to the financial crisis, for the United States of America, United Kingdom, Euro Area and Japan on monthly and quarterly time frequency.

Further research can be pursued on this topic. An interesting expansion of this dissertation would be the inclusion of expectations into the model and/or a counterfactual analysis.

In conclusion, this dissertation finds that Quantitative Easing measures do not produce equal results for every economy, and despite some favourable effects being visible, they appear to be small relatively to the size and type of the Quantitative Easing policies employed.

Appendix

Methodology: United States of America

The end of the housing price bubble in 2006 had major effects into the economy. After two years, by the end of 2008, the output was falling; financial markets were debilitated and short-term rate was near the zero lower bound (ZLB). (Fawley and Neely, 2013)

The Federal Reserve System (Fed) has a dual mandate. The dual mandate refers to the price stability goal – 2% target for the inflation rate; and maximum stability employment – all committee's decision must be acquainted by an eclectic collection of labour market indicators. (Chicago Fed Letter, 1998)

On September 2008 the bankruptcy of Lehman Brothers worsen the already debilitated financial market, risk premia went up and liquidity went down. The lack of dollars was felt across the globe and monetary and fiscal authorities had to intervene to grant dollar liquidity to financial and non-financial firms. In the same week of Lehman Brothers' bankruptcy the Fed extended its foreign exchange swap lines with foreign central banks. More actions aimed at improving liquidity, both national and internationally, were conducted. For instance, swap lines with the BOE, ECB and the Swiss National Bank would serve whichever quantity of funds needed; the US Treasury assured money market mutual fund (MMMF) deposits; the Fed created a program to directly purchase high-grade commercial paper, the commercial paper funding facility (CPFF); and the term action facility (TAF). (Fawley and Neely, 2013) Initially the concern was to improve the functioning on the market but soon it had to change to include GDP growth recovery and the inflation target. Although all the extra measures and the decrease of

the Federal funds rate from more than 5% in 2007 to less than 1% at the end of 2008, the economy was not recovering as desired.

Note that although all of these actions were not typical conventional policies they did not augment the monetary base. At the beginning the US followed a credit easing policy and only in 2008 with measures that increased the money supply it started to be QE approach. (Bernanke, 2009) On November 2008 the Federal Open Market Committee (FOMC) announced the Large Scale Asset Purchase (LSAP), a programme using the creation on money to buy, firstly, Government-Sponsored Enterprise (GSE) debt and Mortgage-Based securities (MGS). After suggestions that the LSAP would be expanded, in March 2009 the FOMC expands the program in size and includes purchases of long-term Treasuries. This programme, also know as QE1 was downsized in size and type of assets purchases in September, November 2008 and finished mid-2009.

At the end of 2010, a FOMC stated its concerns about the low inflation level and Bernanke suggest the need of further QE. On November 2010, the FOMC announced a new programme with $600 billion purchases in Treasuries. QE2 ceases on the last quarter of 2011 as predicted.

Before QE3, the FOMC announced the Maturity Extension Programme in late 2011 and it would last until the end of 2012. It entails the purchase of long-term securities and the sell short-term maturities.

On September 2012 the last QE package is announced, QE3 starts as $40 billion monthly purchases of MBS and two months later is enlarged by $45 billion of long-term Treasury purchases. From December 2013 to September 2014, QE3 was contracted

seven times, by \$5 billion monthly purchase for each kind of asset integrating the whole package. The last purchases under this measure were on October 2014.

The federal fund rate started increasing in 2015 – to between 0,5 and 0,25%; and the discount rate between 0,75 and 1%.

On table VI, the reader can find the full list of announcements – dates and information – regarding the US' QE programmes and the policy rate updates.

In order to measure the impact of the QE policies into the variation of the long-term Government bond yield, four distinct regressions were employed on monthly and quarterly basis:

- Equation 1: from 1999 to 2007;

- Equation 2: from 2008 to 2015;

- Equation 3: from 2008 to 2015 with only QE related variables;

- Equation 4: from 1999 to 2015.

The four regressions resulting from the analysis on a monthly basis are:

- $\Delta\,LRYield$ 1999 to 2007:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + vdr_{t-1} + vdr_{t-2} + \left(\frac{Debt}{GDP}\right)_t + \Delta\left(\frac{Debt}{GDP}\right)_{t-2}$$
$$+\; abay_t + eqta_t + vix_t + \text{reer}_t + INDPRO_t + \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + vdr_t + \Delta\,abay_t + eqta_t + vix_t + \text{reer}_t$$
$$+\;\Delta\,GR\_INDPRO_t + qe\_st_{t-1} + \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\,LRYield_t = \alpha + ann\_qe_t + qe\_st_t + \varepsilon_t$$

- $\Delta\,LRYield$ 1999 to 2015:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + vdr_{t-1} + \Delta\frac{Debt}{GDP}_t + \Delta\,abay_t + eqta_t + vix_t$$
$$+\ \Delta\,GR\_INDPRO_t + INDPRO_t + ann\_qe_t + qe\_st_t + \varepsilon_t$$

The four regressions resulting from the analysis on a quarterly basis are:

- $\Delta\,LRYield$ 1999 to 2007:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + vdr_{t-1} + \Delta\left(\frac{Debt}{GDP}\right)_t + vix_t + \mathrm{reer}_t$$
$$+\ +\Delta\,GR\_INDPRO_t + INDPRO_t + \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + abay_t + vix_t + \mathrm{reer}_t + \Delta\,GR\_INDPRO_t$$
$$+\ ann\_qe_t + qe\_st_t + qe\_st_{t-1} + \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\,LRYield_t = \alpha + ann\_qe_t + ann\_qe_{t-2} + qe\_st_t + \varepsilon_t$$

- $\Delta\,LRYield$ 1999 to 2015:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + abay_t + eqta_t + vix_t + \mathrm{reer}_t + \Delta\,GR\_INDPRO_t$$
$$+\ ann\_qe_t + ann\_qe_{t-2} + qe\_st_t + \varepsilon_t$$

Methodology: United Kingdom

The financial crisis in the United Kingdom led to a decreased in spending, turned markets less liquid and compromised the inflation target of 2%.

As referred before, central banks may have different mandates. The Bank of England is responsible for price stability, i.e. inflation rate target, and backing the Government's economic goals – such as growth and employment. (BOE, 2013)

With the beginning of the financial crisis in 2007, the Bank of England started implementing measures to augment the market liquidity in order to promote consumption. Initially the BOE increase its lending operations in value, beyond the needs of commercial banks to satisfy their reserve targets, and in collateral accepted. On April 2008 a Special Liquidity Scheme (SLS) was created, it was an instrument provided to banks and building societies that permitted the exchange of provisionally illiquid but first-rate quality mortgage-backed and other security for UK Treasury Bills. (Joyce *et al.*, 2011)

Notwithstanding the extra measures taken, the goals of the Monetary Policy Committee (MPC) did not seem to be accomplished. Then at the beginning of 2009 the Asset Purchase Facility Fund was created as a subsidiary of the BOE. Her Majesty's Treasury would reimburse the Fund from whichever costs associated with the Asset Purchase Facility (APF), meaning that the BOE would not be injured in any way possible for the AFP. The issuance of Treasury bills and cash management operations of the Debt Management Office (DMO) up to £50 billion allowed the Fund to purchase private sector assets, such as corporate bonds and commercial paper. The purchases began on February 2009 and the main asset bought at the time was UK Government bonds – so-called gilts. (Joyce *et al.*, 2011)

Joyce, Tong and Woods (2011) have noted that the liquidity premia channel was not relevant in the design of the purchases of gilts – because their market functioned efficiently; but was relevant on the purchases of private sector assets because these markets had liquidity problems.

At the same time, the MPC feared that the inflation target of 2% would not be met. For this reason, it started reducing the instrumental rate, the so-called Bank Rate. During the fourth trimester of 2008 the Bank rate decreased 3 percentage points. In the beginning of 2009 it was reduced to 1,5% and in March the Bank Rate reached 0,5%. (Joyce, Tong and Woods, 2011) Overall the Bank Rate decreased from 5% to 0,5%.

Only on March 2009 the processes of implementing monetary policy were reformed: when the MPC announced that central bank reserves would be used to fund the AFP and that the value of the purchases would be increased and the conditions of the acquisitions would change. (Joyce *et al.*, 2011) As the goal of such policies were to increase the soundness of the markets implied and due to the large size of the programme, the MPC gather monthly to review the suitable scale of the purchases although it fixed targets over periods longer than a month. (Joyce, Tong and Woods, 2011) From this moment on, the AFP was officially an unconventional monetary policy tool.

Monetary policy and financial stability responsibilities of the BOE resulting from the MPC's 2% inflation target require operations in the sterling money markets. These operations are taken within the Sterling Monetary Framework (SMF). (BOE, 2013) As a consequence of the reformulations on monetary policy made in March, these facilities were also amended: reserves objectives were suspended and the remuneration the all reserves started being at the Bank Rate.

On March 2009 the first programme of QE was announced. It consisted in purchases up

to £75 billion in assets, mostly conventional gilts with maturity between five and twenty-five years. In order to increase the money supply, the purchases would be financed increasing the central bank reserves, which means by issuing money. Until the end of the year the programme was expanded in value three times, in May, August and November, up to £200 billion. In August gilts with three years of maturity or more were included in the portfolio. On February 2010 the MPC maintained the stock of assets purchases financed by reserve issuance at £200 billion and the purchases of commercial paper and corporate bonds would be financed by DMO cash management operations and the issuance of Treasury bills. Although the efforts, GDP contracted in the end of 2011 and beginning of 2012. On October 2011 the APF was augmented to £275 billion. The first revision on the maximum value for private asset purchases was on November 2011. Her Majesty's Treasury announced that the upper limit on APF private asset holdings decrease from £50 billion to £10 billion. The programme was expanded two times during 2012: up to £325 billion in March and to £375 billion in July. The BOE decided, on August 2016, to reduce the official Bank Rate from 0,5% to 0,25% and the stock of assets purchases financed by reserve issuance increased to £435 billion. Further alterations were not considered on the data due to lack of data for all variables included.

The table VII portrays all the announcements used in the regression – dates and information – and the updates of the Bank Rate.

In order to measure the impact of the QE policies into the variation of the long-term Government bond yields, four distinct regressions were employed on monthly and quarterly basis:

- Equation 1: from 2000 to 2007;

- Equation 2: from 2008 to 2016;

- Equation 3: from 2008 to 2015/2017 with only QE related variables;

- Equation 4: from 2000 to 2016.

The four regressions resulting from the analysis on a monthly basis are:

- $\Delta\, LRYield$ 2000 to 2007:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + vBankRate_{t-1} + \Delta\, (\frac{Debt}{GDP})_{t-1} + vix_t + \text{reer}_t$$
$$+ \Delta\, GR\_INDPRO_t + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2016:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + \Delta\, LRYield_{t-2} + vBankRate_{t-2} + vix_t + \text{reer}_t$$
$$+ \Delta\, GR\_INDPRO_{t-2} + ann\_qe_{t-3} + afp_{t-2} + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\, LRYield_t = \alpha + ann\_qe_t + ann\_qe_{t-1} + ann\_qe_{t-2} + ann\_qe_{t-3} + afp_t$$
$$+ afp_{t-1} + afp_{t-2} + afp_{t-3} + \varepsilon_t$$

- $\Delta\, LRYield$ 2000 to 2016:

$$\Delta\, LRYield_t = \alpha + LRYield_{t-1} + \Delta\, \frac{Debt}{GDP}_{t-1} + vix_t + \Delta\, GR\_INDPRO_{t-1}$$
$$+ INDPRO_t + afp_{t-2} + \varepsilon_t$$

The four regressions resulting from the analysis on a quarterly basis are:

- $\Delta\, LRYield$ 2000 to 2007:

$$\Delta\, LRYield_t = \alpha + LRYield_{t-2} + vBankRate_{t-1} + \Delta\left(\frac{Debt}{GDP}\right)_t + vix_t + reer_t$$

$$+ + \Delta\, GR\_INDPRO_t + INDPRO_t + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2016:

$$\Delta\, LRYield_t = \alpha + LRYield_{t-1} + vBankRate_{t-2} + vix_t + \Delta\, GR\_INDPRO_t$$

$$+ ann\_qe_{t-1} + afp_t + afp_{t-1} + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\, LRYield_t = \alpha + ann\_qe_t + ann\_qe_{t-1} + afp_t + afp_{t-1} + \varepsilon_t$$

- $\Delta\, LRYield$ 1999 to 2015:

$$\Delta\, LRYield_t = \alpha + LRYield_{t-2} + vBankRate_{t-1} + \Delta\left(\frac{Debt}{GDP}\right)_t + vix_t$$

$$+ \Delta\, GR\_INDPRO_t + INDPRO_t + ann\_qe_{t-1} + afp_t + \varepsilon_t$$

Methodology: Euro Area

The financial turmoil affected the Euro area (EA) in many ways: weak growth, several downwards revisions in the inflation level, investment went down and saving rates went up while consumption decreased. The European Central Bank (ECB) manages the Euro and designs and executes the monetary policy in the Euro zone. Its goal is price stabilization and maintaining an inflation level target around 2%. Besides its main aim, the ECB is assigned of the maintenance and supervision of the stabilization of the financial system in the EA. (Abreu *et al.*, 2012)

At the beginning of the financial crisis, in 2007, the ECB's main refinancing operations rate (MRO) was 4,25%. With the intention of improving the economics scenario, the rate suffered several downgrades and at the end of 2016 it reached the 0%. Although the European QE measures only started in 2015, the ECB was already fighting the decline of the economic indicators by reducing the instrumental rate and implementing less conventional monetary measures, such as the Longer-term Refinancing Operations (Net-LTRO) (which grant long-term refinancing to the financial market), the Targeted Longer-term Refinancing Operations (TLTROs) (which grant financing to credit institutions for periods up to four years) and the Asset Purchase Programme (APP), which had been employed since 2008 in order to improve the Euro's situation. (Afonso and Kazemi, 2017) Until the beginning of 2015, the Asset Purchase Programme (APP) was composed by the Asset-Backed Securities Purchase Programme (ABSPP) and the third Covered Bond Purchase Programme (CBPP3).

On the 22nd of January 2015, Mario Draghi, the president of the ECB, announced the beginning of QE policies in the EA, with an extension of the APP. The Public Sector Purchase Programme (PSPP) in a fund managed by the Eurosystem to purchase bonds

issued by the EA's central governments and debt securities from European institutions and national agencies at a rate of €60 billion per month, from March 2015 to September 2016. On December 2015, regional and local government bonds are included in the list of eligible assets for purchase under the PSPP. Mario Draghi also announced that the measure will last "at least until" March 2017. (Demertzis and Wolff, 2016) On March 2016, it is announced that the monthly purchases under APP will be booted up to €80 billion starting on the next month. The Corporate Sector Purchase Programme (CSPP) is the new addiction to the APP and it consists in the purchase by six Eurosystem national central banks (NCBs) of investment grade Euro-denominated bonds issued by non-bank corporations settled in the EA. At the end of 2016, the ECB announced that the amount of monthly purchases under the APP would decrease to €60 billion starting the following April, not ceasing before December 2017. Purchases of securities with a yield to maturity below the interest rate of the ECB's deposit facility will be permitted under the APP. The PSPP was also modified: Eurosystem central banks will have the possibility to accept cash as collateral in their securities lending facilities without having to reinvest it in a cash-neutral manner. Decreasing the minimum maturity for eligible securities from two years to one also broadens the maturity range accepted. Although data of 2017 is not included in the empirical analysis the following QE update it is worth mentioning. On January 2017 it is confirmed that the net asset purchased will be up to €60 billion a month from April until December 2017 or beyond. The ECB informs that only under PSPP, the purchases of assets with yields below the deposit facility rate (DFR) will be accepted, while the priority being the assets with yields above DFR, thus excluding the purchases of these types of assets under the CBPP3, the ABSPP and the CSPP.

On table VIII, the reader can find the full list of announcements – dates and information – regarding the EA' QE policies and the policy rate updates.

In order to measure the impact of the QE policies into the variation of the long-term Government bond yields, four distinct regressions were employed on monthly and quarterly basis:

- Equation 1: from 2000 to 2007;

- Equation 2: from 2008 to 2016;

- Equation 3: from 2008 to 2017 with only QE related variables;

- Equation 4: from 2000 to 2016/2007.

The four regressions resulting from the analysis on a monthly basis are:

- $\Delta\, LRYield$ 2000 to 2007:

$$\Delta\, LRYield_t = \alpha + LRYield_{t-3} + \Delta\, LRYield_{t-1} + \Delta\, LRYield_{t-2} + vMRO_t$$
$$+ \mathrm{gr}\_(\frac{Debt}{GDP})_t + vix_t + \mathrm{reer}_t + \mathrm{reer}_{t-1} + INDPRO_t + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2016:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + vMRO_{t-1} + \mathrm{gr}\_(\frac{Debt}{GDP})_{t-2} + vix_t + \mathrm{reer}_t$$
$$+ \Delta\, GR\_INDPRO_t + ann\_qe_{t-1} + ann\_qe_{t-2} + app_{t-1} + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\, LRYield_t = \alpha + ann\_qe_{t-2} + ann\_qe_{t-3} + app_{t-2} + app_{t-4} + \varepsilon_t$$

- $\Delta\, LRYield$ 2000 to 2016:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + vMRO_t + vix_t + GR\_INDPRO_t + ann\_qe_{t-2}$$
$$+\ afp_{t-2} + app_{t-4} + \varepsilon_t$$

The four regressions resulting from the analysis on a quarterly basis are:

- $\Delta\, LRYield$ 2000 to 2007:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + \Delta\, LRYield_{t-1} + MRO_{t-3} + \left(\frac{Debt}{GDP}\right)_{t-1} + vix_t$$
$$+\ \mathrm{reer}_t +\ GR\_INDPRO_t + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2016:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + vMRO_{t-1} + \mathrm{gr}\_\left(\frac{Debt}{GDP}\right)_t + vix_t + \mathrm{reer}_t$$
$$+\ \Delta\, GR\_INDPRO_{t-1} + ann\_qe_{t-1} + app_t + \varepsilon_t$$

- $\Delta\, LRYield$ 2008 to 2017 – QE related variables only:

$$\Delta\, LRYield_t = \alpha + ann\_qe_t + ann\_qe_{t-1} + ann\_qe_{t-2} + app_t + app_{t-1} + app_{t-2}$$
$$+\ \varepsilon_t$$

- $\Delta\, LRYield$ 2000 to 2016:

$$\Delta\, LRYield_t = \alpha + \Delta\, LRYield_{t-1} + MRO_t + \Delta\left(\frac{Debt}{GDP}\right)_t + vix_t + ann\_qe_{t-2}$$
$$+\ ann\_qe_{t-3} + app_{t-4} + afp_{t-5} + \varepsilon_t$$

Methodology: Japan

The financial crisis of 2007-2008 impacted Japanese companies and led them to substantial decreases in investment. The Yen devaluated against the dollar and, overall, the Japanese economy sank – observed by the contraction of GDP. The Bank of Japan goal is price stability, which allows a sound development of the economy. (BOJ, 2013)

The burst of the asset price bubble in the early 1990's left the Japanese economy in stagnation and in 2001 with the burst of the "dot-com bubble" led Japan's economy at the hedge of regression. From the early 1990's to 2005 the consumer price index (CPI) decreased 3% in total. (Ugai, 2006) Facing low growth, deflation and a wide number of non-performing loans in its baking system, the Bank of Japan launched the Quantitative Easing programme (QEP) and forward guidance, on March 2001. This unprecedented programme was based in three pillars: forward guidance – commitment to keep the interest rates at the zero level while in a scenario of deflation; increase of the BOJ's balance sheet and increase of the outright purchases of longer-dated Japanese Government securities in order to change the composition of the CB's balance sheet. This programme was active from 2001 to 2006. (Rogers *et al.*, 2014)

Two months after the bankruptcy of the Lehman Brothers, on the 2nd of December 2008, the BOJ announces the Special-Fund-Supplying Operations: a facility to lend an unlimited amount to banks at the uncollateralized overnight call rate (0,3%) and collateralized by corporate debt, active until April 2009. On December 19 it increases the monthly purchases of Japanese Government Bonds (JGB) from ¥1,2 trillion to ¥1,4 trillion; decreased the uncollateralized overnight rate to 0,1% and announces the Corporate Financial Instruments programme (purchase of ¥3 trillions in commercial paper).

The BOJ created and expanded various programmes in order to improve the economy. Due to the broad number of announcements of policies, the programmes will be briefly mentioned below. The complete list of announcements with dates and information is on table IX. The Fixed-rate Operations (FRO) is intended to replace the SFSOs, started with purchases of ¥10 trillions in three-month maturities, on December 2009; was expanded twice until August 2010. The aim of the Growth-Supporting Funding Facility (GSFF) is the increasing of growth through direct provision of funds (¥3 trillion) to financial institutions. The GSFF was negotiated in the first half of 2010. This programme was increased on June 2011, March 2012 and January 2015 up to ¥10 trillions.

On October 2010, BOJ announces the Comprehensive Monetary Easing (CME) policy, which is composed by three measures: clarifying the conditions for exiting Zero Interest-Rate Policy (ZIRP); lowering the target for the uncollateralized overnight call rate; and the Asset Purchase Programme (APP). The goal of the APP was to "encourage the decline of longer-tem interest rates and various risk premia to further enhance monetary easing". (Fawley and Neely, 2013) It included the purchases of short- and long-term Government securities, commercial paper, corporate bonds, exchange-traded funds (ETF) and Japanese real estate investment trusts (J-REITS), with a total size of ¥35 trillions. Until 2013, when the end of APP was announced, it suffered ten increases in size and composition.

On December 2012, Shinzo Abe is elected as prime minister of Japan and initiates, what is commonly called, the *Abenomics*.

The Quantitative and Qualitative Monetary Easing (QQE) is introduced on April 2013 and has two main objectives: "yield curve control": control of short- and long-term

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interest rates through market operations; and "inflation-overshooting commitment": the BOJ commits itself to expand the monetary base until the inflation target of 2% is achieved (before the target was 1%). The BOJ stated that monetary based should increase at a annual pace of ¥60 - ¥70 trillion under QQE.

In order to measure the impact of the QE policies into the variation of the long-term Government bond yields, four distinct regressions were employed on monthly and quarterly basis:

- Equation 1: from 1999 to 2007;

- Equation 2: from 2008 to 2015;

- Equation 3: from 2008 to 2015 with only QE related variables;

- Equation 4: from 1999 to 2015.

The four regressions resulting from the analysis on a monthly basis are:

- $\Delta \, LRYield$ 1999 to 2007:

$$\Delta \, LRYield_t = \alpha + LRYield_{t-1} + LRYield_{t-2} + vdr_{t-3} + + \Delta \left(\frac{Debt}{GDP}\right)_{t-2}$$

$$+ GR\_\left(\frac{Debt}{GDP}\right)_t + vix_t + \varepsilon_t$$

- $\Delta \, LRYield$ 2008 to 2015:

$$\Delta \, LRYield_t = \alpha + LRYield_{t-1} + LRYield_{t-2} + vdr_{t-2} + vdr_{t-3} + \Delta \left(\frac{Debt}{GDP}\right)_t$$

$$+ GR\_\left(\frac{Debt}{GDP}\right)_t + vix_t + \text{reer}_t + ann_t + qe_{t-2} + \varepsilon_t$$

- $\Delta \, LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\,LRYield_t = \alpha + ann_t + ann_{t-1} + ann_{t-2} + ann_{t-3} + qe_t + qe_{t-1} + qe_{t-2}$$
$$+ qe_{t-3} + \varepsilon_t$$

- $\Delta\,LRYield$ 1999 to 2015:

$$\Delta\,LRYield_t = \alpha + \Delta\,LRYield_{t-1} + \Delta\,LRYield_{t-2} + \Delta\,LRYield_{t-4} + \Delta\frac{Debt}{GDP}_{t-1}$$

$$+ GR_-(\frac{Debt}{GDP})_{t-1} + vix_t + GR\_INDPRO_{t-1} + ann_{t-1} + qe_{t-5} + \varepsilon_t$$

The four regressions resulting from the analysis on a quarterly basis are:

- $\Delta\,LRYield$ 2000 to 2007:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + LRYield_{t-2} + \Delta\,(\frac{Debt}{GDP})_{t-4} + vix_t + reer_t$$

$$+ \Delta\,GR\_INDPRO_t + \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015:

$$\Delta\,LRYield_t = \alpha + LRYield_{t-1} + LRYield_{t-3} + vdr_{t-1} + (\frac{Debt}{GDP})_t + \Delta\,(\frac{Debt}{GDP})_{t-1}$$

$$+ vix_t + reer_{t-3} + INDPRO_{t-3} + GR\_INDPRO_t + ann_t + qe_{t-1}$$

$$+ \varepsilon_t$$

- $\Delta\,LRYield$ 2008 to 2015 – QE related variables only:

$$\Delta\,LRYield_t = \alpha + ann_t + ann_{t-1} + qe_t + qe_{t-1} + \varepsilon_t$$

- $\Delta\,LRYield$ 1999 to 2015:

$$\Delta\,LRYield_t = \alpha + \Delta\,LRYield_{t-1} + \Delta\,LRYield_{t-2} + vdr_{t-2} + \Delta\left(\frac{Debt}{GDP}\right)_{t-2} + vix_t$$

$$+ \; INDPRO_{t-1} + ann_t + qe_t + \varepsilon_t$$

Table I - Literature Review

Authors	Country coverage	Objective	Sample Period	Methodology	Results
(Fawley and Neely, 2013)	UK, US, UE, Japan	Portray, for the Fed, BOE, BOJ and ECB, the situation and the motives for the QE programs during the financial crisis of 2007-2009 and the onward years			-Initial efforts of QE were directed to calm down financial market distress and shortly it became an instrument to hit inflation targets, stimulate real economy and contain European sovereign debt crisis; -BOJ and ECB acted more through loans to the banking system; -BOE and FED purchased high quantities of bonds; -As a result of QE held by all 4 BCs the monetary base highly increased but other monetary aggregates did not suffer the same impact.
(Gambacorta, Hofmann and Peersman, 2012)	Canada, Euro area, Japan, Norway, Switzerland, Sweden, UK, US	Evaluate the macroeconomic effects of unconventional monetary policies during the financial crisis of 2007-2009	-Jan 2008 – Jun 2011; -Monthly data	-Panel VAR	-Exogenous rise in CB balance sheets at the zero lower bound leads to a momentary increase in economic activity and consumer prices; - The estimated output effects came out to be qualitatively comparable to the ones found in the literature on the effects of conventional monetary policy, while the impact on the price level is weaker and less persistent; -The unconventional measures had a similar macroeconomic effect across countries; -An immense expansion of CBs balance sheet is needed to achieve a strong monetary stimulus.
(Rogers *et al.*, 2014)	USA, UK, EA, Japan	Surveys the impact of unconventional MP on bond yields, stock prices and exchange rates for the Fed, BOE, BOJ and ECB during the financial crisis of 2007-2009	Daily and intraday asset price data	-OLS estimation; -Structural VAR;	-Policies are effective in easing financial conditions when policy rates are trapped at the zero lower bound, evidently mostly by cutting term premia; -Influence of bond yields into assets prices appeared to have a higher effect on USA than in other economies.
(Joyce, Tong and Woods, 2011)	UK	Assess the effect of QE made by BoE on financial markets and economy in general			-Unconventional monetary policy made a significant effect on the economy but the precise magnitudes are uncertain.
(Joyce *et al.*, 2011)	UK	Assess the effect of QE made by BoE on UK asset prices	-Event-study: 6 announcement dates: 2009: February, March, May, August and November; 2010: February; - Two-day window after announcements; -Time-series: December 91 – December 09;	-Event-study; -Time-series econometrics (VAR and GARCH-M);	-QE decrease medium to long-run government bond yields; - Main transmission channel: portfolio balance channel;
(Baumeister and Benati, 2010)	US & UK	Evaluate the macroeconomic effects of a reduction on the long-	-1954 – 2011	-Time-varying parameter structural VAR (TVP-VAR)	-A compression in the long-term yield spread employs a prevailing effect on both inflation and output when in a zero lower bound situation, as in the case of the U.S. and the U.K.;

		term bond yield spreads during the financial crisis of 2007-2009			-Unconventional monetary policy actions have been successful at lessening significant risks of inflation and output downfalls.
(Driffill, 2015)	EZ, USA, UK	Draw out lessons from USA and UK unconventional monetary policies for the Euro zone.			-The ECB's programme had a much smaller effect on bond yields and thus the effects on output and inflation could be less puissant than in the case of BoE and Fed; -Creation of asset prices bubbles, allowing zombies firms and banks to survive, higher levels of future inflation and the deceleration of the adjustment processes, does not appear to be a concern for EA; -The ECB's efforts seemed to make an impact on the reduction of costs of debt service that could ease the fiscal situation of member states.
(Krishnamurthy and Vissing-Jorgensen, 2011)	US	Assess the effect of QE made by Fed on interest rates with emphasis on the channels and policy's implications	-Start 2008 – end of third quarter 2011; -Intraday data window	Event-study	-QE1 and QE2 reduced nominal interest rates on Treasuries, agencies, corporate bonds and MBSs; -Main transmission channels: signalling effect and "portfolio balance channel".
(Gagnon et al., 2011)	US	Enlighten how LSAP were implemented and through which transmission channels it affected the economy	-Event-study: One-day window; -Time-series: monthly data from January 1985 to June 2008	-Event-study (variations of interest rates around announcements) -Time-series (OLS & DOLS): impact of asset purchases on the ten-year term premium.	-Lifelong reduction of long-term interest rate in securities even in those that were not part of the LASP programme; -Reduction made through lower risk premiums and not by lower expectations of future short-term interest rates; - LASPs lead to a reduction of the long-term private borrowing rates.
(Wright, 2012)	US	Assess the impact on several long-term interest rates of MP shocks during the financial crisis	-Nov 3 2008 – Dec 28 2010; -Daily data	-Structural VAR; -High-frequency event-study.	-Monetary policy shocks affect long-run Treasury and Corporate bonds but its effect fades quite fast, around two months; -The impact of monetary policy shocks is stronger in longer-term interest rates than in short-term interest rates.
(Chung et al., 2010)	USA	-Estimate the impact of the LSAPs on macroeconomic variables such as, inflation, GDP level and unemployment rate; -Incorporate expectations into the analysis.	2009 – 2016	FRB/US Forecast Model	-Improvement of real economy condition made through changes in financial conditions, such as lower foreign exchange value of the dollar and higher stock market valuations; -Increase in GDP; -Lower unemployment rate; -LSAPs contributed to price stability and long-term inflationary consequences of the programme are not a likely scenario; -The study reflects that agents have confidence in the FOMC's actions.
(Attinasi, Checherita and Nickel, 2009)	Austria, Belgium, Finland, France, Greece, Ireland, the Netherlands, Portugal, Spain	Discover the determinants of the increase in the sovereign bond yield spread of the selected countries vis-à-vis Germany in the period	End-July 2007 – end-March 2009	Dynamic panel regression	-Announcements of bank rescue packages steered a revision of sovereign credit risk by investors; -When comparing to Germany, countries with greater expected budget deficits or/and greater government debt ratios have higher government bond yields spreads.

		analysed			
(De Grauwe and Ji, 2014)	EA: Greece, Ireland, Portugal, Spain, Austria, Belgium, Finland, France, Italy, Netherland	-Evaluate changes in Eurozone spreads: -Outlining how much of the downturn is merited to improving fundamentals; -Determining how much could be attributed to optimistic market sentiments sparked by the announcement of OMT in Q3 of 2012.	Q1 2000 – Q3 2013		-Throughout 2010-2012 periphery countries suffered an increase in their spread that could not be justified by changes in the fundamentals, such as debt-to-GDP ratio, but by negative market sentiments; -After Q3 2012 the spreads of periphery countries have declined and, as before, this occurrence could not be attributed to changes in fundamentals but it could be associated with improvement of market sentiments, which coincide exactly with the OMT announcement by the ECB; -Market sentiments are not always in line with the fundamentals what could prevent the market from considering the actuals risks.
(Gerlach, Schulz and Wolff, 2010)	EA: Austria, Belgium, Germany, Spain, Finland, France Greece, Ireland, Italy, Netherland, Portugal	-What factors have been influencing that spread in the euro zone after the introduction of the Euro, focusing on the relation between the banking sector and sovereign risk; -Note: does not access the effect of QE.	January 1999 – February 2009	Dynamic Panel Model	-The size of the banking sector, proxy by aggregate balance sheet to GDP ratio, is an essential factor of sovereign risk spread relative to Germany in the euro area; -If and when readings of aggregate risk rise, yields increase more rapidly in economies with large banking sectors but the rising in aggregate risk is in itself increasing banking risk; -Thus, variations of global risk perception can affect, in size and speed, sovereign risk spreads; -Sovereign spreads diminish with the equity ratio.
(Klepsch and Wollmershäuser, 2011)	EMU: Austria, Belgium, Finland, France, Greece, Germany, Ireland, Italy, the Netherlands, Portugal Spain	-Investigate the determinants of EMU member states' government yield spreads	January 2000 – Sep 2010	Dynamic panel regression	-Spread converged with the introduction of the Euro and abruptly diverged with the financial crisis of 2007; -Before the crisis some spreads' determinants were being ignored by the investors, after the crisis investors gave more attention to countries' credit risk; and risk aversion in the markets became more important; -During the crisis, the fundamentals become more important for investors leading to an increase of spreads; -Sovereign risk is manipulated by equity ratios of banks; -High forecast debt levels have a higher impact on yield spreads than expected GDP growth rates.

Table II - Variables: United States of America

Variable	EViews	Source	Database Code	Database Name
Long-term Bond Yield	LRYield	Board of Governors of the Federal Reserve System	DGS10	10-Year Treasury Constant Maturity Rate, Percent, Monthly, Not Seasonally Adjusted
Instrumental Interest Rate	DISCOUNTR	IMF - International Financial Statistics	INTDSRUSM193N	Interest Rates, Discount Rate for United States©, Percent per Annum, Monthly, Not Seasonally Adjusted
Instrumental Interest Rate	EFFR	Board of Governors of the Federal Reserve System	FEDFUNDS	Effective Federal Funds Rate, Percent, Monthly, Not Seasonally Adjusted
Total Asset of Banks	BASSETS	Board of Governors of the Federal Reserve System	TLAACBMO27NBOG	Total Assets, All Commercial Banks, Billions of U.S. Dollars, Monthly, Not Seasonally Adjusted
GDP		U. S. Bureau of Economic Analysis	GDPC1_NBD20100101	Real Gross Domestic Product, Index Q1 2010=100, Quarterly, Seasonally Adjusted Annual Rate
GDP	GDPR	International Financial Statistics (IFS)	GDPCA	Gross Domestic Product, Real, Index 2010=100; Seasonally Adjusted
Banking Assets/GDP	ABAY		Generated	
Banking Equity/Banking Assets	EQTA	Federal Financial Institutions Examination Council (US)	EQTA	Total Equity to Total Assets for Banks, Percent, Quarterly, Not Seasonally Adjusted
Debt/GDP	DEBT_GDP	Federal Reserve Bank of St. Louis	GFDEGDQ188S	Federal Debt: Total Public Debt as Percent of Gross Domestic Product, Percent of GDP, Seasonally Adjusted
VIX	VIX	Chicago Board Options Exchange	VIXCLS	CBOE Volatility Index: VIX©, Index, Monthly, Not Seasonally Adjusted
Real Effective Exchange Rate	REER	IMF - International Financial Statistics	USI..RECE	US Real Effective FX Rate (REER) Based on Consumer Price Index
Industrial Production	INDPRO	Board of Governors of the Federal Reserve System	INDPRO	Industrial Production Index, Index 2012=100, Monthly, Seasonally Adjusted
Announcements QE	ANN_QE	(Fawley and Neely, 2013) + Board of Governors of the Federal Reserve System	Generated	
QE purchases	QE_ST/QE_CT	Board of Governors of the Federal Reserve System		https://www.newyorkfed.org/markets/pomo/operations/search.html

Table III - Variables: United Kingdom

Variable	EViews	Source	Database Code	Database Name
Long-term Bond Yield	LRYield	OECD	IRLTLT01GBM156N	Long-term GOV Bond Yields: 10-year: Main (Including Benchmark) for the UK
Instrumental Interest Rate	BANK_RATE	Bank of England	BOERUKM	Bank of England Policy Rate in the UK
Debt/GDP	DEBT_GDP	GFS: Government Finance Statistics	GFS.Q.N.GB.W0.S13.S1.C.L.LE.GD.T._Z.XDC_R_B1GQ_CY._T.F.V.N._T	Government debt (consolidated) (as % of GDP)
VIX	VIX	Chicago Board Options Exchange	VIXCLS	CBOE Volatility Index: VIX©, Index, Monthly, Not Seasonally Adjusted
Real Effective Exchange Rate	REER	IMF - International Financial Statistics	UKQ..RECE	UK Real Effective FX Rate (REER) Based on Consumer Price Index
Industrial Production	INDPRO	Bank of England	IPIUKM	Industrial Production Index in the United Kingdom©, Index Jan 2010=100, Monthly, Seasonally Adjusted
Announcements QE	ANN_QE	(Fawley and Neely, 2013) + Bank of England	Generated	
QE purchases	AFP	Bank of England	YWWB9R9	Quantity of Assets purchased by the creation of central bank reserves on a settled basis (in sterling millions)

Table IV - Variables: Euro Area

Variable	EViews	Source	Database Code	Database Name
Long-term Bond Yield	LRYIELD	ECB Statistical Data Warehouse	FM.M.U2.EUR.4F.BB.U2_10Y.YLD	Euro area 10-year Government Benchmark bond yield - Yield
Instrumental Interest Rate	MRO	ECB Statistical Data Warehouse	FM.B.U2.EUR.4F.KR.MRR_FR.LEV	ECB Main refinancing operations - fixed rate tenders (fixed rate) (date of changes) - Level
DEBT/GDP	DEBT_GDP	EUROSTAT	Z8ESBTTXR	Z8 Government Consolidated Gross Debt: GGOVT(% GDP)(ESA2010)
VIX	VIX	Chicago Board Options Exchange	VIXCLS	CBOE Volatility Index: VIX©, Index, Monthly, Not Seasonally Adjusted
Real Effective Exchange Rate	REER	IMF - International Financial Statistics	EMI..RECE	EM Real Effective FX Rate (REER) Based on Consumer Price Index
Industrial Production	INDPRO	EUROSTAT	STS.M.I8.Y.PROD.NS0020.4.000	Euro area 19 (fixed composition) - Industrial Production Index, Total Industry (excluding construction)
Announcements QE	ANN_QE	(Fawley and Neely, 2013) + ECB	Generated	
QE purchases	APP	ECB Statistical Data Warehouse	EMEAPPTPA	EM ECB QE: Asset Purchase Programme, Net Purch Curn

Table V - Variables: Japan

Variable	EViews	Source	Database Code	Database Name
Long-term Bond Yield	LRYIELD	OECD	IRLTLT01JPM156N	Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) for Japan©, Percent, Quarterly, Not Seasonally Adjusted
Instrumental Interest Rate	DISCOUNTR	IMF - International Financial Statistics	INTDSRJPM193N	Interest Rates, Discount Rate for Japan©, Percent per Annum, Monthly, Not Seasonally Adjusted
Debt/GDP	DEBT_GDP	Datastream	JPXGGG%.R	JP General Government - Debt, Gross (%GDP) NADJ
VIX	VIX	Chicago Board Options Exchange	VIXCLS	CBOE Volatility Index: VIX©, Index, Monthly, Not Seasonally Adjusted
Real Effective Exchange Rate	REER	IMF - International Financial Statistics	JPI..RECE	JP Real Effective FX Rate (REER) Based on Consumer Price Index
Industrial Production Index	INDPRO	OECD	JPNPROINDMISMEI	Production of Total Industry in Japan©, Index 2010=100, Monthly, Seasonally Adjusted
Announcements QE	ANN	(Fawley and Neely, 2013) + BOJ	Generated	
QE purchases	QE	Datastream	JPOPRCFLA	JP BOJ: Assets - Treas Discount Bills, Outright Purchases Curn

Table VI - Announcements: United States of America

Date	Programme	Event	Brief Description	Interest Rate News
2008				
25/11/2008	QE1	FOMC statement	LSAPs announced: Fed will purchase $100 billion in Government-Sponsored Enterprise (GSE) debt and $500 billion in MBS.	
01/12/2008	QE1	Bernanke speech	First suggestion of extending QE to Treasuries.	
16/12/2008	QE1	FOMC statement	First suggestion of extending QE to Treasuries by FOMC.	The Fed cuts the federal funds rate from 1% to 0.00-0.25%.
2009				
28/01/2009	QE1	FOMC statement	Fed stands ready to expand QE and buy Treasuries.	
18/03/2009	QE1	FOMC statement	LSAPs expanded: Fed will purchase $300 billion in long-term Treasuries and an additional $750 and $100 billion in MBS and GSE debt, respectively.	Fed expects low rates for "an extended period".
12/08/2009	QE1	FOMC statement	LSAPs slowed: All purchases will finish by the end of October, not mid-September.	
23/09/2009	QE1	FOMC statement	LSAPs slowed: Agency debt and MBS purchases will finish at the end of 2010:Q1.	
04/11/2009	QE1	FOMC statement	LSAPs downsized: Agency debt purchases will finish at $175 billion.	
2010				
10/08/2010	QE1	FOMC statement	Balance sheet maintained: The Fed will reinvest principal payments from LSAPs in Treasuries.	
27/08/2010	QE2	Bernanke speech	Bernanke suggests role for additional QE "should further action prove necessary."	
21/09/2010	QE2	FOMC statement	FOMC emphasizes low inflation, which "is likely to remain subdued for some time before rising to levels the Committee considers consistent with its mandate."	
12/10/2010	QE2	FOMC minutes released	FOMC members' "sense" is that "[additional] accommodation may be appropriate before long."	
15/10/2010	QE2	Bernanke speech	Bernanke reiterates that Fed stands ready to further ease policy.	
03/11/2010	QE2	FOMC statement	QE2 announced: Fed will purchase $600 billion in Treasuries.	
2011				
22/06/2011	QE2	FOMC statement	QE2 finishes: Treasury purchases will wrap up at the end of month, as scheduled; principal payments will continue to be reinvested.	

Date	Program	Type	Description	
21/09/2011	Maturity Extension Program	FOMC statement	Maturity Extension Program ("Operation Twist") announced: The Fed will purchase $400 billion of Treasuries with remaining maturities of 6 to 30 years and sell an equal amount with remaining maturities of 3 years or less; MBS and agency debt principal payments will no longer be reinvested in Treasuries, but instead in MBS.	
2012				
20/06/2012	Maturity Extension Program	FOMC statement	Maturity Extension Program extended: The Fed will continue to purchase long-term securities and sell short-term securities through the end of 2012. Purchases/sales will continue at the current pace, about $45 billion/month.	
22/08/2012	QE3	FOMC minutes released	FOMC members "judged that additional monetary accommodation would likely be warranted fairly soon..."	
13/09/2012	QE3	FOMC statement	QE3 announced: The Fed will purchase $40 billion of MBS per month as long as "the outlook for the labour market does not improve substantially...in the context of price stability."	Fed expects low rates "at least through mid-2015."
12/12/2012	QE3	FOMC statement	QE3 expanded: The Fed will continue to purchase $45 billion of long-term Treasuries per month but will no longer sterilize purchases through the sale of short-term Treasuries.	The Fed expects low rates to be appropriate while unemployment is above 6.5 percent and inflation is forecasted below 2.5 percent.
2013				
18/12/2013	QE3	FOMC minutes released	Beginning in January of 2014, the Fed will decrease the purchase of long-term Treasuries to $40 billion per month and the purchase of MBS to $35 billion per month.	The Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent.
2014				
29/01/2014	QE3	FOMC minutes released	Beginning in February, the Fed will decrease the purchase of long-term Treasuries to $35 billion per month and the purchase of MBS to $30 billion per month.	
19/03/2014	QE3	FOMC minutes released	Beginning in April, the Fed will decrease the purchase of long-term Treasuries to $30 billion per month and the purchase of MBS to $25 billion per month.	
30/04/2014	QE3	FOMC minutes released	Beginning in May, the Fed will decrease the purchase of long-term Treasuries to $25 billion per month and the purchase of MBS to $20 billion per month.	
18/06/2014	QE3	FOMC minutes released	Beginning in July, the Fed will decrease the purchase of long-term Treasuries to $20 billion per month and the purchase of MBS to $15 billion per month.	
30/07/2014	QE3	FOMC minutes released	Beginning in August, the Fed will decrease the purchase of long-term Treasuries to $15 billion per month and the purchase of MBS to $10 billion per month.	

17/09/2014	QE3	FOMC minutes released	Beginning in October, the Fed will decrease the purchase of long-term Treasuries to $10 billion per month and the purchase of MBS to $5 billion per month.	
17/09/2014	QE3	FOMC minutes released	The FOMC discussed ways to normalize the stance of monetary policy and the Federal Reserve's securities holdings.	
29/10/2014	QE3	FOMC minutes released	QE finishes: purchases will wrap up at the end of month, as scheduled; The Committee is maintaining its existing policy of reinvesting principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities and of rolling over maturing Treasury securities at auction.	
2015				
16/12/2015				The Committee decided to raise the target range for the EFFR to 1/4 to 1/2 percent; increase the discount rate at the Banks from 3/4 percent to 1 percent.
2017				
15/03/2017				The Federal Reserve Board has approved the increase of the discount rate at the Banks from 1-1/4 percent to 1-1/2 percent.

Table VII - Announcements: United Kingdom

Date	Programme	Event	Brief description	Interest rate news
2009				
19/01/2009	APF	HM Treasury statement	APF established: The BOE will purchase up to £50 billion of "high quality private sector assets" financed by Treasury issuance.	
11/02/2009	APF	BOE Inflation Report released	The BOE views a slight downside risk to meeting the inflation target, reiterates APF as a potential policy instrument.	
05/03/2009	APF	MPC statement	QE announced: The BOE will purchase up to £75 billion in assets, now financed by reserve issuance; medium- and long-term gilts will comprise the "majority" of new purchases.	The BOE cuts policy rate from 1% to 0.5%.
07/05/2009	APF	MPC statement	QE expanded: The BOE will purchase up to £125 billion in assets.	
06/08/2009	APF	MPC statement	QE expanded: The BOE will purchase up to £175 billion in assets; to accommodate the increased size, the BOE will expand purchases into gilts with remaining maturity of 3 years or more.	
05/11/2009	APF	MPC statement	QE expanded: The BOE will purchase up to £200 billion in assets.	
2010				
04/02/2010	APF	MPC statement	QE maintained: The BOE maintains the stock of asset purchases financed by the issuance of reserves at £200 billion; new purchases of private assets will be financed by Treasury issuance.	
2011				
06/10/2011	APF	MPC statement	QE expanded: The BOE will purchase up to £275 billion in assets financed by reserve issuance; the ceiling on private assets held remains £50 billion.	
29/11/2011	APF	HM Treasury decision	Maximum private asset purchases reduced: HM Treasury lowers the ceiling on APF private asset holdings from £50 billion to £10 billion.	
2012				
09/02/2012	APF	MPC statement	QE expanded: The BOE will purchase up to £325 billion in assets.	
05/07/2012	APF	MPC statement	QE expanded: The BOE will purchase up to £375 billion in assets.	
2013				
24/09/2013		Speech by David Miles	David Miles states: "people should not expect monetary policy to quickly return to normal".	
2016				
03/08/2016			QE expanded: The BOE will purchase up to £435 billion in assets.	The BOE reduced the official Bank Rate to 0.25%.

Table VIII - Announcements: Euro Area

Date	Programme	Event	Brief Description	Interest rate news
2014				
02/10/2014	ABSPP/CBPP3	Governing Council press release	ABSPP explained: ECB announces operational details of asset-backed securities; the list of assets eligible as collateral will be expanded, with case-to-case specific rules in order to enhance the whole euro-area; CBPP3 is announced. LTRO early payments suspended: ECB suspends early-repayments of the 3-year LTROs during the year-end period due to the expected low interest and the concentration of other operations.	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged at 0.05%, 0.30% and -0.20% respectively.
2015				
22/01/2015	QE; PSPP	Governing Council press release	ECB expands purchases to include bonds issued by euro area central governments, agencies and European institutions; PSPP: purchase sovereign bonds from EA Governments and debt securities from European institutions and national agencies	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged at 0.05%, 0.30% and -0.20% respectively.
22/01/2015	TLTRO	Governing Council press release	TLTRO's interest rate altered: The interest rate on the TLTROs will be fixed over the life of each operation at the rate on the MROs prevailing at the time of take-up.	
03/12/2015	PSPP	Governing Council press release	PSPP expanded: will last at least until March 2017, instead of September 2016; list of eligible assets for purchase expanded: regional and local Government bonds.	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility will remain unchanged at 0.05% and 0.30% respectively and the deposit facility will decreased by 10 basis points to -0.30%.
2016				
10/03/2016	APP (ABSPP, PSPP, CSPP) TLTRO II		APP expanded: combined monthly purchases will amount to €80 billion starting in April; Corporate Sector Purchase Programme (CSPP) announced: purchase of investment grade euro-denominated bonds issued by non-bank corporations established in the euro area; TLTRO II: new series of four targeted longer-term refinancing operations will be launched in June.	The ECB decided that the interest rate on the main refinancing operations will decreased by 5 basis points to 0.00%, the interest rates on the marginal lending facility will decreased by 5 basis points to 0.25% and the deposit facility will

			decreased by 10 basis points to -0.40%.
21/04/2016	CSPP	CSPP explained: Outright purchases of investment-grade euro-denominated bonds issued by non-bank corporations established in the euro area will be carried out by six Eurosystem national central banks (NCBs).	
03/05/2016	TLTRO II	TLTRO II: legal acts released.	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged.
02/06/2016	CSPP, PSPP	CSPP and PSPP explained: Governing Council clarifies what is an eligible issuer; CSPP will start on the 8th of June.	
03/11/2016	ABSPP	ABSPP explained: Only ABS for which loan-level data submissions have been made to "designated" repositories may be considered for compliance with the Eurosystem's ABS loan-level requirements.	
08/12/2016	APP	APP diminished: the net asset purchases are intended to be €60 billion from April 2017 to December 2017 or beyond. APP modified: Purchases of securities with a yield to maturity below the interest rate on the ECB's deposit facility will be permitted to the extent necessary. PSPP modified: Eurosystem central banks will have the possibility to also accept cash as collateral in their PSPP securities lending (SL) facilities without having to reinvest it in a cash-neutral manner; The maturity range will be broadened by decreasing the minimum remaining maturity for eligible securities from two years to one year.	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged at 0.00%, 0.25% and -0.40% respectively.
15/12/2016	ABSPP	ABSPP modified: the programme should be fully implemented by national central banks rather than relying on the support from external managers from April 2017.	
2017			
19/01/2017	APP (PSPP, CBPP3, ABSPP, CSPP)	APP diminished: the net asset purchases are intended to be €60 billion from April 2017 to December 2017 or beyond; No purchases below the deposit facility rate (DFR) will be conducted under the CBPP3, the ABSPP or the CSPP; Purchases of assets with yields below the DFR will only occur under the PSPP but priority will be given to assets with yields above the DFR.	The ECB decided that the interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged at 0.00%, 0.25% and -0.40% respectively.

Table IX - Announcements: Japan

Date	Programme	Event	Brief Description	Interest rate news
2008				
12/02/2008	SFSOs	Unscheduled monetary policy meeting	Special-Funds-Supplying Operations announced: The BOJ will operate a facility through the end of April to lend an unlimited amount to banks at the uncollateralized overnight call rate (0,3%) and collateralized by corporate debt.	
19/12/2008	Outright JGB/CFI purchases	Statement on monetary policy	Outright purchases expanded: The BOJ increases monthly JGB purchases (last increased October 2002) from ¥1.2 trillion to ¥1.4 trillion; Corporate Financial Instruments: they will also look into purchasing commercial paper.	The BOJ lowers the r the uncollateralized t call rate from 0.3% to
2009				
22/01/2009	Outright CFI purchases	Statement on monetary policy	Outright purchases announced: The BOJ will purchase up to ¥3 trillion in commercial paper and ABCP and is investigating outright purchases of corporate bonds.	
19/02/2009	Outright CFI purchases	Statement on monetary policy	Outright purchases expanded: The BOJ will extend commercial paper purchases and the SFSOs through the end of September (previously end of March) and will purchase up to ¥1 trillion in corporate bonds.	
18/03/2009	Outright JGB purchases	Statement on monetary policy	Outright purchases expanded: The BOJ increases monthly JGB purchases from ¥1.4 trillion to ¥1.8 trillion.	
15/07/2009	Outright CFI purchases/SFSOs	Statement on monetary policy	Programs extended: The BOJ extends the SFSOs and outright purchases of corporate paper and bonds through the end of the year.	
30/10/2009	Outright CFI purchases/SFSOs	Statement on monetary policy	Status of programs: Outright purchases of corporate finance instruments will expire at the end of 2009 as expected, but the SFSOs will be extended through 2010:Q1; ample liquidity provision past 2010:Q1 will occur through funds- supplying operations against pooled collateral, which will accept a larger range of collateral.	
01/12/2009	FROs	Statement on monetary policy	Fixed-Rate Operations: The BOJ will offer ¥10 trillion in 3-month loans against the full menu of eligible collateral at the uncollateralized overnight call rate.	
2010				
17/03/2010	FROs	Statement on monetary policy	Facility expansion: The BOJ expands the size of the FROs to ¥20 trillion.	
21/05/2010	GSFF	Statement on monetary policy	GSFF announcement: The BOJ will offer ¥3 trillion in 1-year loans to private financial institutions with project proposals for "strengthening the foundations for economic growth."	

30/08/2010	FROs	Unscheduled monetary policy meeting	Facility expansion: The BOJ adds ¥10 trillion in 6-month loans to the FROs.	
05/10/2010	CME	Statement on monetary policy	APP established: The will purchase ¥5 trillion in assets (¥3.5 trillion in JGBs and Treasury discount bills, ¥1 trillion in commercial paper and corporate bonds, and ¥0.5 trillion in ETFs and J-REITs).	The BOJ sets the target for the uncollateralized overnight call rate at around 0 to 0.1%.
2011				
14/03/2011	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥5 trillion in assets (¥0.5 trillion in JGBs, ¥1 trillion in Treasury discount bills, ¥1.5 trillion in commercial paper, ¥1.5 trillion in corporate bonds, ¥0.45 trillion in ETFs, and ¥0.05 trillion in J-REITs).	
14/06/2011	GSFF	Statement on monetary policy	GSFF expanded: The BOJ makes available another ¥0.5 trillion in loans to private financial institutions for the purpose of investing in equity and extending asset-based loans.	
04/08/2011	CME	Statement on monetary policy	APP/FROs expanded: The BOJ will purchase an additional ¥5 trillion in assets (¥2 trillion in JGBs, ¥1.5 trillion in Treasury discount bills, ¥0.1 trillion in commercial paper, ¥0.9 trillion in corporate bonds, ¥0.5 trillion in ETFs, and ¥0.01 trillion in J-REITs); 6-month collateralized loans through the FROs are expanded by ¥5 trillion.	
27/10/2011	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥5 trillion in JGBs.	
2012				
14/02/2012	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥10 trillion in JGBs.	
13/03/2012	GSFF	Statement on monetary policy	GSFF expanded: The BOJ makes available another ¥2 trillion in loans to private financial institutions, including ¥1 trillion in U.S.-dollar-denominated loans and ¥0.5 trillion in smaller-sized (¥1 million-¥10 million) loans.	
27/04/2012	CME	Statement on monetary policy	APP expanded/FROs reduced: The BOJ will purchase an additional ¥10 trillion in JGBs, ¥0.2 trillion in ETFs, and ¥0.01 in J-REITs. The BOJ also reduces the availability of 6-month FRO loans by ¥5 trillion.	
12/07/2012	CME	Statement on monetary policy	APP expanded/FROs reduced: The BOJ will purchase an additional ¥5 trillion in Treasury discount bills and reduces the availability of FRO loans by ¥5 trillion.	
19/09/2012	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥5 trillion in JGBs and ¥5 trillion in Treasury discount bills.	

30/10/2012	CME/SBLF	Statement on monetary policy	APP expanded/SBLF announced: The BOJ will purchase an additional ¥5 trillion in JGBs, ¥5 trillion in Treasury discount bills, ¥0.1 trillion in commercial paper, ¥0.3 trillion in corporate bonds, ¥0.5 trillion in ETFs, and ¥0.01 trillion in J-REITs. Through the SBLF it will fund up to 100 percent of depository institutions' net increase in lending to the nonfinancial sector.
20/12/2012	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥5 trillion JGBs and ¥5 trillion in Treasury discount bills.
2013			
22/01/2013	CME	Statement on monetary policy	APP expanded: The BOJ will purchase an additional ¥2 trillion JGBs. The Bank decided to introduce a "Price Stability Target".
04/04/2013	QQE/CME/SLF	Statement on monetary policy	Introduction of the "Quantitative and Qualitative Monetary Easing" . The monetary base will increase at an annual pace of about ¥60-70 trillion. JGBs with all maturities including 40-year bonds will be made eligible for purchase, and the average remaining maturity of the Bank's JGB purchases will be extended. The purchase JGBs will increase at an annual pace of about ¥50 trillion. The purchase of ETFs and J-REITs will increase at an annual pace of ¥1 trillion and ¥30 billion respectively. APP will finish. Temporary suspension of the "banknote principle". SLF will be relaxed for the time being.
2014			
18/02/2014	SBL/GSFF	Statement on monetary policy	SBL announced: financial institutions will be able to borrow funds from the Bank up to an amount that is twice as much as the net increase in their lending. GSFF announced: the maximum amount of the Bank's fund-provisioning under the main rules will be ¥7 trillion and financial institutions will be able to borrow funds at a fixed rate of 0.1 percent per annum for 4 years instead of 1-3 years at present.
31/10/2014	QQE	Statement on monetary policy	QQE expanded: The BOJ will increase the purchases in order to reach a annual pace of about: ¥80 trillion in JGBs, ¥3 trillion in ETFs and ¥90 billion in J-REITs. The BOJ will increase the average maturity of JGB to 7-10 years. ETFs that track the JPX-Nikkei Index 400 will be eligible for purchase. The Monetary Base will increase at an annual pace of about ¥80 trillion.
2015			
21/01/2015	SBL/GSFF	Statement on monetary policy	GSFF and SBF extended for 1 more year. GSFF/SBF new framework: enabling financial institutions, which do not have a current account at the Bank, to use these facilities through their central organizations. GSFF expanded: increase of the maximum amount of funds that the Bank can provide to each financial institution to ¥2 trillion; the increase of the maximum amount outstanding of its fund-provisioning as a whole to ¥10 trillion.
18/12/2015	QQE	Statement on monetary policy	QQE expanded: new program for purchasing ETFs at an annual pace of about ¥300 billion, in addition to the current program of ETF; Expanding eligible collateral for the Bank's provision of credit; Extending the average remaining maturity of JGB purchases to 7-12 years; The maximum amount of each issue of J-REIT to be purchased shall be increased from the current 5 percent to 10 percent of the total amount of that J-REIT issued.

Table X - Results: United States of America

Variables	1M 1999 M04 - 2007 M12		2M 2008 M01 - 2015M12		3M 2008 M01 - 2015 M12		4M 1999 M03 - 2015 M12		1Q 1999 Q3 - 2007 Q4		2Q 2008 Q1 - 2015 Q4		3Q 2008 Q1 - 2015 Q4		4Q 1999 Q3 - 2015 Q4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
LRYield(-1)	-0.181***	0.049	-0.098***	0.035			-0.088***	0.024	-0.449***	0.135	-0.159**	0.071			-0.204***	0.044
VDiscountR			0.305**	0.143												
VDiscountR(-1)	-0.180***	0.056					-0.103**	0.051	-0.175**	0.083						
VDiscountR(-2)	-0.228***	0.072														
ABAY	-0.023***	0.008									0.060***	0.017			0.043***	0.009
VABAY			-0.034**	0.014			-0.024*	0.014								
EQTA	7.309***	0.082	-0.344***	0.079			-0.131***	0.036							-0.268**	0.101
Debt/GDP	0.111***	0.025														
VDebt/GDP							0.033	0.026	-0.214**	0.098						
VDebt/GDP(-1)																
VDebt/GDP(-2)	-0.249**	0.107														
VIX	-0.027***	0.004	-0.010***	0.002			-0.012	0.003	-0.021**	0.009	-0.034***	0.008			-0.034***	0.005
REER	0.034***	0.009	0.009***	0.003					-4.731*	2.533	-7.369***	2.031			-5.194***	1.307
INDPRO	0.055***	0.018					0.004*	0.004	0.069*	0.039						
VGR_INDPRO			8.327**	3.164			4.202*	2.512	11.330**	5.265	5.624632**	2.373			11.195***	2.602
ANN_QE					-0.096*	0.053	-0.049*	0.030			-0.370***	0.073	-0.336***	0.093	-0.318***	0.064
ANN_QE(-2)											-0.183**	0.082	0.018	0.101	-0.166**	0.074
QE_ST					1.85E-06*	0.000	0.000	0.000			4.89E-06***	0.000	6.19E-06***	0.000	4.83E-06***	0.000
QE_ST(-1)			2.89E-06***	0.000												
Constant	-11.023	3.256	3.305	0.898	-0.048	0.034	2.561	0.595	535.841	286.123	838.134	230.872	-0.084	0.086	594.078	148.389
R2 / DW stat	0.332	1.981	0.428	1.933	0.086	1.741	0.230	1.827	0.627	2.020	0.748	2.022	0.416	1.285	0.624	2.000
No. Of observations	105.000		96.000		96.000		202.000		34.000		32.000		32.000		66.000	

Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table XI - Results: United Kingdom

| | 1M | | 2M | | 3M | | 4M | | 1Q | | 2Q | | 3Q | | 4Q | |
| | 2000 M03 - 2007 M12 | | 2008 M01 - 2016M05 | | 2008 M01 - 2015 M12 | | 2000 M03 - 2016 M04 | | 2000 Q2 - 2007 Q4 | | 2008 Q1 - 2016 Q1 | | 2008 Q1 - 2017 Q1 | | 2000 Q2 - 2016 Q2 | |
Variables	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
LRYield(-1)							-0.085***	0.026			-0.246**	0.106				
LRYield(-2)									-0.244*	0.126					-0.233***	0.071
VLRYield(-1)	0.219***	0.074	0.284***	0.102												
VLRYield(-2)			-0.176*	0.094												
VBankRate(-1)	-0.317***	0.099							-0.487***	0.126					-0.173*	0.088
VBankRate(-2)			-0.234***	0.089							-0.232*	0.118				
VDebt/GDP									0.127**	0.057					0.031	0.032
VDebt/GDP(-1)	0.067	0.053					0.040	0.034								
VDebt/GDP(-2)			0.028	0.024												
VIX	-0.006**	0.002	-0.013***	0.004			-0.010*	0.002	-0.011	0.008	-0.032***	0.007			-0.017***	0.005
REER									0.008	0.014						
INDPRO							0.011*	0.006	0.080***	0.025					0.028	0.022
VGR_INDPRO	-1.329	1.249							-7.808***	2.490	-3.236	3.578			2.784	1.368
VGR_INDPRO(-1)							-0.587	0.548								
VGR_INDPRO(-2)			1.520	1.096												
ANN_QE					-0.009	0.049							-0.019	0.198		
ANN_QE(-1)					0.009	0.044					0.221**	0.102	0.309***	0.091	0.110	0.068
ANN_QE(-2)					0.014	0.050										
ANN_QE(-3)			0.052	0.046	0.070	0.063										
AFP					0.000	0.000					-1.91E-06**	0.000	0.000	0.508	0.000	0.000
AFP(-1)					1.58E-07*	0.000					1.32E-06*	0.000	0.000	0.000		
AFP(-2)			-6.61E-08*	0.000	0.000	0.000	-1.04E-07**	0.000								
AFP(-3)					-1.75E-07*	0.000										
Constant	0.099	0.049	0.281	0.115	-0.094	0.072	-0.137	0.542	-8.490	3.468	1.953	0.604	-0.259	0.129	-1.635	2.429
R2 / DW stat	0.204	1.992	0.345	1.961	0.074	1.319	0.188	1.496	0.511	1.968	0.552	1.991	0.138	1.740	0.422	1.970
No. of observations	94.000		101.000		111.000		194.000		31.000		33.000		37.000		65.000	

Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table XII - Results: Euro Area

	1M		2M		3M		4M		1Q		2Q		3Q		4Q	
Variables	2000 M02 - 2007 M12		2008 M01 - 2016M12		2008 M01 - 2017 M02		1999 M04 - 2017 M01		2000 Q2 - 2007 Q4		2008 Q1 - 2016 Q4		2008 Q1 - 2017 Q1		2000 Q3 - 2016 Q4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
LRYield(-3)	-0.063	0.039														
VLRYield(-1)	0.096	0.075	0.072	0.075			0.140**	0.060	-0.013	0.135	0.213*	0.112			0.250***	0.091
VLRYield(-2)	-0.164*	0.088							-0.049	0.151						
MRO															0.040	0.026
MRO(-3)									0.235*	0.135						
VMRO	-0.208**	0.087					0.011	0.008								
VMRO(-1)			-0.148	0.176							0.357*	0.197				
Debt/GDP(-1)									-0.077**	0.038						
VDebt/GDP															0.084**	0.037
GR_Debt/GDP	4.936	3.095									12.299**	5.514				
GR_Debt/GDP(-2)			11.138	6.780												
VIX	-0.004	0.003	-0.007**	0.003			-0.002	0.002	-0.028***	0.007	-0.021***	0.007			-0.013***	0.004
REER	-0.027*	0.012	0.007*	0.004					-0.019***	0.005	0.029***	0.009				
REER(-1)	0.019	0.012														
INDPRO	0.008*	0.004														
GR_INDPRO							1.527	1.341	14.399**	5.620						
VGR_INDPRO			1.405	1.102												
VGR_INDPRO(-1)											-2.706	2.014				
ANN_QE													-0.224	0.291		
ANN_QE(-1)			-0.096**	0.040							-0.252	0.300	-0.092	0.186		
ANN_QE(-2)			-0.151***	0.056	-0.095	0.074	-0.141*	0.077					-0.039	0.225	0.299***	0.100
ANN_QE(-3)					-0.058	0.063									-0.224	0.148
APP											0.000	0.000	0.000	0.000		
APP(-1)			3.13E-06***	0.000									0.000	0.000		
APP(-2)					5.67E-06**	0.000	7.38E-06***	0.000					0.000	0.000		
APP(-4)					-4.16E-06*	0.000	-6.34E-06***	0.000							-1.47E-06**	0.000
APP(-6)															4.09E-06***	0.000
Constant	0.369	0.485	-0.616	0.406	-0.039	0.026	-0.008	0.050	6.664	2.998	-2.636	0.872	-0.100	0.079	0.075	0.124
R2 / DW stat	0.252	1.978	0.152	2.013	0.056	1.740	0.094	1.980	0.539	1.872	0.331	1.996	0.045	1.533	0.239	1.995
No. of observations	95.000		108.000		110.000		214.000		31.000		36.000		37.000		66.000	

Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table XIII - Results: Japan

Variables	1M 1999 M05 - 2007 M12 Coef	SE	2M 2008 M01 - 2015M12 Coef	SE	3M 2008 M01 - 2015 M12 Coef	SE	4M 1999 M06 - 2015 M12 Coef	SE	1Q 2000 Q2 - 2007 Q4 Coef	SE	2Q 2008 Q1 - 2015 Q4 Coef	SE	3Q 2008 Q1 - 2015 Q4 Coef	SE	4Q 1999 Q4 - 2015 Q4 Coef	SE
LRYield(-1)	-0.012	0.091	-0.130	-1.225					-0.281	0.256	-0.956***	0.205				
LRYield(-2)	-0.166	0.107	-0.045	0.102					-0.073	0.196						
LRYield(-3)											0.178*	0.088				
VLRYield(-1)							0.040	0.104							-0.047	0.097
VLRYield(-2)							-0.186***	0.064							-0.167**	0.077
VLRYield(-4)							-0.145**	0.060								
VDiscountR(-1)											0.492*	0.278				
VDiscountR(-2)			0.818***	0.231											-0.367**	0.171
VDiscountR(-3)	0.318***	0.112	0.257	0.223												
Debt/GDP											-0.015***	0.004				
VDebt/GDP			-0.898**	0.389												
VDebt/GDP(-1)	-0.443**	0.186					-0.068	0.055			0.051***	0.018				
VDebt/GDP(-2)															-0.024	0.015
Vdebt/GDP(-4)									-0.075	0.058						
GR_Debt/GDP			177.937**	74.585												
GR_Debt/GDP(-1)	67.421***	23.919					15.874*	9.070								
VIX	-0.007***	0.002	-0.004**	0.002			-0.003***	0.001	-0.012**	0.005	-0.003	0.002			-0.005*	0.003
REER			0.003**	0.001					0.007	0.005						
REER(-3)											0.003**	0.002				
INDPRO(-1)															-0.003	0.004
INDPRO(-3)											-0.003**	0.001				
GR_INDPRO											-0.690	0.541				
GR_INDPRO(-1)							-0.210	0.215								
VGR_INDPRO									3.453*	1.779						
ANN			0.025	0.017	0.023	0.017					-0.094***	0.028	-0.081*	0.045	-0.018	0.036
ANN(-1)					0.004	0.027							0.096**	0.037		
ANN(-2)					0.000	0.025										
ANN(-3)					0.035	0.022										
QE					0.000	0.000							0.000	0.000	-3.35E-07*	0.000
QE(-1)					7.98E-07***	0.000	0.000	0.000			0.000	0.000	0.000	0.000		
QE(-2)			0.000	0.000	0.000	0.000										
QE(-3)					0.000											
QE(-5)							-5.16E-07**									
Constant	0.376	0.102	-0.098	0.098	-0.042	0.017	0.049	0.023	0.147	0.397	3.648	0.922	-0.051	0.039	0.447	0.420
R2 / DW stat	0.209	2.100	0.165	2.008	0.068	2.026	0.103	1.936	0.447	2.023	0.683	1.994	0.267	2.484	0.164	2.018
No. of observations	104.000		96.000		96.000		199.000		31.000		32.000		32.000		65.000	

Significance levels: *p<0.1, **p<0.05, ***p<0.01

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