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THE IMPACT OF THE ECB'S ASSET PURCHASE PROGRAMME ON EUROPEAN SOVEREIGN YIELDS AND EQUITY MARKETS

José António da Silva Vidrago

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FACULDADE DE **ECONOMIA**

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Supervised by
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Biographical Note

José Vidrago was born in Espinho, Portugal, on October 6th, 1975. He concluded his undergraduate studies, in Economics, at FEP – Porto School of Economics and Management, in 1998. He concluded, at EGP, currently Porto Business School, an MBA in 2004 and his master's thesis in 2008.

José´s professional activity has been almost entirely devoted to capital markets: he started as a financial economist, in 1998, at BDP – Porto Derivatives Exchange, and he had a brief experience at Interbolsa – the Portuguese central securities depository. From 2000 onwards, he has been at the IGFCSS – the Social Security Capitalization Funds Management Institute, where over the years he has had different responsibilities. He currently is President of the board of directors at IGFCSS, an institution with more than 23 billion euros of assets under management (as of September 2022). He has also been active as an entrepreneur (in three companies: Bwizer, Wize On and Belpac) and as a financial consultant.

José has attended a number of courses and seminars on finance, and he has cooperated in the design and implementation of social security reserve funds and sovereign wealth funds in different developing countries (Cape Verde, East Timor, Mozambique and Angola).

José has also been a lecturer teaching Portfolio Management, at Porto Business School, in a post-graduation course that enables students to be certified as financial analysts (CEFA – Certified European Financial Analyst), and at FEP's Master in Finance.

Additionally, the two papers on which this thesis is based have been published in peer reviewed journals.

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Finally, but obviously not least, an apology and an enormous thank you to my family and close friends. To my parents and my parents-in-law, my brothers and sister, to my close friends and, especially, to my wife and confident, Sónia, and our daughter, Bárbara. The investment I made in this thesis had a significant impact on the time I was able to dedicate to our relationships. I am sorry for that but thankful for all the unconditional support I was given. The successful completion of this research would not have happened without their patience, support, friendship and love, for which I am forever indebted.

Abstract

This thesis is composed of two papers. Their objective is to contribute to the understanding of the impact unconventional monetary policy (UMP) options have on financial markets. They look at how sovereign yields and equity markets in the Eurozone and in the periphery have reacted to the ECB's asset purchase programme (APP).

The first paper analyses the announcement effects and the transmission channels of the ECB's APP on core and peripheral sovereign yields at different maturities. Its objectives were: i) to confirm whether the announcement effects of the ECB's APP on euro area sovereign debt yields operate through different transmission channels; ii) to evaluate these transmission channels' importance at different maturities; iii) to analyse the different transmission channels' relevance for core and peripheral markets; and iv) to assess how transmission channels behave with expansionary (positive) and contractionary (negative) UMP surprises.

The second paper analyses the announcement effects of the ECB's APP on core and peripheral Eurozone equity indices and sectors. This paper's objectives are: i) to evaluate the announcement effects of the ECB's APP on euro area broad equity indices; ii) to evaluate these effects on different equity sectors; iii) to evaluate the differences in behaviour between core and peripheral markets and sectors; and iv) to evaluate how these effects vary with expansionary (positive) and contractionary (negative) UMP surprises.

The main results of this thesis suggest that APP announcements affected euro area sovereign yields through different channels: a signalling, a preferred-habitat, a duration premium, a credit premium and a liquidity premium channel; the size of these effects increases the longer the maturity considered and seem to peak around the 10-year maturity bucket, which is in line with findings in Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019), for example.

Our results on symmetry confirm previous research findings (Altavilla et al., 2019) since although the direction of effects for expansionary and contractionary surprises is often different its magnitude is usually not – this is observable in both papers. Results depend, however, on the sign of the policy surprise since, when UMP measures are more expansionary than expected yields fall through the signalling, the preferred-habitat and the

duration premium channels; but when UMP measures are more contractionary than expected yields rise.

We find credit and liquidity effects to be very significant for peripheral markets, both for expansionary and contractionary surprises. They also have the expected direction – expansionary surprises lead to lower yields through these channels and contractionary surprises lead to higher yields. Interestingly, core markets' credit-liquidity effects are symmetric to those estimated for peripheral markets, which is likely related to a "save the euro" factor. We identify and quantify two different quantitative easing factors – building on an argument made by Altavilla et al. (2019) and Wright (2019): one is related to an overall stimulus and another one seems to differentially affect sovereign yields (and equity markets), which helps us better explain our findings.

When it comes to results about equities, the estimates we arrive at are also consistent with other studies' conclusions about the effects' magnitude as well as the difference between the effects estimated using one-day and two-day windows (Altavilla, Carboni, & Motto, 2015). Effects of APP announcements on equity markets depend on the sign of the policy surprise and, therefore, we can complement previous research by contrasting effects with positive and negative UMP surprises. Estimates point to higher equity returns (almost +1%, on average, for a simultaneous one standard deviation move in both surprise measures) with expansionary surprises, and to lower equity returns (approximately -0.5%, on average) when surprises are contractionary, i.e., they have the theoretically expected direction.

Differences in effects for core, euro area and peripheral markets and for different sectors, as well as for the same sector but at the euro area and at the peripheral level, are not statistically significant; additionally, the euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area, but not when they were associated with an overall stimulus.

Resumo

Esta tese é composta por dois artigos. O objetivo é contribuir para perceber o impacto de opções não convencionais de política monetária nos mercados financeiros. Procede-se à análise da forma como as taxas de juro implícitas em dívida soberana e os mercados de ações, da zona Euro e em mercados periféricos, reagiram ao programa de compras de ativos (APP, acrónimo da designação em inglês do programa) do Banco Central Europeu.

O primeiro artigo debruça-se sobre os efeitos dos anúncios e sobre os canais de transmissão do APP nas taxas de juro implícitas em dívida soberana de mercados *core* (Alemanha e o conjunto de soberanas da zona Euro com rating AAA) e periféricos (Portugal, Itália e Espanha). Os objetivos são: i) confirmar se os efeitos dos anúncios do APP se processam através de diferentes canais de transmissão; ii) avaliar a importância de cada um desses canais para diferentes maturidades da dívida soberana; iii) analisar a importância de cada canal de transmissão nos mercados *core* e periféricos; e iv) aferir de que forma se comportam os canais de transmissão com surpresas de política monetária não convencional expansionistas (positivas) e contracionistas (negativas).

O segundo artigo analisa os efeitos dos anúncios do APP em índices de ações genéricos e setoriais de mercados *core* e periféricos. Os respetivos objetivos são: i) avaliar os efeitos dos anúncios do APP em índices de ações genéricos da zona Euro; ii) avaliar estes efeitos em diferentes índices setoriais; iii) avaliar as diferenças de comportamento entre mercados e setores *core* e periféricos; e iv) avaliar de que forma estes efeitos variam com surpresas de política monetária não convencional expansionistas (positivas) e contracionistas (negativas).

Os principais resultados desta tese sugerem que os anúncios do APP afetaram as taxas de juro implícitas em dívida soberana da zona Euro através de vários canais de transmissão: um de sinalização, um de habitat preferido, um de prémio de risco de duração, um de prémio de risco de crédito e um de prémio de risco de liquidez; a dimensão destes efeitos parece aumentar com a maturidade da dívida soberana considerada e parece atingir um efeito máximo em torno da maturidade dos 10 anos, o que é coerente com resultados de outros artigos, como por exemplo Altavilla et al. (2019).

Os resultados obtidos no que diz respeito à questão da simetria dos impactos dos anúncios do APP confirmam também os resultados de estudos anteriores (Altavilla et al., 2019), pois embora a direção dos efeitos com surpresas expansionistas e contracionistas seja diferente a respetiva magnitude não é – constatação observável em ambos os artigos. Os resultados dependem efetivamente, no entanto, do sinal da surpresa de política pois quando os anúncios são mais expansionistas do que esperado as taxas de juro implícitas caiem através dos canais de sinalização, habitat preferido e prémio de risco de duração; já quando as surpresas são mais contracionistas do que o esperado as taxas sobem.

Os efeitos detetados através dos canais prémio de risco de crédito e de liquidez são muito significativos para mercados periféricos, com surpresas expansionistas ou contracionistas, tendo igualmente a direção esperada – surpresas expansionistas conduzem a taxas mais baixas através destes dois canais e surpresas contracionistas provocam taxas mais elevadas. Um aspeto interessante resulta do facto de que os efeitos detetados, para mercados *core*, através dos canais prémio de risco de crédito e de liquidez, são simétricos, i.e., têm uma direção diferente, aos estimados para mercados periféricos, o que estará provavelmente relacionado com um fator de "salvamento do euro". Identificam-se e quantificam-se dois fatores distintos de acomodação quantitativa – com base num argumento usado por Altavilla et al. (2019) e Wright (2019): um relacionado com estímulo monetário genérico e outro que parece afetar de forma diferenciada taxas de juro implícitas de dívida soberana (e os mercados de ações), o que ajuda a explicar os resultados identificados.

No que diz respeito aos resultados relativamente a ações, as estimativas obtidas são também consistentes com as conclusões de outros estudos sobre a magnitude dos efeitos bem como sobre a diferença entre os impactos estimados com janelas de um e dois dias (Altavilla et al., 2015). Os efeitos em ações dos anúncios do APP dependem igualmente do sinal da surpresa de política monetária não convencional, o que permite complementar estudos anteriores pelo contraste que se consegue extrair entre os efeitos com surpresas positivas e negativas. Os resultados apontam para um efeito positivo no retorno dos índices acionistas (quase +1%, em média, para uma variação simultânea de um desvio padrão em ambas as medidas de surpresa) com surpresas expansionistas e um efeito negativo (aproximadamente -0.5%, média) com surpresas contracionistas, i.e., têm igualmente a direção teoricamente esperada.

A diferença de comportamento para índices acionistas *core*, da zona euro ou periféricos, e para diferentes setores, bem como para o mesmo setor, mas para a zona euro por contraposição à periferia, não é estatisticamente significativa; adicionalmente, os mercados acionistas da zona euro parecem ter sido afetadas, de forma inesperada, sempre que os intervenientes no mercado associaram os anúncios do APP com a ideia de salvaguarda do euro, mas não quando os associaram a estímulos genéricos.

Contents

List of Tables

Chapter 1

Chapter 2

Chapter 3

List of Graphs

Chapter 2

List of Appendices

Chapter 2

Chapter 3

Abbreviations

Chapter 1

ECB – European Central Bank

CBPP – Covered Bond Purchase Programme

CBPP2 – Second Covered Bond Purchase Programme

CBPP3 – Third Covered Bond Purchase Programme

SMP – Securities Market Programme

OMT – Outright Monetary Transactions

ABSPP – Asset-Backed Securities Purchase Programme

CSPP – Corporate Sector Purchase Programme

PSPP – Public Sector Purchase Programme

APP – Asset Purchase Programme

UMP – Unconventional Monetary Policies

ZLB – Zero Lower Bound

QE – Quantitative Easing

US – United States

UK – United Kingdom

FED – Federal Reserve

BoE – Bank of England

BoJ – Bank of Japan

CDS – Credit Default Swaps

GMT – Greenwich Mean Time

OIS – Overnight Index Swap

CBBT – Composite Bloomberg Bond Trader

PSI20 – Portuguese Stock Index 20

IBEX35 – Iberia Index 35

FTSE MIB – Financial Times Stock Exchange Milano Indice di Borsa

DAX30 – Deutscher Aktien Index 30

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UK – United Kingdom

GMT – Greenwich Mean Time

OIS – Overnight Index Swaps

CDS – Credit Default Swaps

ISDA – International Swaps and Derivatives Association

G7 – Group of Seven

VIX – Chicago Board Options Exchange Volatility Index

CBBT – Composite Bloomberg Bond Trader

Chapter 3

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GMT – Greenwich Mean Time

PEPP – Pandemic Emergency Purchase Programme

PSI20 – Portuguese Stock Index 20

IBEX35 – Iberia Index 35

FTSE MIB – Financial Times Stock Exchange Milano Indice di Borsa

DAX30 – Deutscher Aktien Index 30

VIX – Chicago Board Options Exchange Volatility Index

Chapter 4

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References

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics, 108*, 162-179. doi:https://doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2015). *Asset purchase programmes and financial markets: lessons from the euro area.* ECB Working Paper, 1864. European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf

Wright, J. H. (2019). Comment on "Measuring euro area monetary policy" by Carlo Altavilla, Luca Brugnolini, Refet Gürkaynak, Giuseppe Ragusa and Roberto Motto. *Journal of Monetary Economics, 108*, 180-184. doi:https://doi.org/10.1016/j.jmoneco.2019.08.017

CHAPTER 1

INTRODUCTION

1. Introduction

1.1. Motivation and research purpose

The European Central Bank (ECB) has, since the beginning of the 2007-08 financial crisis, implemented several unconventional measures. Liquidity provision operations to the banking sector started in 2008 and were repeated several times later. A covered bond purchase programme (CBPP, with a €60 billion target[1]) was initiated in 2009 – it was the first asset purchase programme. A second covered bond purchase programme (CBPP2) was launched in 2011 and it was completed by October 2012 (target: €16.4 billion; net holdings, as of March 2018: €4.5 billion). In 2014 a third covered bond purchase programme (CBPP3) was initiated, and it was still on-going in 2018 (net holdings, as of March 2018: €249 billion). In May 2010 the Securities Market Programme (SMP) was introduced. Between 2010 and early 2012 the ECB bought approximately €214 billion (net holdings, as of March 2018: €85.2 billion). In 2012 the ECB announced the Outright Monetary Transactions programme (OMT) although no operation had yet been implemented as of March 2018. In 2014 an asset-backed securities purchase programme (ABSPP) was started, and it was still on-going in 2018 (net holdings, as of March 2018: €26 billion). In 2016 a corporate sector purchase programme (CSPP) was initiated and was also still on-going in 2018 (net holdings, as of March 2018: €149 billion). In 2015 (March 9th), the ECB started to buy public sector securities under the Public Sector Purchase Programme (PSPP). This programme was on-going in 2018 (net holdings, as of March 2018: €1945 billion). The 2018 on-going programmes were all included in the expanded asset purchase programme (APP) since they all shared the same objective[2]. All other programmes (not included in the APP) were of a different nature[3].

The impact of unconventional monetary policies (UMP) on asset prices is an issue that researchers have previously discussed. The idea that if interest rates fall so low that further expansion of the money supply cannot drive them lower (the zero lower bound – ZLB), has been profusely discussed – see McCallum (2000), Eggertsson and Woodford (2003) and

[1] The CBPP was completed in June 2010; net holdings as of March 2018 were €5.8 billion. March 2018 is the cut-off date used for all data. ECB information on these programmes can be accessed here: http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html

[2] According to the ECB, "private sector securities and public sector securities are purchased to address the risks of a too prolonged period of low inflation" – See: http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html

[3] They were justified by the ECB under the argument that "its policies were not being transmitted effectively" (Driffill, 2016, p.395).

Bernanke, Reinhart, and Sack (2004), for a reflection about how monetary policy should be conducted when the zero bound is reached, and the concern about entering a liquidity trap. However, the recent behaviour of central banks has created an environment where this subject (UMP) can be more thoroughly studied.

The pure expectations theory of the term structure (Modigliani & Sutch, 1966, 1967) predicts that long term interest rates are related to expectations of future short interest rates, i.e., the forward rate reflects the consensus expectation of the future short interest rate. In a variant of the expectations theory, the essential idea of the proponents of the liquidity preference theory is that, since short term investors dominate the market, there is an expected interest rate or liquidity premium that depends on the relative supply of longer maturity securities and the degree of risk aversion (Modigliani & Sutch, 1966). Tobin (1961, 1963) and Modigliani and Sutch (1966, 1967) laid the intellectual groundwork for the idea of imperfect links between short- and long-term securities markets and the preferred-habitat model.

Throughout the 1970s and 1980s, the expectations theory was predominant in policy circles (D'Amico, English, López-Salido, & Nelson, 2012). The same authors argue that the idea that there is "scope for monetary policy to affect longer term rates via means other than short term rate policy" (p.423) only (re)emerged in the late 1990s and early 2000s.

Eggertsson and Woodford (2003) argue that, when it comes to fighting a deflationary slump, the management of expectations is key. According to these authors, "open-market operations should be largely ineffective to the extent that they fail to change expectations regarding future policy" (p.147) and they, therefore, contrast central bank's actions with a view to signalling, i.e., changing expectations about future interest rate policy (useful)[4], and actions intended at creating some sort of direct effects, i.e., portfolio shifts (futile).

Bernanke et al. (2004) consider three classes of UMP: communication to influence expectations about the future course of short term interest rates, changes to the composition of the central bank's balance sheet (credit easing) and, finally, increases in the size of the central bank balance sheet (quantitative easing – QE). QE is defined as the policy of injecting

[4] This signalling channel is also argued for in Gurkaynak, Sack, and Swanson (2005), since a "future path of policy" factor is shown to be associated with the central bank's "ability to manipulate financial market expectations of future policy actions and thereby longer-term interest rates and the economy more generally" (p.87).

reserves (central bank liquidity) through the purchase of securities (Joyce, Lasaosa, Stevens, & Tong, 2011). The assumption that financial markets are frictionless is a strong one and relaxing it, considering that money and other financial assets are imperfect substitutes, provides the context to theoretically frame results such as those described in Bernanke et al. (2004)[5]. Their findings help to refute the hypothesis that UMP, including quantitative easing, are not likely to succeed, concluding that there is "evidence that relative supplies of securities matter for yields".

A more rigorous theoretical partial equilibrium approach to a preferred-habitat setting has, more recently, been established. This model (Vayanos & Vila, 2009) leads to the idea that when risk aversion is high, conventional monetary policy decisions become less effective, since forward rates cease to respond to changes in expected short rates, and directly intervening in long term bond markets might become more effective in influencing long rates. D'Amico et al. (2012) point out that preferred-habitat investors are inclined to buy securities of certain maturities while arbitrageurs' profit by trading across maturities, although risk aversion prevents them from taking complete advantage of opportunities. This justifies why changing the quantities of sovereign debt held by the private sector might lead to asset price adjustments since "in segmented-market models featuring imperfect asset substitution, a reduction in the stock of securities of a particular maturity in the hands of private investors creates a shortage of those assets that cannot be wholly relieved, at existing asset prices, by substitution into other securities. The shortage thus prompts an adjustment of financial market prices" (D'Amico et al., 2012, p.425). This process, by depending on the relative stocks of financial assets, is expected to be persistent (Joyce et al., 2011).

The signalling channel[6] is independent of market segmentation and it operates to the extent that market expectations of the short-term policy interest rate are affected by central bank purchases (D'Amico et al., 2012). A traditional preferred-habitat channel[7] exists since, assuming arbitrageurs' high risk aversion and market segmentation[8], central bank purchases seem to have large effects on those targeted assets over which preferred-habitat investors have specific demand, and spill-overs to non-targeted assets are limited (Altavilla, Carboni,

[5] Eggertsson and Woodford (2003) use a model with a representative agent and assume complete financial markets.
[6] Also known as the expectations channel.
[7] Also known as the local supply, or scarcity, channel.
[8] Results in D'Amico and King (2013), for example, support a view of segmentation or imperfect substitution.

& Motto, 2015). This channel would not exist in a representative agent model. Most literature considers these two channels (Joyce et al., 2011). A wider range of risk premia[9] is impacted, especially when the risk bearing capacity of arbitrageurs is higher, as purchases become less effective vis-à-vis the targeted assets but spill-overs to non-targeted assets become more significant (Altavilla et al., 2015). Consider the arbitrageurs' optimization problem: as they integrate market segments (with lower risk aversion), purchases spill-over to non-targeted assets and one talks of a portfolio rebalancing channel. A general equilibrium channel is also in operation, whether assets are targeted or non-targeted, via the anticipation of better macroeconomic conditions (Altavilla et al., 2015). The interaction between arbitrageurs' risk aversion, the role of the preferred-habitat investors and the size and composition of the purchase programme influences the importance of each channel. As Vayanos and Vila (2009) state: "when arbitrageur risk aversion is low, the restrictions are particularly tight because the short rate is effectively the only risk factor.… with multiple risk factors, the restrictions become looser, and demand effects acquire a preferred-habitat flavor" (p.4).

According to Bernhard and Ebner (2017) there is no consensus when it comes to the quantity and designation of transmission channels of unconventional monetary policies – Bauer and Neely (2014), for example, focus on the signalling and the portfolio balance channels. Furthermore, they "are not mutually exclusive and can work in parallel" (Fratzscher, Lo Duca, & Straub, 2016b, p.42). In fact, methodologically, each asset under consideration demands a specific empirical model in order to make an attempt at disentangling and quantifying the relative importance of the individual spill-over channels. By doing that, and squaring results with theoretical mechanisms, some tentative, qualitative, conclusions about this question are possible (Bernhard & Ebner, 2017). Results in Carpenter, Demiralp, Ihrig, and Klee (2015) suggest that there is some market segmentation and so a preferred-habitat motivation may be plausible, and they find evidence of direct and indirect effects from asset purchases.

Our research is related to a large empirical literature about the effects of UMP on asset prices. Most of these papers are about the United States (US) and the United Kingdom (UK) experiences. Research about the Eurozone is more limited and, usually, focused on the early

[9] Such as interest rate, credit, liquidity or equity risk.

purchase programmes which have a different nature[10]. Joyce et al. (2011) is a reference about the UK (analysing effects on sovereign and corporate bonds, the foreign exchange and the equity markets). Gagnon, Raskin, Remache, and Sack (2011), Krishnamurthy and Vissing-Jorgensen (2011), D'Amico et al. (2012) and Hamilton and Wu (2012) are mentioned about the US (focusing on treasury yields). Christensen and Rudebusch (2012) deal with both countries' experiences (also focusing on treasury yields).

Rogers, Scotti, and Wright (2014) analyse the impact of UMP by the ECB (excluding the PSPP), Federal Reserve (Fed), Bank of England (BoE) and Bank of Japan (BoJ) on sovereign yields, the foreign exchange and the equity markets. Mamaysky (2018) describes the impact of UMP by the ECB (excluding the PSPP), Fed and BoE – analysing effects on sovereign yields, the equity and the Credit Default Swaps (CDS) markets. Ghysels, Idier, Manganelli, and Vergote (2017), Trebesch and Zettelmeyer (2014), De Pooter, Martin, and Pruitt (2018) and Eser and Schwaab (2016) focus on the ECB's SMP. Jager and Grigoriadis (2017) and Krishnamurthy, Nagel, and Vissing-Jorgensen (2018) analyse other ECB programmes (but not the PSPP). Neely (2015) and Glick and Leduc (2012) analyse spill-over effects of the Fed's and the BoE's UMP. Bernhard and Ebner (2017) analyse those of the Fed's, the ECB's and the BoE's UMP on Swiss asset prices. Fratzscher et al. (2016b) and Fratzscher, Lo Duca, and Straub (2016a) study the domestic and non-domestic effects of, respectively, the Fed's and the ECB's (excluding the PSPP) UMP. Papadamou, Siriopoulos, and Kyriazis Nikolaos (2020) provide a recent overview of research about UMP impact by major central banks. Aksit (2021), for the US, and Rostagno et al. (2021), for the euro area, highlight the difficulties of analysing the impact of UMP on asset prices, including both forward guidance and quantitative easing, when dealing with the ZLB.

For the UK and the US, Altavilla et al. (2015, p.4) sum up the main (qualitative) conclusions: "first, the impact on assets targeted by [the initial] purchase programmes… is generally found to be stronger than the one exerted by subsequent programmes implemented when financial market distress receded[11]. Second, there are multiple channels… with "narrow channels" being relatively more important than "broad channels" — channels are defined as

[10] The SMP and the OMT were targeted at normalizing market functioning. Liquidity provision operations were intended to address a liquidity shortage problem.
[11] According to Gern, Jannsen, Kooths, and Wolters (2015), several empirical studies' findings support the argument that the QE programmes were less effective when interest rates and financial market distress were already at very low levels.

"narrow" when the impact is concentrated on the assets targeted by the purchase programme, with little spill-overs to other market segments. Third, the bulk of the impact of purchase programmes is found to arise at announcement ("stock effects"), whereas "flow effects" generated by the actual implementation of the purchases are limited".

Altavilla et al. (2015), Driffill (2016), Georgiadis and Grab (2016), Haitsma, Unalmis, and de Haan (2016) and Fausch and Sigonius (2018) look at the (early) effects of the APP in the Eurozone and are more closely related to our research. Eser, Lemke, Nyholm, Radde, and Vladu (2019) (impact on yields) and Koijen, Koulischer, Nguyen, and Yogo (2020) focus on the APP but follow a very different methodological approach. A couple of these papers, Altavilla et al. (2015) and Georgiadis and Grab (2016), also estimate the importance of transmission channels.

1.2. Methodology, sampling procedure and composition

Following the aforementioned empirical literature, we use an event study methodology in our research. The assumption is that the surprise in UMP can be measured "from the jumps in asset prices in a particular window around the announcement time" (Haitsma et al., 2016, p.104). Two different ways of quantifying the impact of UMP on asset prices are considered. On one hand, we sum up the reactions of the impacted prices to announcements[12], making the implicit assumption that effects are permanent (Fratzscher et al., 2016a). On another hand, a calibration based on a specific form of measurement of the surprise content[13] of the announcement is also used.

Identification of UMP shocks implies defining the relevant set of events and measuring the extent of policy surprise – see Gürkaynak and Wright (2013) and Bernhard and Ebner (2017), for example.

The event set definition is typically based on a narrative approach whereby events, that contain information about the programmes, are selected (Bernhard & Ebner, 2017). Since the leakage of information has an impact, one cannot limit the assessment to formal announcement dates since it would lead to an underestimation of the programme's overall

[12] Joyce et al. (2011), Bernanke et al. (2004), Krishnamurthy and Vissing-Jorgensen (2011) or Gagnon et al. (2011), for example, consider this to be a reasonable way to proceed.
[13] To figure out "the amount of news each announcement contained" (Joyce et al., 2011, p.136).

impact (Altavilla et al., 2015). Given the importance of this, somewhat arbitrary, definition, testing results with different event sets is relevant. Restricting the number of events mitigates the problem of no news, reducing noise while, on another hand, it can lead to situations where a move was expected but nothing happened[14]. Following Bernhard and Ebner (2017) we argue that a larger event set helps to mitigate an important limitation of most previous studies, namely, restrictions on inference and interpretation due to small data samples.

Based on related research and the ECB website, eighty-nine event days – from June 1st, 2014, to March 31st, 2018 – were identified. The starting point was a group of fifteen event days[15] when relevant information or changes to the APP were communicated to the market (through meeting statements or ECB president speeches). Seventy-four additional event days, i.e., other ECB meeting dates and all other dates when the ECB president mentioned the APP, were considered because, based on previous research (Leombroni, Vedolin, Venter, & Whelan, 2018), due care was given to the fact that central bank communications significantly affect asset prices not only around policy announcements but also around other ECB president speeches. The event set thus includes both dates when ECB decisions about the APP were *definitely* made and dates when market participants could have made *inferences* about the programme.

The APP aggregated all programmes that shared the same objective, and therefore using its announcements is justified because our study is focused on unconventional quantitative easing measures; additionally, many specific programme events overlap, making it impossible to completely separate the different programmes[16]. Each programme's effects cannot be perfectly isolated, weakening a programme-specific analysis. Fendel and Neugebauer (2018), analysing this issue, conclude that "distinguishing the different programs gives little insights" (p.19) and that "it is not possible to claim consistent program-specific effects" (p.24).

[14] With an event study approach there is probably an underestimation of the programme's effects since only stock (also known as permanent) effects are taken into consideration; flow effects (or temporary effects, when actual purchases occur) are not considered (Altavilla et al., 2015). This is a more significant problem in a crisis environment where financial constraints are most likely to be binding, which makes arbitrage possible only when actual transactions take place, and market interventions might have information content (Fratzscher et al., 2016a). On another hand "in a preferred-habitat model, there are natural mechanisms that might cause the effects to wear off over time" (Gürkaynak & Wright, 2013, p.57).

[15] Some of these days were previously identified in Driffill (2016), Altavilla et al. (2015), Bernhard and Ebner (2017), Georgiadis and Grab (2016) and Haitsma et al. (2016).

[16] It is questionable whether the different programmes included in the APP can even be compared because the applied instruments differ considerably.

Furthermore, it is important to clarify the time interval (window) used to determine the APP's effects. In earlier research it was common practice to use longer windows[17] (two days) since markets were frequently operating at less-than-optimal conditions, the policies being analysed were still new and markets had to properly digest information they had never had to deal with before. For example, Joyce et al. (2011, p.139) state that "asset prices are unlikely to anticipate fully this process, given the novelty of QE and uncertainty about the transmission mechanism". Since the novelty has faded away, purchase programmes have become more common and market conditions have returned to non-crisis levels, daily changes in prices around the event dates have become the norm. This helps to mitigate the risk of reverse causality (more on this ahead) and it allows for a more precise identification of the effects of UMP since "one-day windows are unlikely to be contaminated by other pieces of news" (Hosono & Isobe, 2014, p.9). Essentially, although one should not use a window that is too narrow, since market participants need time to assimilate news, assumptions that underlie event studies are likelier to hold as the window around the policy event shrinks (Rigobon & Sack, 2004). In this thesis, a one-day window was considered as the baseline case, but a window of two days was also analysed.

There is no clear way to determine UMP expectations and, therefore, unexpected announcements and the size of the policy shock[18]. However, given a large enough set of events "it is no longer plausible to argue that all events are fully surprising to market participants. Rather, it is appropriate to assume that market anticipation of unconventional policy announcements improves over time" (Bernhard & Ebner, 2017, p.114). Additionally, following the results of Glick and Leduc (2012), considering the more expansionary announcements in contrast to the less expansionary may herald important information (Bernhard & Ebner, 2017). There are qualitative measures of UMP expectations, however Haitsma et al. (2016) refer that most studies measure policy surprises utilizing asset prices (i.e., quantitative measures) thereby addressing what is known as attenuation bias (Rosa, 2012). If markets are efficient, expected policy changes are already reflected in asset prices and only unanticipated policy changes will affect prices (Haitsma et al., 2016). Hosono and Isobe (2014) and Bernhard and Ebner (2017), following Wright (2012), make use of daily

[17] Joyce et al. (2011) and Krishnamurthy and Vissing-Jorgensen (2011) use a window of two days.
[18] See Rogers et al. (2014) and Bernhard and Ebner (2017). A standard choice about the best (market-based) measure of the surprise content of conventional monetary policy announcements does exist – see Kuttner (2001) and Gürkaynak, Sack, and Swanson (2007), for example.

changes in German bond futures' prices while Rogers et al. (2014) suggest the use of changes in the Italian yield spread (versus Germany) since ECB policies were, to some extent, intended to reduce intra Eurozone spreads. The one day change in the price of bond futures (German bund, approximately 10 years, most active contract, measured between the announcement day close price and the previous day close price), was used as the UMP "macroeconomic" surprise measure – it is also the measure used in Hosono and Isobe (2014), Bernhard and Ebner (2017) and Glick and Leduc (2012). This allows for the detection of policy measures that provide overall stimulus. Measuring a second type of stimulus that may differentially affect sovereign yields and equities implies simultaneously considering, following an argument made by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019), an additional surprise measure which may be linked with a "save the euro" factor. We derived this measure from the one-day change in the Italy-Germany 10-year yield spread[19].

The aforementioned event days were, as a consequence, additionally classified as positive (event days that are more expansionary than expected, i.e., depending on the surprise measure, days when the price of bond futures increased or the Italy-Germany 10-year yield spread fell) or negative surprises (event days that are more restrictive than expected, i.e., depending on the surprise measure, days when the price of bond futures decreased or the Italy-Germany 10-year yield spread rose). The baseline set (with 89 days) and a core set of events when the programme definitely underwent changes (with 15 event days) were used in an event study regression analysis.

An important issue when analysing the impact of UMP is endogeneity, as central banks may be seen as reacting to market developments. Kontonikas and Kostakis (2013) contend this is not a problem when using daily data since market daily developments are unlikely to determine the central banks' actions[20] – particularly in a non-crisis environment[21]. In addition,

[19] Following a procedure suggested, for instance, in Swanson (2017), we regress the one day change in the Italy-Germany 10 year yield spread on a constant and the one day change in the price of bond futures. We define the residuals of this regression as our "save the euro" surprise measure. The two surprise measures are therefore orthogonal.

[20] Altavilla et al. (2015), Bernhard and Ebner (2017), Glick and Leduc (2012), Rogers et al. (2014), Hosono and Isobe (2014), Fratzscher et al. (2016a) or Wright (2012), for example, use the same argument.

[21] This makes the argument for using the (OLS) event study approach – instead of heteroscedasticity-based identification – stronger (Gürkaynak & Wright, 2013). The event-study approach is an extreme case of Rigobon and Sack (2004)'s heteroskedasticity based estimator, in which the shift in the variance of the policy shock is large enough to dominate all other shocks. Rosa (2011), however, argues that "the ordinary least squares approach tends to outperform in an expected squared error sense the heteroscedasticity-based estimator for both small and large sample sizes. Hence in general the event-study methodology should be preferred" (p.430).

a short time window (one day) is likely to minimize contamination by other news (Haitsma et al., 2016) but controlling for other macroeconomic news and other variables that take into consideration previous trends in asset prices and market developments is important, also helping to reduce the potential problem of endogeneity and the possibility that price movements have other causes beyond unexpected UMP (Bernhard & Ebner, 2017).

Sovereign (on the run) yields for Portugal, Spain, Italy and Germany (2, 5, 10, 15 and 30 year maturity end of day yields) and OIS (Overnight Index Swap) rates, for the same maturities, are extracted on a daily basis using Bloomberg CBBT prices[22]. Yields for the Eurozone (all countries and AAA rated countries) are extracted, for the same maturities, from the ECB website and are modelled par yields[23]. CDS rates are extracted on a daily basis using Thomson Reuters Datastream – the 15 year maturity is not available.

Equity index returns for Portugal (PSI20), Spain (Ibex35), Italy (FTSE MIB), Germany (DAX30) and the Eurozone (Eurostoxx50 and Eurostoxx) are extracted on a daily basis using Bloomberg. Equity sector indices' returns for the Eurozone (19 super sectors) are also extracted from Bloomberg and comparable sector indices for the peripheral markets are constructed by aggregating the returns of equity stocks domiciled in Portugal, Spain and Italy that were members of each of the aforementioned Eurozone supersectors – thus creating 19 additional (peripheral) super sectors[24].

Daily data for the control variables is also extracted from Bloomberg (the one day lagged change of each model's dependent variable, in order to consider previous trends in asset prices, and the same day changes of the VIX index, US treasury 10-year yield and the Citi Eurozone Surprise Index, in order to consider other market developments and macroeconomic news).

All data start in June 1st, 2014, and end in March 31st, 2018.

[22] Bloomberg CBBT (Composite Bloomberg Bond Trader) prices are calculated using only the most recently updated executable prices.
[23] See, for additional information: https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html.
[24] Every change in composition in the Eurostoxx index between June 1st, 2014, and March 31st, 2018, was taken into consideration when creating these peripheral sector indices so as to ensure comparability with the Eurozone respective sector index.

1.3. Structure of the Thesis

Building on the theme relevance and using a common methodological approach, yet adapted to each specific question that was addressed, two papers were prepared. These papers deal with the ECB's APP impact on different markets or market segments but offer a common framework of analysis that makes it possible to extract comparable conclusions and policy implications and that can easily be adapted to analyse other markets or market segments.

Our first paper, presented in Chapter 2[25], provides a detailed analysis, for core and peripheral sovereign debt, of the transmission channels through which the announcement effects of the programme operate, considering both positive and negative UMP surprises. In particular, we believe to be the first to consider, empirically, the possible simultaneous influence of two QE factors – mentioned by Altavilla et al. (2019). We analyse transmission channels for core (AAA euro area sovereigns) and non-core (Portugal, Spain and Italy) markets as well as how transmission channels operated at different maturities, in order to achieve a more comprehensive analysis of the programme's effects. We consider a large set of relevant events, enhancing our ability to make inferences and interpret results, and we control for market expectations, limiting what is known as attenuation bias, by simultaneously considering both a "macroeconomic" surprise measure and a "save the euro" surprise measure which, to our knowledge, has not been previously done in this context. Finally, as Rogers et al. (2014) state it has been "difficult to investigate [asymmetry] in the context of unconventional monetary policy because most (but not all) surprises have been easings" (p.776) and we, therefore, enlarged the scope of our analysis by contrasting the behaviour of transmission channels with positive and negative UMP surprises, which can also be of interest when central banks announce asset redemptions or the exit from UMP in general.

With the second paper, presented in Chapter 3[26], and following a similar methodological approach, we also provide a detailed analysis, for different equity indices, of the announcement effects of the APP. Positive and negative UMP surprises are studied as well

[25] This chapter has been published in an international peer-reviewed journal – vide Farinha and Vidrago (2021a).
[26] This chapter has been published in an international peer-reviewed journal – vide Farinha and Vidrago (2021b).

as the abovementioned possible simultaneous influence of two QE factors on equity markets. A more comprehensive understanding of the programme's effects on equity markets is possible since we consider two euro area indices in addition to the German, the Portuguese, the Spanish and the Italian broad equity indices, to contrast the effects of the APP on euro area, one core and several peripheral equity markets. Our objective is to evaluate if and how effects differ across these markets. Sector indices, for the euro area and for peripheral markets, are also studied in order to determine whether this is a relevant dimension when it comes to APP effects on equities.

Finally, in Chapter 4 we summarize the main findings, highlighting the contribution of each paper to the overall conclusion of the thesis and its policy implications; we also discuss this analysis' limitations and future research opportunities.

Table 1.1 compares the two papers systematising their purpose, focus, data sources, main research contributions and policy implications.

	Paper "The impact of the ECB's asset purchase programme on core and peripheral sovereign yields and its transmission channels" – Chapter 2	**Paper "The impact of the ECB's asset purchase programme on euro area equities" – Chapter 3**
Purpose	i) to confirm whether the announcement effects of the ECB's APP on euro area sovereign debt yields operate through different transmission channels; ii) to evaluate these transmission channels' importance at different maturities; iii) to analyse the different transmission channels' relevance for core and peripheral markets; iv) to assess how transmission channels behave with expansionary (positive) and contractionary (negative) UMP surprises.	i) to evaluate the announcement effects of the ECB's APP on euro area broad equity indices; ii) to evaluate these effects on different equity sectors; iii) to evaluate the differences in behaviour between core and peripheral markets and sectors; iv) to evaluate how these effects vary with expansionary (positive) and contractionary (negative) UMP surprises.

	Paper "The impact of the ECB's asset purchase programme on core and peripheral sovereign yields and its transmission channels" – Chapter 2	**Paper "The impact of the ECB's asset purchase programme on euro area equities" – Chapter 3**
Focus	analysis of the announcement effects and the transmission channels of the ECB's APP on core and peripheral sovereign yields at different maturities.	analysis of the announcement effects of the ECB's APP on core and peripheral Eurozone equity indices and sectors
Data Sources	ECB website Bloomberg Thomson Reuters Datastream	ECB website Bloomberg

	Paper "The impact of the ECB's asset purchase programme on core and peripheral sovereign yields and its transmission channels" – Chapter 2	**Paper "The impact of the ECB's asset purchase programme on euro area equities" – Chapter 3**
Main Research Contributions	detailed analysis of the transmission channels of the ECB's APP on core and peripheral sovereign yields at different maturities, for positive and negative UMP surprises, considering two QE factors ("macroeconomic QE", for policy measures that provide overall stimulus, and "save the euro QE", for a second type of stimulus that may differentially affect sovereign yields)	detailed analysis of the ECB's APP impact on core and peripheral Eurozone equity indices and sectors, for positive and negative UMP surprises, considering two QE factors ("macroeconomic QE", for policy measures that provide overall stimulus, and "save the euro QE", for a second type of stimulus that may differentially affect equities)
Policy Implications	For portfolio managers, policy makers (monetary and fiscal authorities) and corporate finance managers	For portfolio managers, policy makers (monetary authorities) and corporate finance managers

Table 1.1. – Comparison between the two papers

References

Aksit, D. (2021). Breaking the zero lower bound period: The shift across two unconventional policies. *Economics Letters, 198*, 109673. doi: https://doi.org/10.1016/j.econlet.2020.109673

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics, 108*, 162-179. doi: https://doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2015). *Asset purchase programmes and financial markets: lessons from the euro area.* ECB Working Paper, 1864. European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf

Bauer, M. D., & Neely, C. J. (2014). International Channels of the Fed's Unconventional Monetary Policy. *Journal of International Money and Finance, 44*(June), 24-46. doi: https://doi.org/10.1016/j.jimonfin.2013.12.007

Bernanke, B. S., Reinhart, V. R., & Sack, B. P. (2004). Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment. *Brookings Papers on Economic Activity, 36*(4), 1-100. doi: https://doi.org/10.1353/eca.2005.0002

Bernhard, S., & Ebner, T. (2017). Cross-Border Spillover Effects of Unconventional Monetary Policies on Swiss Asset Prices. *Journal of International Money and Finance, 75*(July), 109-127. doi: https://doi.org/10.1016/j.jimonfin.2017.04.001

Carpenter, S., Demiralp, S., Ihrig, J., & Klee, E. (2015). Analyzing Federal Reserve asset purchases: From whom does the Fed buy? *Journal of Banking and Finance, 52*(C), 230-244. doi: https://doi.org/10.1016/j.jbankfin.2014.04.029

Christensen, J. H. E., & Rudebusch, G. D. (2012). The Response of Interest Rates to US and UK Quantitative Easing*. *Economic Journal, 122*(564), F385-F414.

D'Amico, S., English, W., López-Salido, D., & Nelson, E. (2012). The Federal Reserve's Large-scale Asset Purchase Programmes: Rationale and Effects*. *Economic Journal, 122*(564), F415-F446. doi: https://doi.org/10.1111/j.1468-0297.2012.02550.x

D'Amico, S., & King, T. B. (2013). Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply. *Journal of Financial Economics, 108*(2), 425-448. doi: https://doi.org/10.1016/j.jfineco.2012.11.007

De Pooter, M., Martin, R. F., & Pruitt, S. (2018). The Liquidity Effects of Official Bond Market Intervention. *Journal of Financial & Quantitative Analysis, 53*(1), 243-268. doi: https://doi.org/10.1017/S0022109017000898

Driffill, J. (2016). Unconventional Monetary Policy in the Euro Zone. *Open Economies Review, 27*(2), 387-404. doi: https://doi.org/10.1007/s11079-016-9393-0

Eggertsson, G. B., & Woodford, M. (2003). The Zero Bound on Interest Rates and Optimal Monetary Policy. *Brookings Papers on Economic Activity, 34*(1), 139-235. doi: https://doi.org/10.1353/eca.2003.0010

Eser, F., Lemke, W., Nyholm, K., Radde, S., & Vladu, A. (2019). *Tracing the impact of the ECB's asset purchase programme on the yield curve*. ECB Working Paper Series, 2293. European Central Bank.

Eser, F., & Schwaab, B. (2016). Evaluating the impact of unconventional monetary policy measures: Empirical evidence from the ECB's Securities Markets Programme. *Journal of Financial Economics, 119*(1), 147-167. doi: https://doi.org/10.1016/j.jfineco.2015.06.003

Farinha, J. B., & Vidrago, J. (2021a). The impact of the ECB's asset purchase programme on core and peripheral sovereign yields and its transmission channels. *The Journal of Economic Asymmetries, 24*, e00213. doi: https://doi.org/10.1016/j.jeca.2021.e00213

Farinha, J. B., & Vidrago, J. (2021b). The impact of the ECB's asset purchase programme on euro area equities. *The Quarterly Review of Economics and Finance, 82*, 270-279. doi: https://doi.org/10.1016/j.qref.2021.09.010

Fausch, J., & Sigonius, M. (2018). The impact of ECB monetary policy surprises on the German stock market. *Journal of Macroeconomics, 55*, 46-63. doi: https://doi.org/10.1016/j.jmacro.2017.09.001

Fendel, R., & Neugebauer, F. (2018). *Country-specific Euro area government bond yield reactions to ECB's non-standard monetary policy announcements*. WHU – Working Paper Series in Economics - WP 18/02. WHU - Otto Beisheim School of Management. Vallendar. Retrieved from https://opus4.kobv.de/opus4-whu/frontdoor/index/index/docId/645

Fratzscher, M., Lo Duca, M., & Straub, R. (2016a). ECB Unconventional Monetary Policy: Market Impact and International Spillovers. *IMF Economic Review, 64*(1), 36-74. doi: https://doi.org/10.1057/imfer.2016.5

Fratzscher, M., Lo Duca, M., & Straub, R. (2016b). On the International Spillovers of US Quantitative Easing. *Economic Journal, 128*(608), 330-377. doi: https://doi.org/10.1111/ecoj.12435

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases. *International Journal Central Banking, 7*(1), 3-43.

Georgiadis, G., & Grab, J. (2016). Global Financial Market Impact of the Announcement of the ECB's Asset Purchase Programme. *Journal of Financial Stability, 26*(October), 257-265. doi: https://doi.org/10.1016/j.jfs.2016.07.009

Gern, K.-J., Jannsen, N., Kooths, S., & Wolters, M. (2015). Quantitative Easing in the Euro Area: Transmission Channels and Risks. *Intereconomics, 50*(4), 206-212. doi: http://dx.doi.org/10.1007/s10272-015-0543-1

Ghysels, E., Idier, J., Manganelli, S., & Vergote, O. (2017). A High-Frequency Assessment of the ECB Securities Markets Programme. *Journal of the European Economic Association, 15*(1), 218-243. doi: https://doi.org/10.1093/jeea/jvw003

Glick, R., & Leduc, S. (2012). Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets. *Journal of International Money and Finance, 31*(8), 2078-2101. doi: https://doi.org/10.1016/j.jimonfin.2012.05.009

Gurkaynak, R. S., Sack, B., & Swanson, E. T. (2005). Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal Central Banking, 1*(1), 55-93.

Gürkaynak, R. S., Sack, B. P., & Swanson, E. T. (2007). Market-Based Measures of Monetary Policy Expectations. *Journal of Business & Economic Statistics, 25*(2), 201-212. doi: https://doi.org/10.1198/073500106000000387

Gürkaynak, R. S., & Wright, J. H. (2013). Identification and Inference Using Event Studies. *The Manchester School, 81*(S1), 48-65. doi: https://doi.org/10.1111/manc.12020

Haitsma, R., Unalmis, D., & de Haan, J. (2016). The Impact of the ECB's Conventional and Unconventional Monetary Policies on Stock Markets. *Journal of Macroeconomics, 48*(June), 101-116. doi: https://doi.org/10.1016/j.jmacro.2016.02.004

Hamilton, J. D., & Wu, J. C. (2012). The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment. *Journal of Money, Credit & Banking, 44*(1), 3-46. doi: https://doi.org/10.1111/j.1538-4616.2011.00477.x

Hosono, K., & Isobe, S. (2014). *The Financial Market Impact of Unconventional Monetary Policies in the U.S., the U.K., the Eurozone, and Japan*. Discussion papers, 14A-05. Policy Research Institute, Ministry of Finance Japan. Retrieved from https://EconPapers.repec.org/RePEc:mof:wpaper:ron259

Jager, J., & Grigoriadis, T. (2017). The Effectiveness of the ECB's Unconventional Monetary Policy: Comparative Evidence from Crisis and Non-crisis Euro-area Countries. *Journal of International Money and Finance, 78*(November), 21-43. doi: https://doi.org/10.1016/j.jimonfin.2017.07.021

Joyce, M. A. S., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal Central Banking, 7*(3), 113-161.

Koijen, R. S. J., Koulischer, F., Nguyen, B., & Yogo, M. (2020). Inspecting the mechanism of quantitative easing in the euro area. *Journal of Financial Economics*. doi: https://doi.org/10.1016/j.jfineco.2020.11.006

Kontonikas, A., & Kostakis, A. (2013). On Monetary Policy and Stock Market Anomalies. *Journal of Business Finance & Accounting, 40*(7/8), 1009-1042. doi: https://doi.org/10.1111/jbfa.12028

Krishnamurthy, A., Nagel, S., & Vissing-Jorgensen, A. (2018). ECB Policies Involving Government Bond Purchases: Impact and Channels. *Review of Finance, 22*(1), 1-44. doi: https://doi.org/10.1093/rof/rfx053

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. *Brookings Papers on Economic Activity, 42*(2), 215-287.

Kuttner, K. N. (2001). Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market. *Journal of Monetary Economics, 47*(3), 523-544. doi: https://doi.org/10.1016/S0304-3932(01)00055-1

Leombroni, M., Vedolin, A., Venter, G., & Whelan, P. (2018). *Central Bank Communication and the Yield Curve*. C.E.P.R. Discussion Papers, CEPR Discussion Papers: 12970. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=eoh&AN=1709960&lang=pt-pt&site=ehost-live&scope=site

Mamaysky, H. (2018). The Time Horizon of Price Responses to Quantitative Easing. *Journal of Banking and Finance, 90*, 32-49. doi: https://doi.org/10.1016/j.jbankfin.2018.02.016

McCallum, B. T. (2000). Theoretical Analysis Regarding a Zero Lower Bound on Nominal Interest Rates. *Journal of Money, Credit & Banking, 32*(4), 870-904. doi: https://doi.org/10.2307/2601148

Neely, C. J. (2015). Unconventional monetary policy had large international effects. *Journal of Banking & Finance, 52*(March), 101-111. doi: https://doi.org/10.1016/j.jbankfin.2014.11.019

Papadamou, S., Siriopoulos, C., & Kyriazis Nikolaos, A. (2020). A survey of empirical findings on unconventional central bank policies. *Journal of Economic Studies, 47*(7), 1533-1577. doi: https://doi.org/10.1108/JES-04-2019-0186

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics, 51*(8), 1553-1575. doi: http://dx.doi.org/10.1016/j.jmoneco.2004.02.004

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

Rosa, C. (2011). The Validity of the Event-Study Approach: Evidence from the Impact of the Fed's Monetary Policy on US and Foreign Asset Prices. *Economica, 78*(311), 429-439. doi: https://doi.org/10.1111/j.1468-0335.2009.00828.x

Rosa, C. (2012). *How 'unconventional' are large-scale asset purchases? The impact of monetary policy on asset prices*. Staff Reports, 560. Federal Reserve Bank of New York. Retrieved from http://www.newyorkfed.org/research/staff_reports/sr560.pdf

Rostagno, M., Altavilla, C., Carboni, G., Lemke, W., Motto, R., & Guilhem, A. S. (2021). *Combining negative rates, forward guidance and asset purchases: Identification and impacts of the ECB's unconventional policies*. ECB Working Paper Series, 2564. European Central Bank.

Swanson, E. T. (2017). *Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets*. National Bureau of Economic Research, Inc, NBER Working Papers: 23311. Retrieved from http://www.nber.org/papers/w23311.pdf

Trebesch, C., & Zettelmeyer, J. (2014). ECB interventions in distressed sovereign debt markets : the case of Greek bonds. In *CESifo Working Paper Series, 4731*: Ifo Institute.

Vayanos, D., & Vila, J.-L. (2009). *A Preferred-Habitat Model of the Term Structure of Interest Rates*. NBER Working Paper Series, 15487. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w15487.pdf

Wright, J. H. (2012). What does Monetary Policy do to Long-term Interest Rates at the Zero Lower Bound?*. *Economic Journal, 122*(564), F447-F466. doi: https://doi.org/10.1111/j.1468-0297.2012.02556.x

CHAPTER 2

THE IMPACT OF THE ECB'S ASSET PURCHASE PROGRAMME ON CORE AND PERIPHERAL SOVEREIGN YIELDS AND ITS TRANSMISSION CHANNELS

2. THE IMPACT OF THE ECB'S ASSET PURCHASE PROGRAMME ON CORE AND PERIPHERAL SOVEREIGN YIELDS AND ITS TRANSMISSION CHANNELS

Abstract

Using data from June 2014 to March 2018, this paper analyses the transmission channels of the announcement effects of the ECB's asset purchase programme (APP) on core and peripheral sovereign yields at different maturities. To the best of our knowledge, we are the first to study in as much detail these transmission channels. Our results show these effects operate through different channels, and their magnitude is larger the longer the maturity. For the ECB's APP, we find evidence that when policy is more expansionary than expected, yields drop through a signalling, a preferred-habitat and a duration premium channel; when policy is more contractionary than expected yields rise via these channels. We also report important credit and liquidity channel effects for peripheral markets: these are very significant both for expansionary and contractionary surprises, and they have the expected direction – expansionary surprises lead to lower yields through these channels and contractionary surprises lead to higher ones. On another hand credit and liquidity effects for core markets are symmetric to the peripheral markets' and our paper is the first to empirically identify and quantify the impact of two different quantitative easing (QE) factors, one that is related to overall stimulus and another one that may differentially affect sovereign yields. We also confirm previous findings about non-linearity of asset price responses, since although the direction of effects for expansionary and contractionary surprises is usually different its magnitude is generally not.

Keywords: sovereign yields, unconventional monetary policy, asset purchase programmes, transmission channels

JEL CLASSIFICATION CODES: E52, E58, G12, G15

2.1. Introduction

Since the start of the 2007-08 financial crisis, the European Central Bank (ECB) has implemented a number of unconventional measures. Liquidity provision operations to the banking sector began in 2008 and the ECB used them again later. Multiple purchase programmes were implemented since 2009 and some were still ongoing in 2018[1]. The expanded asset purchase programme (APP) aggregated all programmes that shared the same objective[2] and were active in 2018. Other programmes (not included in the APP) had a different purpose[3]. The APP includes the Corporate Sector Purchase Programme (CSPP), the Asset-backed Securities Purchase Programme (ABSPP), the third Covered Bond Purchase Programme (CBPP3) and the Public Sector Purchase Programme (PSPP).

The ECB initiated a covered bond purchase programme (CBPP, with a €60 billion target) in 2009 – it was the first euro area's asset purchase programme. A second covered bond purchase programme (CBPP2) was launched in 2011 and was completed by October 2012 (target: €16.4 billion; net holdings, as of March 2018: €4.5 billion). In 2014, the third covered bond purchase programme (CBPP3) was introduced and was still ongoing in 2018 (net holdings, as of March 2018: €249 billion). It was, therefore, included in the APP together with other programmes that the ECB decided to implement since then. In the same year, an asset-backed securities purchase programme started (ABSPP; net holdings, as of March 2018: €26 billion). In 2015, the ECB began buying public sector securities under the Public Sector Purchase Programme (PSPP; net holdings, as of March 2018: €1945 billion) and, finally, in 2016, the ECB implemented a corporate sector purchase programme (CSPP; net holdings, as of March 2018: €149 billion).

Although the effects of unconventional monetary policies (UMP) on asset prices have been previously the object of academic debate this subject has recently been more comprehensively studied given the importance these central bank policies have acquired.

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[1] For information on all ECB Asset purchase programmes: http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html (accessed 4 April 2019).

[2] According to the ECB, "private sector securities and public sector securities are purchased to address the risks of a too prolonged period of low inflation" – ECB Asset purchase programmes: http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html (accessed 4 April 2019).

[3] The ECB implemented them because "its policies were not being transmitted effectively" (Driffill, 2016, p.395). In May 2010 the Securities Market Programme (SMP) was introduced. Between 2010 and early 2012 the ECB bought approximately €214 billion (net holdings, as of March 2018: €85.2 billion). In 2012 the ECB announced the Outright Monetary Transactions programme (OMT) although no operation had yet been implemented, as of March 2018.

Specifically, our paper objectives are: i) to confirm whether the announcement effects of the ECB's APP on euro area sovereign debt yields operate through different transmission channels; ii) to evaluate these transmission channels' importance at different maturities; iii) to analyse the different transmission channels' relevance for core and peripheral markets; and iv) to assess how transmission channels behave with expansionary (positive) and contractionary (negative) UMP surprises.

Our main contribution to the research discussion is a detailed analysis, for core and peripheral sovereign debt, of the transmission channels through which the announcement effects of the programme operate, considering both positive and negative UMP surprises. In particular, we believe to be the first to consider, empirically, the possible simultaneous influence of two QE factors – mentioned by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019). We analyse transmission channels for core (AAA euro area sovereigns) and non-core (Portugal, Spain and Italy) markets as well as how transmission channels operated at different maturities, in order to achieve a more comprehensive analysis of the programme's effects. We consider a large set of relevant events, enhancing our ability to make inferences and interpret results, and we control for market expectations, limiting what is known as attenuation bias, by simultaneously considering both a "macroeconomic" surprise measure and a "save the euro" surprise measure which, to our knowledge, has not been previously done in this context. Finally, as Rogers, Scotti, and Wright (2014) state it has been "difficult to investigate [asymmetry] in the context of unconventional monetary policy because most (but not all) surprises have been easings" (p.776) and we, therefore, enlarged the scope of our analysis by contrasting the behaviour of transmission channels with positive and negative UMP surprises, which can also be of interest when central banks announce asset redemptions or the exit from UMP in general.

The ECB designed some UMP to restore the proper functioning of financial markets and intermediation while other UMP provided policy accommodation. Since, methodologically, approaches are different[4] we focused on a specific policy intended to deliver accommodation. We first identified dates when the ECB made decisions about the APP or when market participants could have made inferences about the programme. We then categorized these

[4] For a discussion about how markets react to UMP in crisis and non-crisis periods see Haitsma, Unalmis, and de Haan (2016) and Swanson (2011), who cautions against generalizing early programmes' results and for concentrating on "more normal times" (p.153), i.e., when the degree of market segmentation is lower.

event days as positive (more expansionary than expected) or negative surprises (more restrictive than expected). We use this information in an event study with regression analysis. A more detailed explanation of the selected events and their classification methodology is presented in section 2.3.

2.2. Literature Review

According to Bernhard and Ebner (2017), there is no consensus when it comes to the quantity and designation of transmission channels of unconventional monetary policies, i.e., the channels through which UMP affect financial markets, but most of the related literature on QE refers to the signalling and portfolio balance channels – see, for example, Bernanke, Reinhart, and Sack (2004) and Joyce, Lasaosa, Stevens, and Tong (2011).

The signalling channel, also known as the expectations channel, is independent of market segmentation and it operates to the extent that central bank purchases affect market expectations of the short-term policy interest rate (D'Amico, English, López-Salido, & Nelson, 2012). QE can also affect asset prices by changing the relative supplies of different assets only when a model with financial frictions or incomplete markets, and with imperfect substitutability between different assets, is considered. The direct impact on asset prices of investors rebalancing their portfolios in response to QE-related asset purchases is reflected through a portfolio balance channel — in the relevant literature, these effects are typically reorganized under the general umbrella of a risk premium channel.

Although the idea of imperfect links between short and long term securities markets and the preferred-habitat model was first advanced by Tobin (1961, 1963) and Modigliani and Sutch (1966, 1967), a more rigorous theoretical partial equilibrium approach to a preferred-habitat setting has been developed by Vayanos and Vila (2009). This model helps to explain how, when risk aversion is high, conventional monetary policy decisions become less effective, since forward rates stop reacting to changes in expected short rates, as predicted by the pure expectations theory of the term structure of interest rates described by Modigliani and Sutch (1966, 1967). Relaxing the strong assumption that financial markets are frictionless and considering instead that money and other financial assets are imperfect substitutes allows, consequently, for the argument that directly intervening in long-term bond markets might become more effective in influencing long rates. The interaction between arbitrageurs' risk aversion, the role of the preferred-habitat investors and the size and

composition of the purchase programme influences the importance of each channel (Vayanos & Vila, 2009) since they are not mutually exclusive and, hence, can work in parallel (Fratzscher, Lo Duca, & Straub, 2016).

A traditional preferred-habitat effect, also known as the local supply, or scarcity, effect, exists since, assuming arbitrageurs' high risk aversion and market segmentation, central bank purchases seem to have large effects on those targeted assets over which preferred-habitat investors have specific demand and spillovers to non-targeted assets are limited (Altavilla, Carboni, & Motto, 2015). This effect would not be present in a representative agent model. Additionally, when arbitrageurs are active market participants a duration effect can be detected since yields across all maturities are lowered via a compression of premia which is likely to affect long maturities more.

A wider range of risk premia is also impacted. This is true directly, via a quantity of risky asset mechanism, since an asset purchase programme that shortens the maturity structure of the supply of defaultable bonds held by the private sector compresses credit premia (vis-à-vis the default-free bonds) across the whole term structure of the targeted class, but also indirectly, especially when the risk-bearing capacity of arbitrageurs is higher and they integrate market segments, as purchases become less effective vis-à-vis the targeted assets but spillovers to non-targeted assets become more significant (Altavilla et al., 2015) – a portfolio rebalancing channel. This indirect impact can also be a result of a general equilibrium effect, whether assets are targeted or non-targeted, by means of the anticipation of better macroeconomic conditions[5].

In addition, on one hand, the central bank's presence in the market, as a significant buyer, may improve market functioning and thereby reduce premia for illiquidity (reflecting the fact that the central bank's purchases may make it less costly for investors to sell assets when required). On another hand, as argued by Schlepper, Hofer, Riordan, and Schrimpf (2017), liquidity might deteriorate due to issues of availability of the purchased securities.

We have, as a consequence, considered under the general risk-premium umbrella the local supply (preferred-habitat or scarcity) channel, a duration channel, a credit risk channel and a liquidity risk channel. The signalling channel refers to the fact that asset purchases may

[5] This can also affect equity risk premia – see Altavilla et al. (2015) and Joyce et al. (2011).

provide a signal on the path of risk-free short-term rates to be expected going forward, even if purchases would not, by themselves, have direct effects on asset prices.

There is an extensive empirical literature about the effects of UMP on asset prices. A significant proportion of it is about the effects of UMP in the United States (US) and in the United Kingdom (UK). Papadamou, Siriopoulos, and Kyriazis Nikolaos (2020) provide a recent overview of research about UMP impact by major central banks. A summary of the most significant (qualitative) conclusions about the UK and the US experiences with UMP, can be found in Altavilla et al. (2015, p.4): "first, the impact on assets targeted by [the initial] purchase programmes… is generally found to be stronger than the one exerted by subsequent programmes implemented when financial market distress receded. Second, there are multiple channels… with "narrow channels" being relatively more important than "broad channels" — channels are "narrow" when the impact is concentrated on the assets targeted by the purchase programme, with little spillovers to other market segments. Third, the bulk of the impact of purchase programmes is found to arise at announcement ("stock effects"), whereas "flow effects" generated by the actual implementation of the purchases are limited".

Research about the impact of UMP on the euro area's financial assets is often focused on the early purchase programmes, which have a different nature[6]. Nevertheless, work on asset price responses to monetary policy for the euro area and related questions has been conducted by Driffill (2016), Haitsma et al. (2016), Andrade and Ferroni (2021), Fausch and Sigonius (2018), Leombroni, Vedolin, Venter, and Whelan (2018), Cieslak and Schrimpf (2019), Jarocinski and Karadi (2018), and Altavilla et al. (2019) among others. However, these authors do not study the issue of transmission channels, between UMP surprises and asset prices, at all or they do it following a different perspective from the one we followed. A couple of additional papers look at the (early) effects of the APP in the euro area, are more closely related to our research and estimate the importance of transmission channels: Altavilla et al. (2015) and Georgiadis and Grab (2016).

Using events for the APP between September 2014 and March 2015, Altavilla et al. (2015) conclude that 10-year sovereign yields for the euro area declined by 30-50 bps (twice that for Italy and Spain). They focus on yields at 5, 10 and 20-year maturities for the euro

[6] The SMP and the OMT programme were implemented by the ECB to normalize market functioning. The objective of liquidity provision operations was to address a liquidity shortage problem.

area, Germany, France, Italy and Spain. Results point to a signalling effect of, at most, -10 bps (at two-year horizons), there is support for a preferred-habitat channel and a duration effect is estimated at about -10 bps (10-year maturity); finally, a credit premium channel is also significant at between -13 bps, for France, -56 bps, for Spain, and -58 bps, for Italy (10-year maturity). This leads Altavilla et al. (2015) to conclude that the programme has "…supported the duration and the credit channels. At the same time, the low degree of financial stress prevailing at announcement of the programme, while weakening the local supply channel, has facilitated spillovers to non-targeted assets" (p.40).

Using events for the APP between September 2014 and January 2015, Georgiadis and Grab (2016) conclude that 10-year sovereign yields for the euro area declined by 4-7 bps. This paper identifies three transmission channels (signalling, portfolio rebalancing and confidence channel), testing their relevance and whether the "evidence is consistent with particular transmission channels having been at play" (p.262). The conclusion is that "the decline in euro area sovereign bond yields… occurred through the portfolio rebalancing channel." (p.262).

Of relevance to our results is also Altavilla et al. (2019). In contrast to some literature that suggests that the US monetary policy has asymmetric real effects (Tenreyro & Thwaites, 2016), their results argue for the lack of asymmetry in asset prices responses to positive and negative ECB surprises, i.e., their magnitude is not different.

First, we find evidence that APP announcements affect sovereign yields through different channels: a signalling channel, a preferred-habitat channel, a duration premium channel, a credit premium channel and a liquidity premium channel. Second, our analysis reveals that the signalling, the preferred-habitat and the duration premium effects are significant when UMP surprises are positive, but they are statistically weaker when surprises are negative – although they do, generally, have the expected direction. Third, the credit-liquidity premium channel is generally not significant for AAA euro area sovereigns (core markets) but, for peripheral markets, it is significant both for positive and negative UMP surprises. Fourth, we document that credit and liquidity effects are, clearly, dependent on the sign of the policy surprise: as expected yields fall, through both the credit and the liquidity channels, when surprises are positive and rise when surprises are negative. Fifth, these effects have different directions but generally do not have different magnitudes. Finally, by

considering both a "macroeconomic" surprise measure and a "save the euro" surprise measure, we are able to explain seemingly contradictory results, especially for peripheral markets.

The rest of the paper is organised as follows. Section 2.3 describes the methodological options, the regression model as well as all data. Section 2.4 contains the results, the discussion and an analysis of the robustness checks we conducted. Finally, section 2.5 concludes. We relegate complementary information to the Appendices.

2.3. Methodology and data

We use an event study methodology based on the aforementioned empirical literature. We first consider that jumps in asset prices in a particular window around events (Haitsma et al., 2016) can be used to measure the surprise in UMP and we subsequently apply a specific form of measurement of the surprise content of the announcement to calibrate the effects accordingly. In order to identify UMP shocks, we have to first define the relevant set of events and then measure the extent of policy surprise.

We use a narrative approach to define the event set. This task is somewhat arbitrary and subjective (Fendel & Neugebauer, 2018) but in order to avoid the potential underestimation of the programme's overall impact, as a result of information leakage, we do not limit the assessment to formal announcement dates –following Altavilla et al. (2015). The problem of no news can be mitigated by restricting the number of events, which reduces noise. However, on another hand, this procedure can generate situations where nothing happened although a move was expected[7]. Most previous studies allow only for restricted inference and interpretation due to small data samples. We, therefore, following Bernhard and Ebner (2017), argue that a larger event set helps to mitigate that important limitation allowing us to enrich our conclusions since a long sample period increases the validity and reliability of findings, by improving statistical properties with additional observations. We, nevertheless, check results for a more limited event set.

[7] With the methodology we have chosen (an event study) only stock (also known as permanent) effects are taken into consideration and it therefore probably leads to an underestimation of the programme's effects; flow effects (or temporary effects, when actual purchases occur) are not considered (Altavilla et al., 2015). In a crisis environment, when financial constraints are most likely to be binding, this is a more significant problem, since in such an environment arbitrage is only possible when actual transactions take place, and market interventions might have information content (Fratzscher et al., 2016).

We identified eighty-nine event days between June 1st, 2014, and March 31st, 2018. Related research and the ECB website were the sources for this information. We refer the reader to the complete list of events in Appendix 2.A. We initially identified a group of fifteen event days. These are days either previously highlighted[8] as containing relevant new information about the APP or days corresponding to meeting statements or speeches when the ECB first communicated APP changes to the market. We, then, considered seventy-four additional event days: other ECB meeting dates and all other dates (from June 2014 to March 2018) when the ECB president mentioned the APP, since central bank communications significantly affect asset prices not only around policy announcements but also around other ECB president speeches (Leombroni et al., 2018). We therefore considered both dates when ECB decisions about the APP were *definitely* made and dates when market participants could have made *inferences* about the programme. These dates have all been adjusted for the time at which the relevant event took place[9]. The use of APP announcements, which aggregated all programmes that shared the same objective, is justified because our study is focused on unconventional quantitative easing measures and because many specific programme events overlap, which renders impossible a pure separation of the different programmes[10]. The effects of each programme cannot be distinguished perfectly weakening a programme-specific analysis. Fendel and Neugebauer (2018) try to distinguish these effects and come to the conclusion that "distinguishing the different programs gives little insights" (p.19) and that "it is not possible to claim consistent program-specific effects" (p.24).

Our focus is on announcements and not on amounts of asset purchases. Previous research (Falagiarda & Reitz, 2015) confirms the possibility of extracting quantitative conclusions from qualitative variables (a dummy) since announcements not linked to a specific size had impact on quantitative numbers. It is, nonetheless, all the more relevant to adequately try and determine UMP expectations and the size of the policy shock as discussed below.

[8] See Driffill (2016), Altavilla et al. (2015), Bernhard and Ebner (2017), Georgiadis and Grab (2016) and Haitsma et al. (2016).
[9] For example, Mario Draghi's February 2015 Introductory Statement to the plenary debate of the European Parliament on the ECB's Annual Report was delivered on February 25th at 17h38m (GMT); in the event list we considered February 26th as the relevant event day.
[10] It is questionable whether the different programmes included in the APP can even be compared because the applied instruments differ considerably.

Another important methodological consideration is the window used to measure the APP's effects. When central banks first implemented the most recent UMP measures, markets were frequently operating inefficiently, the unconventional policies under scrutiny were still new and markets had to make sense of information they had never dealt with before, and therefore, in earlier research[11], using a longer window was common practice. More recently daily and intraday changes in prices around the events have become the methodological standard since these purchase programmes have become less of a novelty and market conditions have returned to non-crisis levels.

Nevertheless, given the presence of a "save the euro" like factor (Wright, 2019) we argue that markets, specifically peripheral markets, might still not be operating efficiently and therefore a daily window is a reasonable choice since market participants need time to assimilate news, and therefore one should not use a window that is too narrow. This choice helps to lessen the risk of reverse causality (an important consideration we will come back to further ahead) and it allows for a precise identification of the effects of UMP since contamination by other news is unlikely (Hosono & Isobe, 2014).

Following Rogers et al. (2014) and Bernhard and Ebner (2017), we agree that there is no clear consensus when it comes to determining UMP expectations and, therefore, unexpected announcements and the size of the policy shock[12]. We also consider that with a large enough set of events one cannot plausibly argue that all events are fully surprising to market participants and we should assume that market anticipation of unconventional policy announcements improves over time (Bernhard & Ebner, 2017). In fact, our procedure, by making the dummy variables interact with the policy surprise measures, is akin to endogenously assigning different weights, the size of the policy shock, to different announcements which would, otherwise, all be weighed equally. Qualitative measures of UMP expectations[13] exist, but most studies measure policy surprises utilizing quantitative measures[14] (i.e., asset prices) which make it possible to address what is known as attenuation bias (Rosa, 2012). The assumption is that with efficient markets expected policy changes are

[11] Joyce et al. (2011) and Krishnamurthy and Vissing-Jorgensen (2011) use a window of two days.
[12] This is in contrast to what happens with the measurement of the surprise content of conventional monetary policy announcements, where a standard choice about the best (market-based) measure does exist.
[13] Such as survey data from professional forecasters and measures of expectations based on newspaper articles.
[14] Bernhard and Ebner (2017) list alternative measures proposed in the literature.

already reflected in asset prices and only unanticipated policy changes are supposed to affect them (Haitsma et al., 2016).

Hosono and Isobe (2014) and Bernhard and Ebner (2017), following Wright (2012), use daily changes in German bond futures' prices; Rogers et al. (2014) use daily changes in the Italian yield spread (versus Germany), which is also argued for by Altavilla et al. (2019) and Wright (2019) since ECB policies were also intended to reduce intra-euro area spreads.

We considered the one day change in the price of bond futures (German bund, approximately 10 years, most active contract), i.e., the same measure as the one used in Hosono and Isobe (2014), Bernhard and Ebner (2017) and Glick and Leduc (2012), as our UMP "macroeconomic" surprise measure. The price change was measured between the announcement day close price and the previous day close price. Our objective here is detecting policy measures that provide overall stimulus. In order to measure a second type of stimulus that may differentially affect sovereign yields we simultaneously considered, following an argument made by Altavilla et al. (2019), an additional surprise measure which we associate with a "save the euro" factor. We derived this measure from the one-day change in the Italy-Germany 10-year yield spread[15].

Altavilla et al. (2019) describe a "macroeconomic easing QE" that lowers the long-term euro area safe rate and spreads. In addition, an alternative is QE that is perceived to particularly affect peripheral yields, i.e., a "second type of QE factor" which can differentially affect sovereign yields rather than providing overall stimulus – we try to measure the two simultaneously, by allowing for two different types of QE surprises.

Finally, following the results of Glick and Leduc (2012), we assume important information may be extracted by contrasting the more expansionary announcements with the less expansionary ones (Bernhard & Ebner, 2017). We, therefore, classified the identified event days either as positive, i.e., events are more expansionary than expected[16], or negative surprises, i.e., events are more restrictive than expected[17].

[15] Following a procedure suggested, for instance, in Swanson (2017), we regress the one day change in the Italy-Germany 10 year yield spread on a constant and the one day change in the price of bond futures. We define the residuals of this regression as our "save the euro" surprise measure. The two surprise measures are therefore orthogonal.
[16] There are 52 event days when the price of bond futures rose and 49 event days when the yield spread fell.
[17] There are 37 event days when the price of bond futures fell and 40 event days when the yield spread rose.

Central banks may be seen as reacting to market developments, therefore endogeneity can be an important issue when analysing the impact of UMP. However, since market daily developments are unlikely to determine central banks' actions[18] – particularly in a non-crisis environment – Kontonikas and Kostakis (2013) argue endogeneity is not a problem when using daily data. We similarly consider, therefore, that the likelihood that our results are contaminated by reverse causality (running from asset returns to changes in monetary policy) is minimized by using daily data. In addition, contamination by other news (Haitsma et al., 2016) is likely minimized with such a short time window. However, controlling for other macroeconomic news and other variables that take into consideration previous trends in asset prices and market developments is important, since it helps to reduce the potential problem of endogeneity and the possibility that price movements have other causes beyond unexpected UMP (Bernhard & Ebner, 2017).

Nevertheless, we have considered the risk of reverse causality and the possibility of an omitted variable bias[19]. On the one hand and as mentioned before, we handled these risks by using control variables to incorporate in our analysis previous trends in asset prices and market developments, which could lead to subsequent policy interventions and asset price changes. As argued, considering theses controls mitigates potential endogeneity issues. On another hand, we have also tested for Granger causality in our data set and, accordingly, past asset price developments do not seem to drive the surprise measures we used[20]. It is also important to remember that from a central banking practice perspective, short-run developments in asset prices are unlikely to determine policy decisions, which by itself reduces the relevance of the endogeneity bias. Additionally, the use of daily changes in asset prices allows markets sufficient time to process policy news without contaminating the measurement – as argued in Hosono and Isobe (2014). We, therefore, have taken into consideration both the time necessary for asset returns to reflect an UMP shock, which is longer than with conventional policies, and the need to avoid contamination by other news, which is likely to occur if the window considered is too large.

[18] The same argument is used, for example, by Altavilla et al. (2015), Bernhard and Ebner (2017), Glick and Leduc (2012), Rogers et al. (2014), Hosono and Isobe (2014), Fratzscher et al. (2016) or Wright (2012).
[19] The literature dealing with asset price effects of conventional monetary policy argues that both endogeneity and the omitted variable bias are minor issues – Rigobon and Sack (2004) and Rosa (2011).
[20] We find no bilateral or reverse causality between the surprise measures and the dependent variables used.

In order to disentangle the different transmission channels we have considered, we start from the following equality[21]:

$$\Delta y_{m,t}^{b} = \Delta OIS_{t}^{b} + \Delta\left(GER_{t}^{b} - OIS_{t}^{b}\right) + \Delta CDS_{m,t}^{b} + \Delta\left(y_{m,t}^{b} - GER_{t}^{b} - CDS_{m,t}^{b}\right) \quad \text{(Eq 2.1.)}$$

Where $\Delta y_{m,t}^{b}$ represents the one-day change in yields for market m and maturity bucket b, ΔOIS_{t}^{b} is the one-day change in OIS (Overnight Index Swap) yields for maturity bucket b and ΔGER_{t}^{b} is the one-day change in German yields for maturity bucket b. $\Delta CDS_{m,t}^{b}$ is the one day change in CDS (Credit Default Swap) rates for market m, maturity bucket b. Markets (m) are Germany, Portugal, Spain, Italy and the euro area (AAA-rated countries) and maturity buckets (b) are 2, 5, 10, 15 and 30 years.

Following Joyce et al. (2011) and Altavilla et al. (2015), five previously mentioned potential transmission channels are allowed for with the decomposition of $\Delta y_{m,t}^{b}$ we propose on the right-hand side of equality (2.1).

First, since Altavilla et al. (2015) argue that the signalling channel is more clearly present at intermediate maturities (approximate 2 years) and is unlikely to become stronger at longer maturities we proxied this channel by the 2-year maturity OIS rate changes.

Consequently, we consider a new equality by further decomposing the first term in the right-hand side of equality (2.1):

$$\Delta y_{m,t}^{b} = \Delta OIS_{t}^{2Y} + \Delta\left(OIS_{t}^{b} - OIS_{t}^{2Y}\right) + \Delta\left(GER_{t}^{b} - OIS_{t}^{b}\right) + \Delta CDS_{m,t}^{b} + \Delta\left(y_{m,t}^{b} - GER_{t}^{b} - CDS_{m,t}^{b}\right) \quad \text{(Eq 2.2.)}$$

The first term in the right-hand side of this new equality (ΔOIS_{t}^{2Y}) was, as mentioned, used as a proxy for the signalling channel.

Second, a duration premium channel is considered since a purchase programme, such as the ECB's, is expected to lower yields across all maturities, more so at longer maturities, through premia reduction as a consequence of arbitrageurs being active market participants – under low risk aversion. This duration premium channel was estimated using OIS rates at

[21] The right-hand side conveniently decomposes $\Delta y_{m,t}^{b}$ in its components.

different maturities and was considered identical for all markets – the second term in the right-hand side of equality (2.2): $\Delta\left(OIS_t^b - OIS_t^{2Y}\right)$.

Third, the interaction between arbitrageurs and preferred-habitat investors is additionally highlighted by considering the aforementioned local supply, or scarcity, channel – commonly referred to as the preferred-habitat channel. As Altavilla et al. (2015, p.16) mention, under arbitrary large levels of risk aversion "long bond prices are disconnected from the short-term rate as preferred-habitat investors, the sole type of bond market participant, do not integrate maturity segments. Akin to a situation of extreme segmentation, the n−period bond yields are pinned down by equilibrium conditions between the demand of preferred-habitat investors and the supply of bonds at a specific maturity". We estimated a preferred-habitat channel by considering the spread of sovereign German rates (assumed to be risk-free) over OIS rates for each maturity – the third term in the right-hand side of equality (2.2): $\Delta\left(GER_t^b - OIS_t^b\right)$.

Fourth, an asset purchase programme may have direct (if the programme directly targets non-default-free bonds) and indirect effects (via, once again, the role of arbitrageurs in integrating market segments) on credit premia. A credit premium channel was estimated using CDS rates[22] for each market and maturity bucket – the fourth term in the right-hand side of equality (2.2): $\Delta CDS_{m,t}^b$.

Finally, the presence of an additional significant buyer in the market (the central bank) "may improve market functioning and thereby reduce premia for illiquidity" (Joyce et al., 2011, p.118). Alternatively, liquidity might deteriorate due to issues of availability of the purchased securities. A liquidity premium channel was estimated using the bond-CDS basis, once again for each market and maturity bucket – the fifth term in the right-hand side of equality (2.2): $\Delta\left(y_{m,t}^b - GER_t^b - CDS_{m,t}^b\right)$.

[22] This is a simplification since, as Krishnamurthy, Nagel, and Vissing-Jorgensen (2018) explain, "The ISDA Master Agreement that governs CDS contracts explicitly states that for G7 countries such as Italy, CDS contracts do not cover losses from redenomination risk. In contrast, for Spain and Portugal, that are not G7 countries, CDS contracts would be presumed to cover losses from redenomination." (p.17). So, for Italy, when a credit risk premium is mentioned, redenomination risk is excluded (and it is reflected in what, here, is designated as a liquidity risk premium); on another hand, for Portugal and Spain the credit risk premium includes both default and redenomination risks.

In order to estimate how each of these channels operated and adapting the approach used in Joyce et al. (2011) and Altavilla et al. (2015), we considered the following model:

$$\Delta Channel_t = \alpha + \beta_1 D_t \Delta F_t D_{Fpos} + \beta_2 D_t \Delta F_t D_{Fneg} + \beta_3 D_t \Delta S_t D_{Spos} + \beta_4 D_t \Delta S_t D_{Sneg} + \boldsymbol{\gamma C_t} + \epsilon_t \quad \text{(Eq 2.3.)}$$

Where the dependent variable ($\Delta Channel_t$) represents the one-day change in each of the proxies used to estimate the transmission channels. ΔOIS_t^{2Y} for the signalling channel (equal for all maturity buckets and for all markets). $\Delta\left(OIS_t^b - OIS_t^{2Y}\right)$ for the duration premium channel for maturity bucket b (equal for all markets). $\Delta\left(GER_t^b - OIS_t^b\right)$ for the preferred-habitat channel for maturity bucket b (equal for all markets). $\Delta CDS_{m,t}^b$ for the credit premium channel for maturity bucket b and market m. Finally, we used $\Delta\left(y_{m,t}^b - GER_t^b - CDS_{m,t}^b\right)$ to estimate the liquidity premium channel for maturity bucket b and market m.

D_t is a dummy variable that takes the value of one in all event days and zero otherwise. ΔF_t and ΔS_t are the standardised measures of the "macroeconomic" and the "save the euro" policy surprises, respectively. D_{pos} and D_{neg} are dummy variables that take the value of one in positive and negative surprise UMP event days, respectively, and zero otherwise. $\boldsymbol{C_t}$ is a vector of control variables. We use the one day lagged change of the dependent variable, in order to consider previous trends in asset prices. We also consider, on one hand, the same day percentage changes of the VIX index and of the US treasury 10-year yield, in order to consider other global market developments and, on the other hand, the Citi Eurozone Surprise Index, to control for euro area macroeconomic news.

Sovereign (on the run) yields for Portugal, Spain, Italy and Germany (2, 5, 10, 15 and 30-year maturity end of day yields) and OIS rates, for the same maturities, are extracted on a daily basis using Bloomberg CBBT prices[23]. We extracted modelled par yields for the euro area (AAA-rated countries), for the same maturity buckets, from the ECB website[24]. CDS rates are obtained on a daily basis using Thomson Reuters Datastream – the 15-year maturity is not available. As for the independent variables, we gathered information about the event set,

[23] Bloomberg CBBT prices are calculated using only the most recently updated executable prices.
[24] ECB Euro area yield curves: https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html (accessed 4 April 2019).

as mentioned before, from related research and from the ECB website (see Appendix 2.A). Daily data for the control variables are also extracted using Bloomberg. All data start on June 1st, 2014, and end on March 31st, 2018. In Appendix 2.B we present some descriptive statistics.

2.4. Results and discussion

2.4.1. Impact Estimation

2.4.1.1. Common Transmission Channels

As mentioned before, APP announcements are thought to affect sovereign yields through different channels. Table 2.1 shows the estimated impact through transmission channels common to all euro area sovereign markets, i.e., the signalling, the preferred-habitat and the duration premium channel.

	positive surprises						negative surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Channel	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Signalling	-0.006%	**	-0.009%	**	-0.014%	35.4***	0.009%	**	0.002%		0.011%	3.79*
Preferred-Habitat												
2Y	-0.003%		-0.001%		-0.004%	2.6	-0.001%		-0.002%		-0.003%	1.76
5Y	-0.005%	**	-0.003%	*	-0.008%	14.06***	0.000%		-0.001%		-0.001%	.33
10Y	-0.008%	***	-0.001%		-0.009%	11.76***	0.002%		0.000%		0.002%	.91
15Y	-0.004%		-0.004%	*	-0.007%	8.02***	0.001%		0.000%		0.002%	.28
30Y	-0.005%	*	-0.004%		-0.009%	9.23***	0.001%		0.000%		0.001%	.25
Duration												
2Y												
5Y	-0.011%	***	0.002%		-0.009%	15.49***	0.006%	***	0.000%		0.006%	6.79***
10Y	-0.020%	***	0.007%		-0.013%	17.89***	0.004%		0.000%		0.004%	1.1
15Y	-0.021%	***	0.009%		-0.013%	11.23***	0.002%		0.000%		0.002%	.24
30Y	-0.019%	***	0.010%		-0.008%	2.91*	0.000%		0.001%		0.001%	.03

Note: the table reports the reaction in yields, through different channels, to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 2.1. - Estimated Impacts (Common Channel Effects)

Our estimates show that these effects are statistically significant when UMP surprises are positive, but they are statistically weaker when surprises are negative – although they generally do have the expected direction, i.e., positive surprises lead to lower yields through all common channels and negative surprises lead to higher ones, particularly in all statistically significant cases. Remember that in an important portion of the analysed period, economic circumstances justified a persistent easing bias by the central bank, and it is, therefore, understandable that contractionary surprises were less credible, weaker or quickly reversed[1].

When surprises are positive, a simultaneous one standard deviation move[2] in both surprise measures translates into a total signalling effect of -1.4 bps. As for when surprises are negative, we estimate this effect at +1.1 bps. When we focus on the 10-year maturity, for positive surprises, total common effects ascend to -3.6 bps (the -1.4 bps signalling effect, a -0.9 bps preferred-habitat effect and a -1.3 bps duration premium effect, all statistically significant at the 1% level). When surprises are negative, total common effects are +1.7 bps.

The magnitude of effects is larger the longer the maturity and effects seem to peak at the 10-year maturity bucket, which is consistent with other research findings, e.g., Altavilla et al. (2019), and with the fact that programme purchases were concentrated around that yield curve area – as Evgenidis, Tsagkanos, and Siriopoulos (2017) highlight "asset purchase programs were successful at flattening the yield spread".

Overall, when surprises are positive, all but the 2-year preferred-habitat total effect are statistically significant (mostly at the 1% level). With negative surprises only the signalling and the 5-year duration effects are statistically significant (at the 10% and the 1% levels, respectively).

2.4.1.2. Market Specific Transmission Channels

We now turn to transmission channels that are market-specific, i.e., the credit premium and the liquidity premium channels. First, since it is not possible to decompose these two effects for AAA euro area sovereigns, Table 2.2 shows the estimated aggregated credit-

[1] On an intraday basis which could justify our findings. Estimates using a longer (two-day) event window are not materially different from the baseline case (one-day).
[2] Equivalent to a 3.75 bps move in 10-year yields (bund future) and a 5.04 bps move in the 10-year Italy-Germany spread.

liquidity impact for core (AAA euro area sovereigns) and non-core (Portugal, Spain and Italy) markets[3].

Aggregated credit-liquidity effects are sometimes not significant for AAA euro area sovereigns (core markets) but at the long end of the maturity curve (15 and 30-year maturities for both positive and negative surprises and the 10-year maturity for negative surprises) the impact is statistically significant. The overall effect, i.e., a higher credit-liquidity aggregated premium with positive policy surprises and a lower premium with negative surprises, is symmetric to the peripheral markets' aggregated effect. This is likely because investors viewed UMP measures that differentially lowered peripheral credit and liquidity premia (which are mostly associated with our "save the euro" factor) as made at the expense of core markets, i.e., those countries that mainly have to finance and guarantee for the asset purchase programmes. We elaborate on this in sub-section 2.4.1.3.

Focusing on the 10-year maturity, the aggregated credit-liquidity premium estimated total impact for core markets is +1.3 bps for positive surprises (+1.4 bps identified with the "macroeconomic QE" factor and -0.1 bps with the "save the euro" factor – the former is statistically significant at the 5% level). Impact is -0.9 bps for negative surprises (total effect is statistically significant at the 1% level).

[3] For AAA euro area sovereigns there is no information about CDS rates so equality (2.2) becomes $\Delta y_{m,t}^{b} = \Delta OIS_t^{2Y} + \Delta(OIS_t^{b} - OIS_t^{2Y}) + \Delta(GER_t^{b} - OIS_t^{b}) + \Delta\left(y_{m,t}^{b} - GER_t^{b}\right)$ and we adjust model (2.3) accordingly.

	positive surprises						negative surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos}$ + $\beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg}$ + $\beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Market /Channel	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Credit-Liquidity												
EUR AAA 2Y	0.001%		0.000%		0.001%	0.04	-0.003%		0.004%		0.002%	0.34
EUR AAA 5Y	0.005%		0.001%		0.006%	2.07	-0.006%	*	0.002%		-0.004%	1.33
EUR AAA 10Y	0.014%	**	-0.001%		0.013%	2.70	-0.006%	**	-0.003%		-0.009%	7.04***
EUR AAA 15Y	0.013%	*	0.001%		0.014%	3.01*	-0.003%		-0.007%		-0.010%	7.77***
EUR AAA 30Y	0.014%		0.003%		0.017%	3.02*	0.000%		-0.011%	**	-0.011%	7.73***
Portugal 2Y	-0.002%		-0.008%		-0.011%	1.06	-0.015%	*	0.023%	**	0.008%	0.89
Portugal 5Y	-0.010%		-0.017%		-0.027%	3.15*	-0.021%	***	0.044%	***	0.023%	8.33***
Portugal 10Y	0.003%		-0.045%	***	-0.042%	9.29***	-0.012%	***	0.048%	***	0.035%	25.23***
Portugal 15Y	0.001%		-0.042%	***	-0.042%	20.95***	-0.011%	**	0.049%	***	0.037%	23.91***
Portugal 30Y	-0.006%		-0.037%	***	-0.043%	10.34***	-0.011%	**	0.048%	***	0.038%	23.46***
Spain 2Y	-0.012%		0.001%		-0.011%	3.39*	-0.012%		0.034%		0.021%	2.21
Spain 5Y	-0.009%		-0.016%	**	-0.026%	21.15***	-0.013%	***	0.034%	***	0.021%	28.71***
Spain 10Y	0.003%		-0.034%	***	-0.032%	59.42***	-0.012%	***	0.043%	***	0.030%	56.67***
Spain 15Y	-0.004%		-0.031%	***	-0.035%	34.81***	-0.011%	***	0.043%	***	0.032%	80.37***
Spain 30Y	-0.007%		-0.030%	***	-0.037%	13.70***	-0.008%	**	0.043%	***	0.035%	51.29***
Italy 2Y	-0.005%		-0.017%	***	-0.022%	12.81***	-0.006%		0.021%	**	0.015%	3.43*
Italy 5Y	-0.002%		-0.031%	***	-0.033%	56.58***	-0.010%	***	0.035%	***	0.025%	43.27***
Italy 10Y	0.004%		-0.044%	***	-0.040%	191.64***	-0.010%	***	0.047%	***	0.037%	321.87***
Italy 15Y	0.003%		-0.037%	***	-0.034%	48.13***	-0.008%	***	0.037%	***	0.029%	76.62***
Italy 30Y	0.000%		-0.037%	***	-0.036%	21.16***	-0.006%	***	0.035%	***	0.029%	64.88***

Note: the table reports the reaction in yields, through different channels, to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 2.2. – Estimated Effects (Market Specific Channels – Aggregated Credit-Liquidity Premium)

Additionally, we document that credit and liquidity effects for peripheral markets are, clearly, dependent on the sign of the policy surprise. Credit-liquidity aggregated effects for peripheral markets are significant for both positive and negative UMP surprises and they have the expected direction – positive surprises lead to a fall in yields (-4 bps for Italy, 10-year maturity, for example) and negative surprises lead to a rise (+3.7 bps for Italy, 10-year maturity, for example). Results are statistically very significant (mostly at the 1% level).

Table 2.3 and Table 2.4 complement results in Table 2.2 and are of particular interest since they report the estimated disaggregated credit premium and liquidity premium impact for peripheral (Portugal, Spain and Italy) markets.

With positive surprises, credit premium effects for peripheral markets are all statistically highly significant (at the 1% level) and have the expected direction, i.e., with expansionary surprises, peripheral markets' credit premia fell (-2.3 bps for Italy, 10-year maturity, for example). With negative surprises, credit effects have the expected direction but only those for Italy seem, at first glance, to be statistically significant (+0.9 bps for Italy, 10-year maturity, for example). This seems puzzling but further analysis, related to the way we measured UMP surprises using two different factors and which we document in sub-section 2.4.1.3, allows us to clarify this situation.

As for liquidity premium effects, these are mostly also statistically highly significant and have the expected direction as well, especially for longer maturities (more than 2 years), therefore probably reflecting the central bank's presence/absence in the market as a significant buyer. With positive surprises, liquidity premia for peripheral markets dropped (-1.9 bps for Italy, 10-year maturity, for example) and they increased with negative surprises (+2.9 bps for Italy, 10-year maturity, for example).

As was the case in the previous sub-section, the magnitude of effects is once again larger the longer the maturity, in accordance with previous research findings (Altavilla et al., 2019) and with the APP's pattern of purchases.

	positive surprises						negative surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Market Channel	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Credit												
Portugal 2Y	-0.010%	*	-0.011%	*	-0.021%	8.04***	-0.013%	**	0.023%	***	0.010%	1.75
Portugal 5Y	-0.011%	*	-0.016%	***	-0.027%	14.24***	-0.014%	**	0.022%	***	0.009%	1.65
Portugal 10Y	-0.014%	*	-0.017%	***	-0.030%	13.25***	-0.014%	***	0.023%	***	0.009%	1.98
Portugal 15Y												
Portugal 30Y	-0.014%		-0.021%	***	-0.035%	10.02***	-0.015%	***	0.023%	***	0.008%	1.56
Spain 2Y	-0.002%		-0.008%	***	-0.010%	14.36***	-0.007%	***	0.010%	***	0.003%	2.04
Spain 5Y	-0.003%		-0.009%	***	-0.012%	13.12***	-0.010%	**	0.013%	***	0.003%	0.73
Spain 10Y	-0.004%		-0.008%	**	-0.012%	8.30***	-0.013%	**	0.016%	***	0.002%	0.16
Spain 15Y												
Spain 30Y	-0.008%	*	-0.004%		-0.013%	9.11***	-0.003%		0.013%	***	0.010%	9.34***
Italy 2Y	-0.003%		-0.014%	***	-0.017%	18.91***	-0.007%	***	0.014%	***	0.008%	12.43***
Italy 5Y	-0.005%		-0.017%	***	-0.022%	21.87***	-0.009%	***	0.018%	***	0.009%	18.96***
Italy 10Y	-0.005%		-0.018%	***	-0.023%	25.14***	-0.011%	***	0.019%	***	0.009%	10.89***
Italy 15Y												
Italy 30Y	-0.005%		-0.018%	***	-0.022%	24.74***	-0.011%	***	0.020%	***	0.009%	12.35***

Note: the table reports the reaction in yields, through different channels, to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 2.3. – Estimated Effects (Market Specific Channels – Credit Premium Effect)

	positive surprises						negative surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Market/Channel	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Liquidity												
Portugal 2Y	0.008%		0.002%		0.010%	0.62	-0.001%		-0.001%		-0.002%	0.01
Portugal 5Y	0.002%		-0.001%		0.001%	0.01	-0.008%		0.023%	**	0.015%	2.96*
Portugal 10Y	0.017%	**	-0.028%	***	-0.011%	0.88	0.001%		0.027%	***	0.028%	15.17***
Portugal 15Y												
Portugal 30Y	0.009%		-0.012%		-0.004%	0.12	0.004%		0.028%	***	0.031%	41.51***
Spain 2Y	-0.009%		0.008%		-0.001%	0.05	-0.005%		0.023%		0.018%	1.47
Spain 5Y	-0.005%		-0.008%		-0.013%	5.44**	-0.003%		0.020%	***	0.018%	11.86***
Spain 10Y	0.007%		-0.026%	***	-0.019%	14.93***	0.001%		0.029%	***	0.030%	38.73***
Spain 15Y												
Spain 30Y	0.002%		-0.025%	***	-0.023%	4.55**	-0.005%		0.031%	***	0.026%	33.40***
Italy 2Y	-0.002%		-0.005%		-0.007%	2.43	0.002%		0.006%		0.007%	0.78
Italy 5Y	0.003%		-0.016%	***	-0.013%	6.88***	0.000%		0.017%	***	0.017%	17.65***
Italy 10Y	0.008%	*	-0.027%	***	-0.019%	16.63***	0.001%		0.028%	***	0.029%	59.98***
Italy 15Y												
Italy 30Y	0.005%		-0.019%	***	-0.014%	2.92*	0.005%	*	0.016%	***	0.021%	26.78***

Note: the table reports the reaction in yields, through different channels, to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 2.4. – Estimated Effects (Market Specific Channels – Liquidity Premium Effect)

2.4.1.3. Total Effects and QE Factors: "Macroeconomic QE" versus "Save the Euro QE"

As mentioned before and building on arguments made by Altavilla et al. (2019) we have defined our surprise measures in order to identify two different QE factors, one that is related to overall stimulus – "Macroeconomic QE" – and another one that may differentially affect sovereign yields – "Save the Euro QE".

Signalling, preferred-habitat and duration premium effects are essentially derived from the "macroeconomic" surprise measure (bund future) which is consistent with their nature, i.e., these are effects common to all euro area sovereign markets and they reflect policy measures that provide overall stimulus. Common effects estimated using the "save the euro" surprise measure are mostly statistically insignificant but for one particular exception, the signalling effect for positive surprises (-0.9 bps, 5% level). Remember that the signalling effect captures the extent to which market expectations of the short-term policy interest rate are affected by central bank purchases. As peripheral and core economies are known to have had divergent performances some purchases' announcements may have plausibly been associated by investors to this uneven economic behaviour, signalling lower rates due specifically to peripheral economies' underperformance. Our results seem to confirm this interpretation.

Aggregated credit-liquidity effects are symmetric between core and peripheral markets and, as we mentioned, this is likely related to a "save the euro" factor. This is consistent with the fact that market-specific effects for peripheral markets estimated using the "save the euro" surprise measure are, with a few exceptions for short maturities, statistically very significant (usually at the 1% level) and explain most of the aggregated credit-liquidity effects for the periphery.

Credit premium effects with positive surprises have the same direction when we consider both the "macroeconomic" as well as the "save the euro" surprise measure, i.e., lower yields, although only the latter is statistically significant (once again, at the 1% level) and it explains most of the overall credit effect. When we consider negative surprises, for Portugal and Spain, the higher credit premium highlighted through the "save the euro" surprise measure is almost completely compensated by a lower credit premium estimated

through the "macroeconomic" surprise measure – this also happens in Italy although with a smaller magnitude. This behaviour is highly relevant and very likely associated with the fact that effects on peripheral credit premia with negative policy surprises were different depending on the nature of the surprise. If it derived from a lower overall stimulus ("macro QE"), it instigated higher yields across all markets but lower spreads for peripheral markets but if it was viewed, alternatively, as specifically less beneficial to peripheral sovereign yields (differentially affecting them, i.e., "save the euro QE") it concomitantly originated higher yields across all markets and higher spreads for peripheral markets.

When it comes to liquidity premium effects, the "save the euro" surprise measure is also the only generally statistically significant (mostly at the 1% level) and explains most of the overall liquidity effect. The few cases when the "macroeconomic" surprise measure seems to be statistically significant point to an increased liquidity premium effect, both when faced with positive and negative surprises – this might be related to arguments about general liquidity and availability of the purchased securities since the ECB became a major player in the market. As Schlepper et al. (2017, p.38) argue "liquidity has deteriorated throughout the purchase program and likely also as a result of the purchase program". In fact, a common explanation for the bund tantrum, an episode of especially high volatility in German bonds, on 7 May 2015, is that market liquidity had deteriorated since, anticipating the ECB's asset purchase programme, "trades speculating on a continued decline in rates had become relatively crowded" (Riordan & Schrimpf, 2015).

A proper analysis of the role of traders and institutional investors is beyond the scope of this paper and is linked to the way the regulatory environment evolved since the 2007-2008 financial crisis. Analysing effects of central bank asset purchases on the functioning of bond markets, requires security level data, more granular data on purchases and high-frequency transaction-level bond market data. According to Schlepper et al. (2017, p.4): "Understanding the impact of official sector purchases on market functioning and quality in fixed income markets is highly relevant from a policy perspective, especially against the backdrop of changing nature of intermediation in fixed income markets in recent years". Our research is based on on-the-run and par (benchmark) yields and on UMP announcements and is, therefore, ill-suited for this purpose.

Finally, our results illustrate how impact for core markets is mostly derived from the "macroeconomic" factor. For peripheral markets, when surprises are positive both factors help to explain the total impact while for negative surprises, the "save the euro" factor is the only relevant one[1]. This, by the way, is consistent, in particular, with the above-mentioned credit premium effects, when surprises are negative.

2.4.2. Robustness checks

Overall, results[2] are consistent with other research findings.

As mentioned before, Altavilla et al. (2015) point to a signalling effect of, at most, -10 bps (at two-year horizons), a preferred-habitat effect and a duration premium effect that is estimated at about -10 bps (10-year maturity). Using our methodology and applying it to the same (more restricted than ours) event set these authors used we get a -0.12% cumulative signalling effect, and a -0.07% cumulative effect for the 10-year bund maturity (-0.02% cumulative duration effect and a -0.05% cumulative preferred-habitat effect).

As for the aggregated credit-liquidity premium, Altavilla et al. (2015) refer, for example, a significant effect at -58 bps, for Italy (10-year maturity). We estimate a -0.43% cumulative effect (-0.57% for positive surprises and +0.14% for negative surprises).

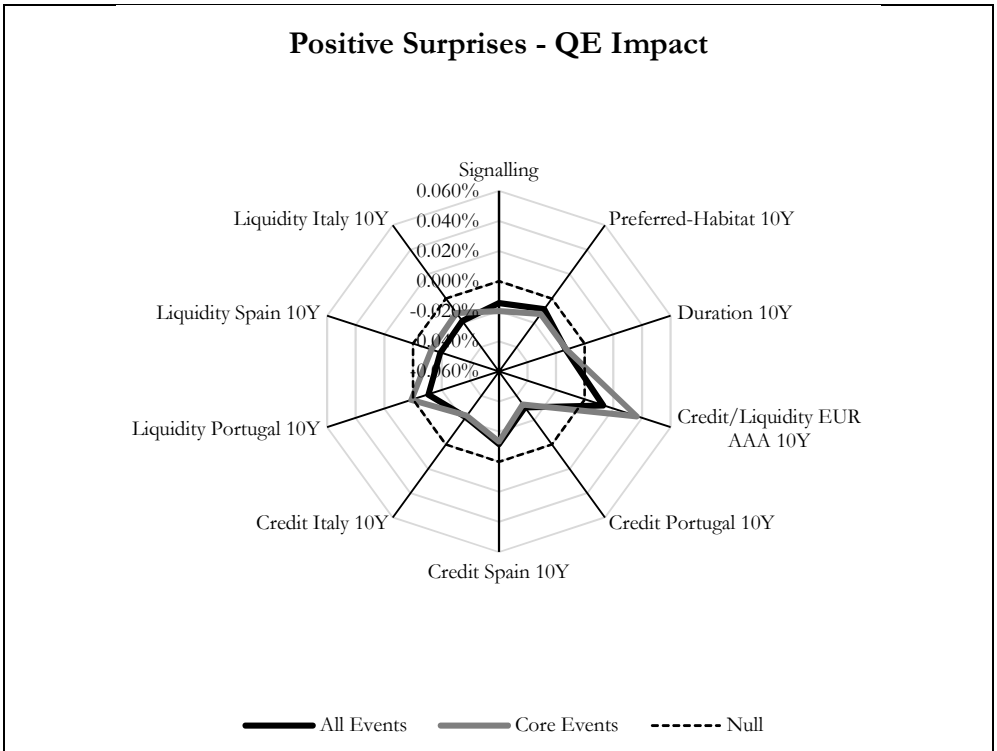
We, additionally, estimated results using a two-day event window and results are not qualitatively altered by considering a larger window instead of the baseline case (one day).

Finally, we also estimated results using a more restricted ("core") event set. For this we used the initially identified group of fifteen event days – events marked in bold in Appendix 2.A. Graph 2.1 and Graph 2.2 show total QE impact estimates for, respectively, positive and negative surprises. We represent, for parsimony, a limited set of results (the signalling and the 10 year preferred-habitat, duration, credit and liquidity effects for the analysed markets). As can be seen, results are also not qualitatively altered by considering this alternative event

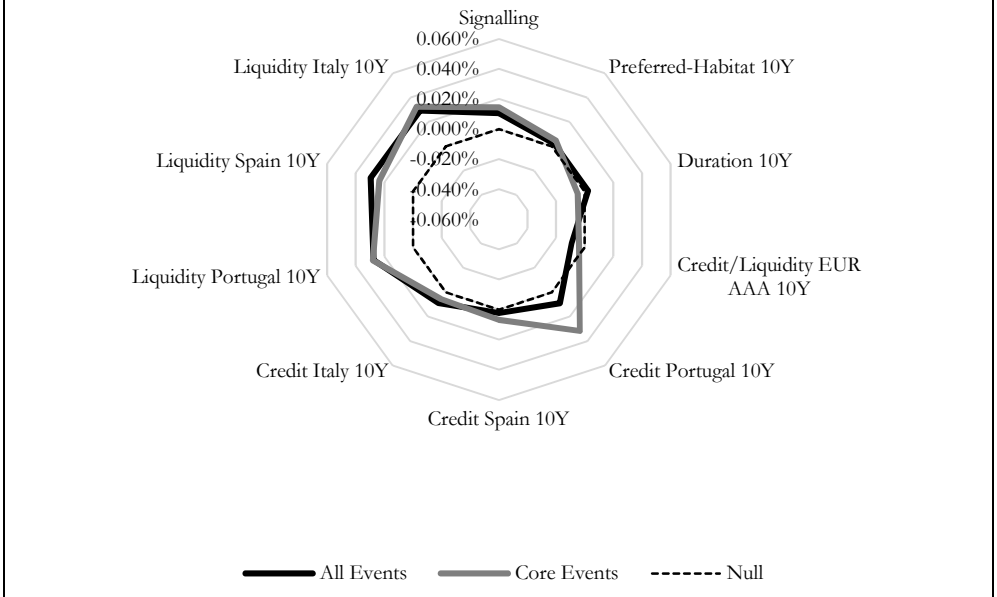
[1] For a clear visual perspective of this, see Graph 2.C.9 through Graph 2.C.16 in Appendix 2.C.
[2] For an overview of all effects, see Graph 2.C.1 through Graph 2.C.16 in Appendix 2.C.

set although, as expected, this much smaller data sample restricts inference and interpretation[3].

[3] For positive surprises, the largest (quantitative) difference is the aggregated credit/liquidity effect for AAA euro area sovereigns. As for negative surprises, the largest (quantitative) difference occurs for the 10-year Portuguese credit effect.



Graph 2.1 – Positive Surprises QE Impact (all events vs core events)



Graph 2.2 – Negative Surprises QE Impact (all events vs core events)

2.4.3. Symmetry

The way our analysis was structured allows for a detailed study about non-linearity. When it comes to the issue of symmetry, we are dealing with two components: first, a question of whether the sign, the direction, of the estimated effects differs between positive and negative surprises and, second, whether its size, i.e., its magnitude is different.

In order to analyse these two different questions, we use the following strategy[4]. First, in addition to the original regression (3) above we considered another alternative regression where we substitute the surprise measures for their absolute values. Second, if in the original regression (3) the sign of coefficients associated with positive and negative surprises is the same, then we use the alternative regression's coefficients to test for whether the effects have the same direction. In this case, we then go back to the original regression's coefficients to test for whether the effect's magnitude is the same. Alternatively, if, once again in the original regression (3), the sign of coefficients associated with positive and negative surprises is not the same, then we can only conclude on whether effects for positive and negative surprises are different from one another, which is also the case whenever at least one of the coefficients is not statistically significant.

Starting with transmission channels common to all markets, our results show that the total signalling effects have different directions (for positive and negative surprises), but we do not reject the hypothesis they have similar magnitudes. This is also the case for the 5-year total duration premium effect. In all other cases, positive and negative surprise total effects are different from one another but do not have different directions. We come to the same conclusion, generally speaking, when we take into consideration only the "macroeconomic" surprise measure. On another hand, when the "save the euro" surprise measure is considered effects, for positive and negative surprises, are not statistically different. This is consistent with what we mentioned before, i.e., that signalling, preferred-habitat and duration premium effects are essentially derived from the "macroeconomic" surprise measure which is understandable since these are effects common to all euro area sovereign markets and they reflect policy measures that provide overall stimulus.

[4] Check Appendix 2.D for the detailed results.

As for market-specific transmission channels, whether we consider the aggregated or the disaggregated credit and liquidity channels, in most cases total and "save the euro" effects also have different directions (for positive and negative surprises) but do not have different magnitudes while "macroeconomic" effects are usually not different from one another. The one exception is Italy, where all credit (total) effects have different directions and different magnitudes: impact when surprises are negative is smaller. This asymmetry also exists for the Italian liquidity (total) effect where impact when surprises are negative is usually larger, although, strictly speaking, the 10-year maturity is the only statistically significant case. This pattern is likely related to the way the "macroeconomic" and the "save the euro" factors interact, as we have explained before.

Our results are therefore aligned with other previous research findings when it comes to symmetry, i.e., we find that although the direction of effects for positive and negative UMP surprises is often different its magnitude is usually not.

2.5. Conclusions

To the best of our knowledge, we are the first to study in as much detail the transmission channels for the effects of the ECB APP, across core and peripheral sovereign debt markets at different maturities. We used a specific empirical model to determine the importance of the individual channels through which the APP affected sovereign yields in the euro area. Considering known theoretical mechanisms and combining them with these empirical results, some tentative, qualitative, conclusions were possible.

Our findings show that APP announcements affected euro area sovereign yields through a signalling channel, a preferred-habitat channel, a duration premium channel, a credit premium channel and a liquidity premium channel. The size of these effects increases the longer the maturity considered and seem to peak around the 10-year maturity bucket, which is in line with findings in Altavilla et al. (2019), for example. Our detailed results also confirm that although the direction of effects for expansionary and contractionary surprises is often different its magnitude is usually not.

Results depend, however, on the sign of the policy surprise since, when UMP measures are more expansionary than expected yields fall through the signalling, the preferred-habitat and the duration premium channels; but when UMP measures are more contractionary than

expected yields rise. When it comes to credit and liquidity effects, we find them to be very significant for peripheral markets, both for expansionary and contractionary surprises. They also have the expected direction – expansionary surprises lead to lower yields through these channels and contractionary surprises lead to higher yields while, interestingly, core markets' credit-liquidity effects are symmetric to those estimated for peripheral markets, which is likely related to a "save the euro" factor – an important conclusion made possible by the methodological approach we adopted in this paper.

In fact, we are, to the best of our knowledge, the first to empirically identify and quantify two different quantitative easing factors – building on an argument made by Altavilla et al. (2019) and Wright (2019): one is related to an overall stimulus and another one seems to differentially affect sovereign yields, which helps us better explain our findings.

Appendix 2.A.

Date	Event	Source
05-06-2014	ECB press conference Inferences were possibly made	Haitsma et al. (2016) https://www.ecb.europa.eu/press/pressconf/2014/html/is140605.en.html
07-08-2014 **[Core]**	**ECB Statement + Draghi also emphasized that the ECB's purchases of privately held assets may be expanded beyond the ABS markets. He said that "QE in government bonds... Is still on the table."**	https://www.ecb.europa.eu/press/pressconf/2014/html/is140807.en.html
25-08-2014 **[Core]**	**Mario Draghi makes a speech at Jackson Hole, in which he links the need for monetary and fiscal policies to stimulate aggregate demand with policies aimed at achieving structural change.**	**Drifill (2016)**
04-09-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
12-09-2014	News conference following a meeting of euro-area finance ministers in Milan	Altavilla et al. (2015)

Date	Event	Source
22-09-2014 **[Core]**	**Mario Draghi makes a speech to the European Parliament Economic and Monetary Affairs committee**	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
24-09-2014	Interview with Europe 1, conducted on 23 September 2014 and aired on 24 September 2014	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2014/html/index.en.html
25-09-2014	Interview with Lithuanian business daily Verslo Zinios	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2014/html/index.en.html
02-10-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
09-10-2014	Mario Draghi: Recovery and Reform in the euro area. Opening remarks by Mario Draghi, President of the ECB, Brookings Institution, Washington, 9 October 2014	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
10-10-2014	Statement at the Thirtieth meeting of the IMFC, Washington	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
24-10-2014	An ECB spokesman reading from Mario Draghi's speaking	Altavilla et al. (2015)

Date	Event	Source
	points at a euro area summit, Brussels	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
06-11-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
12-11-2014	Mario Draghi: The economic policy of Federico Caffè in our times. Speech by Mario Draghi, President of the ECB, to mark the centenary of the birth of Federico Caffè at the Lecture room of the School of Economics and Business Studies "Federico Caffè", Rome, 12 November 2014	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
17-11-2014	Introductory remarks at the EP's Economic and Monetary Affairs Committee	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-11-2014	Speech at the Frankfurt European Banking Congress, Frankfurt am Main	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
27-11-2014	Introductory remarks at the Finnish parliament and speech at the University of Helsinki	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
04-12-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
02-01-2015	Interview with Handelsblatt, published on 2 January 2015	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2015/html/index.en.html
08-01-2015	Letter to Mr Luke Ming Flanagan (member of the European Parliament), published on 8 January 2015	Altavilla et al. (2015)
15-01-2015	Interview with Die Zeit, published on 15 January 2015	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2015/html/index.en.html
22-01-2015 **[Core]**	**Expanded Asset Purchase Program**	**Haitsma et al. (2016)** https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
26-02-2015	Mario Draghi: Introductory statement to the plenary debate of the European Parliament on the ECB's Annual Report 2013. Mario Draghi, President of the ECB, Brussels, 25 February 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
05-03-2015 **[Core]**	**Timing for PSPP**	**Altavilla et al. (2015)** https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
09-03-2015 **[Core]**	**APP begins**	**Drifill (2016)**
11-03-2015	Mario Draghi: The ECB and its Watchers XVI Conference. Speech by Mario Draghi, President of the ECB, Frankfurt am Main, 11 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
26-03-2015	Mario Draghi: Introductory statement at the Italian Parliament. Speech by Mario Draghi, President of the ECB, at the Italian Parliament, Rome, 26 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
31-03-2015	Mario Draghi: Accounts and accountability. Speech by Mario Draghi, President of the ECB, at the Euro50 Group Roundtable on "Monetary Policy in Times of Turbulence", Frankfurt am Main, 31 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
15-04-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html

Date	Event	Source
20-04-2015	Mario Draghi: Euro area economic outlook, the ECB's monetary policy and current policy challenges. Statement by Mario Draghi, President of the ECB, prepared for the thirty-first meeting of the International Monetary and Financial Committee, Washington DC, 17 April 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-05-2015	Mario Draghi: The ECB's recent monetary policy measures: Effectiveness and challenges. Camdessus lecture by Mario Draghi, President of the ECB, IMF, Washington, DC, 14 May 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
03-06-2015 **[Core]**	**ECB Statement + Draghi "Says ECB Governing Council Has Not Discussed QE Exit Plan"**	https://www.ecb.europa.eu/press/pr/date/2015/html/index.en.html
15-06-2015	Mario Draghi: Hearing at the European Parliament's Economic and Monetary Affairs Committee. Introductory statement by Mario Draghi, President of the ECB, Brussels, 15 June 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
16-07-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
03-09-2015 **[Core]**	**ECB Statement + Governing Council decided to increase the issue share limit from the initial limit of 25% to 33% + Draghi said at a news conference that "the asset purchase programme provides sufficient flexibility in terms of adjusting the size, composition and duration of the programme". It was "intended to run until the end of September 2016, or beyond, if necessary,"**	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
23-09-2015	Mario Draghi: President's introductory remarks at the regular ECON hearing. Introductory statement by Mario Draghi, President of the ECB, Brussels, 23 September 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
12-10-2015	Mario Draghi: Euro area economic outlook, the ECB's monetary policy and current policy challenges. Statement by Mario Draghi, President of the ECB, at the thirty-second meeting of the International	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	Monetary and Financial Committee, Lima, 9 October 2015	
22-10-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
04-11-2015	Mario Draghi: Reception for the Opening of the European Cultural Days. Welcome address by Mario Draghi, President of the ECB, Frankfurt, 3 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
05-11-2015	Mario Draghi: Speech to mark the opening of the academic year at the Università Cattolica del Sacro Cuore. Speech by Mario Draghi, President of the ECB, Università Cattolica del Sacro Cuore, Milan, 5 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
09-11-2015 [Core]	**Increase in PSPP issue share limit enlarges purchasable universe**	https://www.ecb.europa.eu/press/pr/date/2015/html/index.en.html
12-11-2015 [Core]	**Mario Draghi: Hearing at the European Parliament's Economic and Monetary Affairs Committee. Introductory statement by Mario Draghi, President of**	**https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html**

Date	Event	Source
	the ECB, Brussels, 12 November 2015	
20-11-2015	Mario Draghi: Monetary Policy: Past, Present and Future. Speech by Mario Draghi, President of the ECB, at the Frankfurt European Banking Congress, 20 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
03-12-2015 **[Core]**	**ECB Statement. The GC "decided to extend the asset purchase programme (APP). The monthly purchases of €60 billion under the APP are now intended to run until the end of March 2017, or beyond, if necessary"**	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
07-12-2015	Mario Draghi: Global and domestic inflation. Speech by Mario Draghi, President of the ECB, Economic Club of New York, 4 December 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-12-2015	Mario Draghi: Monetary policy and structural reforms in the euro area. Speech by Mario Draghi, President of the ECB, Prometeia40, Bologna, 14 December 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
21-01-2016 **[Core]**	**ECB Statement + "It will therefore be necessary to review and possibly reconsider our monetary policy stance at our next meeting in early March"**	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
26-01-2016	Mario Draghi: How domestic economic strength can prevail over global weakness. Keynote speech by Mario Draghi, President of the ECB, at the Deutsche Börse Group New Year's reception 2016, Eschborn, 25 January 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
01-02-2016	Mario Draghi: European Parliament plenary debate on the ECB Annual Report for 2014. Introductory statement by Mario Draghi, President of the ECB, Strasbourg, 1 February	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
04-02-2016	Mario Draghi: How central banks meet the challenge of low inflation. Marjolin lecture delivered by Mario Draghi, President of the ECB, at the SUERF conference organised by the Deutsche Bundesbank, Frankfurt, 4 February 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
10-03-2016 **[Core]**	**Combined monthly purchases under the APP are to increase as of 1 April 2016 to €80 billion from €60 billion.**	**https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html**
15-04-2016	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-third meeting of the International Monetary and Financial Committee, Washington DC, 15 April 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-04-2016	ECB Statement	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
02-06-2016	ECB Statement	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
21-06-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, Brussels, 21 June 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-07-2016	Governing Council confirms that the monthly asset purchases of €80 billion are intended to run until the end of March 2017, or beyond, if necessary, and in any case until	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html

Date	Event	Source
	it sees a sustained adjustment in the path of inflation consistent with its inflation aim.	
08-09-2016	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
26-09-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, Brussels, 26 September 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
28-09-2016	Mario Draghi: Working together for growth in Europe. Introductory remarks by Mario Draghi, President of the ECB, at Deutscher Bundestag, Berlin, 28 September 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
07-10-2016	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-fourth meeting of the International Monetary and Financial Committee, Washington DC, 7 October 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
20-10-2016	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
25-10-2016	Mario Draghi: Stability, equity and monetary policy. Speech by Mario Draghi, President of the ECB, 2nd DIW Europe Lecture, German Institute for Economic Research (DIW), Berlin, 25 October 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-11-2016	Mario Draghi: Introductory statement to the plenary debate of the European Parliament on the ECB's Annual Report 2015. Mario Draghi, President of the ECB, Strasbourg, 21 November 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
28-11-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement of Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 28 November 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
08-12-2016 **[Core]**	**ECB adjusts parameters of its asset purchase programme (APP). Governing Council decided to continue its purchases under the asset purchase programme (APP) at the current monthly pace of €80 billion until the end of March 2017. From April 2017, the net asset purchases are intended to continue at a monthly pace of €60 billion until the end of December 2017, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim.**	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
19-01-2017	ECB provides further details on APP purchases of assets with yields below the deposit facility rate	https://www.ecb.europa.eu/press/pr/date/2017/html/index.en.html
06-02-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	ECB, at the ECON committee of the European Parliament, Brussels, 6 February 2017	
09-03-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
06-04-2017	Mario Draghi: Monetary policy and the economic recovery in the euro area. Speech by Mario Draghi, President of the ECB, at The ECB and Its Watchers XVIII Conference, Frankfurt am Main, 6 April 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-04-2017	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-fifth meeting of the International Monetary and Financial Committee, Washington DC, 21 April 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
27-04-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
10-05-2017	Mario Draghi: Introductory remarks at the House of Representatives of the Netherlands. Introductory remarks by Mario Draghi, President of the ECB, at the Tweede Kamer der Staten-	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	Generaal, The Hague, 10 May 2017	
24-05-2017	Mario Draghi: The interaction between monetary policy and financial stability in the euro area. Keynote speech by Mario Draghi, President of the ECB, at the First Conference on Financial Stability organised by the Banco de España and Centro de Estudios Monetarios y Financieros, Madrid, 24 May 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
08-06-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
27-06-2017	Mario Draghi: Accompanying the economic recovery. Introductory speech by Mario Draghi, President of the ECB, at the ECB Forum on Central Banking, Sintra, 27 June 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
20-07-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
23-08-2017	Mario Draghi: The interdependence of research and policymaking. Speech by Mario Draghi, President of the ECB, at the Lindau Nobel	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	Laureate Meeting, Lindau, Germany, 23 August 2017	
07-09-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
25-09-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 25 September 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
16-10-2017	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-sixth meeting of the International Monetary and Financial Committee, Washington D.C., 13 October 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
26-10-2017 **[Core]**	**The asset purchase programme (APP) will continue at the current monthly pace of €60 billion until the end of December 2017. From January 2018 the net asset purchases are intended to continue at a monthly pace of €30 billion until the end of September 2018, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim. The Eurosystem will reinvest the principal payments from maturing securities purchased under the APP for an extended period of time after the end of its net asset purchases, and in any case for as long as necessary. This will contribute both to favourable liquidity conditions and to an appropriate monetary policy stance.**	**https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html**

Date	Event	Source
17-11-2017	Mario Draghi: Monetary policy and the outlook for the economy. Speech by Mario Draghi, President of the ECB, at the Frankfurt European Banking Congress "Europe into a New Era – How to Seize the Opportunities", Frankfurt am Main, 17 November 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
20-11-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory Statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 20 November 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-12-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
25-01-2018	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
05-02-2018	Mario Draghi: European Parliament plenary debate on the ECB Annual Report for 2016. Introductory statement and closing remarks by Mario Draghi, President of the ECB, Strasbourg, 5 February 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
26-02-2018	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory Statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 26 February 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
08-03-2018	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
14-03-2018	Mario Draghi: Monetary Policy in the Euro Area. Speech by Mario Draghi, President of the ECB, The ECB and Its Watchers XIX Conference organised by the Institute for Monetary and Financial Stability, Frankfurt, 14 March 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Appendix 2.B.

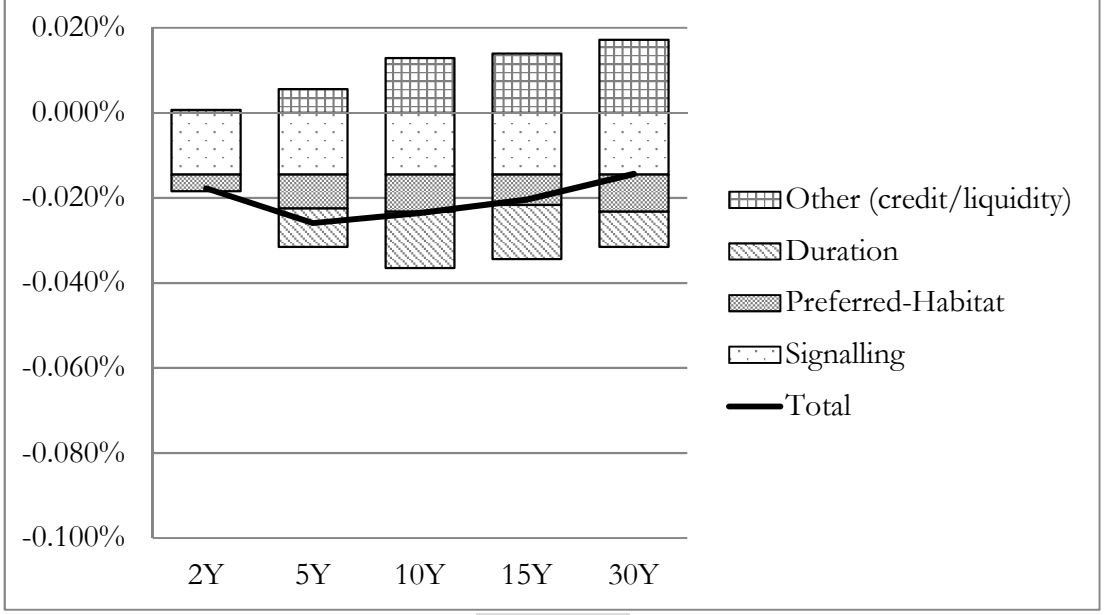
Variable	Mean	Std. Dev.	Min	Max	
Euro 2Y Yield (All)	-0,001%	0,016%	-0,094%	0,092%	Yield Daily Change
Euro 5Y Yield (All)	-0,001%	0,027%	-0,164%	0,137%	Yield Daily Change
Euro 10Y Yield (All)	-0,001%	0,035%	-0,147%	0,161%	Yield Daily Change
Euro 15Y Yield (All)	-0,001%	0,037%	-0,216%	0,164%	Yield Daily Change
Euro 30Y Yield (All)	-0,001%	0,039%	-0,285%	0,170%	Yield Daily Change
Euro 2Y Yield (AAA)	-0,001%	0,015%	-0,083%	0,113%	Yield Daily Change
Euro 5Y Yield (AAA)	-0,001%	0,025%	-0,104%	0,129%	Yield Daily Change
Euro 10Y Yield (AAA)	-0,001%	0,035%	-0,188%	0,172%	Yield Daily Change
Euro 15Y Yield (AAA)	-0,001%	0,040%	-0,216%	0,213%	Yield Daily Change
Euro 30Y Yield (AAA)	-0,001%	0,043%	-0,215%	0,242%	Yield Daily Change
Germany 2Y Yield	-0,001%	0,016%	-0,076%	0,133%	Yield Daily Change
Germany 5Y Yield	-0,001%	0,026%	-0,092%	0,179%	Yield Daily Change
Germany 10Y Yield	-0,001%	0,037%	-0,140%	0,196%	Yield Daily Change
Germany 15Y Yield	-0,001%	0,039%	-0,166%	0,180%	Yield Daily Change
Germany 30Y Yield	-0,001%	0,044%	-0,232%	0,187%	Yield Daily Change
Portugal 2Y Yield	-0,001%	0,053%	-0,332%	0,695%	Yield Daily Change
Portugal 5Y Yield	-0,002%	0,069%	-0,275%	0,802%	Yield Daily Change
Portugal 10Y Yield	-0,002%	0,072%	-0,373%	0,397%	Yield Daily Change
Portugal 15Y Yield	-0,002%	0,069%	-0,384%	0,355%	Yield Daily Change

Variable	Mean	Std. Dev.	Min	Max	
Portugal 30Y Yield	-0,002%	0,069%	-0,474%	0,370%	Yield Daily Change
Spain 2Y Yield	-0,001%	0,027%	-0,149%	0,329%	Yield Daily Change
Spain 5Y Yield	-0,001%	0,041%	-0,233%	0,206%	Yield Daily Change
Spain 10Y Yield	-0,002%	0,050%	-0,185%	0,276%	Yield Daily Change
Spain 15Y Yield	-0,001%	0,051%	-0,195%	0,362%	Yield Daily Change
Spain 30Y Yield	-0,002%	0,051%	-0,270%	0,324%	Yield Daily Change
Italy 2Y Yield	-0,001%	0,051%	-0,718%	0,687%	Yield Daily Change
Italy 5Y Yield	-0,001%	0,046%	-0,351%	0,309%	Yield Daily Change
Italy 10Y Yield	-0,001%	0,053%	-0,169%	0,279%	Yield Daily Change
Italy 15Y Yield	-0,001%	0,052%	-0,182%	0,464%	Yield Daily Change
Italy 30Y Yield	-0,001%	0,048%	-0,241%	0,315%	Yield Daily Change
Germany CDS 2Y	0,000%	0,004%	-0,033%	0,029%	CDS Rate Daily Change
Germany CDS 5Y	0,000%	0,008%	-0,060%	0,069%	CDS Rate Daily Change
Germany CDS 10Y	0,000%	0,018%	-0,115%	0,115%	CDS Rate Daily Change
Germany CDS 15Y	n.d.	n.d.	0,000%	0,000%	CDS Rate Daily Change
Germany CDS 30Y	0,000%	0,016%	-0,092%	0,101%	CDS Rate Daily Change

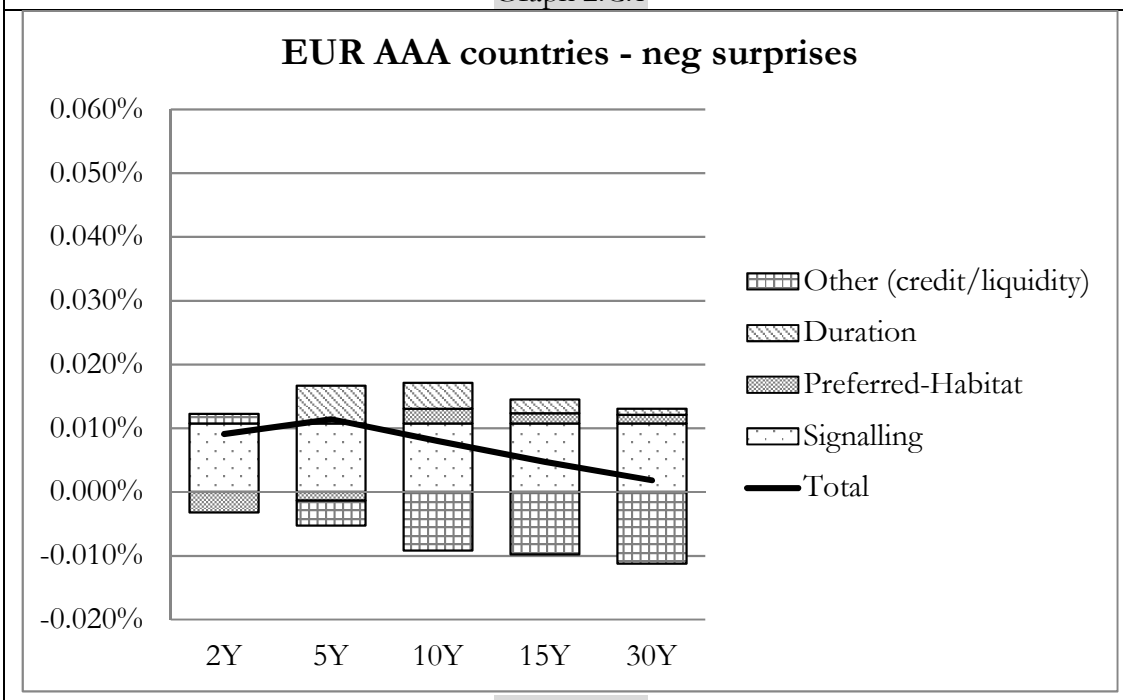
Variable	Mean	Std. Dev.	Min	Max	
Portugal CDS 2Y	-0,001%	0,057%	-0,462%	0,462%	CDS Rate Daily Change
Portugal CDS 5Y	-0,001%	0,056%	-0,448%	0,450%	CDS Rate Daily Change
Portugal CDS 10Y	-0,001%	0,056%	-0,429%	0,434%	CDS Rate Daily Change
Portugal CDS 15Y	n.d.	n.d.	0,000%	0,000%	CDS Rate Daily Change
Portugal CDS 30Y	-0,001%	0,058%	-0,410%	0,414%	CDS Rate Daily Change
Spain CDS 2Y	0,000%	0,020%	-0,103%	0,203%	CDS Rate Daily Change
Spain CDS 5Y	0,000%	0,024%	-0,133%	0,244%	CDS Rate Daily Change
Spain CDS 10Y	-0,001%	0,027%	-0,139%	0,235%	CDS Rate Daily Change
Spain CDS 15Y	n.d.	n.d.	0,000%	0,000%	CDS Rate Daily Change
Spain CDS 30Y	0,000%	0,034%	-0,271%	0,285%	CDS Rate Daily Change
Italy CDS 2Y	0,000%	0,026%	-0,115%	0,209%	CDS Rate Daily Change
Italy CDS 5Y	0,000%	0,031%	-0,145%	0,249%	CDS Rate Daily Change

Variable	Mean	Std. Dev.	Min	Max	
Italy CDS 10Y	-0,001%	0,032%	-0,150%	0,241%	CDS Rate Daily Change
Italy CDS 15Y	n.d.	n.d.	0,000%	0,000%	CDS Rate Daily Change
Italy CDS 30Y	0,000%	0,031%	-0,146%	0,235%	CDS Rate Daily Change
OIS 2Y	0,000%	0,011%	-0,065%	0,136%	Yield Daily Change
OIS 5Y	0,000%	0,022%	-0,076%	0,167%	Yield Daily Change
OIS 10Y	-0,001%	0,032%	-0,120%	0,168%	Yield Daily Change
OIS 15Y	-0,001%	0,036%	-0,153%	0,175%	Yield Daily Change
OIS 30Y	-0,001%	0,038%	-0,198%	0,168%	Yield Daily Change
ITA-GER 10Y	0,000%	0,050%	-0,256%	0,365%	Yield Spread Daily Change
VIX	0,078%	8,391%	-29,983%	76,825%	VIX Percentage Daily Change
US 10Y Yield	0,000%	0,045%	-0,186%	0,202%	Yield Daily Change
Eurozone Citi Surprise Index	-0,016	4,745	-26,000	36,500	Index Daily Change
Bund Future	0,008%	0,357%	-2,707%	1,411%	Future Price Daily Change

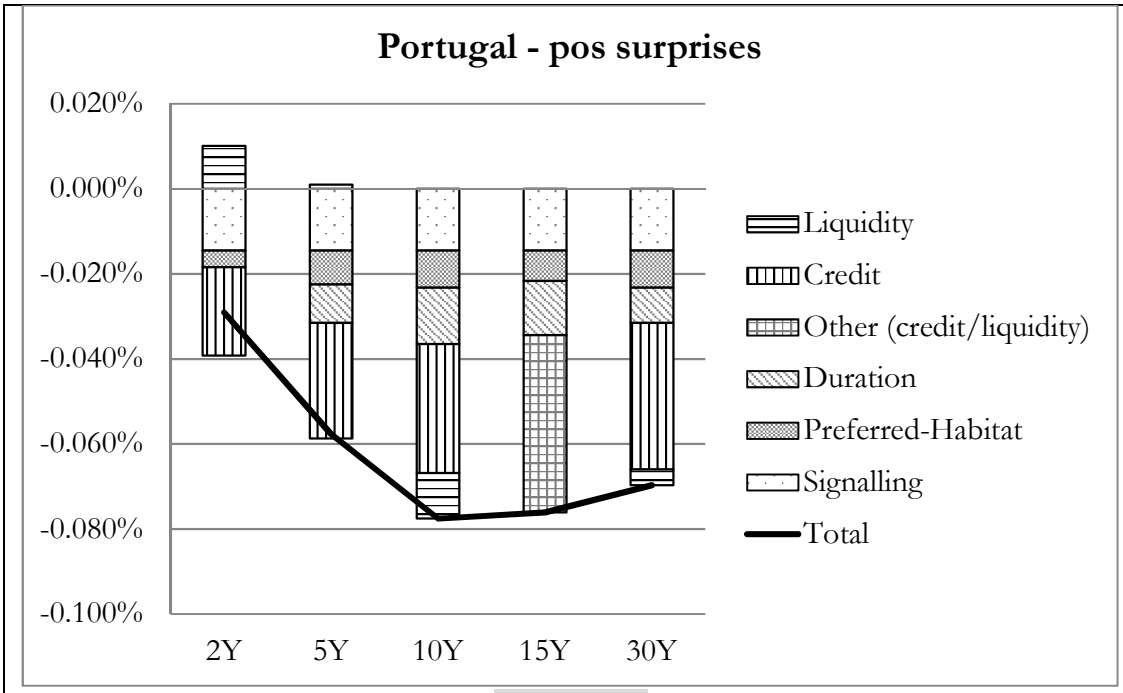
Appendix 2.C.



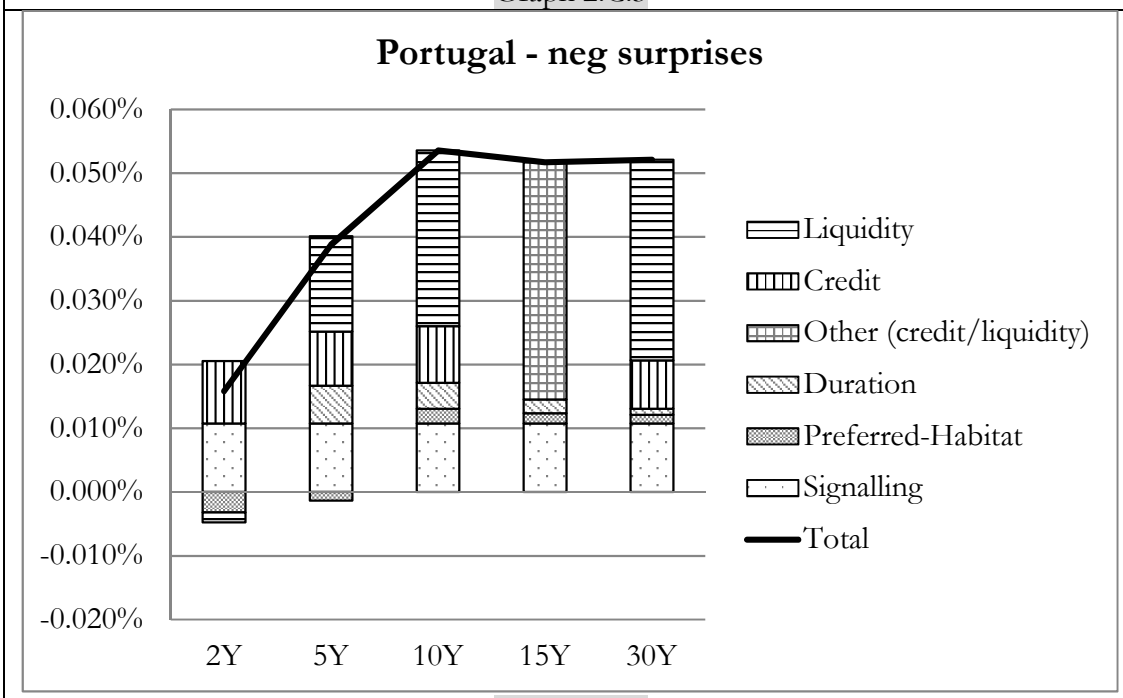
Graph 2.C.1



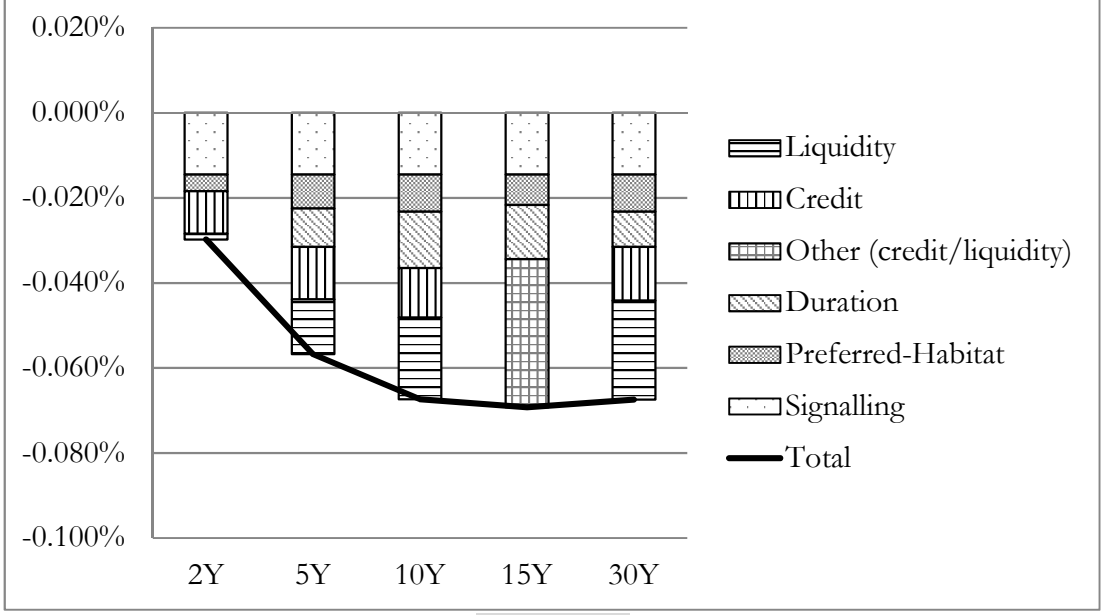
Graph 2.C.2



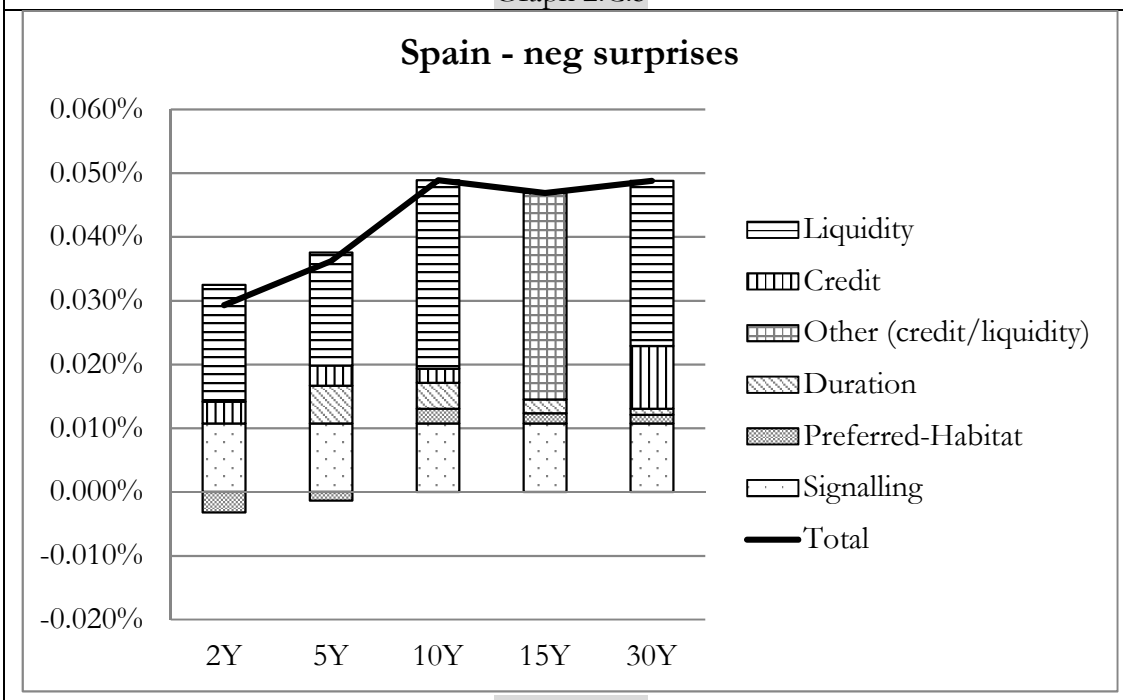
Graph 2.C.3



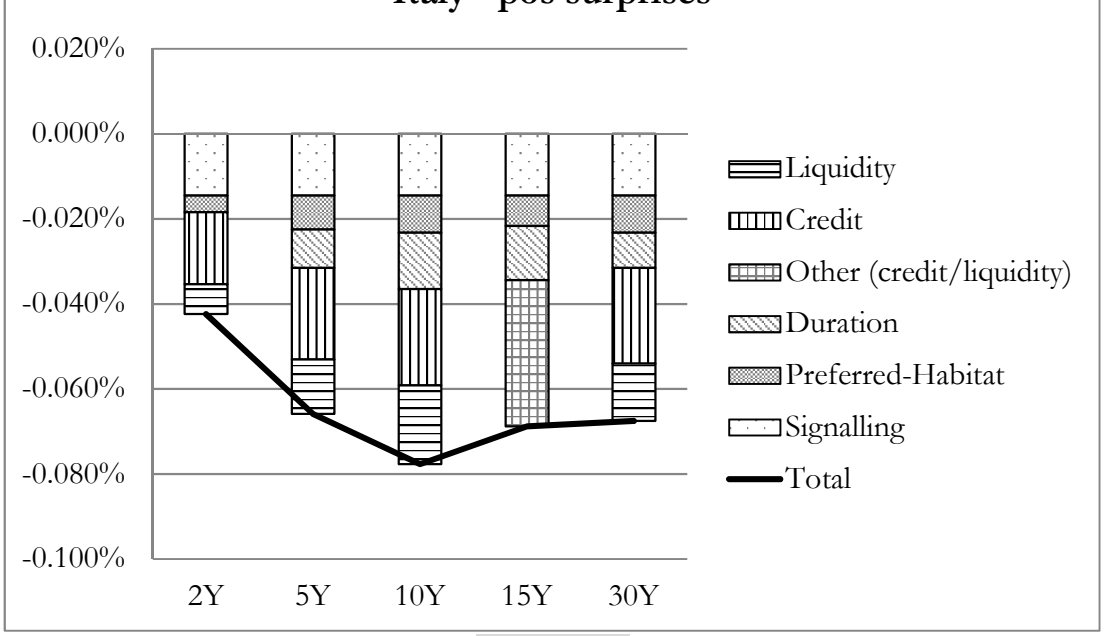
Graph 2.C.4



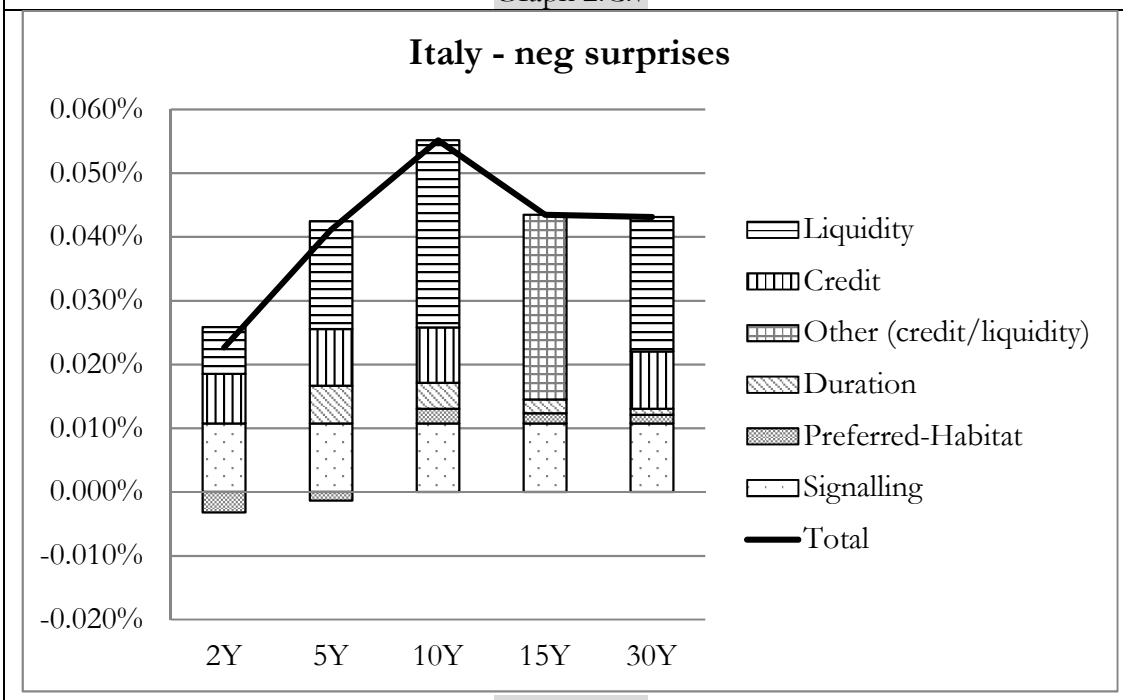
Graph 2.C.5



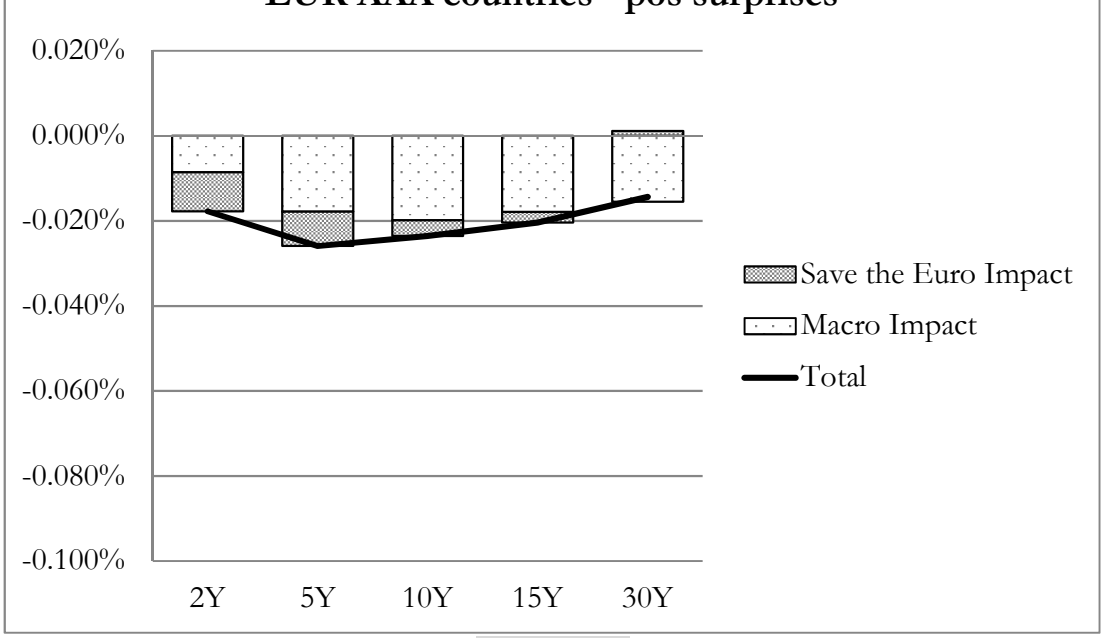
Graph 2.C.6



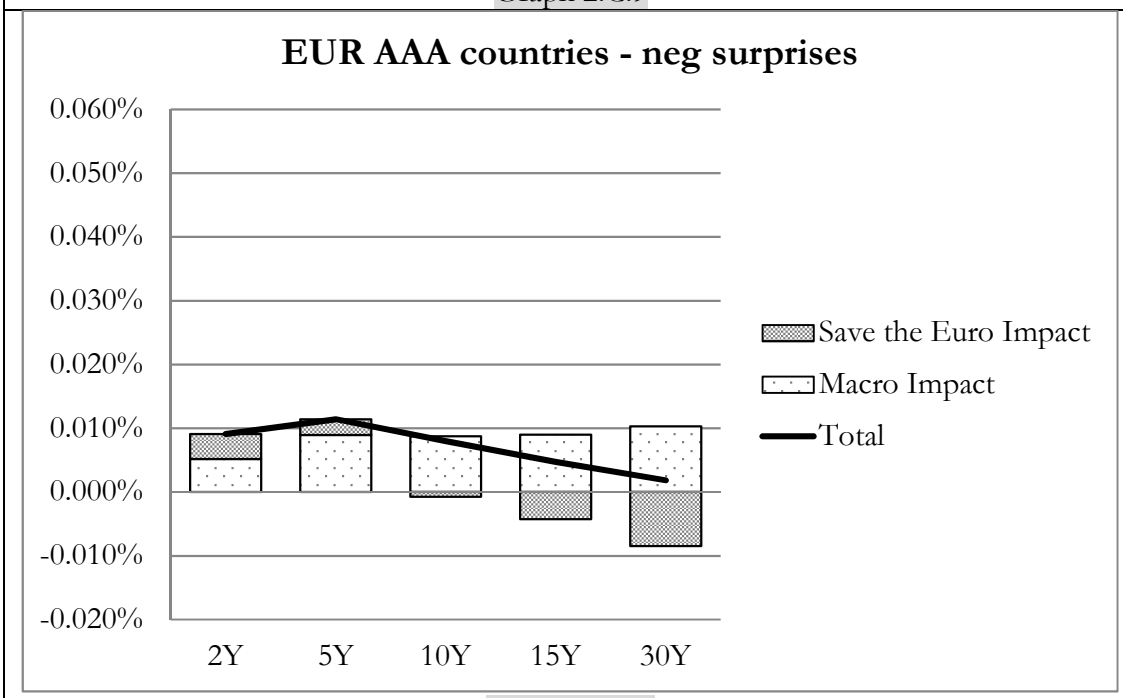
Graph 2.C.7



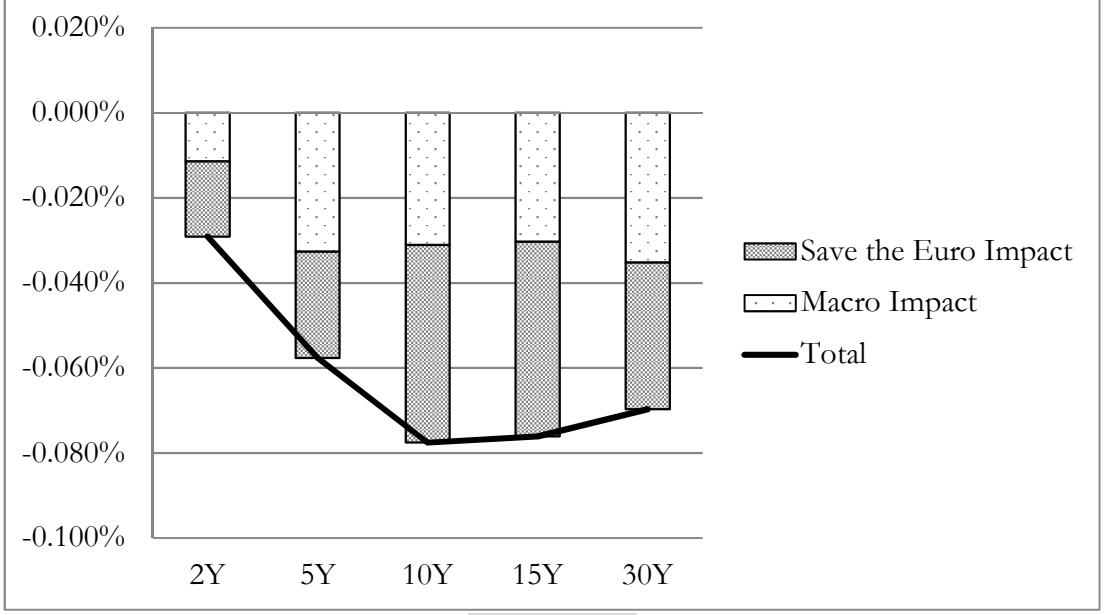
Graph 2.C.8



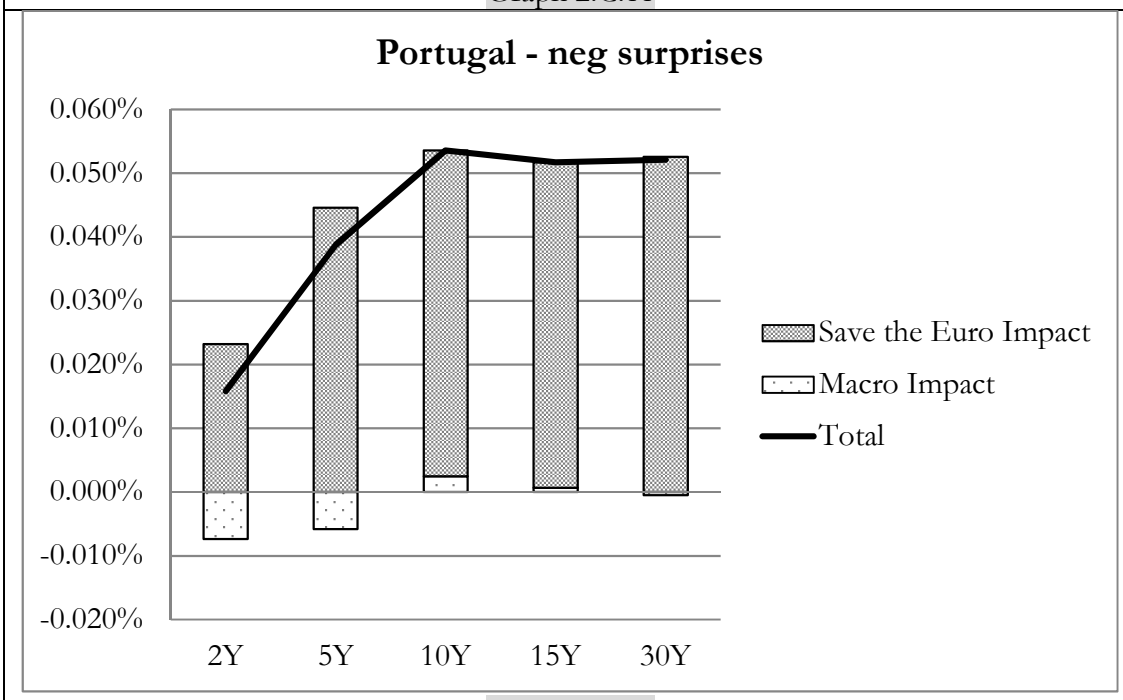
Graph 2.C.9



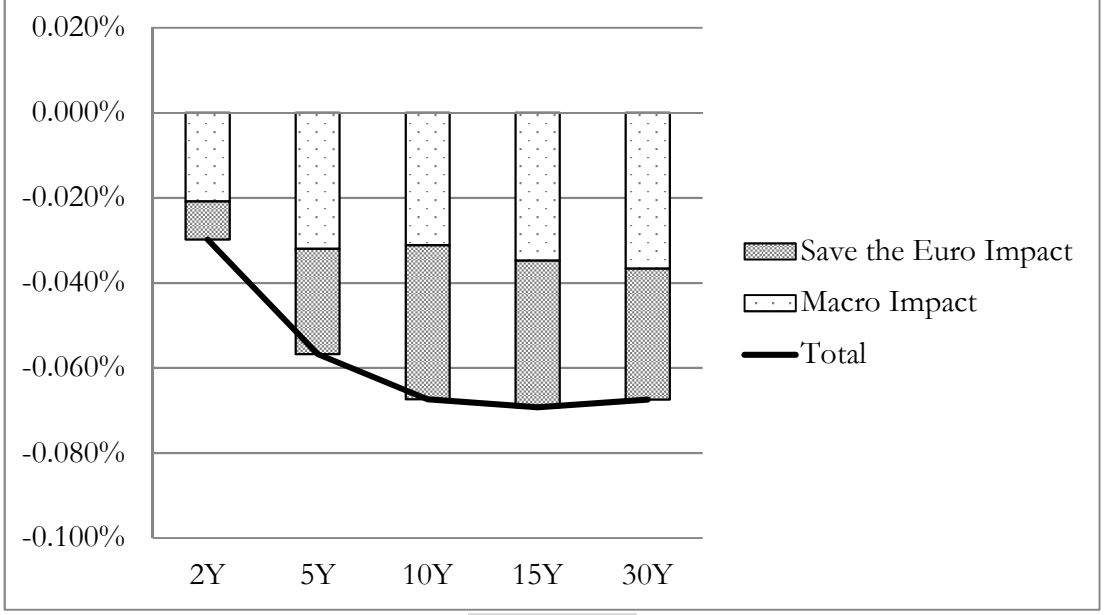
Graph 2.C.10



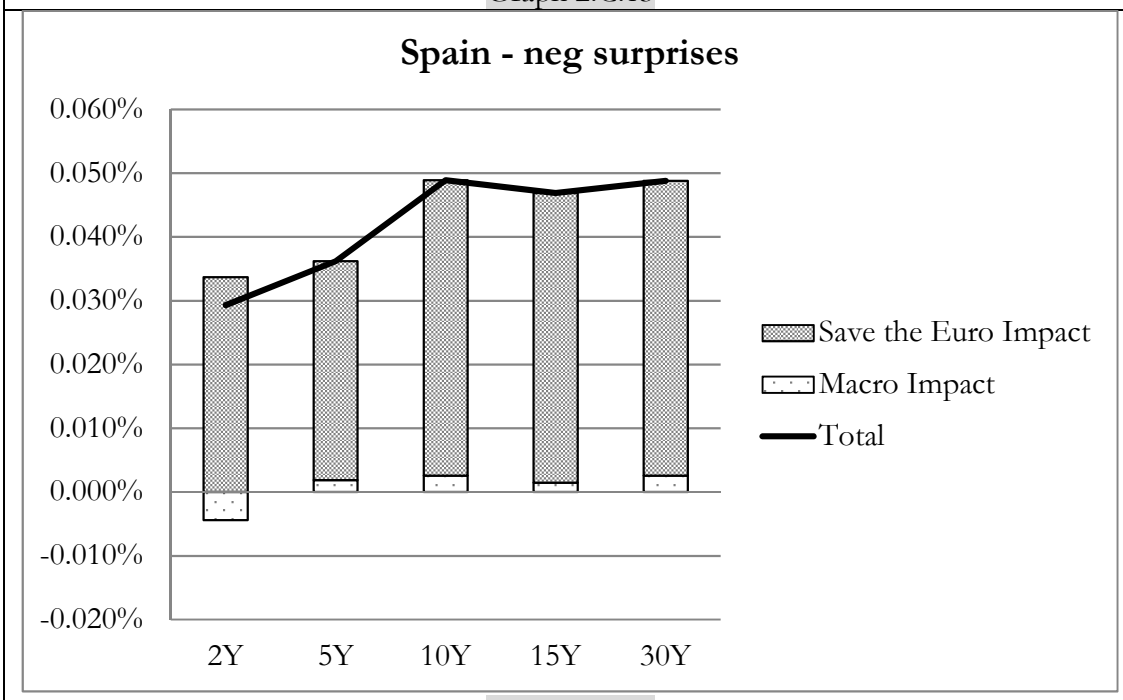
Graph 2.C.11



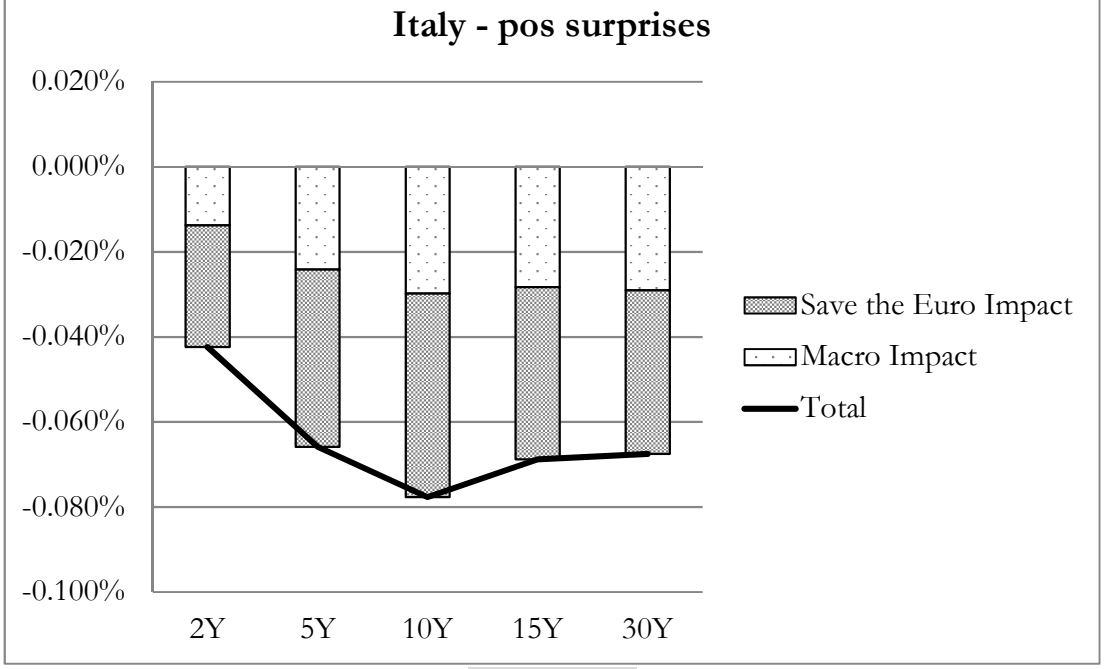
Graph 2.C.12



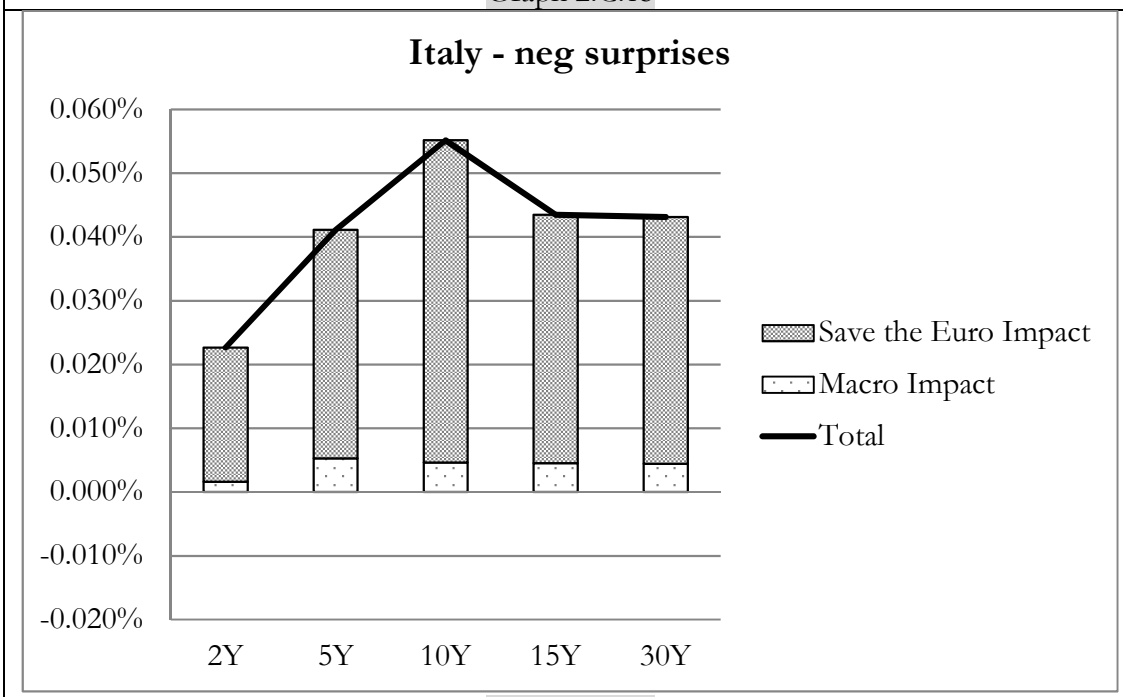
Graph 2.C.13



Graph 2.C.14



Graph 2.C.15



Graph 2.C.16

Appendix 2.D.

Testing for Symmetry																		
	$\beta_1=\beta_2$ regression: abs(surprise measures)			$\beta_1=\beta_2$			$\beta_3=\beta_4$ regression: abs(surprise measures)			$\beta_3=\beta_4$			$\beta_1+\beta_3=\beta_2+\beta_4$ regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$		
Channel	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Signalling	-0.00006**	0.00009**	11.23***	-0.00006**	-0.00009**	0.24	-0.00008**	0.00002	6.41**	0.00009**	0.00002	1.70	-0.00014***	0.00011*	14.84***	-0.00014***	-0.00011*	0.46
Preferred Habitat																		
2Y	-0.00003	-0.00001	0.54	-0.00003	0.00001	1.17	-0.00001	-0.00002	0.25	0.00001	-0.00002	0.49	- 0.00004	- 0.00003	0.03	- 0.00004	0.00003	5.53**
5Y	-0.00005**	0.00000	4.29**	-0.00005**	0.00000	1.96	-0.00003*	-0.00001	0.20	0.00003*	-0.00001	1.70	-0.00008***	- 0.00001	3.53*	-0.00008***	0.00001	11.34***
10Y	-0.00008***	0.00002	14.28***	-0.00008***	-0.00002	3.12*	-0.00001	0.00000	0.26	0.00001	0.00000	0.06	-0.00009***	0.00002	7.61***	-0.00009***	- 0.00002	4.70**
15Y	-0.00004	0.00001	4.29**	-0.00004	-0.00001	0.35	-0.00003*	0.00000	1.38	0.00004*	0.00000	0.84	-0.00007***	0.00002	3.59*	-0.00007***	- 0.00002	2.98*
30Y	-0.00005*	0.00001	4.45**	-0.00005*	-0.00001	0.95	-0.00004	0.00000	1.63	0.00004	0.00000	0.76	-0.00009***	0.00001	5.10**	-0.00009***	- 0.00001	4.61**
Duration																		
2Y																		
5Y	-0.00011***	0.00006***	32.76***	-0.00011***	-0.00006***	3.51*	0.00002	0.00000	0.60	-0.00002	0.00000	0.56	-0.00009***	0.00006***	21.32***	-0.00009***	-0.00006***	0.93
10Y	-0.0002***	0.00004	21.83***	-0.0002***	-0.00004	8.63***	0.00007	0.00000	1.45	-0.00007	0.00000	1.39	-0.00013***	0.00004	15.05***	-0.00013***	- 0.00004	2.82*
15Y	-0.00022***	0.00002	15.53***	-0.00021***	-0.00002	8.82***	0.00009	0.00001	1.48	-0.00009	0.00000	1.37	-0.00013***	0.00002	9.02***	-0.00013***	- 0.00002	2.59
30Y	-0.00019***	0.00000	7.54***	-0.00019***	0.00000	4.03**	0.00011	0.00001	1.37	-0.00010	0.00001	1.03	-0.00008*	0.00001	1.96	-0.00008*	- 0.00001	0.74

Note: in columns 5 through 7, 11 through 13 and 17 through 19, we report results for the original regression (3); in columns 2 through 4, 8 through 10 and 14 through 16, we report, instead, results for the alternative regression, i.e., we substitute the surprise measures for their absolute values.
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table D.1 – Tests of Symmetry (Common Channel Effects)

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Market Channel	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Aggregated Credit Liquidity																		
EUR AAA 2Y	0.00001	-0.00002	0.62	0.00001	0.00003	0.11	0.00000	0.00004	1.85	0.00000	0.00004	0.79	0.00001	0.00001	0.04	0.00001	- 0.00002	0.35
EUR AAA 5Y	0.00005	-0.00006*	5.73**	0.00005	0.00006*	0.06	0.00000	0.00002	0.17	-0.00001	0.00002	0.29	0.00005	- 0.00004	2.58	0.00006	0.00004	0.16
EUR AAA 10Y	0.00015**	-0.00006**	8.60***	0.00014**	0.00006**	0.96	-0.00002	-0.00003	0.11	0.00001	-0.00003	0.51	0.00013	-0.00009***	5.25**	0.00013	0.00009***	0.26
EUR AAA 15Y	0.00014*	-0.00003	5.32**	0.00013*	0.00003	1.39	0.00000	-0.00007	1.47	-0.00001	-0.00007	0.93	0.00014*	-0.0001***	6.11**	0.00014*	0.0001***	0.28
EUR AAA 30Y	0.00015	0.00000	2.75*	0.00014	0.00000	1.77	0.00002	-0.00012**	3.91**	-0.00003	-0.00011**	1.15	0.00017*	-0.00011***	5.90**	0.00017*	0.00011***	0.38
Portugal 2Y	-0.00002	-0.00015*	1.94	-0.00002	0.00015*	1.62	-0.00010	0.00023**	9.05***	0.00008	0.00023**	1.04	- 0.00011	0.00008	1.81	- 0.00011	- 0.00008	0.06
Portugal 5Y	-0.00010	-0.00021***	1.13	-0.00010	0.00021***	6.03**	-0.00017	0.00043***	17.66***	0.00017	0.00044***	2.28	-0.00027*	0.00023***	7.23***	-0.00027*	-0.00023***	0.07
Portugal 10Y	0.00003	-0.00012***	2.41	0.00003	0.00012***	0.72	-0.00045***	0.00047***	49.30***	0.00045***	0.00048***	0.04	-0.00042***	0.00036***	21.87***	-0.00042***	-0.00035***	0.20
Portugal 15Y	0.00001	-0.00011**	1.49	0.00001	0.00011**	0.96	-0.00043***	0.00048***	60.82***	0.00042***	0.00049***	0.20	-0.00042***	0.00037***	40.7***	-0.00042***	-0.00037***	0.16
Portugal 30Y	-0.00005	-0.0001**	0.18	-0.00006	0.00011**	1.41	-0.00038***	0.00048***	45.82***	0.00037***	0.00048***	0.56	-0.00043***	0.00038***	25.86***	-0.00043***	-0.00038***	0.12
Spain 2Y	-0.00012	-0.00012	0.00	-0.00012	0.00012	2.34	0.00001	0.00034	3.28*	-0.00001	0.00034	1.75	-0.00011*	0.00022	3.51*	-0.00011*	- 0.00021	0.57
Spain 5Y	-0.00009	-0.00013***	0.27	-0.00009	0.00013***	7.50***	-0.00017**	0.00033***	43.27***	0.00016**	0.00034***	2.72*	-0.00026***	0.00021***	44.05***	-0.00026***	-0.00021***	0.61
Spain 10Y	0.00003	-0.00012***	7.90***	0.00003	0.00012***	2.73*	-0.00035***	0.00042***	250.91***	0.00034***	0.00043***	1.29	-0.00032***	0.0003***	83.95***	-0.00032***	-0.0003***	0.13
Spain 15Y	-0.00004	-0.0001***	1.27	-0.00004	0.00011***	5.03**	-0.00031***	0.00043***	180.56***	0.00031***	0.00043***	2.51	-0.00035***	0.00032***	79.24***	-0.00035***	-0.00032***	0.17
Spain 30Y	-0.00007	-0.00007**	0.00	-0.00007	0.00008**	2.03	-0.00031***	0.00042***	108.86***	0.0003***	0.00043***	1.96	-0.00038***	0.00035***	36.54***	-0.00037***	-0.00035***	0.05
Italy 2Y	-0.00004	-0.00006	0.06	-0.00005	0.00006	1.34	-0.00018***	0.00021**	15.96***	0.00017***	0.00021**	0.10	-0.00022***	0.00015*	10.79***	-0.00022***	-0.00015*	0.55
Italy 5Y	-0.00001	-0.00009***	2.08	-0.00002	0.0001***	3.42*	-0.00032***	0.00034***	120.06***	0.00031***	0.00035***	0.19	-0.00033***	0.00025***	88.95***	-0.00033***	-0.00025***	2.25
Italy 10Y	0.00004	-0.0001***	13.90***	0.00004	0.0001***	3.34*	-0.00044***	0.00046***	1299.77***	0.00044***	0.00047***	0.90	-0.0004***	0.00037***	437.65***	-0.0004***	-0.00037***	0.80
Italy 15Y	0.00003	-0.00007***	4.17**	0.00003	0.00008***	0.74	-0.00037***	0.00036***	252.27***	0.00037***	0.00037***	0.01	-0.00035***	0.00029***	92.02***	-0.00034***	-0.00029***	1.09
Italy 30Y	0.00000	-0.00005***	0.75	0.00000	0.00006***	0.49	-0.00037***	0.00034***	171.24***	0.00037***	0.00035***	0.07	-0.00036***	0.00029***	46.08***	-0.00036***	-0.00029***	0.98
Credit																		
Portugal 2Y	-0.0001*	-0.00013**	0.16	-0.0001*	0.00013**	6.82***	-0.00011*	0.00023***	16.14***	0.00011*	0.00023***	1.66	-0.00021***	0.00010	8.06***	-0.00021***	- 0.00010	1.22

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Market Channel	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Portugal 5Y	-0.00011*	-0.00013**	0.10	-0.00011*	0.00014**	8.04***	-0.00017***	0.00022***	23.56***	0.00016***	0.00022***	0.43	-0.00027***	0.00008	12.24***	-0.00027***	- 0.00009	4.06**
Portugal 10Y	-0.00014*	-0.00014***	0.00	-0.00014*	0.00014***	8.89***	-0.00017***	0.00022***	24.99***	0.00017***	0.00023***	0.51	-0.00031***	0.00009	12.72***	-0.0003***	- 0.00009	4.64**
Portugal 15Y																		
Portugal 30Y	-0.00014	-0.00015***	0.01	-0.00014	0.00015***	7.27***	-0.00021***	0.00022***	22.33***	0.00021***	0.00023***	0.05	-0.00035***	0.00007	10.15***	-0.00035***	- 0.00008	5.32**
Spain 2Y	-0.00002	-0.00007***	2.45	-0.00002	0.00007***	4.96**	-0.00008***	0.0001***	47.81***	0.00008***	0.0001***	0.49	-0.0001***	0.00003	12.19***	-0.0001***	- 0.00003	4.19**
Spain 5Y	-0.00003	-0.0001**	2.09	-0.00003	0.0001**	4.57**	-0.00009***	0.00013***	33.10***	0.00009***	0.00013***	0.71	-0.00012***	0.00003	8.24***	-0.00012***	- 0.00003	3.79*
Spain 10Y	-0.00004	-0.00013**	2.10	-0.00004	0.00013**	3.65*	-0.00008**	0.00015***	24.21***	0.00008**	0.00016***	1.57	-0.00012***	0.00002	3.82*	-0.00012***	- 0.00002	2.39
Spain 15Y																		
Spain 30Y	-0.00008*	-0.00003	0.94	-0.00008*	0.00003	4.23**	-0.00005	0.00013***	7.10***	0.00004	0.00013***	1.42	-0.00013***	0.0001***	17.18***	-0.00013***	-0.0001***	0.30
Italy 2Y	-0.00003	-0.00006***	1.31	-0.00003	0.00007***	7.88***	-0.00014***	0.00014***	52.21***	0.00014***	0.00014***	0.02	-0.00017***	0.00008***	27.93***	-0.00017***	-0.00008***	4.71**
Italy 5Y	-0.00004	-0.00009***	2.11	-0.00005	0.00009***	10.12***	-0.00018***	0.00018***	70.06***	0.00017***	0.00018***	0.04	-0.00022***	0.00009***	32.62***	-0.00022***	-0.00009***	7.27***
Italy 10Y	-0.00005	-0.0001***	2.40	-0.00005	0.00011***	10.26***	-0.00018***	0.00019***	66.14***	0.00018***	0.00019***	0.08	-0.00023***	0.00009***	30.39***	-0.00023***	-0.00009***	8.76***
Italy 15Y																		
Italy 30Y	-0.00005	-0.00011***	3.08*	-0.00005	0.00011***	11.16***	-0.00018***	0.0002***	77.36***	0.00018***	0.0002***	0.17	-0.00023***	0.00009***	30.95***	-0.00022***	-0.00009***	8.48***
Liquidity																		
Portugal 2Y	0.00009	-0.00001	0.45	0.00008	0.00001	0.17	0.00001	-0.00001	0.03	-0.00002	-0.00001	0.00	0.00010	- 0.00002	0.34	0.00010	0.00002	0.25
Portugal 5Y	0.00002	-0.00008	0.96	0.00002	0.00008	0.22	-0.00001	0.00023**	4.04**	0.00001	0.00023**	2.02	0.00001	0.00015*	0.64	0.00001	-0.00015*	1.31
Portugal 10Y	0.00017**	0.00001	2.75*	0.00017**	-0.00001	2.69	-0.00028***	0.00026***	27.93***	0.00028***	0.00027***	0.01	- 0.00011	0.00028***	6.65**	- 0.00011	-0.00028***	1.97
Portugal 15Y																		
Portugal 30Y	0.00009	0.00004	0.51	0.00009	-0.00004	1.65	-0.00013	0.00028***	12.02***	0.00012	0.00028***	0.94	- 0.00004	0.00032***	9.23***	- 0.00004	-0.00031***	6.20**
Spain 2Y	-0.00010	-0.00005	0.30	-0.00009	0.00005	0.73	0.00008	0.00023	0.66	-0.00008	0.00023	1.43	- 0.00001	0.00018	1.17	- 0.00001	- 0.00018	1.42
Spain 5Y	-0.00005	-0.00002	0.16	-0.00005	0.00003	0.75	-0.00008	0.0002***	14.82***	0.00008	0.0002***	1.49	-0.00013**	0.00018***	15.65***	-0.00013**	-0.00018***	0.44
Spain 10Y	0.00007	0.00001	0.89	0.00007	-0.00001	0.81	-0.00026***	0.00029***	99.48***	0.00026***	0.00029***	0.20	-0.00019***	0.0003***	48.45***	-0.00019***	-0.0003***	2.40

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Market Channel	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Spain 15Y																		
Spain 30Y	0.00002	-0.00005	0.47	0.00002	0.00005	0.12	-0.00025***	0.00031***	44.36***	0.00025***	0.00031***	0.51	-0.00023**	0.00026***	15.03***	-0.00023**	-0.00026***	0.06
Italy 2Y	-0.00002	0.00002	0.33	-0.00002	-0.00002	0.00	-0.00005	0.00005	1.55	0.00005	0.00006	0.00	- 0.00007	0.00007	1.81	- 0.00007	- 0.00007	0.00
Italy 5Y	0.00003	0.00000	0.20	0.00003	0.00000	0.24	-0.00016***	0.00017***	23.75***	0.00016***	0.00017***	0.02	-0.00013***	0.00017***	18.97***	-0.00013***	-0.00017***	0.49
Italy 10Y	0.00008*	0.00001	2.57	0.00008*	-0.00001	2.37	-0.00027***	0.00028***	97.99***	0.00027***	0.00028***	0.04	-0.00018***	0.00029***	53.13***	-0.00019***	-0.00029***	4.38**
Italy 15Y																		
Italy 30Y	0.00005	0.00005*	0.01	0.00005	-0.00005*	1.81	-0.00018***	0.00016***	22.87***	0.00019***	0.00016***	0.08	-0.00013*	0.00021***	13.04***	-0.00014*	-0.00021***	0.87

Note: in columns 5 through 7, 11 through 13 and 17 through 19, we report results for the original regression (3); in columns 2 through 4, 8 through 10 and 14 through 16, we report, instead, results for the alternative regression, i.e., we substitute the surprise measures for their absolute values.

***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table D.2 – Tests of Symmetry (Market Specific Channels)

References

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics, 108*, 162-179. doi: https://doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2015). *Asset purchase programmes and financial markets: lessons from the euro area.* ECB Working Paper, 1864. European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf

Andrade, P., & Ferroni, F. (2021). Delphic and odyssean monetary policy shocks: Evidence from the euro area. *Journal of Monetary Economics, 117*, 816-832. doi: https://doi.org/10.1016/j.jmoneco.2020.06.002

Bernanke, B. S., Reinhart, V. R., & Sack, B. P. (2004). Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment. *Brookings Papers on Economic Activity, 36*(4), 1-100. doi: https://doi.org/10.1353/eca.2005.0002

Bernhard, S., & Ebner, T. (2017). Cross-Border Spillover Effects of Unconventional Monetary Policies on Swiss Asset Prices. *Journal of International Money and Finance, 75*(July), 109-127. doi: https://doi.org/10.1016/j.jimonfin.2017.04.001

Cieslak, A., & Schrimpf, A. (2019). Non-monetary News in Central Bank Communication. *Journal of International Economics, 118*, 293-315.

D'Amico, S., English, W., López-Salido, D., & Nelson, E. (2012). The Federal Reserve's Large-scale Asset Purchase Programmes: Rationale and Effects*. *Economic Journal, 122*(564), F415-F446. doi: https://doi.org/10.1111/j.1468-0297.2012.02550.x

Driffill, J. (2016). Unconventional Monetary Policy in the Euro Zone. *Open Economies Review, 27*(2), 387-404. doi: https://doi.org/10.1007/s11079-016-9393-0

Evgenidis, A., Tsagkanos, A., & Siriopoulos, C. (2017). Towards an asymmetric long run equilibrium between stock market uncertainty and the yield spread. A threshold vector error correction approach. *Research in International Business and Finance, 39*, 267-279. doi: https://doi.org/10.1016/j.ribaf.2016.08.002

Falagiarda, M., & Reitz, S. (2015). Announcements of ECB unconventional programs: Implications for the sovereign spreads of stressed euro area countries. *Journal of International Money and Finance, 53*(C), 276-295. doi: https://doi.org/10.1016/j.jimonfin.2015.02.005

Fausch, J., & Sigonius, M. (2018). The impact of ECB monetary policy surprises on the German stock market. *Journal of Macroeconomics, 55*, 46-63. doi: https://doi.org/10.1016/j.jmacro.2017.09.001

Fendel, R., & Neugebauer, F. (2018). *Country-specific Euro area government bond yield reactions to ECB's non-standard monetary policy announcements*. WHU – Working Paper Series in Economics - WP 18/02. WHU - Otto Beisheim School of Management. Vallendar. Retrieved from https://opus4.kobv.de/opus4-whu/frontdoor/index/index/docId/645

Fratzscher, M., Lo Duca, M., & Straub, R. (2016). On the International Spillovers of US Quantitative Easing. *Economic Journal, 128*(608), 330-377. doi: https://doi.org/10.1111/ecoj.12435

Georgiadis, G., & Grab, J. (2016). Global Financial Market Impact of the Announcement of the ECB's Asset Purchase Programme. *Journal of Financial Stability, 26*(October), 257-265. doi: https://doi.org/10.1016/j.jfs.2016.07.009

Glick, R., & Leduc, S. (2012). Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets. *Journal of International Money and Finance, 31*(8), 2078-2101. doi: https://doi.org/10.1016/j.jimonfin.2012.05.009

Haitsma, R., Unalmis, D., & de Haan, J. (2016). The Impact of the ECB's Conventional and Unconventional Monetary Policies on Stock Markets. *Journal of Macroeconomics, 48*(June), 101-116. doi: https://doi.org/10.1016/j.jmacro.2016.02.004

Hosono, K., & Isobe, S. (2014). *The Financial Market Impact of Unconventional Monetary Policies in the U.S., the U.K., the Eurozone, and Japan*. Discussion papers, 14A-05. Policy Research Institute, Ministry of Finance Japan. Retrieved from https://EconPapers.repec.org/RePEc:mof:wpaper:ron259

Jarocinski, M., & Karadi, P. (2018). *Deconstructing monetary policy surprises: the role of information shocks*. European Central Bank, Working Paper Series: 2133. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=eoh&AN=1710090&lang=pt-pt&site=ehost-live&scope=site

Joyce, M. A. S., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal Central Banking, 7*(3), 113-161.

Kontonikas, A., & Kostakis, A. (2013). On Monetary Policy and Stock Market Anomalies. *Journal of Business Finance & Accounting, 40*(7/8), 1009-1042. doi: https://doi.org/10.1111/jbfa.12028

Krishnamurthy, A., Nagel, S., & Vissing-Jorgensen, A. (2018). ECB Policies Involving Government Bond Purchases: Impact and Channels. *Review of Finance, 22*(1), 1-44. doi: https://doi.org/10.1093/rof/rfx053

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. *Brookings Papers on Economic Activity, 42*(2), 215-287.

Leombroni, M., Vedolin, A., Venter, G., & Whelan, P. (2018). *Central Bank Communication and the Yield Curve*. C.E.P.R. Discussion Papers, CEPR Discussion Papers: 12970. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=eoh&AN=1709960&lang=pt-pt&site=ehost-live&scope=site

Modigliani, F., & Sutch, R. (1966). Innovations in interest rate policy. *The American Economic Review, 56*(1/2), 178-197.

Modigliani, F., & Sutch, R. (1967). Debt management and the term structure of interest rates: An empirical analysis of recent experience. *Journal of Political Economy, 75*(4), 569-589.

Papadamou, S., Siriopoulos, C., & Kyriazis Nikolaos, A. (2020). A survey of empirical findings on unconventional central bank policies. *Journal of Economic Studies, 47*(7), 1533-1577. doi: https://doi.org/10.1108/JES-04-2019-0186

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics, 51*(8), 1553-1575. doi: http://dx.doi.org/10.1016/j.jmoneco.2004.02.004

Riordan, R., & Schrimpf, A. (2015). Volatility and Evaporating Liquidity During the Bund Tantrum. *BIS Quarterly Review*, 11–12.

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

Rosa, C. (2011). The Validity of the Event-Study Approach: Evidence from the Impact of the Fed's Monetary Policy on US and Foreign Asset Prices. *Economica, 78*(311), 429-439. doi: https://doi.org/10.1111/j.1468-0335.2009.00828.x

Rosa, C. (2012). *How 'unconventional' are large-scale asset purchases? The impact of monetary policy on asset prices.* Staff Reports, 560. Federal Reserve Bank of New York. Retrieved from http://www.newyorkfed.org/research/staff_reports/sr560.pdf

Schlepper, K., Hofer, H., Riordan, R., & Schrimpf, A. (2017). *Scarcity effects of QE: A transaction-level analysis in the Bund market.* BIS Working Paper, 625. Retrieved from https://www.bis.org/publ/work625.pdf

Swanson, E. T. (2011). Let's Twist Again: A High-Frequency Event-Study Analysis of Operation Twist and Its Implications for QE2. *Brookings Papers on Economic Activity, 42*(1), 151-188.

Swanson, E. T. (2017). *Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets.* National Bureau of Economic Research, Inc, NBER Working Papers: 23311. Retrieved from http://www.nber.org/papers/w23311.pdf

Tenreyro, S., & Thwaites, G. (2016). Pushing on a String: US Monetary Policy Is Less Powerful in Recessions. *American Economic Journal: Macroeconomics, 8*(4), 43-74. doi: http://www.aeaweb.org/aej-macro/

Tobin, J. (1961). Money, capital, and other stores of value. *The American Economic Review, 51*(2), 26-37.

Tobin, J. (1963). An essay on the principle of debt management, in: Fiscal and debt management policies: Commission on money and credit. In C. o. m. a. credit (Ed.), *Fiscal and debt management policies*. Englewood Cliffs, NJ: Prentice Hall Inc.

Vayanos, D., & Vila, J.-L. (2009). *A Preferred-Habitat Model of the Term Structure of Interest Rates*. NBER Working Paper Series, 15487. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w15487.pdf

Wright, J. H. (2012). What does Monetary Policy do to Long-term Interest Rates at the Zero Lower Bound?*. *Economic Journal, 122*(564), F447-F466. doi: https://doi.org/10.1111/j.1468-0297.2012.02556.x

Wright, J. H. (2019). Comment on "Measuring euro area monetary policy" by Carlo Altavilla, Luca Brugnolini, Refet Gürkaynak, Giuseppe Ragusa and Roberto Motto. *Journal of Monetary Economics, 108*, 180-184. doi: https://doi.org/10.1016/j.jmoneco.2019.08.017

CHAPTER 3

THE IMPACT OF THE ECB'S ASSET PURCHASE PROGRAMME ON EURO AREA EQUITIES

3. THE IMPACT OF THE ECB'S ASSET PURCHASE PROGRAMME ON EURO AREA EQUITIES

Abstract

We study the announcement effects of the ECB's asset purchase programme (APP) on core and peripheral euro area equity indices and sectors, using a data set for June 2014-March 2018. This paper uses an event study with a one-day window and our results show that effects are statistically relevant and have the expected direction. A simultaneous one standard deviation change in both policy surprise measures we considered translates into a higher return, of close to +1% on average, when surprises are more expansionary than expected. When surprises are more contractionary than expected, returns are lower, by less than -0.5% on average. This asymmetric reaction to policy surprises is statistically significant and we confirm previous findings about the non-linearity of asset price responses. We are, to the best of our knowledge, the first to empirically identify and quantify the impact of two simultaneous but different quantitative easing (QE) factors, one that is related to overall stimulus and another one that may differentially affect equity markets. Finally, we conclude that effects of the ECB's APP are mostly derived from the latter QE factor – a "save the euro" QE factor.

Keywords: unconventional monetary policy, asset purchase programmes, spillovers, equities, asymmetry

JEL CLASSIFICATION CODES: E52, E58, G15

3.1. Introduction

The effects of unconventional monetary policies (UMP) on asset prices have been previously studied but this subject has recently been more comprehensively analysed given the importance these central bank policies have acquired. When it comes to the effects of the ECB APP on euro area equity markets, we hypothesize that it might have different effects across core and peripheral equity markets, across different sectors and when considering either contractionary or expansionary policy surprises. Our objectives are, therefore: i) to evaluate the announcement effects of the ECB's APP on euro area broad equity indices; ii) to evaluate these effects on different equity sectors; iii) to evaluate the differences in behaviour between core and peripheral markets and sectors; and iv) to evaluate how these effects vary with expansionary (positive) and contractionary (negative) UMP surprises.

Ever since the financial crisis began, in 2007-08, the European Central Bank (ECB) has implemented several unconventional measures. Liquidity provision operations to the banking sector were recurrently used since 2008. Additionally, several purchase programmes were implemented since 2009 and some were still ongoing in 2018[1]. The programmes that were still active in 2018 were all included in the expanded asset purchase programme (APP) since they were all supposed to address the risk of a long period of low inflation – as such, they had a policy accommodation purpose. All other programmes (not included in the APP) were justified by the ECB under the argument that "its policies were not being transmitted effectively" (Driffill, 2016, p.395). The APP includes the Corporate Sector Purchase Programme (CSPP), the Asset-backed Securities Purchase Programme (ABSPP), the third Covered Bond Purchase Programme (CBPP3) and the Public Sector Purchase Programme (PSPP).

The ECB initiated a covered bond purchase programme (CBPP, with a €60 billion target) in 2009 – it was the first euro area's asset purchase programme. A second covered bond purchase programme (CBPP2) was launched in 2011 and was completed by October 2012 (target: €16.4 billion; net holdings, as of March 2018: €4.5 billion). In 2014, the third covered bond purchase programme (CBPP3) was introduced and was still ongoing in 2018 (net holdings, as of March 2018: €249 billion). It was, therefore, included in the APP together

[1] For information on all ECB asset purchase programmes: http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html (accessed 4 April 2019).

with other programmes that the ECB decided to implement since then. In the same year, an asset-backed securities purchase programme started (ABSPP; net holdings, as of March 2018: €26 billion). In 2015, the ECB began buying public sector securities under the Public Sector Purchase Programme (PSPP; net holdings, as of March 2018: €1945 billion) and, finally, in 2016, the ECB implemented a corporate sector purchase programme (CSPP; net holdings, as of March 2018: €149 billion).

Central bank purchases and their financial markets' impact are at the centre of investment professionals' reflections since the degree of portfolio diversification, risk assessment practices and risk management strategies are affected (Kontonikas & Kostakis, 2013). Purchases have also macroeconomic implications as the links between monetary policy and asset prices affect the monetary policy transmission mechanism (Rosa, 2011). Additionally, depending on exposure to monetary policy risk, purchases have implications at the corporate financial management level, namely when it comes to determining the cost of capital (Kontonikas & Kostakis, 2013).

Our main contribution to the research discussion is a detailed analysis, for different equity indices, of the announcement effects of the APP, considering both positive and negative UMP surprises. In particular, we are the first to consider, empirically, the possible simultaneous influence of two QE factors – mentioned by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019). A more comprehensive understanding of the programme's effects is possible since we consider two euro area indices in addition to the German, the Portuguese, the Spanish and the Italian broad equity indices, to contrast the effects of the APP on euro area, one core and several peripheral equity markets. Our objective is to evaluate if and how effects differ across these markets. Sector indices, for the euro area and for peripheral markets, are also studied in order to determine whether this is a relevant dimension when it comes to APP effects on equities. We consider a large set of relevant events, enhancing our ability to make inferences and interpret results, and we control for market expectations, limiting what is known as attenuation bias, by simultaneously considering both a "macroeconomic" surprise measure and a "save the euro" surprise measure which, to our knowledge, has not been previously done in this context. Finally, as Rogers, Scotti, and Wright (2014) state it has been "difficult to investigate [asymmetry] in the context of unconventional monetary policy because most (but not all) surprises have been

easings" (p.776) and we, therefore, enlarged the scope of our analysis by contrasting effects with positive and negative UMP surprises.

Our results show that although the direction of effects for expansionary and contractionary surprises is often different its magnitude is usually not – in line with previous research findings (Altavilla et al., 2019). Indeed, we document that the effects of APP announcements on equity markets depend on the sign of the policy surprise and have the theoretically expected direction: higher equity returns with expansionary surprises (+0.80%, for a simultaneous standard deviation change in both policy surprise measures considered) and lower equity returns when surprises are contractionary (-0.43%). Differences in effects for core, euro area and peripheral markets and for different sectors, as well as for the same sector but at the euro area and at the peripheral level, are not statistically significant but the estimates we arrive at are also consistent with other studies' conclusions about the effects' magnitude as well as the difference between the effects estimated using one-day and two-day windows (Altavilla, Carboni, & Motto, 2015). By considering the above mentioned two QE factors we conclude that euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area, but not when they were associated with an overall stimulus.

The ECB designed some UMP to restore the proper functioning of financial markets and intermediation while other UMP provided policy accommodation. Since, methodologically, approaches are different[2] we focused on a specific policy intended to deliver accommodation. We first identified dates when the ECB made decisions about the APP or when market participants could have made inferences about the programme. We then categorized these event days as positive (more expansionary than expected) or negative surprises (more restrictive than expected). We use this information in an event study with regression analysis. A more detailed explanation of the selected events and their classification methodology is presented in section 3.3.

[2] For a discussion about how markets react to UMP in crisis and non-crisis periods see Haitsma, Unalmis, and de Haan (2016) and Swanson (2011), who cautions against generalizing early programmes' results and for concentrating on "more normal times" (p.153), i.e., when the degree of market segmentation is lower.

3.2. Literature Review

Although the idea of imperfect links between short and long term securities markets and the preferred-habitat model was first advanced by Tobin (1961, 1963) and Modigliani and Sutch (1966, 1967), a more rigorous theoretical partial equilibrium approach to a preferred-habitat setting has been developed by Vayanos and Vila (2009). This model helps to explain how, when risk aversion is high, conventional monetary policy decisions become less effective, since forward rates stop reacting to changes in expected short rates, as predicted by the pure expectations theory of the term structure of interest rates described by Modigliani and Sutch (1966, 1967).

Relaxing the strong assumption that financial markets are frictionless and considering instead that money and other financial assets are imperfect substitutes allows, consequently, for the argument that directly intervening in long-term bond markets might become more effective in influencing long rates. Assuming arbitrageurs' high risk aversion and market segmentation, central bank purchases seem to have large effects on those targeted assets over which preferred-habitat investors have specific demand and spillovers to non-targeted assets are limited (Altavilla et al., 2015). However, a wider range of risk premia, such as an interest rate premium, a credit premium, a liquidity premium or an equity risk premium, is impacted, especially when the risk-bearing capacity of arbitrageurs is higher, as purchases become less effective vis-à-vis the targeted assets but spillovers to non-targeted assets become more significant (Altavilla et al., 2015). With lower risk aversion, and as arbitrageurs integrate market segments, purchases spillover to non-targeted assets and a portfolio rebalancing channel becomes effective. A general equilibrium channel is also in operation, whether assets are targeted or non-targeted, via the anticipation of better macroeconomic conditions (Altavilla et al., 2015).

There is an extensive empirical literature about the effects of UMP on asset prices. A significant proportion of it is about the effects of UMP in the United States (US) and in the United Kingdom (UK). Papadamou, Siriopoulos, and Kyriazis Nikolaos (2020) provide a recent overview of research about UMP impact by major central banks.

Research about the impact of UMP on the euro area's financial assets is often focused on the early purchase programmes, which have a different nature[3]. Nevertheless, work on asset price responses to monetary policy for the euro area and related questions has been conducted by Altavilla et al. (2015), Driffill (2016), Haitsma et al. (2016), Georgiadis and Grab (2016), Andrade and Ferroni (2021), Fausch and Sigonius (2018), Leombroni, Vedolin, Venter, and Whelan (2018), Cieslak and Schrimpf (2019), Jarocinski and Karadi (2018), and Altavilla et al. (2019), among others.

Altavilla et al. (2015), Driffill (2016), Georgiadis and Grab (2016), Haitsma et al. (2016) and Fausch and Sigonius (2018) are more closely related to our paper. Altavilla et al. (2015) conclude that the euro area equity index (Dow Jones Euro Stoxx) was up, at announcement dates, by between 1% and 5% depending on the methodology used (accumulated effect). Georgiadis and Grab (2016) conclude that the accumulated effect of APP related news on the euro area equity market index amounts to almost 11%. Haitsma et al. (2016) point out that ECB unconventional monetary policy surprises cause an increase of the Euro Stoxx 50 average return (on event days) of 0.5%. Additionally, these authors refer that several equity sectors are significantly influenced by such surprises and highly leveraged, value and past loser stocks, show a larger reaction. Finally, Fausch and Sigonius (2018) in particular look at the effects on German equity markets. They argue that, on average, returns were higher by 0.31% per event day.

Of relevance to our results is also Altavilla et al. (2019). In contrast to some literature which suggests that the US monetary policy has asymmetric real effects (Tenreyro & Thwaites, 2016), their results argue for the lack of asymmetry in asset prices responses to positive and negative ECB surprises, i.e., their magnitude is not different.

First, we find evidence that APP announcements lead to higher equity returns when UMP surprises are positive and to lower equity returns when surprises are negative, i.e., they have the expected direction. Second, these effects are statistically significant for core (Germany), euro area and peripheral (Portugal, Spain and Italy) markets. Third, we also demonstrate these effects exist for sector indices. Fourth, estimated effects have different directions but generally do not have different magnitudes. Finally, by considering both a

[3] The Securities Markets Programme (SMP) and the Outright Monetary Transactions (OMT) programme were implemented by the ECB to normalize market functioning. The objective of liquidity provision operations was to address a liquidity shortage problem.

"macroeconomic" surprise measure and a "save the euro" surprise measure we can show most of the reported effects on equities are due to the latter QE factor.

The rest of the paper is organised as follows. Section 3.3 describes the methodological options, the regression model as well as all data. Section 3.4 contains the results, the discussion and an analysis of the robustness checks we conducted. Finally, section 3.5 concludes. We relegate complementary information to the Appendices.

3.3. Methodology and data

We use an event study methodology based on the aforementioned empirical literature. We first consider that jumps in asset prices in a particular window around events (Haitsma et al., 2016) can be used to measure the surprise in UMP and we subsequently apply a specific form of measurement of the surprise content of the announcement to calibrate the effects accordingly. In order to identify UMP shocks, we must first define the relevant set of events and then measure the extent of policy surprise.

We use a narrative approach to define the event set. In order to avoid the potential underestimation of the programme's overall impact, as a result of information leakage, we do not limit the assessment to formal announcement dates –following Altavilla et al. (2015). The problem of no news can be mitigated by restricting the number of events, which reduces noise. However, on another hand, this procedure can generate situations where nothing happened although a move was expected. Most previous studies allow only for restricted inference and interpretation due to small data samples. We, therefore, following Bernhard and Ebner (2017), argue that a larger event set helps to mitigate that important limitation allowing us to strengthen our conclusions.

We identified eighty-nine event days between June 1st, 2014, and March 31st, 2018. Related research and the ECB website were the sources for this information. We refer the reader to the complete list of events in Appendix 3.A. We initially identified a group of fifteen event days – events marked as "core" (in bold) in Appendix 3.A. These are days either previously highlighted[4] as containing relevant new information about the APP or days corresponding to meeting statements or speeches when the ECB first communicated APP

[4] See Driffill (2016), Altavilla et al. (2015), Bernhard and Ebner (2017), Georgiadis and Grab (2016) and Haitsma et al. (2016).

changes to the market. We, then, considered seventy-four additional event days: other ECB meeting dates and all other dates (from June 2014 to March 2018) when the ECB president mentioned the APP, since central bank communications significantly affect asset prices not only around policy announcements but also around other ECB president speeches (Leombroni et al., 2018). We therefore considered both dates when ECB decisions about the APP were *definitely* made and dates when market participants could have made *inferences* about the programme. These dates have all been adjusted for the time at which the relevant event took place[5].

Another important methodological consideration is the window used to measure the APP's effects. When central banks first implemented the most recent UMP measures, markets were frequently operating inefficiently, the unconventional policies under scrutiny were still new and markets had to make sense of information they had never dealt with before, and therefore, in earlier research[6], using a longer window was common practice. More recently daily and intraday changes in prices around the events have become the methodological standard since these purchase programmes have become less of a novelty and market conditions have returned to non-crisis levels.

Nevertheless, given the presence of a "save the euro" like factor (Wright, 2019) we argue that markets, specifically peripheral markets, might still not be operating efficiently and therefore a daily window is a reasonable choice since market participants need time to assimilate news, and therefore one should not use a window that is too narrow. This choice helps to lessen the risk of reverse causality (an important consideration we will come back to further ahead) and it allows for a precise identification of the effects of UMP since contamination by other news is unlikely (Hosono & Isobe, 2014).

Following Rogers et al. (2014) and Bernhard and Ebner (2017), we agree that there is no clear consensus when it comes to determining UMP expectations and, therefore, unexpected announcements and the size of the policy shock[7]. We also consider that with a

[5] For example, Mario Draghi's February 2015 Introductory Statement to the plenary debate of the European Parliament on the ECB's Annual Report was delivered on February 25th at 17h38m (GMT); in the event list we considered February 26th as the relevant event day.
[6] Joyce, Lasaosa, Stevens, and Tong (2011) and Krishnamurthy and Vissing-Jorgensen (2011) use a window of two days.
[7] This is in contrast to what happens with the measurement of the surprise content of conventional monetary policy announcements, where a standard choice about the best (market-based) measure does exist.

large enough set of events one cannot plausibly argue that all events are fully surprising to market participants and we should assume that market anticipation of unconventional policy announcements improves over time (Bernhard & Ebner, 2017). Qualitative measures of UMP expectations[8] exist, but most studies measure policy surprises utilizing quantitative measures[9] (i.e., asset prices) which make it possible to address what is known as attenuation bias (Rosa, 2012). The assumption is that with efficient markets expected policy changes are already reflected in asset prices and only unanticipated policy changes are supposed to affect them (Haitsma et al., 2016).

Hosono and Isobe (2014) and Bernhard and Ebner (2017), following Wright (2012), use daily changes in German bond futures' prices; Rogers et al. (2014) use daily changes in the Italian yield spread (versus Germany), which is also argued for by Altavilla et al. (2019) and Wright (2019) since ECB policies were also intended to reduce intra-euro area spreads.

We considered the one day change in the price of bond futures (German bund, approximately 10 years, most active contract), i.e., the same measure as the one used in Hosono and Isobe (2014), Bernhard and Ebner (2017) and Glick and Leduc (2012), as our UMP "macroeconomic" surprise measure. The price change was measured between the announcement day close price and the previous day close price. Our objective here is detecting policy measures that provide overall stimulus. In order to measure a second type of stimulus that may differentially affect equity markets we simultaneously considered, following an argument made by Altavilla et al. (2019), an additional surprise measure which we associate with a "save the euro" factor. We derived this measure from the one-day change in the Italy-Germany 10-year yield spread[10].

Finally, following the results of Glick and Leduc (2012), we assume important information may be extracted by contrasting the more expansionary announcements with the less expansionary ones (Bernhard & Ebner, 2017). We, therefore, classified the identified

[8] Such as survey data from professional forecasters and measures of expectations based on newspaper articles.
[9] Bernhard and Ebner (2017) list alternative measures proposed in the literature.
[10] Following a procedure suggested, for instance, in Swanson (2017), we regress the one day change in the Italy-Germany 10-year yield spread on a constant and the one day change in the price of bond futures. We define the residuals of this regression as our "save the euro" surprise measure. The two surprise measures are therefore orthogonal.

event days either as positive, i.e., events are more expansionary than expected[11] or negative surprises, i.e., events are more restrictive than expected[12].

As central banks may be seen as reacting to market developments, endogeneity can be an important issue when analysing the impact of UMP. However, since market daily developments are unlikely to determine central banks' actions[13] – particularly in a non-crisis environment – Kontonikas and Kostakis (2013) argue endogeneity is not a problem when using daily data. We similarly consider, therefore, that the likelihood that our results are contaminated by reverse causality (running from asset returns to changes in monetary policy) is minimized by using daily data. In addition, contamination by other news (Haitsma et al., 2016) is likely minimized with such a short time window. Nevertheless, controlling for other macroeconomic news and other variables that take into consideration previous trends in asset prices and market developments is important, since it helps to reduce the potential problem of endogeneity and the possibility that price movements have other causes beyond unexpected UMP (Bernhard & Ebner, 2017).

Notwithstanding, we have considered the risk of reverse causality and the possibility of an omitted variable bias[14]. On the one hand and as mentioned before, we handled these risks by using control variables to incorporate in our analysis previous trends in asset prices and market developments, which could lead to subsequent policy interventions and asset price changes. As argued, considering theses controls mitigates potential endogeneity issues. On another hand, we have also tested for Granger causality in our data set and, accordingly, past asset price developments do not seem to drive the surprise measures we used[15]. It is also important to remember that from a central banking practice perspective, short-run developments in asset prices are unlikely to determine policy decisions, which by itself reduces the relevance of the endogeneity bias. Additionally, the use of daily changes in asset prices allows markets sufficient time to process policy news without contaminating the measurement – as argued in Hosono and Isobe (2014). We, therefore, have taken into

[11] There are fifty-two days when the price of bond futures rose and forty-nine days when the yield spread fell.
[12] There are thirty-seven days when the price of bond futures fell and forty days when the yield spread rose.
[13] The same argument is used, for example, by Altavilla et al. (2015), Bernhard and Ebner (2017), Glick and Leduc (2012), Rogers et al. (2014), Hosono and Isobe (2014), Fratzscher, Lo Duca, and Straub (2016) or Wright (2012).
[14] The literature dealing with asset price effects of conventional monetary policy argues that both endogeneity and the omitted variable bias are minor issues – Rigobon and Sack (2004) and Rosa (2011).
[15] We find no bilateral or reverse causality between the surprise measures and the dependent variables used.

consideration both the time necessary for asset returns to reflect an UMP shock, which is longer than with conventional policies, and the need to avoid contamination by other news, which is likely to occur if the window considered is too large.

Adapting the approach used in Joyce et al. (2011) and Altavilla et al. (2015), we considered the following model:

$$\Delta r_t = \alpha + \beta_1 D_t \Delta F_t D_{Fpos} + \beta_2 D_t \Delta F_t D_{Fneg} + \beta_3 D_t \Delta S_t D_{Spos} + \beta_4 D_t \Delta S_t D_{Sneg} + \boldsymbol{\gamma C_t} + \epsilon_t \qquad \text{(Eq 3.1.)}$$

Where the dependent variable (Δr_t) is the one-day equity index return (details below). D_t is a dummy variable that takes the value of one in all event days and zero otherwise. ΔF_t and ΔS_t are the standardised measures of the "macroeconomic" and the "save the euro" policy surprises, respectively. D_{pos} and D_{neg} are dummy variables that take the value of one in positive and negative surprise UMP event days, respectively, and zero otherwise. $\boldsymbol{C_t}$ is a vector of control variables. We use the one day lagged change of the dependent variable, in order to consider previous trends in asset prices. We also consider, on one hand, the same day changes of the VIX index and of the US treasury 10-year yield, in order to consider other global market developments and, on the other hand, the Citi Eurozone Surprise Index, to control for euro area macroeconomic news.

Dependent variables are equity index returns for Portugal (PSI20), Spain (IBEX35), Italy (FTSE MIB), Germany (DAX30) and the euro area (Eurostoxx50/SX5E and Eurostoxx/SXXE) extracted daily using Bloomberg. Equity sector indices' returns for the euro area (19 super sectors) are also taken from Bloomberg and comparable sector indices for the peripheral markets are constructed by aggregating the returns of equity stocks domiciled in Portugal, Spain and Italy that were members of each of the aforementioned euro area super sectors – thus creating 19 additional (peripheral) super sectors[16]. As for the independent variables, we gathered information about the event set, as mentioned before, from related research and from the ECB website (see Appendix 3.A). Daily data for the

[16] Every change in composition in the Eurostoxx index between June 1st, 2014, and March 31st, 2018, was taken into consideration when creating these peripheral sector indices to ensure comparability with the euro area respective sector index.

control variables are also extracted using Bloomberg. All data start on June 1st, 2014, and end on March 31st 2018[17].

3.4. Results and discussion

3.4.1. Impact estimation

3.4.1.1. Broad equity indices

Table 3.1 shows the estimated impact of APP announcements on euro area equity markets. We have considered, in this sub-section, broad equity indices for core (Germany), euro area and peripheral (Portugal, Spain and Italy) markets[18].

[17] By the first quarter of 2018 the ECB had already communicated its intention to end net asset purchases. APP holdings peaked in late 2018 and were at roughly the same level through the end of 2019 – relevant announcements about the APP were, therefore, available by March 2018. On November 1, 2019 net purchases were restarted under the APP at a monthly pace of €20 billion and by early 2020 the ECB decided on a comprehensive package of monetary policy measures, including additional net asset purchases of €120 billion under the APP and a new asset purchase programme (PEPP: Pandemic Emergency Purchase Programme), due to the coronavirus outbreak – we chose to concentrate, as mentioned before, in more normal times when the degree of market segmentation is lower and therefore do not consider these crisis announcements.

[18] For an easier perception of estimates, in Appendix 3.B we include a graphical representation of the results.

	positive surprises						negative surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Index	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
DAX30	0.32%		0.58%	***	0.91%	20.47***	-0.09%		-0.41%	**	-0.50%	5.89**
IBEX35	0.22%		0.48%	***	0.70%	19.02***	0.05%		-0.33%		-0.28%	1.63
MIB	0.17%		0.79%	***	0.96%	16.05***	0.04%		-0.54%	**	-0.50%	5.09**
PSI20	0.18%		0.45%	**	0.63%	8.98***	0.04%		-0.42%	**	-0.38%	7.21***
SX5E	0.30%		0.57%	***	0.87%	21.12***	-0.04%		-0.42%	**	-0.46%	4.57**
SXXE	0.28%		0.49%	***	0.76%	18.79***	-0.04%		-0.40%	**	-0.44%	5.51**

Note: the table reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 3.1. - Estimated Impacts (Broad Equity Indices)

The reaction in equity returns is expressed in percentage per standard deviation change[1] in each surprise measure (for estimates of the "macroeconomic" and the "save the euro" QE) or simultaneously in both surprise measures (for estimates of total QE). For example, in the first line of Table 3.1 estimates for the German index (DAX30) are exhibited. When policy surprises are expansionary, a "macroeconomic" QE effect of +0.32% (statistically insignificant), per standard deviation change in the bund future price, and an orthogonal "save the euro" QE effect of +0.58% (the relevant coefficient has a p-value smaller than 0.01), per standard deviation change in the Italy-Germany 10-year spread, are estimated. The total QE effect, when considering a simultaneous standard deviation change in both policy surprise measures, is estimated at +0.91% and is statistically highly significant (F-statistic of 20.47). On another hand, when policy surprises are contractionary, the "macroeconomic" and the "save the euro" QE effects are estimated at -0.09% (statistically insignificant) and -0.41% (the relevant coefficient has a p-value smaller than 0.05), respectively. The total QE effect in this case is -0.50% and is also significant (F-statistic of 5.89).

Our estimates show that total effects are statistically significant both when UMP surprises are positive and negative. They also have the expected direction, i.e., positive surprises lead to higher returns and negative surprises lead to lower ones.

When surprises are positive, a simultaneous one standard deviation move in both surprise measures translates into a total effect between +0.63% (Portugal) and +0.96% (Italy) – a +0.80% average impact for all indices considered. As for when surprises are negative, we estimate this effect at between -0.28% (Spain) and -0.50% (Germany and Italy) – a -0.43% average impact for all indices analysed. The effect in Spain, with negative surprises, is the only statistically non-significant case (F-statistic of 1.63, with a p-value of 0.20).

At first glance, estimated effects seem to be larger with positive surprises but, statistically, this is only true for the DAX and the Eurostoxx50 indices[2].

There is not a statistically significant difference between effects at core (Germany), euro area and peripheral markets (Portugal, Spain and Italy).

[1] Equivalent to a 3.75 bps move in 10-year yields (bund future) and a 5.04 bps move in the 10-year Italy-Germany spread.
[2] In sub-section 3.4.4, we analyse the issue of symmetry.

3.4.1.2. Sector indices

We now turn to effects on sector indices. We have estimated effects for euro area sectors (Table 3.2) and for peripheral sectors (Table 3.3).

Again, results show that euro area and peripheral sector effects are usually statistically significant for positive and negative UMP surprises. They also have the expected direction, i.e., positive surprises lead to higher returns and negative surprises lead to lower ones, particularly in all statistically relevant cases.

When it comes to euro area sectors, and considering only the statistically significant cases, the Automobiles and Parts sector has the largest estimated effects, at +1.09% for positive surprises and -0.75% for negative surprises. The Travel and Leisure sector has the smallest estimated effects, +0.44% and -0.32%, respectively. For positive surprises, all but the Media sector estimated effects are statistically very significant (1% significance levels). As for negative surprises, only three (out of nineteen) sectors are not statistically significant (at the usual thresholds), and all estimated effects have the expected direction.

In the case of peripheral sectors, and once again considering only the statistically significant cases, the Personal Care, Drug and Grocery Stores sector has the largest estimated effects, at +1.06% for positive surprises and -0.78% for negative surprises. The Real Estate sector has the smallest estimated effect when surprises are positive, +0.37%, and when surprises are negative the smallest effect is estimated for the Health Care sector, at -0.40%. For positive surprises, all but two (out of seventeen) sectors are statistically significant and for negative surprises, seven (out of seventeen) sectors are not statistically significant (at the usual thresholds), but all statistically significant estimated effects have the expected direction.

Once again, although estimated effects seem to have different sizes for positive and negative UMP surprises, strictly speaking, we find that is true in only two cases, both for euro area (Food, Beverage and Tobacco; Utilities) and for peripheral sectors (Financial Services; Retailers). As already indicated, in sub-section 3.4.4 we elaborate on the issue of symmetry.

Differences in estimated effects for different sectors, as well as for the same sector but at the euro area and at the peripheral level, are not statistically significant.

	Positive Surprises						Negative Surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Index (Euro Area)	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Automobiles and Parts	0.47%	*	0.62%	***	1.09%	17.65***	-0.21%		-0.53%	**	-0.74%	12.45***
Banks	0.04%		0.70%	***	0.74%	8.72***	0.20%		-0.34%		-0.15%	0.23
Basic Resources	0.11%		0.74%	***	0.85%	7.09***	-0.20%		-0.21%		-0.41%	2.99*
Chemicals	0.24%		0.59%	***	0.82%	13.59**	-0.06%		-0.31%		-0.37%	2.56
Construction and Materials	0.25%		0.40%	**	0.65%	8.90***	-0.13%		-0.42%	**	-0.54%	7.92***
Financial Services	0.48%	**	0.19%		0.67%	19.13**	-0.03%		-0.42%	***	-0.45%	8.49***
Food, Beverage and Tobacco	0.36%		0.50%	**	0.87%	15.36***	-0.18%		-0.26%		-0.44%	4.40**
Health Care	0.44%	*	0.27%	*	0.71%	10.14**	0.05%		-0.60%	***	-0.55%	8.38***
Industrial Goods and Services	0.25%		0.49%	***	0.74%	14.22***	-0.15%		-0.33%	*	-0.48%	8.13***
Insurance	0.26%		0.35%	**	0.61%	8.33***	-0.04%		-0.36%	**	-0.39%	3.81*
Media	0.05%		0.24%		0.28%	2.01	-0.07%		-0.22%		-0.30%	2.62
Energy	0.10%		0.65%	***	0.75%	7.22***	-0.20%		-0.34%		-0.54%	4.94**
Pers Care, Drug & Grocery Stores	0.42%	*	0.39%	**	0.82%	13.08***	-0.03%		-0.43%	**	-0.47%	4.33**
Real Estate	0.77%	***	0.04%		0.82%	21.97**	-0.05%		-0.53%	***	-0.58%	12.66***
Retailers	0.21%		0.44%	***	0.65%	10.97**	-0.01%		-0.39%	**	-0.40%	5.42**
Technology	0.19%		0.49%	***	0.68%	13.55**	-0.11%		-0.39%	**	-0.50%	8.07***
Telecommunications	0.40%		0.48%	***	0.87%	12.24**	-0.06%		-0.37%	*	-0.43%	3.50*
Travel and Leisure	0.40%	*	0.04%		0.44%	7.17***	0.13%		-0.45%	***	-0.32%	3.58*
Utilities	0.40%	***	0.38%	***	0.78%	21.07**	0.10%		-0.52%	***	-0.43%	8.76***

Note: the table reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 3.2. – Estimated Effects (Euro Area Sector Indices)

	Positive Surprises						Negative Surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Index (Periphery)	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
Automobiles and Parts	0.66%	*	0.36%		1.02%	7.74***	-0.20%		-0.50%	*	-0.70%	8.53***
Banks	-0.07%		0.81%	***	0.74%	7.56**	0.21%		-0.33%		-0.12%	0.12
Basic Resources	-0.14%		0.84%	***	0.70%	2.44	-0.40%	**	-0.09%		-0.49%	1.76
Chemicals	n.a.		n.a.		n.a.		n.a.		n.a.		n.a.	
Construction and Materials	0.33%		0.32%	*	0.65%	9.64***	-0.23%		-0.16%		-0.39%	2.29
Financial Services	0.47%	*	0.50%	**	0.97%	19.02*	-0.12%		-0.41%	**	-0.53%	8.53***
Food, Beverage and Tobacco	0.50%	**	0.26%		0.76%	10.64***	-0.01%		-0.48%	**	-0.49%	5.29**
Health Care	0.34%		0.17%		0.51%	4.01**	0.08%		-0.49%	**	-0.40%	4.95**
Industrial Goods and Services	0.24%		0.28%	*	0.52%	9.56***	-0.09%		-0.45%	**	-0.54%	10.07***
Insurance	0.12%		0.53%	***	0.65%	8.65**	0.03%		-0.44%		-0.41%	2.58
Media	-0.35%		0.89%	**	0.54%	2.36	-0.16%		0.29%		0.13%	0.16
Energy	-0.03%		0.65%	***	0.62%	4.51**	-0.17%		-0.29%		-0.46%	3.63*
Personal Care, Drug and Grocery Stores	0.44%		0.62%	***	1.06%	14.64***	0.09%		-0.87%	***	-0.78%	8.31***
Real Estate	0.57%	**	-0.19%	*	0.37%	3.06*	-0.02%		0.05%		0.03%	0.10
Retailers	0.50%	**	0.41%	**	0.91%	19.59*	0.02%		-0.49%	**	-0.47%	4.41**
Technology	-0.01%		0.90%	***	0.89%	3.33*	-0.37%	**	-0.21%		-0.58%	3.22*
Telecommunications	0.27%		0.60%	***	0.86%	10.33*	-0.06%		-0.13%		-0.19%	0.59
Travel and Leisure	n.a.		n.a.		n.a.		n.a.		n.a.		n.a.	
Utilities	0.38%	**	0.40%	***	0.78%	17.17*	0.10%		-0.58%	***	-0.48%	11.04***

Note: the table reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 3.3. – Estimated Effects (Peripheral Sector Indices)

3.4.2. "Macroeconomic QE" versus "Save the Euro QE"

As mentioned before and building on arguments made by Altavilla et al. (2019) we have defined our surprise measures in order to identify two simultaneous orthogonal QE factors, one that is related to overall stimulus – "Macroeconomic QE" – and another one that may differentially affect equity markets – "Save the Euro QE".

Data in Table 3.1, Table 3.2 and Table 3.3, show that most of the effects described in sub-sections 3.4.1.1 and 3.4.1.2 are derived from the "save the euro" factor. In fact, in all but a limited number of sectors, the "macroeconomic" factor seems to be statistically irrelevant. With positive surprises, the Automobiles and Parts, the Financial Services, the Real Estate, the Personal Care, Drug and Grocery Stores and the Utilities sectors have, both for the euro area and for the periphery, statistically significant "macroeconomic" effects. When surprises are positive, the euro area Health Care sector and the peripheral Food, Beverage and Tobacco sector, as well as, with negative surprises, the Basic Resources and the Technology sectors also have statistically significant overall stimulus effects. No discernible pattern is otherwise present.

Referring to our previous argument, with lower risk aversion, and as arbitrageurs integrate market segments, APP bond purchases spillover to non-targeted assets (e.g., equities) and a portfolio-rebalancing channel as well as a general equilibrium channel (via the anticipation of better macroeconomic conditions) may become effective (Altavilla et al., 2015). These are likely the channels through which APP announcements affected euro area equity markets. Nevertheless, the importance of the "save the euro" factor we document is probably related to the fact that euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area, but not when they were associated with an overall stimulus.

In fact, as we will show ahead, when we consider a larger two-day event window, results reinforce the idea that the "macroeconomic" factor is statistically irrelevant, while the "save the euro" factor retains its importance.

3.4.3. Robustness checks

Overall, results are consistent with other research findings.

As outlined before, Altavilla et al. (2015) conclude that the euro area equity index (Dow Jones Euro Stoxx) was up, at announcement dates, by between 1% and 5% (accumulated effect) depending on the methodology used – specifically, their estimates based on a controlled event study, methodologically closer to our approach, are +2% (one-day window) and +1% (two-day window). Using our methodology and applying it to the same (more restricted than ours) event set these authors used we get, for the euro area indices we selected, i.e., Eurostoxx50 and Eurostoxx, and using the statistically significant coefficients, a +2.06% and a +1.13% cumulative effect, respectively – our estimates are therefore consistent with results presented by Altavilla et al. (2015).

On another hand, we estimated results using a two-day event window (Table 3.4)[1].

[1] We report results for broad equity indices only. For the sake of parsimony, estimates for sector indices, using a two-day event window, are not shown since they reproduce the same pattern.

	Positive Surprises						Negative Surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Index	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
DAX30	-0.12%		0.59%	***	0.47%	12.51***	0.01%		-0.29%	*	-0.28%	3.87**
IBEX35	-0.28%	**	0.64%	***	0.35%	11.41***	0.09%		-0.27%		-0.18%	1.45
MIB	-0.28%	*	0.83%	***	0.55%	14.32***	0.13%		-0.45%	**	-0.33%	3.74*
PSI20	-0.15%		0.46%	***	0.30%	7.50***	0.06%		-0.30%		-0.24%	2.99*
SX5E	-0.16%		0.63%	***	0.47%	14.65***	0.04%		-0.29%	*	-0.25%	2.76*
SXXE	-0.14%		0.55%	***	0.41%	13.41***	0.03%		-0.26%	*	-0.23%	3.19*

Note: the table reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using a two-day window. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 3.4. – Estimated Impacts (Broad Equity Indices – two-day window)

When we consider a larger two-day event window, results point to an apparent reversion of the one-day spillover effects when only the price change of bond futures is used as a policy surprise measure (the "macroeconomic" QE factor), although most values are, as was already the case with a one-day window, statistically insignificant. No such reversion, however, is observable when we use the measure derived from the change in the Italy-Germany spread as a policy surprise measure. For the "save the euro" QE factor, results remain consistent and do not change materially when compared with the baseline case.

This strongly reiterates this factor's importance since total QE remains statistically significant[1] although its magnitude is now, approximately, half the one-day window estimate: when policy surprises are expansionary, this is estimated at +0.50%, on average, and when policy surprises are contractionary total QE is estimated at -0.25%, on average – this pattern (i.e., the two-day window's effect is half the one-day window effect) is identical to what Altavilla et al. (2015) report, as mentioned above.

Finally, we estimated results using a more restricted subset of events. For this check we considered only the previously identified group of fifteen event days which include days either previously highlighted as containing relevant new information about the APP or days corresponding to meeting statements or speeches when the ECB first communicated APP changes to the market[2].

As mentioned before, statistical inference is more challenging with this more restricted subset of events. Nevertheless, results in Table 3.5 reinforce our previous conclusions: our estimates show that total effects have the expected direction, i.e., positive surprises lead to higher returns and negative surprises lead to lower ones. When surprises are positive, a simultaneous one standard deviation move in both surprise measures translates into a total effect between +0.92% (Spain) and +1.44% (Italy) – a +1.10% average impact for all indices considered – slightly larger than the effect (+0.80%) estimated using the complete event set (Table 3.1) and always statistically highly significant. As for when surprises are negative, we estimate this effect at between -0.28% (Portugal) and -0.47% (euro area, the SX5E index) – a -0.36% average impact for all indices analysed – very similar to the effect (-0.43%) estimated using the complete event set (Table 3.1). However, due to a much smaller

[1] With the sole exception of the Spanish index, when policy surprises are contractionary – this was already the case with a one-day window.
[2] Once again, we report results for broad equity indices only.

sample, estimates for total QE when policy surprises are contractionary are now not statistically significant.

	Positive Surprises						Negative Surprises					
	$\beta_1.D_t.\Delta F_t.D_{Fpos}$		$\beta_3.D_t.\Delta S_t.D_{Spos}$		$\beta_1.D_t.\Delta F_t.D_{Fpos} + \beta_3.D_t.\Delta S_t.D_{Spos}$	$\beta_1-\beta_3=0$	$\beta_2.D_t.\Delta F_t.D_{Fneg}$		$\beta_4.D_t.\Delta S_t.D_{Sneg}$		$\beta_2.D_t.\Delta F_t.D_{Fneg} + \beta_4.D_t.\Delta S_t.D_{Sneg}$	$\beta_2-\beta_4=0$
Index	Macro QE Impact	Sig β_1	Save the Euro QE Impact	Sig β_3	QE Impact	F-test	Macro QE Impact	Sig β_2	Save the Euro QE Impact	Sig β_4	QE Impact	F-test
DAX30	-0,15%		1,22%	**	1,06%	4.45**	-0,64%	**	0,32%		-0,32%	0.60
IBEX35	0,23%		0,69%		0,92%	10.57***	-0,42%	*	0,10%		-0,32%	0.69
MIB	0,34%		1,10%	*	1,44%	12.05***	-0,40%		0,04%		-0,37%	0.66
PSI20	-0,33%		1,28%	***	0,95%	7.17***	-0,32%	*	0,05%		-0,28%	1.13
SX5E	0,02%		1,11%	**	1,13%	7.61***	-0,58%	**	0,11%		-0,47%	1.64
SXXE	0,08%		0,98%	**	1,07%	7.66***	-0,52%	**	0,11%		-0,41%	1.67

Note: the table reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using a daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).
***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).

Table 3.5. – Estimated Impacts (Broad Equity Indices – restricted subset of events)

3.4.4. Symmetry

The way our analysis was structured allows for a detailed study about non-linearity. When it comes to the issue of symmetry, we are dealing with two components: first, a question of whether the sign, the direction, of the estimated effects differs between positive and negative surprises and, second, whether its size, i.e., its magnitude is different.

In order to analyse these two different questions, we use the following strategy[1]. First, in addition to the original regression (1) above we considered another alternative regression where we substitute the surprise measures for their absolute values. Second, if in the original regression (1) the sign of coefficients associated with positive and negative surprises is the same, then we use the alternative regression's coefficients to test for whether the effects have the same direction. In this case, we then go back to the original regression's coefficients to test for whether the effect's magnitude is the same. Alternatively, if, once again in the original regression (1), the sign of coefficients associated with positive and negative surprises is not the same, then we can only conclude on whether effects for positive and negative surprises are different from one another, which is also the case whenever at least one of the coefficients is not statistically significant.

Our results show that total effects have different directions (for positive and negative surprises) but, in most cases and as was mentioned before in sub-sections 3.4.1.1 and 3.4.1.2, we usually do not reject the hypothesis they have similar magnitudes. We come to the same conclusion, generally speaking, when we take into consideration only the "save the euro" surprise measure (instead of the total effects). When only the "macroeconomic" measure is analysed, effects, with positive and negative surprises, are sometimes different from one another but in most cases we cannot reject the hypothesis they are equal.

Our results are therefore aligned with other previous research findings when it comes to symmetry, i.e., we find that although the direction of statistically significant effects (total and "save the euro") for positive and negative UMP surprises is often different, its magnitude is usually not.

[1] Check Appendix 3.C for the detailed results. We follow a strategy similar to the one used by Bernhard and Ebner (2017).

3.5. Conclusions

To the best of our knowledge, we are the first to analyse the effects of the ECB APP on euro area equity markets, for core and peripheral equity indices, considering both positive and negative UMP surprises. We additionally take into account, empirically, the possible, simultaneous, existence of two QE factors: one related to overall stimulus and another one that may differentially affect equities.

Our results on symmetry confirm previous research findings (Altavilla et al., 2019) since although the direction of effects for expansionary and contractionary surprises is often different its magnitude is usually not. The estimates we arrive at are also consistent with other studies' conclusions about the effects' magnitude as well as the difference between the effects estimated using one-day and two-day windows (Altavilla et al., 2015).

On another hand, we find evidence that effects of APP announcements on equity markets depend on the sign of the policy surprise and, therefore, we can complement previous research by contrasting effects with positive and negative UMP surprises. Estimates point to higher equity returns with expansionary surprises and to lower equity returns when surprises are contractionary, i.e., they have the theoretically expected direction. Effects are statistically significant for core, euro area and peripheral broad equity markets as well as for sector indices (also at the euro area and at the peripheral level). Differences in effects for core, euro area and peripheral markets and for different sectors, as well as for the same sector but at the euro area and at the peripheral level, are not statistically significant.

As mentioned before, we are, to the best of our knowledge, the first to empirically identify and quantify two different quantitative easing factors, building on an argument made by Altavilla et al. (2019) and Wright (2019), which helps us better explain our findings. By considering both a "macroeconomic" surprise measure and a "save the euro" surprise measure we can show most of the reported effects are due to the latter QE factor, i.e., we document that euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area, but not when they were associated with an overall stimulus.

Additional research could explore the possibility to further refine our results using intraday data – one must be aware, however, that an intraday window might be too narrow

(as we argued above and especially given the conclusion about the QE factors' relative relevance). Other relevant dimensions (e.g., value/growth, small/large) might also be added to our analysis and provide additional insights. Finally, our focus is on announcements and not on the amounts of asset purchases. Falagiarda and Reitz (2015) confirm that announcements not linked to a specific size have an impact on quantitative numbers and our procedure, by making the dummy variables interact with the policy surprise measures, is akin to endogenously assigning different weights, i.e., the size of the policy shock, to different announcements which would, otherwise, all be weighed equally. Nevertheless, a different methodological option (taking into consideration amounts of asset purchases might add value – with the methodology we have chosen (an event study) only stock (also known as permanent) effects are taken into consideration and it therefore probably leads to an underestimation of the programme's effects; flow effects (or temporary effects, when actual purchases occur) are not considered (Altavilla et al., 2015). In a crisis environment, when financial constraints are most likely to be binding, this is a more significant problem, since in such an environment arbitrage is only possible when actual transactions take place, and market interventions might have information content (Fratzscher et al., 2016).

Appendix 3.A.

Date	Event	Source
05-06-2014	ECB press conference Inferences were possibly made	Haitsma et al. (2016) https://www.ecb.europa.eu/press/pressconf/2014/html/is140605.en.html
07-08-2014 **[Core]**	**ECB Statement + Draghi also emphasized that the ECB's purchases of privately held assets may be expanded beyond the ABS markets. He said that "QE in government bonds... Is still on the table."**	https://www.ecb.europa.eu/press/pressconf/2014/html/is140807.en.html
25-08-2014 **[Core]**	**Mario Draghi makes a speech at Jackson Hole, in which he links the need for monetary and fiscal policies to stimulate aggregate demand with policies aimed at achieving structural change.**	**Drifill (2016)**
04-09-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
12-09-2014	News conference following a meeting of euro-area finance ministers in Milan	Altavilla et al. (2015)

Date	Event	Source
22-09-2014 **[Core]**	**Mario Draghi makes a speech to the European Parliament Economic and Monetary Affairs committee**	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
24-09-2014	Interview with Europe 1, conducted on 23 September 2014 and aired on 24 September 2014	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2014/html/index.en.html
25-09-2014	Interview with Lithuanian business daily Verslo Zinios	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2014/html/index.en.html
02-10-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
09-10-2014	Mario Draghi: Recovery and Reform in the euro area. Opening remarks by Mario Draghi, President of the ECB, Brookings Institution, Washington, 9 October 2014	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
10-10-2014	Statement at the Thirtieth meeting of the IMFC, Washington	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
24-10-2014	An ECB spokesman reading from Mario Draghi's speaking	Altavilla et al. (2015)

Date	Event	Source
	points at a euro area summit, Brussels	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
06-11-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
12-11-2014	Mario Draghi: The economic policy of Federico Caffè in our times. Speech by Mario Draghi, President of the ECB, to mark the centenary of the birth of Federico Caffè at the Lecture room of the School of Economics and Business Studies "Federico Caffè", Rome, 12 November 2014	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
17-11-2014	Introductory remarks at the EP's Economic and Monetary Affairs Committee	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-11-2014	Speech at the Frankfurt European Banking Congress, Frankfurt am Main	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
27-11-2014	Introductory remarks at the Finnish parliament and speech at the University of Helsinki	Altavilla et al. (2015) https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
04-12-2014	ECB press conference	Altavilla et al. (2015) https://www.ecb.europa.eu/press/pressconf/2014/html/index.en.html
02-01-2015	Interview with Handelsblatt, published on 2 January 2015	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2015/html/index.en.html
08-01-2015	Letter to Mr Luke Ming Flanagan (member of the European Parliament), published on 8 January 2015	Altavilla et al. (2015)
15-01-2015	Interview with Die Zeit, published on 15 January 2015	Altavilla et al. (2015) https://www.ecb.europa.eu/press/inter/date/2015/html/index.en.html
22-01-2015 **[Core]**	**Expanded Asset Purchase Program**	**Haitsma et al. (2016)** https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
26-02-2015	Mario Draghi: Introductory statement to the plenary debate of the European Parliament on the ECB's Annual Report 2013. Mario Draghi, President of the ECB, Brussels, 25 February 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
05-03-2015 **[Core]**	**Timing for PSPP**	**Altavilla et al. (2015)** https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
09-03-2015 **[Core]**	**APP begins**	**Drifill (2016)**
11-03-2015	Mario Draghi: The ECB and its Watchers XVI Conference. Speech by Mario Draghi, President of the ECB, Frankfurt am Main, 11 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
26-03-2015	Mario Draghi: Introductory statement at the Italian Parliament. Speech by Mario Draghi, President of the ECB, at the Italian Parliament, Rome, 26 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
31-03-2015	Mario Draghi: Accounts and accountability. Speech by Mario Draghi, President of the ECB, at the Euro50 Group Roundtable on "Monetary Policy in Times of Turbulence", Frankfurt am Main, 31 March 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
15-04-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html

Date	Event	Source
20-04-2015	Mario Draghi: Euro area economic outlook, the ECB's monetary policy and current policy challenges. Statement by Mario Draghi, President of the ECB, prepared for the thirty-first meeting of the International Monetary and Financial Committee, Washington DC, 17 April 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-05-2015	Mario Draghi: The ECB's recent monetary policy measures: Effectiveness and challenges. Camdessus lecture by Mario Draghi, President of the ECB, IMF, Washington, DC, 14 May 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
03-06-2015 [Core]	**ECB Statement + Draghi "Says ECB Governing Council Has Not Discussed QE Exit Plan"**	https://www.ecb.europa.eu/press/pr/date/2015/html/index.en.html
15-06-2015	Mario Draghi: Hearing at the European Parliament's Economic and Monetary Affairs Committee. Introductory statement by Mario Draghi, President of the ECB, Brussels, 15 June 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
16-07-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
03-09-2015 **[Core]**	**ECB Statement + Governing Council decided to increase the issue share limit from the initial limit of 25% to 33% + Draghi said at a news conference that "the asset purchase programme provides sufficient flexibility in terms of adjusting the size, composition and duration of the programme". It was "intended to run until the end of September 2016, or beyond, if necessary,"**	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
23-09-2015	Mario Draghi: President's introductory remarks at the regular ECON hearing. Introductory statement by Mario Draghi, President of the ECB, Brussels, 23 September 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
12-10-2015	Mario Draghi: Euro area economic outlook, the ECB's monetary policy and current policy challenges. Statement by Mario Draghi, President of the ECB, at the thirty-second	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	meeting of the International Monetary and Financial Committee, Lima, 9 October 2015	
22-10-2015	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
04-11-2015	Mario Draghi: Reception for the Opening of the European Cultural Days. Welcome address by Mario Draghi, President of the ECB, Frankfurt, 3 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
05-11-2015	Mario Draghi: Speech to mark the opening of the academic year at the Università Cattolica del Sacro Cuore. Speech by Mario Draghi, President of the ECB, Università Cattolica del Sacro Cuore, Milan, 5 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
09-11-2015 [Core]	**Increase in PSPP issue share limit enlarges purchasable universe**	https://www.ecb.europa.eu/press/pr/date/2015/html/index.en.html
12-11-2015 [Core]	**Mario Draghi: Hearing at the European Parliament's Economic and Monetary Affairs Committee. Introductory statement by Mario Draghi, President of**	**https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html**

Date	Event	Source
	the ECB, Brussels, 12 November 2015	
20-11-2015	Mario Draghi: Monetary Policy: Past, Present and Future. Speech by Mario Draghi, President of the ECB, at the Frankfurt European Banking Congress, 20 November 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
03-12-2015 **[Core]**	**ECB Statement. The GC "decided to extend the asset purchase programme (APP). The monthly purchases of €60 billion under the APP are now intended to run until the end of March 2017, or beyond, if necessary"**	https://www.ecb.europa.eu/press/pressconf/2015/html/index.en.html
07-12-2015	Mario Draghi: Global and domestic inflation. Speech by Mario Draghi, President of the ECB, Economic Club of New York, 4 December 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-12-2015	Mario Draghi: Monetary policy and structural reforms in the euro area. Speech by Mario Draghi, President of the ECB, Prometeia40, Bologna, 14 December 2015	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
21-01-2016 **[Core]**	**ECB Statement + "It will therefore be necessary to review and possibly reconsider our monetary policy stance at our next meeting in early March"**	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
26-01-2016	Mario Draghi: How domestic economic strength can prevail over global weakness. Keynote speech by Mario Draghi, President of the ECB, at the Deutsche Börse Group New Year's reception 2016, Eschborn, 25 January 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
01-02-2016	Mario Draghi: European Parliament plenary debate on the ECB Annual Report for 2014. Introductory statement by Mario Draghi, President of the ECB, Strasbourg, 1 February	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
04-02-2016	Mario Draghi: How central banks meet the challenge of low inflation. Marjolin lecture delivered by Mario Draghi, President of the ECB, at the SUERF conference organised by the Deutsche Bundesbank, Frankfurt, 4 February 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
10-03-2016 **[Core]**	**Combined monthly purchases under the APP are to increase as of 1 April 2016 to €80 billion from €60 billion.**	**https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html**
15-04-2016	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-third meeting of the International Monetary and Financial Committee, Washington DC, 15 April 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-04-2016	ECB Statement	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
02-06-2016	ECB Statement	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
21-06-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, Brussels, 21 June 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-07-2016	Governing Council confirms that the monthly asset purchases of €80 billion are intended to run until the end of March 2017, or beyond, if necessary, and in any case until	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html

Date	Event	Source
	it sees a sustained adjustment in the path of inflation consistent with its inflation aim.	
08-09-2016	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
26-09-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, Brussels, 26 September 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
28-09-2016	Mario Draghi: Working together for growth in Europe. Introductory remarks by Mario Draghi, President of the ECB, at Deutscher Bundestag, Berlin, 28 September 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
07-10-2016	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-fourth meeting of the International Monetary and Financial Committee, Washington DC, 7 October 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
20-10-2016	ECB Statement	https://www.ecb.europa.eu/press/pressconf/2016/html/index.en.html
25-10-2016	Mario Draghi: Stability, equity and monetary policy. Speech by Mario Draghi, President of the ECB, 2nd DIW Europe Lecture, German Institute for Economic Research (DIW), Berlin, 25 October 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-11-2016	Mario Draghi: Introductory statement to the plenary debate of the European Parliament on the ECB's Annual Report 2015. Mario Draghi, President of the ECB, Strasbourg, 21 November 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
28-11-2016	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement of Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 28 November 2016	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
08-12-2016 **[Core]**	**ECB adjusts parameters of its asset purchase programme (APP). Governing Council decided to continue its purchases under the asset purchase programme (APP) at the current monthly pace of €80 billion until the end of March 2017. From April 2017, the net asset purchases are intended to continue at a monthly pace of €60 billion until the end of December 2017, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim.**	https://www.ecb.europa.eu/press/pr/date/2016/html/index.en.html
19-01-2017	ECB provides further details on APP purchases of assets with yields below the deposit facility rate	https://www.ecb.europa.eu/press/pr/date/2017/html/index.en.html
06-02-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	ECB, at the ECON committee of the European Parliament, Brussels, 6 February 2017	
09-03-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
06-04-2017	Mario Draghi: Monetary policy and the economic recovery in the euro area. Speech by Mario Draghi, President of the ECB, at The ECB and Its Watchers XVIII Conference, Frankfurt am Main, 6 April 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
21-04-2017	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-fifth meeting of the International Monetary and Financial Committee, Washington DC, 21 April 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
27-04-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
10-05-2017	Mario Draghi: Introductory remarks at the House of Representatives of the Netherlands. Introductory remarks by Mario Draghi, President of the ECB, at the Tweede Kamer der Staten-	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
	Generaal, The Hague, 10 May 2017	
24-05-2017	Mario Draghi: The interaction between monetary policy and financial stability in the euro area. Keynote speech by Mario Draghi, President of the ECB, at the First Conference on Financial Stability organised by the Banco de España and Centro de Estudios Monetarios y Financieros, Madrid, 24 May 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
08-06-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
27-06-2017	Mario Draghi: Accompanying the economic recovery. Introductory speech by Mario Draghi, President of the ECB, at the ECB Forum on Central Banking, Sintra, 27 June 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
20-07-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
23-08-2017	Mario Draghi: The interdependence of research and policymaking. Speech by Mario Draghi, President of the ECB, at the Lindau Nobel	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

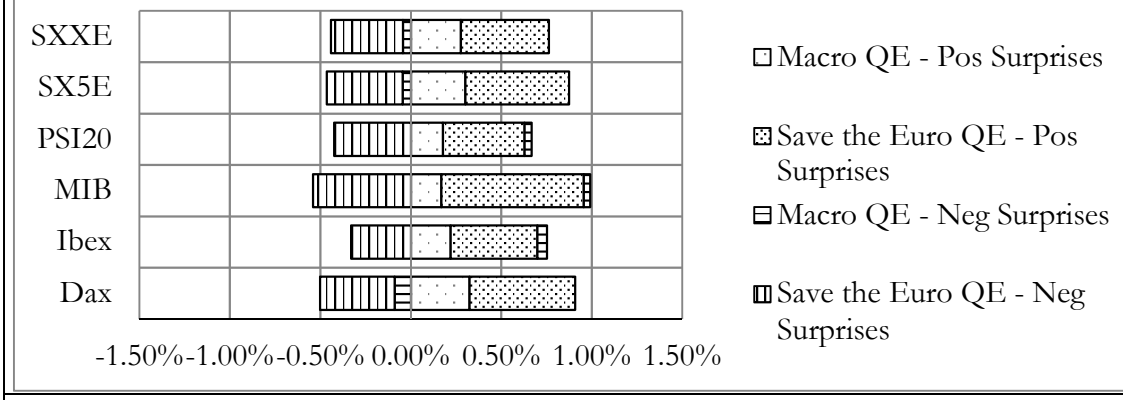
Date	Event	Source
	Laureate Meeting, Lindau, Germany, 23 August 2017	
07-09-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
25-09-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 25 September 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
16-10-2017	Mario Draghi: IMFC Statement. Statement by Mario Draghi, President of the ECB, at the thirty-sixth meeting of the International Monetary and Financial Committee, Washington D.C., 13 October 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Date	Event	Source
26-10-2017 **[Core]**	**The asset purchase programme (APP) will continue at the current monthly pace of €60 billion until the end of December 2017. From January 2018 the net asset purchases are intended to continue at a monthly pace of €30 billion until the end of September 2018, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim. The Eurosystem will reinvest the principal payments from maturing securities purchased under the APP for an extended period of time after the end of its net asset purchases, and in any case for as long as necessary. This will contribute both to favourable liquidity conditions and to an appropriate monetary policy stance.**	**https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html**

Date	Event	Source
17-11-2017	Mario Draghi: Monetary policy and the outlook for the economy. Speech by Mario Draghi, President of the ECB, at the Frankfurt European Banking Congress "Europe into a New Era – How to Seize the Opportunities", Frankfurt am Main, 17 November 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
20-11-2017	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory Statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 20 November 2017	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
14-12-2017	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
25-01-2018	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
05-02-2018	Mario Draghi: European Parliament plenary debate on the ECB Annual Report for 2016. Introductory statement and closing remarks by Mario Draghi, President of the ECB, Strasbourg, 5 February 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

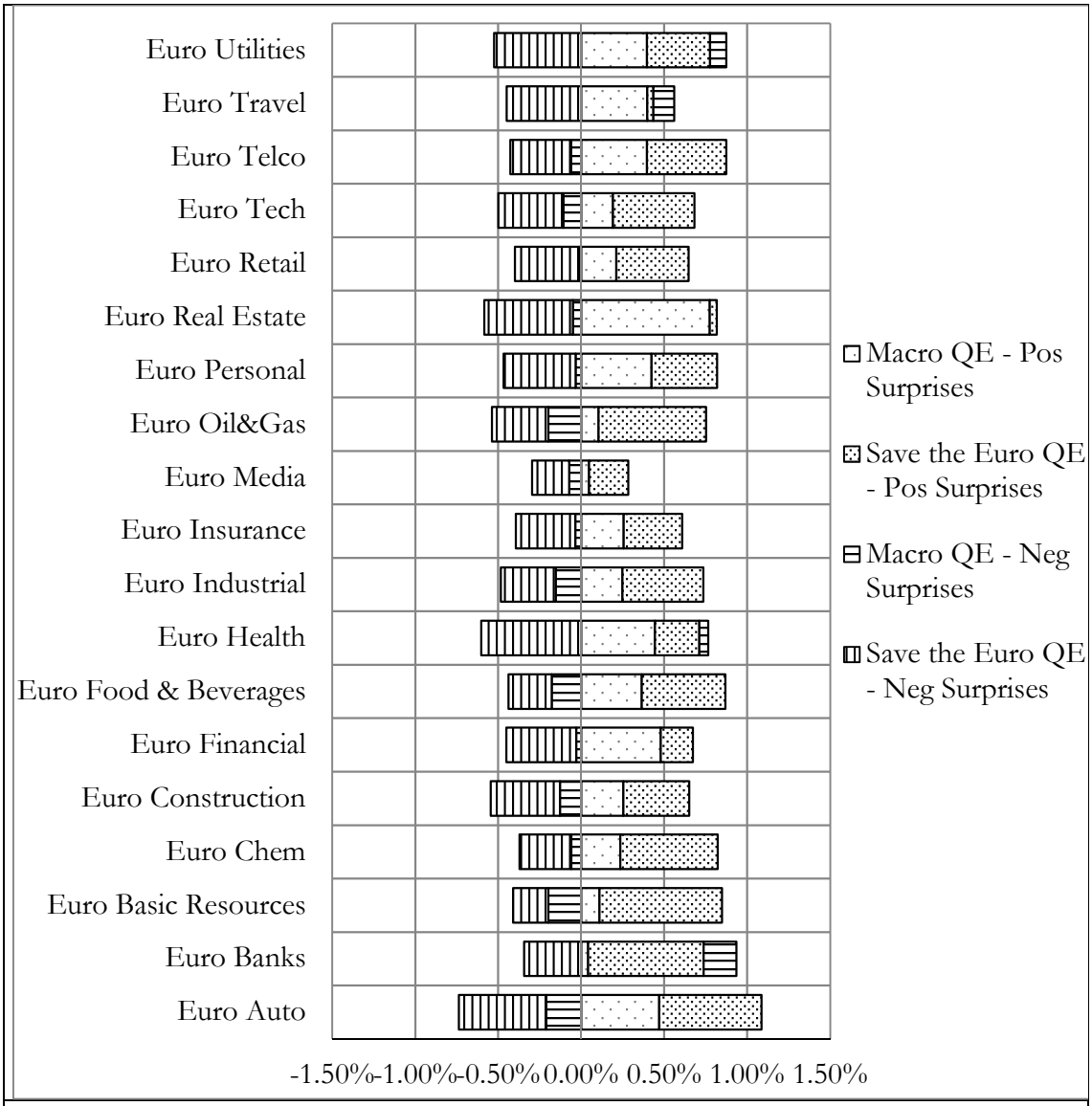
Date	Event	Source
26-02-2018	Mario Draghi: Hearing of the Committee on Economic and Monetary Affairs of the European Parliament. Introductory Statement by Mario Draghi, President of the ECB, at the ECON committee of the European Parliament, Brussels, 26 February 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html
08-03-2018	ECB Statement	https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html
14-03-2018	Mario Draghi: Monetary Policy in the Euro Area. Speech by Mario Draghi, President of the ECB, The ECB and Its Watchers XIX Conference organised by the Institute for Monetary and Financial Stability, Frankfurt, 14 March 2018	https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

Appendix 3.B.



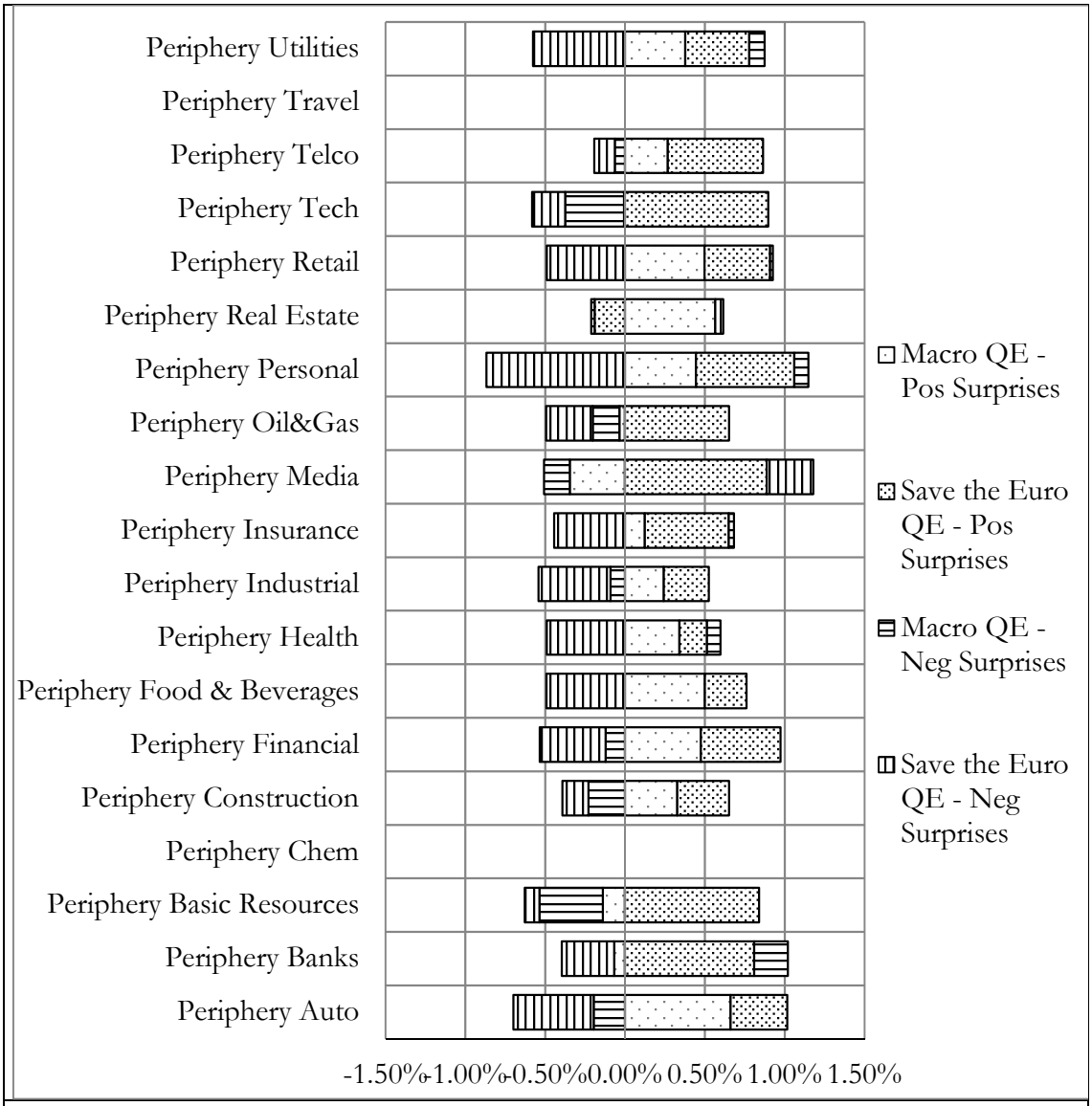
Note: the graph reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).

Graph 3.B.1 – Estimated Impacts (Broad Equity Indices)



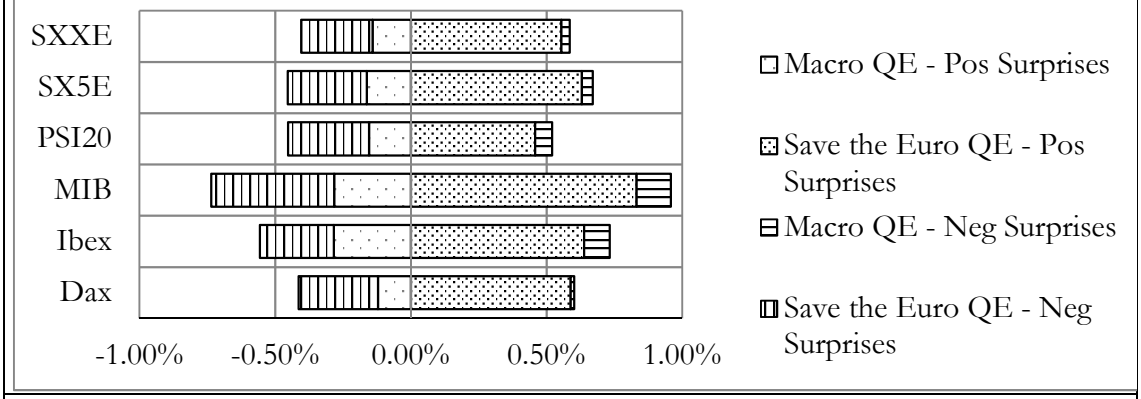
Note: the graph reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).

Graph 3.B.2 – Estimated Impacts (Euro Area Sector Indices)



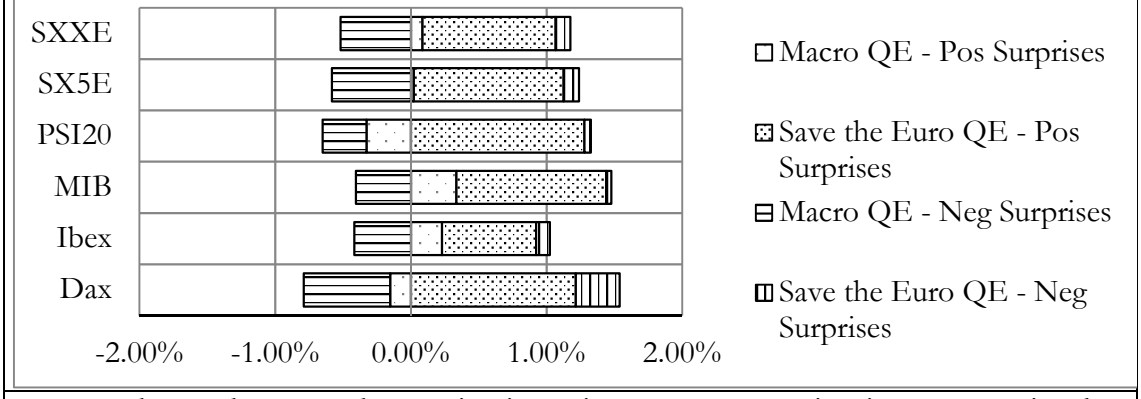
Note: the graph reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).

Graph 3.B.3 – Estimated Impacts (Peripheral Sector Indices)



Note: the graph reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using a two-day window. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).

Graph 3.B.4 – Estimated Impacts (Broad Equity Indices – two-day window)



Note: the graph reports the reaction in equity returns to surprises in unconventional monetary policy (APP) using daily data. We express the reaction in percentage per standard deviation change in the surprise measures (bund future price change for the Macro QE impact and Italy-Germany 10 year spread change for the Save the Euro QE impact).

Graph 3.B.5 – Estimated Impacts (Broad Equity Indices – restricted subset of events)

Appendix 3.C.

Testing for Symmetry																		
	$\beta_1=\beta_2$ regression: abs(surprise measures)			$\beta_1=\beta_2$			$\beta_3=\beta_4$ regression: abs(surprise measures)			$\beta_3=\beta_4$			$\beta_1+\beta_3=\beta_2+\beta_4$ regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$		
Index	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
DAX30	0.00338	-0.00091	3.03*	0.00324	0.00089	0.61	0.00568***	-0.0042**	23.57***	-0.00584***	-0.00413**	0.33	0.00906***	-0.00511**	17.86***	0.00908***	0.00502**	3.12*
IBEX35	0.00218	0.00046	0.71	0.00220	-0.00053	0.87	0.00483***	-0.00327	12.22***	-0.0048***	-0.00331	0.24	0.007***	- 0.00280	10.77***	0.00699***	0.00278	3.06*
MIB	0.00169	0.00026	0.32	0.00169	-0.00035	0.40	0.00787***	-0.00535**	23.52***	-0.00787***	-0.0054**	0.46	0.00956***	-0.00509**	16.05***	0.00955***	0.00505**	2.49
PSI20	0.00177	0.00032	0.41	0.00178	-0.00039	0.65	0.0045**	-0.00414**	16.77***	-0.0045**	-0.00423**	0.01	0.00627***	-0.00382***	14.35***	0.00628***	0.00384***	1.02
SX5E	0.00309	-0.00049	2.36	0.00300	0.00045	0.81	0.00565***	-0.00422**	22.28***	-0.00573***	-0.0042**	0.28	0.00873***	-0.00471**	16.21***	0.00874***	0.00465**	3.02*
SXXE	0.00287	-0.00047	2.47	0.00277	0.00044	0.77	0.00475***	-0.00401**	22.42***	-0.00487***	-0.00398**	0.11	0.00762***	-0.00448**	16.56***	0.00763***	0.00442**	2.32
Note: in columns 5 through 7, 11 through 13 and 17 through 19, we report results for the original regression (1); in columns 2 through 4, 8 through 10 and 14 through 16, we report, instead, results for the alternative regression, i.e., we substitute the surprise measures for their absolute values. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).																		
Table C.1 – Tests of Symmetry (Broad Equity Indices)																		

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Index	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Euro Area																		
Automobiles and Parts	0.00491*	-0.00212	6.37**	0.0047*	0.00211	0.52	0.00592***	-0.00535**	21.17***	-0.00616***	-0.00526**	0.06	0.01083***	-0.00747***	25.15***	0.01086***	0.00737***	1.41
Banks	0.00033	0.00187	0.26	0.00042	-0.00197	0.36	0.0071***	-0.00340	10.31***	-0.00696***	-0.00345	0.61	0.00743***	- 0.00153	3.83*	0.00738***	0.00148	3.16*
Basic Resources	0.00126	-0.00203	0.95	0.00110	0.00198	0.04	0.00715***	-0.00213	14.03***	-0.00737***	-0.00212	2.00	0.00841***	-0.00416*	8.19***	0.00847***	0.0041*	1.55
Chemicals	0.00252	-0.00062	1.27	0.00236	0.00059	0.29	0.00566***	-0.00317	15.70***	-0.00586***	-0.00312	0.69	0.00818***	- 0.00378	10.27***	0.00822***	0.00372	2.98*
Construction and Materials	0.00268	-0.00129	2.34	0.00254	0.00128	0.18	0.00381**	-0.00421**	16.09***	-0.00398**	-0.00416**	0.00	0.00649***	-0.0055***	12.58***	0.00651***	0.00544***	0.21
Financial Services	0.00491**	-0.00029	6.86***	0.0048**	0.00031	2.94*	0.00182	-0.0043***	14.66***	-0.00193	-0.00421***	0.93	0.00673***	-0.00458***	21.25***	0.00672***	0.00451***	1.41
Food, Beverage and Tobacco	0.00377	-0.00182	4.23**	0.00365	0.00178	0.33	0.00486**	-0.00260	10.36***	-0.00504**	-0.00261	0.52	0.00863***	-0.00441**	13.58***	0.00868***	0.00439**	3.05*
Health Care	0.00455*	0.00053	2.54	0.00444*	-0.00053	3.32*	0.00259*	-0.0061***	17.92***	-0.00268*	-0.00603***	1.55	0.00714***	-0.00557***	14.19***	0.00712***	0.0055***	0.45
Industrial Goods and Services	0.00258	-0.00157	3.44*	0.00248	0.00155	0.11	0.00476***	-0.00333*	20.06***	-0.00488***	-0.0033*	0.36	0.00734***	-0.00491***	16.92***	0.00736***	0.00485***	1.40
Insurance	0.00273	-0.00033	1.25	0.00256	0.00035	0.48	0.00335**	-0.00372**	16.43***	-0.00352**	-0.00359**	0.00	0.00608***	-0.00405*	8.61***	0.00608***	0.00394*	0.91
Media	0.00071	-0.00070	0.30	0.00047	0.00074	0.01	0.00208	-0.00234	7.50***	-0.00237	-0.00222	0.00	0.00279	- 0.00303	3.59*	0.00284	0.00295	0.00
Energy	0.00113	-0.00204	1.28	0.00104	0.00199	0.05	0.00636***	-0.00339	12.59***	-0.00648***	-0.00340	0.73	0.0075***	-0.00544**	11.08***	0.00752***	0.00538**	0.37
Personal Care, Drug and Grocery Stores	0.00442*	-0.00035	2.89*	0.00425*	0.00035	1.49	0.00375**	-0.00439**	15.14***	-0.00395**	-0.00432**	0.02	0.00817***	-0.00473**	11.95***	0.00819***	0.00467**	1.95
Real Estate	0.00782***	-0.00050	14.82***	0.00774***	0.00051	6.06**	0.00036	-0.00536***	10.31***	-0.00042	-0.00533***	4.50**	0.00818***	-0.00586***	27.79***	0.00816***	0.00584***	1.24
Retailers	0.00231	-0.00012	1.03	0.00212	0.00012	0.57	0.00411***	-0.00394**	20.82***	-0.00436***	-0.00389**	0.04	0.00642***	-0.00406**	11.73***	0.00647***	0.004**	1.49
Technology	0.00195	-0.00112	1.87	0.00191	0.00107	0.09	0.00487***	-0.0039**	24.22***	-0.00491***	-0.00392**	0.15	0.00682***	-0.00502***	15.70***	0.00681***	0.00499***	0.80
Telecommunications	0.00403	-0.00065	2.94*	0.00395	0.00062	0.89	0.00472***	-0.00368*	13.53***	-0.00479***	-0.00365*	0.13	0.00874***	-0.00433*	11.00***	0.00874***	0.00427*	2.70
Travel and Leisure	0.00421*	0.00133	1.62	0.00398*	-0.00126	3.04*	0.00009	-0.00464***	8.27***	-0.00038	-0.0045***	2.28	0.00431***	-0.00332*	8.25***	0.00435***	0.00324*	0.31
Utilities	0.00401***	0.00094	3.73*	0.00397***	-0.00098	6.11**	0.00376***	-0.00523***	21.51***	-0.0038***	-0.00525***	0.36	0.00777***	-0.00429***	25.2***	0.00777***	0.00427***	2.93*

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Index	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Periphery																		
Automobiles and Parts	0.00677*	-0.00195	6.37**	0.0066*	0.00196	1.27	0.00340	-0.00513*	7.31***	-0.00357	-0.00503*	0.12	0.01017***	-0.00708***	13.17***	0.01017***	0.00699***	0.65
Banks	-0.00084	0.00198	0.81	-0.00067	-0.00212	0.11	0.00831***	-0.00318	9.85***	-0.00808***	-0.00330	0.91	0.00747***	- 0.00120	3.07*	0.00741***	0.00118	2.94*
Basic Resources	-0.00134	-0.00408**	0.31	-0.00138	0.00399**	0.64	0.0083***	-0.00086	6.02**	-0.00839***	-0.00091	1.70	0.00696	- 0.00493	3.25*	0.00701	0.00490	0.18
Chemicals	n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.	
Construction and Materials	0.00330	-0.00233	4.34**	0.00328	0.00228	0.09	0.00318*	-0.00160	2.37	-0.00324*	-0.00164	0.19	0.00648***	- 0.00392	8.77***	0.00651***	0.00392	0.67
Financial Services	0.00483*	-0.00123	4.53**	0.00474*	0.00121	1.01	0.00492**	-0.00421**	15.74***	-0.005**	-0.00413**	0.06	0.00975***	-0.00544***	22.23***	0.00974***	0.00534***	3.11*
Food, Beverage and Tobacco	0.00508**	-0.00011	3.87**	0.00501**	0.00009	2.52	0.00254	-0.00483**	10.13***	-0.00261	-0.00482**	0.46	0.00762***	-0.00494**	10.98***	0.00762***	0.00491**	1.27
Health Care	0.00346	0.00082	0.92	0.00340	-0.00084	1.70	0.00167	-0.00484**	6.86***	-0.00174	-0.00489**	1.07	0.00513**	-0.00403**	6.95***	0.00514**	0.00405**	0.15
Industrial Goods and Services	0.00250	-0.00093	2.10	0.00244	0.00091	0.31	0.00274*	-0.00451**	8.72***	-0.00281*	-0.00451**	0.47	0.00524***	-0.00544***	17.98***	0.00525***	0.00541***	0.01
Insurance	0.00123	0.00028	0.11	0.00123	-0.00034	0.20	0.00529***	-0.00445	13.01***	-0.00526***	-0.00445	0.05	0.00652***	- 0.00416	7.22***	0.00649***	0.00411	0.80
Media	-0.00344	-0.00174	0.19	-0.00345	0.00163	0.95	0.00876**	0.00303	1.73	-0.00887**	0.00293	4.03**	0.00532	0.00129	0.62	0.00541	- 0.00130	2.22
Energy	-0.00027	-0.00173	0.21	-0.00035	0.00167	0.19	0.00639***	-0.00290	11.16***	-0.00651***	-0.00292	0.88	0.00613**	-0.00463*	7.65***	0.00616**	0.00459*	0.18
Personal Care, Drug and Grocery Stores	0.00448	0.00082	1.43	0.00445	-0.00089	1.91	0.00617***	-0.00867***	30.21***	-0.00615***	-0.00867***	0.42	0.01065***	-0.00785***	17.84***	0.0106***	0.00778***	0.73
Real Estate	0.00569**	-0.00017	5.35**	0.00566**	0.00021	3.24*	-0.00193*	0.00044	3.39*	0.00192*	0.00050	0.56	0.00375*	0.00028	1.74	0.00374*	- 0.00030	4.08**
Retailers	0.00511**	0.00013	2.81*	0.00498**	-0.00016	2.30	0.00396**	-0.00489**	16.08***	-0.00411**	-0.00489**	0.08	0.00906***	-0.00476**	16.15***	0.00909***	0.00473**	2.80*
Technology	-0.00010	-0.00382**	0.49	-0.00006	0.00369**	0.31	0.00899***	-0.00195	7.24***	-0.00896***	-0.00206	1.47	0.00889*	-0.00577*	4.80**	0.0089*	0.00575*	0.42
Telecommunications	0.00267	-0.00070	1.53	0.00269	0.00063	0.33	0.00599***	-0.00128	7.26***	-0.00596***	-0.00130	1.53	0.00866***	- 0.00198	6.09**	0.00865***	0.00193	5.17**
Travel and Leisure	n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.		n.a.	n.a.	
Utilities	0.0038**	0.00091	2.54	0.00377**	-0.00095	4.15**	0.00398***	-0.00573***	23.56***	-0.00402***	-0.00576***	0.49	0.00778***	-0.00482***	23.98***	0.00778***	0.0048***	1.90

	Testing for Symmetry																	
	$\beta_1=\beta_2$ alternative regression: abs(surprise measures)			$\beta_1=\beta_2$ original regression			$\beta_3=\beta_4$ alternative regression: abs(surprise measures)			$\beta_3=\beta_4$ original regression			$\beta_1+\beta_3=\beta_2+\beta_4$ alternative regression: abs(surprise measures)			$\beta_1-\beta_3=\beta_2-\beta_4$ original regression		
Index	β_1	β_2	F-test	β_1	β_2	F-test	β_3	β_4	F-test	β_3	β_4	F-test	$\beta_1+\beta_3$	$\beta_2+\beta_4$	F-test	$\beta_1-\beta_3$	$\beta_2-\beta_4$	F-test
Note: in columns 5 through 7, 11 through 13 and 17 through 19, we report results for the original regression (1); in columns 2 through 4, 8 through 10 and 14 through 16, we report, instead, results for the alternative regression, i.e., we substitute the surprise measures for their absolute values. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, constant and controls omitted. N=957 (after adjustments).																		
Table C.2 – Tests of Symmetry (Euro Area and Peripheral Sector Indices)																		

References

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics, 108*, 162-179. doi: https://doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2015). *Asset purchase programmes and financial markets: lessons from the euro area.* ECB Working Paper, 1864. European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf

Andrade, P., & Ferroni, F. (2021). Delphic and odyssean monetary policy shocks: Evidence from the euro area. *Journal of Monetary Economics, 117*, 816-832. doi: https://doi.org/10.1016/j.jmoneco.2020.06.002

Bernhard, S., & Ebner, T. (2017). Cross-Border Spillover Effects of Unconventional Monetary Policies on Swiss Asset Prices. *Journal of International Money and Finance, 75*(July), 109-127. doi: https://doi.org/10.1016/j.jimonfin.2017.04.001

Cieslak, A., & Schrimpf, A. (2019). Non-monetary News in Central Bank Communication. *Journal of International Economics, 118*, 293-315.

Driffill, J. (2016). Unconventional Monetary Policy in the Euro Zone. *Open Economies Review, 27*(2), 387-404. doi: https://doi.org/10.1007/s11079-016-9393-0

Falagiarda, M., & Reitz, S. (2015). Announcements of ECB unconventional programs: Implications for the sovereign spreads of stressed euro area countries. *Journal of International Money and Finance, 53*(C), 276-295. doi: https://doi.org/10.1016/j.jimonfin.2015.02.005

Fausch, J., & Sigonius, M. (2018). The impact of ECB monetary policy surprises on the German stock market. *Journal of Macroeconomics, 55*, 46-63. doi: https://doi.org/10.1016/j.jmacro.2017.09.001

Fratzscher, M., Lo Duca, M., & Straub, R. (2016). ECB Unconventional Monetary Policy: Market Impact and International Spillovers. *IMF Economic Review, 64*(1), 36-74. doi: https://doi.org/10.1057/imfer.2016.5

Georgiadis, G., & Grab, J. (2016). Global Financial Market Impact of the Announcement of the ECB's Asset Purchase Programme. *Journal of Financial Stability, 26*(October), 257-265. doi: https://doi.org/10.1016/j.jfs.2016.07.009

Glick, R., & Leduc, S. (2012). Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets. *Journal of International Money and Finance, 31*(8), 2078-2101. doi: https://doi.org/10.1016/j.jimonfin.2012.05.009

Haitsma, R., Unalmis, D., & de Haan, J. (2016). The Impact of the ECB's Conventional and Unconventional Monetary Policies on Stock Markets. *Journal of Macroeconomics, 48*(June), 101-116. doi: https://doi.org/10.1016/j.jmacro.2016.02.004

Hosono, K., & Isobe, S. (2014). *The Financial Market Impact of Unconventional Monetary Policies in the U.S., the U.K., the Eurozone, and Japan*. Discussion papers, 14A-05. Policy Research Institute, Ministry of Finance Japan. Retrieved from https://EconPapers.repec.org/RePEc:mof:wpaper:ron259

Jarocinski, M., & Karadi, P. (2018). *Deconstructing monetary policy surprises: the role of information shocks*. European Central Bank, Working Paper Series: 2133. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=eoh&AN=1710090&lang=pt-pt&site=ehost-live&scope=site

Joyce, M. A. S., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal Central Banking, 7*(3), 113-161.

Kontonikas, A., & Kostakis, A. (2013). On Monetary Policy and Stock Market Anomalies. *Journal of Business Finance & Accounting, 40*(7/8), 1009-1042. doi: https://doi.org/10.1111/jbfa.12028

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. *Brookings Papers on Economic Activity, 42*(2), 215-287.

Leombroni, M., Vedolin, A., Venter, G., & Whelan, P. (2018). *Central Bank Communication and the Yield Curve*. C.E.P.R. Discussion Papers, CEPR Discussion Papers: 12970.

Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=eoh&AN=1709960&lang=pt-pt&site=ehost-live&scope=site

Modigliani, F., & Sutch, R. (1966). Innovations in interest rate policy. *The American Economic Review, 56*(1/2), 178-197.

Modigliani, F., & Sutch, R. (1967). Debt management and the term structure of interest rates: An empirical analysis of recent experience. *Journal of Political Economy, 75*(4), 569-589.

Papadamou, S., Siriopoulos, C., & Kyriazis Nikolaos, A. (2020). A survey of empirical findings on unconventional central bank policies. *Journal of Economic Studies, 47*(7), 1533-1577. doi: https://doi.org/10.1108/JES-04-2019-0186

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics, 51*(8), 1553-1575. doi: http://dx.doi.org/10.1016/j.jmoneco.2004.02.004

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

Rosa, C. (2011). The Validity of the Event-Study Approach: Evidence from the Impact of the Fed's Monetary Policy on US and Foreign Asset Prices. *Economica, 78*(311), 429-439. doi: https://doi.org/10.1111/j.1468-0335.2009.00828.x

Rosa, C. (2012). *How 'unconventional' are large-scale asset purchases? The impact of monetary policy on asset prices.* Staff Reports, 560. Federal Reserve Bank of New York. Retrieved from http://www.newyorkfed.org/research/staff_reports/sr560.pdf

Swanson, E. T. (2011). Let's Twist Again: A High-Frequency Event-Study Analysis of Operation Twist and Its Implications for QE2. *Brookings Papers on Economic Activity, 42*(1), 151-188.

Swanson, E. T. (2017). *Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets*. National Bureau of Economic Research, Inc, NBER Working Papers: 23311. Retrieved from http://www.nber.org/papers/w23311.pdf

Tenreyro, S., & Thwaites, G. (2016). Pushing on a String: US Monetary Policy Is Less Powerful in Recessions. *American Economic Journal: Macroeconomics, 8*(4), 43-74. doi: http://www.aeaweb.org/aej-macro/

Tobin, J. (1961). Money, capital, and other stores of value. *The American Economic Review, 51*(2), 26-37.

Tobin, J. (1963). An essay on the principle of debt management, in: Fiscal and debt management policies: Commission on money and credit. In C. o. m. a. credit (Ed.), *Fiscal and debt management policies*. Englewood Cliffs, NJ: Prentice Hall Inc.

Vayanos, D., & Vila, J.-L. (2009). *A Preferred-Habitat Model of the Term Structure of Interest Rates*. NBER Working Paper Series, 15487. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w15487.pdf

Wright, J. H. (2012). What does Monetary Policy do to Long-term Interest Rates at the Zero Lower Bound?*. *Economic Journal, 122*(564), F447-F466. doi: https://doi.org/10.1111/j.1468-0297.2012.02556.x

Wright, J. H. (2019). Comment on "Measuring euro area monetary policy" by Carlo Altavilla, Luca Brugnolini, Refet Gürkaynak, Giuseppe Ragusa and Roberto Motto. *Journal of Monetary Economics, 108*, 180-184. doi: https://doi.org/10.1016/j.jmoneco.2019.08.017

CHAPTER 4

CONCLUSIONS

4. CONCLUSIONS

This chapter presents this thesis' general conclusions, research contributions and policy implications, its limitations and suggestions for further research work.

4.1. General conclusions

The 2007-08 financial crisis led the ECB to implement several unconventional measures. The impact of UMP on asset prices is an issue that researchers have previously discussed. However, the recent behaviour of central banks has created an environment where this subject can be more thoroughly studied.

The first paper, presented in Chapter 2, focuses on the announcement effects of the ECB's APP on core and peripheral sovereign yields at different maturities

Its first objective was to confirm whether the announcement effects of the ECB's APP on euro area sovereign debt yields operate through different transmission channels.

This paper uses a detailed analysis of the transmission channels for the effects of the ECB APP, across core and peripheral sovereign debt markets at different maturities. In order to determine the importance of the individual channels through which the APP affected sovereign yields in the euro area, a specific empirical model, based on known theoretical mechanisms, was used.

Our results show that APP announcements affected euro area sovereign yields through all the discussed theoretical channels: a signalling channel, a preferred-habitat channel, a duration premium channel, a credit premium channel and a liquidity premium channel.

Second, the analysis was also intended to evaluate these transmission channels' importance at different maturities. We conclude that the size of effects increases the longer the maturity considered. They also seem to peak around the 10-year maturity bucket, which is in line with findings in Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019), for example.

Our analysis was also intended (third objective) to study the different transmission channels' relevance for core and peripheral markets; and, fourth, to assess how transmission channels behave with expansionary (positive) and contractionary (negative) UMP surprises.

When UMP measures are more expansionary than expected yields fall through the signalling, the preferred-habitat and the duration premium channels (the common transmission channels); but when UMP measures are more contractionary than expected yields rise. The sign of policy surprises matters and common effects have the theoretically expected behaviour.

As for credit and liquidity effects (market specific transmission channels), they are very significant for peripheral markets, both for expansionary (which lead to lower yields) and contractionary surprises (which lead to higher yields). Effects have the expected direction and, interestingly, core markets' credit-liquidity effects are symmetric to those estimated for peripheral markets. This is linked to the important conclusion, made possible by the methodological approach we adopted in this paper, that there was a "save the euro" factor in operation with the ECB's APP.

More specifically, with positive surprises, a simultaneous one standard deviation move in both surprise measures translates into (when we focus on the 10-year maturity, for example): a -1.4 bps signalling effect; a -0.9 bps preferred-habitat effect; a -1.3 bps duration premium effect; total common effects ascend to -3.6 bps. These are all statistically significant at the 1% level). With negative surprises (again focusing on the 10-year maturity, for example) we estimate the signalling effect at +1.1 bps. When surprises are negative, total common effects are +1.7 bps.

Turning now to market specific transmission channels, with positive surprises, credit premium effects for peripheral markets are (10-year maturity, for example): -2.3 bps for Italy; -1.2 bps for Spain; -3.0 bps for Portugal; These are all statistically highly significant (at the 1% level) and have the expected direction, i.e., with expansionary surprises, peripheral markets' credit premia fell. With negative surprises, credit effects have the expected direction but, apparently, only those for Italy seem, at first glance, to be statistically significant (+0.9 bps for Italy, +0.2 bps for Spain and +0.9 bps for Portugal, 10-year maturity). This seems puzzling but further analysis, related to the way we measured UMP surprises using two different factors, allowed us to clarify this situation.

Liquidity premium effects are mostly also statistically highly significant and have the expected direction as well, especially for longer maturities (more than 2 years). This is likely a consequence of the ECB's importance as a buyer for these securities.

With positive surprises, liquidity premia are (10-year maturity, for example): -1.9 bps for Italy; -1.9 bps for Spain; -1.1 bps for Portugal. Liquidity premia increased with negative surprises (+2.9 bps for Italy, +3.0 bps for Spain and 2.8 bps for Portugal, 10-year maturity).

One of the most important contributions of this paper followed from the way we empirically identified and quantified two different quantitative easing factors – building on an argument made by Altavilla et al. (2019) and Wright (2019): one is related to an overall stimulus and another one seems to differentially affect sovereign yields. This helps us better explain our findings.

Common transmission channels effects (signalling, preferred-habitat and duration premium) are essentially derived from the "macroeconomic" surprise measure (bund future). This is consistent with their nature: remember that these are effects common to all euro area sovereign markets and they reflect policy measures that provide overall stimulus. As mentioned before, aggregated credit-liquidity effects are symmetric between core and peripheral markets. This is consistent since market-specific effects for peripheral markets, derived from the "save the euro" surprise measure, describe most of these markets' aggregated credit-liquidity effects and are statistically very significant (usually at the 1% level, with a few exceptions for short maturities). In fact, this is an expression of the risk that increasingly accumulates on the ECB's balance sheet and which constitutes a fiscal risk for core countries (Jager & Grigoriadis, 2017).

The paper in Chapter 3 discusses the announcement effects of the ECB's APP on core and peripheral euro area equity indices and sectors. Theoretically, monetary policy influences stock prices since it can affect the rates that market participants use to discount future cash flows and the expected cash flows themselves (Kontonikas & Kostakis, 2013).

This paper's first objective was to evaluate the announcement effects of the ECB's APP on euro area broad equity indices. For the analysed equity markets our results are consistent with other research conclusions. The effects' magnitude as well as the difference between the effects estimated using one-day and two-day windows are consistent with those estimated by Altavilla, Carboni, and Motto (2015). Specifically, the two-day window's effect is half the one-day window effect, which is identical to what Altavilla et al. (2015) report.

One of our objectives (fourth) was also to evaluate how these effects vary with expansionary (positive) and contractionary (negative) UMP surprises. Our analysis lends support to the idea that effects of APP announcements on equity markets depend on the sign of the policy surprise – this is a contribution to previous research about the APP's equity effects. When surprises are positive, a simultaneous one standard deviation move in both surprise measures translates into a total effect between +0.63% (Portugal) and +0.96% (Italy) – a +0.80% average impact for all indices considered. As for when surprises are negative, we estimate this effect at between -0.28% (Spain) and -0.50% (Germany and Italy) – a -0.43% average impact for all indices analysed. Effects are statistically significant for core, euro area and peripheral broad equity markets and they have the theoretically expected direction.

Euro area and peripheral sector effects are usually statistically significant for positive and negative UMP surprises (second objective of this paper). They also have the expected direction, i.e., positive surprises lead to higher returns and negative surprises lead to lower ones, particularly in all statistically relevant cases.

When comparing the behaviour of core and peripheral markets and sectors, we conclude that differences in effects for core, euro area and peripheral markets and for different sectors, as well as for the same sector but at the euro area and at the peripheral level, are not statistically significant (third objective).

Additionally, we have also considered, empirically, the possible, simultaneous, existence of the aforementioned two QE factors (one related to overall stimulus and another one that may differentially affect equities, in this case).

Taking into consideration both a "macroeconomic" surprise measure and a "save the euro" surprise measure we can show that most of the reported equity effects are due to the latter QE factor, i.e., we document that euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area, but not when they were associated with an overall stimulus. This is a relevant conclusion and an important contribution that is strengthened because when we consider a larger two-day event window, results reinforce the idea that the "macroeconomic" factor is statistically irrelevant, while the "save the euro" factor retains its importance.

Finally, our analysis also allowed for a detailed study about non-linearity. When dealing with the issue of symmetry, we must examine two components: first, whether the sign, the direction, of the estimated effects differs between positive and negative surprises and, second, whether its size, i.e., its magnitude is different.

Our results on symmetry, both for sovereign yields and for equity markets, confirm previous research findings (Altavilla et al., 2019) since although the direction of effects for expansionary and contractionary surprises is often different its magnitude is usually not.

In short, we conclude that the ECB's APP has had economically and statistically relevant effects, with the theoretically expected direction, on the analysed Eurozone financial assets. Furthermore, we identify and quantify two different quantitative easing factors, one related to overall stimulus ("macroeconomic QE") and another one which differentially affects sovereign yields and equities ("save the euro QE"), which helps us better explain our findings – this stands as a significant research contribution.

4.2. Research contributions and policy implications

Since the 2007-08 financial crisis unconventional monetary policies have become the new conventional (Driffill, 2016).

Since portfolio management issues, such as the degree of portfolio diversification, risk assessment practices and risk management strategies, are affected by central bank purchases (Kontonikas & Kostakis, 2013), their financial markets' impact are important for investment professionals. Obviously, accurate estimates of the responsiveness of asset prices to monetary policy are important for effective investment and risk management decisions (Rigobon & Sack, 2004).

These purchases have also macroeconomic implications, because the links between monetary policy and asset prices affect the monetary policy transmission mechanism (Rosa, 2011). Reliable estimates of the reaction of asset prices to a policy instrument are a critical step in formulating effective policy decisions since these asset prices— including longer-term interest rates and stock prices—determine private borrowing costs and changes in wealth, which in turn influence real economic activity (Rigobon & Sack, 2004).

Additionally, central bank QE purchases have implications at the corporate financial management level, e.g., when determining the cost of capital (Kontonikas & Kostakis, 2013) and can influence the structure of debt issuance by governments (D'Amico & King, 2013) – this depends on exposure to monetary policy risk.

Our analysis conceptualizes and applies a framework through which effects of the ECB's APP on different markets can be assessed. As such, our results offer some, more detailed and theoretically grounded, guidance about how similar programmes can be expected to perform and, therefore, to impact central banks' actions when it comes to UMP options, investment professionals' likely reaction to UMP by central banks, corporate financial managers' attitudes towards the determination of cost of capital, and government debt issuance structures, in an environment where unconventional monetary policies have become more conventional.

We are, to the best of our knowledge, the first to document the impact of asymmetry in the context of the ECB's APP. We consider a new, more extensive, set of relevant events. This is an improvement on pre-existent research because using an enlarged event list allows us to study, extract inferences and interpret results, with positive and negative UMP surprises, which complements previous research about the APP. We take into consideration market expectations, and therefore limit what is known as attenuation bias. As Rogers, Scotti, and Wright (2014) state it has been "difficult to investigate [asymmetry] in the context of unconventional monetary policy because most (but not all) surprises have been easings" (p.776). In this respect, our results are consistent with Altavilla et al. (2019)'s, since although some literature suggests that the US monetary policy has asymmetric real effects (Tenreyro & Thwaites, 2016), our findings corroborate the idea that asset prices responses to positive and negative ECB surprises have different signs but their magnitude is not different. This is an important analysis which can certainly add value when central banks announce the reversion of QE purchases.

As mentioned before (1.1. – Motivation and research purpose), most research about UMPs' impact in the financial markets is focused on the US and the UK experiences. Research about the Eurozone is more limited and, usually, focused on the early purchase programmes which have a different nature. Our intended purpose was, also, to

methodologically refine and to, largely, complement current analysis of the effects of the ECB's APP.

As stated, a detailed comparison between core and peripheral transmissions channels of the effects on sovereign yields of the programme is a specific contribution of our first paper, presented in Chapter 2, to the current research discussion. We considered how different maturities behaved, aiming at a more comprehensive analysis of the programme's effects.

The second paper, presented in Chapter 3, compares core and peripheral effects of the programme on equity markets.

The results we reached because of the way we managed to consider two different quantitative easing factors are especially relevant for the euro area.

When considering effects on sovereign yields, common effects estimated using the "save the euro" surprise measure are mostly statistically insignificant but aggregated credit-liquidity effects are symmetric between core and peripheral markets and this is likely related to the "save the euro" factor This is consistent with the fact that market-specific effects for peripheral markets estimated using the "save the euro" surprise measure are, generally, statistically very significant (usually at the 1% level) and explain most of the aggregated credit-liquidity effects for the periphery.

Effects on peripheral credit premia with negative policy surprises were different depending on the nature of the surprise. On one hand, when dealing with a lower overall stimulus ("macro QE"), yields across all markets were higher but spreads for peripheral markets were lower. On another hand, if central bank interventions were perceived as specifically less beneficial to peripheral sovereign yields (differentially affecting them, i.e., "save the euro QE"), yields across all markets were also higher but spreads for peripheral markets would also increase. Most of the overall liquidity effect is explained through the "save the euro" surprise measure – the only one generally statistically significant (mostly at the 1% level).

Our results highlight the "macro QE" factor, i.e., overall stimulus, as the most important one for core markets' effects. For peripheral markets, when surprises are positive both

factors help to explain the total impact while for negative surprises, the "save the euro" factor is the only relevant one.

As for equity markets, the importance of the "save the euro" factor that we document is probably related to the fact that the euro area's equity markets were unexpectedly affected whenever market participants associated the ECB APP's announcements with safeguarding the euro area but not when they were associated with an overall stimulus, which is obviously very significant (from a policy response perspective).

4.3. Limitations and future research

Further research could focus on refining our results using intraday data – an important caveat must be considered, though, since an intraday window might be too narrow. In fact, our conclusion about the QE factors' relative relevance strongly argues for the existence of a "save the euro" factor (Wright, 2019). Under those circumstances, some of the analysed markets (peripheral markets) might still not be operating efficiently which makes a daily window a better option, since market participants need time to assimilate news. Unconventional monetary policy decisions are frequently complicated and often explained in subsequent press conferences, which renders questionable "the assumption that the monetary policy surprise can be directly measured from the jumps in government bond yields in an intradaily window around the announcement time" (Rogers et al., 2014, p.753). Fendel and Neugebauer (2018) argue that the effects of ECB's asset purchase announcements on government bond yields arise with a one-day delay, and justify that because of the "locus of transactions and agents who trade: institutional investors trade government bonds OTC on trading floors" (p.26). They conclude that more frequent data is not likely to give additional insights.

This thesis focus is on announcements and not on amounts of asset purchases. Nevertheless, with our methodological approach, dummy variables interact with the policy surprise measures, which endogenously generates different weights (by considering the size of policy shocks associated with each announcement). If we had not made that option, events would all be weighed equally – which does not make sense since we cannot argue that all events are equally surprising or that investor's anticipation of UMP announcements did not improve over time (Bernhard & Ebner, 2017). Furthermore, other research results confirm

that announcements not linked to a specific size have an impact on quantitative numbers (Falagiarda & Reitz, 2015).

Finally, we should remember that in an event study – the methodological option we chose – only stock, also known as permanent, effects are taken into consideration. This leads to an underestimation of the programme's effects; flow effects, or temporary effects, that exist when actual purchases occur, are not considered – see D'Amico and King (2013) and Altavilla et al. (2015), for example. This is a potentially important problem in a crisis environment, when financial constraints are most likely to be binding, since in such an environment arbitrage is only possible when actual transactions take place, and market interventions might have information content (Fratzscher, Lo Duca, & Straub, 2016).

The approach followed allows room for future research developments. Analysis of the APP's impact on other markets or extensions to our analysis, specifically when it comes to the euro area's equity market, seems also to be an interesting course of action for future research. For example, following Haitsma, Unalmis, and de Haan (2016), analysis of impact depending on level of leverage, past performance and style (value versus growth) is an obvious extension of our research which could provide additional insights. Additionally, analysis of the possibility to apply our methodology to other central banks' UMP actions, based on event databases for each major central bank similar to the one we constructed for the ECB's APP, might be worth exploring but is left for future research.

References

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics, 108*, 162-179. doi: https://doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2015). *Asset purchase programmes and financial markets: lessons from the euro area.* ECB Working Paper, 1864. European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf

Bernhard, S., & Ebner, T. (2017). Cross-Border Spillover Effects of Unconventional Monetary Policies on Swiss Asset Prices. *Journal of International Money and Finance, 75*(July), 109-127. doi: https://doi.org/10.1016/j.jimonfin.2017.04.001

D'Amico, S., & King, T. B. (2013). Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply. *Journal of Financial Economics, 108*(2), 425-448. doi: https://doi.org/10.1016/j.jfineco.2012.11.007

Driffill, J. (2016). Unconventional Monetary Policy in the Euro Zone. *Open Economies Review, 27*(2), 387-404. doi: https://doi.org/10.1007/s11079-016-9393-0

Falagiarda, M., & Reitz, S. (2015). Announcements of ECB unconventional programs: Implications for the sovereign spreads of stressed euro area countries. *Journal of International Money and Finance, 53*(C), 276-295. doi: https://doi.org/10.1016/j.jimonfin.2015.02.005

Fendel, R., & Neugebauer, F. (2018). *Country-specific Euro area government bond yield reactions to ECB's non-standard monetary policy announcements.* WHU – Working Paper Series in Economics - WP 18/02. WHU - Otto Beisheim School of Management. Vallendar. Retrieved from https://opus4.kobv.de/opus4-whu/frontdoor/index/index/docId/645

Fratzscher, M., Lo Duca, M., & Straub, R. (2016). ECB Unconventional Monetary Policy: Market Impact and International Spillovers. *IMF Economic Review, 64*(1), 36-74. doi: https://doi.org/10.1057/imfer.2016.5

Haitsma, R., Unalmis, D., & de Haan, J. (2016). The Impact of the ECB's Conventional and Unconventional Monetary Policies on Stock Markets. *Journal of Macroeconomics, 48*(June), 101-116. doi: https://doi.org/10.1016/j.jmacro.2016.02.004

Jager, J., & Grigoriadis, T. (2017). The Effectiveness of the ECB's Unconventional Monetary Policy: Comparative Evidence from Crisis and Non-crisis Euro-area Countries. *Journal of International Money and Finance, 78*(November), 21-43. doi: https://doi.org/10.1016/j.jimonfin.2017.07.021

Kontonikas, A., & Kostakis, A. (2013). On Monetary Policy and Stock Market Anomalies. *Journal of Business Finance & Accounting, 40*(7/8), 1009-1042. doi: https://doi.org/10.1111/jbfa.12028

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics, 51*(8), 1553-1575. doi: http://dx.doi.org/10.1016/j.jmoneco.2004.02.004

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

Rosa, C. (2011). The Validity of the Event-Study Approach: Evidence from the Impact of the Fed's Monetary Policy on US and Foreign Asset Prices. *Economica, 78*(311), 429-439. doi: https://doi.org/10.1111/j.1468-0335.2009.00828.x

Tenreyro, S., & Thwaites, G. (2016). Pushing on a String: US Monetary Policy Is Less Powerful in Recessions. *American Economic Journal: Macroeconomics, 8*(4), 43-74. doi: http://www.aeaweb.org/aej-macro/

Wright, J. H. (2019). Comment on "Measuring euro area monetary policy" by Carlo Altavilla, Luca Brugnolini, Refet Gürkaynak, Giuseppe Ragusa and Roberto Motto. *Journal of Monetary Economics, 108*, 180-184. doi: https://doi.org/10.1016/j.jmoneco.2019.08.017