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A theoretical and empirical analysis of the ECB's response to the COVID-19 pandemic

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Católica Porto Business School
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A theoretical and empirical analysis of the ECB's response to the COVID-19 pandemic

Final work in Academic Context presented to Universidade Católica Portuguesa to obtain the master's degree in Finance

by

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Abstract

This thesis aims to examine the impact of the European Central Bank's Pandemic Emergency Purchase Programme on euro area banks, non-financial firms, and governments cost of borrowing. The base sample used on the regression analysis is constituted by 751 sovereign bonds, 2116 corporate bonds, 469 covered bonds, and 725 asset-backed securities issued between January 1st, 2019, and December 31st,2021. Furthermore, a subsample was created to account for the bonds that are eligible for the PEPP. We find that the PEPP successfully reduced corporate, covered, and sovereign bond spreads in both the announcement and purchasing periods. For asset-backed securities, contrary to what we expected, the findings are not as clear as we find mixed results between the full sample, in which we observed a spread reduction during the purchasing periods and the subsample in which we do not find any significant impact.

Keywords: quantitative easing; European Central Bank; PEPP; cost of borrowing; spreads; unconventional monetary policies; corporate bonds; sovereign bonds; covered bonds; asset-backed securities.

Number of Words: 10815

Resumo

O principal objetivo desta dissertação é examinar o impacto do PEPP, o programa de compra de ativos implementado pelo Banco Central Europeu durante o COVID-19, nos custos de financiamento dos governos, empresas e bancos da zona euro. A amostra base utilizada na análise de regressão é constituída por 751 obrigações soberanas, 2116 obrigações corporativas, 469 obrigações hipotecárias, e 725 obrigações garantidas por créditos emitidas entre 1 de Janeiro de 2019 e 31 de Dezembro de 2021. De modo a analisar o impacto de elegibilidade, uma subamostra foi construída com títulos elegíveis segundo os critérios impostos pelo BCE.

Concluiu-se que o programa implementado pelo BCE durante a pandemia reduziu com sucesso o spread das obrigações corporativas, obrigações hipotecárias e obrigações soberanas durante o período de anúncio e de compra. Contrariamente ao esperado, em relação ao impacto nos spreads de obrigações garantidas por crédito, os resultados não são claros devido à incompatibilidade entre os resultados obtidos através da amostra base, onde observamos uma redução de spreads durante o período de compra, e a subamostra, onde não encontramos qualquer impacto significativo.

Palavras-chave: Banco Central Europeu; PEPP; custo de financiamento; spreads; obrigações soberanas; obrigações corporativas; obrigações hipotecárias; obrigações garantidas por créditos

Número de palavras: 10815

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List of Abbreviations

WHO - World Health Organization

ECB - European Central Bank

PEPP - Pandemic Emergency Purchase Programme

SURE - Support to mitigate Unemployment Risks in an Emergency

LSAP - Large Scale Asset Purchase Programme

SMP - Securities Market Programme

FED - Federal Reserve

TIPS - Treasury Inflation-Protected Securities

CPI - Consumer Pricing Index

APP - Asset Purchase Programme

CBPP - Covered Bond Purchase Programme

ABSPP - Asset-Backed Security Purchase Programme

CSPP - Corporate Sector Purchase Programme

CVB - Covered Bond

NCB - National Central Bank

OMT - Outright Monetary Transaction

HICP - Harmonised Index of Consumer Price

TLTRO - Targeted Long Term Refinancing Operation

ASW - Asset Swap

EAPP - Expanded Asset Purchase Programme

ABS - Asset-Backed Security

PELTRO - Pandemic Emergency Long-Term Refinancing Operation

OAS - Option Adjusted Spread

CB - Corporate Bond

SB - Sovereign Bond

1. Introduction

At the time of writing this thesis, the coronavirus pandemic has engulfed the nations of the world for more than two years. The first COVID-19 infection was reported at the end of the year 2019 in Wuhan, one of China's largest cities with a population of around 11.5 million, and since then it has been spreading all over the world at a very fast rate.

The World Health Organization (WHO) officially declared the SARS-CoV-2 outbreak a public health emergency of international concern on January 30th, 2020, and a global pandemic on March 11th, 2020.

The spreading of the coronavirus has disrupted business activity by producing a sudden deglobalization of the world, in the sense that it pushed countries into a prolonged lockdown, and thus disrupting supply chains and forcing businesses and productions to shut down, at least temporarily. This created an enormous uncertainty surrounding the world's economy and the future of humanity itself. This uncertainty was responsible for a great reduction in asset prices around the world and prompted investors to sell risky assets and buy safer assets, such as bonds. This was particularly true from the end of February to the end of March 2020 (Cheema, *et al*., 2020).

Due to the unprecedented level of volatility that affected the financial markets, the central banks were forced to intervene by implementing a series of different programs with the goal of providing liquidity to an increasingly more fragile economy. The European Central Bank (ECB) response to the pandemic was significantly wider and faster when compared, for example, to the European sovereign debt crisis. The ECB did not move the reference interest rates, because they were already negative, but announced one of the largest asset purchase programs ever implemented in the Euro

area, the Pandemic Emergency Purchase Program (PEPP), through which the ECB would buy 1,850 billion Eur in assets, including public and corporate debt securities across the Eurozone, on top of the increase in the regular quantitative easing program and the European Commission's Support to mitigate Unemployment Risks in Emergency (SURE) program.[1]

Given all these extraordinary conditions and the efforts made by the ECB to try and manage the economic disaster, the main objective of this work is to assess the effectiveness of the PEPP.

This thesis contributes to the existing literature that seeks to examine the impact of the ECB's PEPP on the spread of sovereign bonds (SB), corporate bonds (CB), covered bonds (CVB) and asset-backed securities (ABS) simultaneously. So far, the literature has focused mostly on event-based studies surrounding sovereign bond yields (Altavilla et al., 2021; Benigno et al., 2021; Blot et al., 2021; Haan and Moesner, 2021; Laine and Nelimarkk, 2021) and although all these studies reached the conclusion that the PEPP was indeed effective, they do not provide enough details regarding the impact that the direct purchases made by the ECB had on bond yield spreads. In this thesis we are going to perform a regression analysis of the impact of ECB's PEPP on Euro area financial companies, non-financial companies and countries cost of funding using a sample that includes 4,061 bonds issued between January 1st, 2018, and December 31st, 2021. In this sample we use four types of bonds: ABS – 725 observations; CB – 2,116 observations; CVB – 469 observations; SB – 751 observations. To assess the impact of the PEPP on potentially eligible bonds, a sub sample was also created with bonds that were eligible for the PEPP according to the ECB's criteria. The subsample contains: SB - 702 observations, CB - 1140 observations, CVB - 382 observations and ABS - 40 observations, which equals to approximately 56% of the full

[1] For more details regarding the ECB's response to the COVID-19 pandemic, see https://www.ecb.europa.eu/home/search/coronavirus/html/index.en.html and https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/financial-assistance-eu/funding-mechanisms-and-facilities/sure_en

sample. Our results show that the PEPP effectively reduced the spreads of corporate, covered, and sovereign bonds in both the announcement and purchasing periods. For ABS, contrary to what we expected, the findings are not as clear as we find mixed results between the full sample, in which we observed a spread reduction during the purchasing periods, and the subsample in which we do not find any significant impact.

This thesis is structured as follows: section 2 reviews the literature that is found to be relevant to the development of the research, section 3 outlines the empirical model and describes the dataset and variables, section 4 puts forward the hypotheses and provides a more detailed look into both the full sample and subsample selection, section 5 presents the main finding of the model and Section 6 concludes the paper.

2. Literature Review

2.1. Transmission Channels of Unconventional Monetary Policy

The conventional instrument of monetary policy in the most developed economies in the world is the short-term nominal interest rates (Bernanke *et al*., 2004). In the case of the ECB there are three key short-term interest rates controlled by the governing council, which are, the interest rate on main refinancing operations, used by banks to borrow liquidity from the Eurosystem against collateral on a weekly basis, the rate on the deposit facility, which banks use to make overnight deposits, and the interest rate on the marginal lending facility, which provide overnight credit to banks from the Eurosystem. Both the rate on the deposit facility and the rate on the marginal lending facility act as an interval for the overnight interest rate at which banks lend to each other, with the deposit facility rate acting as the floor and the marginal lending facility rate as the ceiling.[2] These interest rates are used to impact and influence the overall level of economic activity.

As it can be seen in the figure below, in the last couple of years, these short-term interest rates have been gradually trending lower and, in 2020, the deposit facility rate reached -0.5% while the marginal lending facility rate stood at 0.25%.

[2] For further analysis, see https://www.ecb.europa.eu/mopo/decisions/html/index.en.html

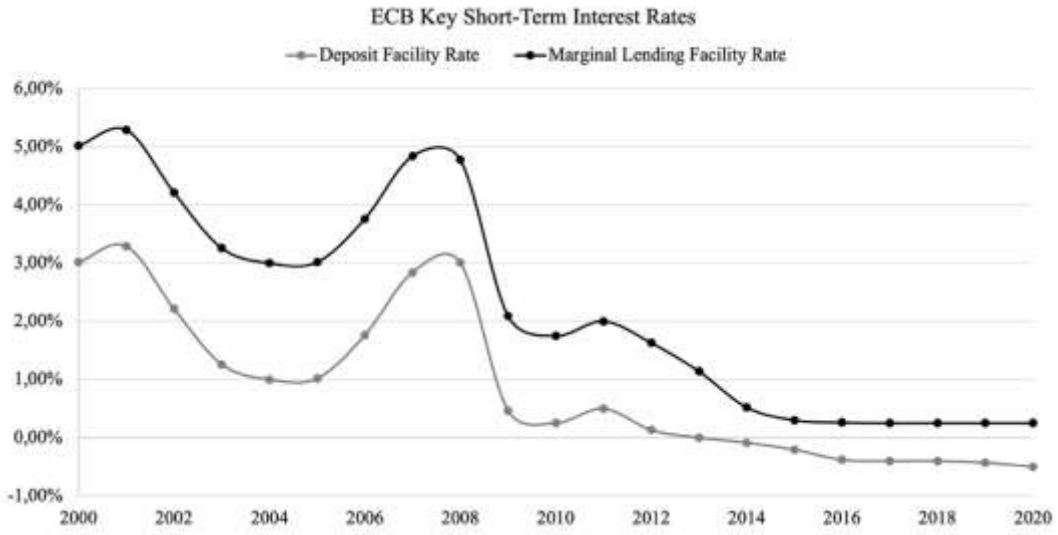

Figure 1: ECB short-term interest rates from 2000-2020

Source: Federal Reserve Economic Data

When the key short-term interest rates get to this level, the ECB's ability to utilize its traditional tools or carry out efficient conventional monetary policy gets extremely impaired, as the attempt to lower short-term interest rates even further or increase the volume of reserves offers no guaranteed boost in aggregate demand (Hamilton and Wu, 2011). In this case, central banks are forced to implement unconventional monetary policies to stimulate the economy. These policies essentially include forward guidance, collateral easing, and quantitative easing (Ariccia *et al.*, 2018). Forward guidance is connected to the central bank's ability to influence the overall economy by communicating about how the policy rate or monetary policy will be set in the future (Woodford, 2012). Collateral easing is implemented by the ECB to ensure that credit institutions maintain sufficient eligible collateral to be able to participate in all liquidity-providing operations, through this policy the ECB increases its risk tolerance by basically "allowing" these institutions to provide a larger scope of assets as collateral against lending facilities. Typically, only high-

quality liquid assets are accepted as collateral, but as economic conditions deteriorate, the ECB assumes the liquidity risk to aid the economy as the precautionary demand for liquidity increases.[3] Quantitative easing, which is the focus of this work, refers to policies that expand the central bank's balance sheet, by acquiring assets that replace long-term holdings with short-term reserves in the balance sheet of the central bank's counterparty (Malliaropulos and Migiakis, 2018). This is intended to lower interest rates and increase the money supply in the economy. When central banks implement quantitative easing, the price of the bonds bought through these asset purchase programmes tends to increase while the bond yield subsequently decreases, which means that the interest rate these bondholders get decreases. The lower interest rate on government or corporate bonds then translates into lower interest rates on loans for households and businesses (Bank of England, 2021).[4]

According to Andrade *et al*. (2016) and Malliaropulos, D. and Migiakis, P. (2018) quantitative easing affects bond yields through four main channels: signalling channel, portfolio rebalancing channel, liquidity channel and reanchoring channel. The signalling channel represents the impact that the announcements regarding asset purchase programmes have on market expectations concerning future short-term interest rates. As an expansionary asset purchase programme is announced, market participants can expect a period of lower interest rates and higher liquidity. If, for example, the ECB announces a large asset purchase programme, this might signal a commitment to easy monetary policy for the foreseeable future, which in turn will force investors to revise down their expectations for future short-term interest rates causing long-term bond yields to fall (Christensen and Rudebusch, 2012). Although, at first, this might look identical to forward

[3] For further analysis, see https://www.bportugal.pt/en/page/non-standard-measures-related-covid-19-pandemic

[4] For more information regarding the quantitative easing process, see https://www.bankofengland.co.uk/monetary-policy/quantitative-easing and https://www.ecb.europa.eu/ecb/educational/explainers/show-me/html/app_infographic.en.html

guidance, the signalling channel is much more efficient when it comes to influencing the market, as the announcement is more credible. Credibility is higher because purchases of long-term assets expose the central bank to possible losses on its balance sheet in case short term interest rates increase. This provides an incentive to keep rates low and to only increase them gradually (Andrade *et al*. 2016). There are several papers confirming the importance of the signalling channel, such as, Bauer and Rudebusch (2014) and Falagiarda and Rietz (2015), which find a strong and significant signalling channel effect for the Federal Reserve's (FED) first Large Scale Asset Purchase (LSAP) Programme implemented in the US from November 2008 to March 2010 and for the Securities Market Programme (SMP) carried out in May 2010.

The portfolio rebalancing channel refers to the direct impact on asset prices of investors rebalancing their portfolios as a response to the central bank's asset purchases (Joyce *et al*., 2011). Mario Draghi, former president of the ECB, describes the portfolio rebalancing channel as: "Basically substitute bonds with cash, and therefore banks, at that point, will have more incentive to lend to the private sector, households and companies" (Mario Draghi, 2015).[5] This basically means that when the ECB buys financial assets the demand of these assets increases which, as said previously, pushes down the yield earned by the holders of those assets. The lower returns will force investors to move towards more risky and higher yielding investments, usually these investments include corporate bonds, shares of publicly traded companies and even loans to businesses and households (Lerven, 2016). This channel relies on the imperfect substitutability between different asset classes, which is caused by the fact that agents have a so-called preferred habitat that makes them reluctant to sell their preferred bonds (Christensen and Krogstrup, 2018).

[5] Mario Draghi, former president of the ECB, provided a brief explanation of the portfolio rebalancing channel during his introductory statements on the ECB's press conference in Frankfurt am Main, see https://www.ecb.europa.eu/press/pressconf/2015/html/is150122.en.html#qa

This market friction among different types of investors ultimately leads to an enhancement of the impact of the asset purchase programme (Boermans and Vermeulen, 2018). Both Gagnon *et al*. (2011) and Joyce *et al*. (2011), study the impact on bond yields of several key announcements regarding the FED's LSAP and the Bank of England's (BOE) Quantitative easing programmes and found that the reduction in yields of both the 10-year US treasury and the long-term UK government bond was mainly driven by the portfolio rebalancing channel.

Regarding the liquidity channel, Joyce *et al*. (2011), state that "the presence of the central bank in the market as a buyer of assets may improve market functioning and therefore reduce the premia for illiquidity". In other words when the ECB enters the market it is the equivalent of having a trusted buyer with deep pockets. Although it is very hard to isolate, Christensen and Gillan (2019), study the liquidity channel by analysing how the FED's second quantitative easing programme, active from November 2010 to June 2011, affected the liquidity premiums in Treasury Inflation-Protected Securities (TIPS) and inflation swap contracts and found that these purchases temporarily reduced the liquidity premiums in the markets for TIPS and inflation swaps. Both these financial products are adjusted for inflation using the Consumer Pricing Index (CPI), which means that in a frictionless world the inflation swap rate is equal to the break-even inflation. This allows for a more quantifiable measure of the variation in liquidity premium.

Finally, the reanchoring channel is connected to the fact that, uncertainty regarding the length of the horizon over which price stability will be restore might generate movements in long-term inflation expectations outside of what the central bank views as optimum. Through this channel, the ECB can guide long-term inflation expectations closer to its price stability objective and reverse these deviations (Andrade *et al*., 2016). Beck *et al*. (2019) provide evidence of the reanchoring channel by exhibiting an increase on both the CPI and inflation expectations following

quantitative easing announcements, the authors even go as far as to mention that in a regime where the ECB is only able to utilize conventional monetary policy tools, economic agents might question the central bank's ability to ensure price stability and avoid a liquidity trap scenario, characterized by a period of persistent deflation. Andrade *et al*. (2016), also find evidence that supports this channel by analysing a survey forecast that reveals that after significant decrease in long-term inflation expectations during 2014, these expectations returned to a level consistent with the ECB's price stability target after the announcement of the Asset Purchase Programme (APP).

2.2. Previous ECB Asset Purchase Programmes

The second strand of literature relates to the papers that seek to examine the effectiveness of the previous major APP carried out by the ECB during periods of crisis in the last decade. In response to the global financial crisis, which was caused by the 2008 US subprime market collapse and the late 2009 and early 2010 European sovereign debt crisis, the ECB was forced to, in the years that followed, implement a series of non-standard measures, consisting on recurrent purchases of financial assets to lower medium and long term yields in order to stimulate economic activity, raise inflation and ultimately provide the amount of policy accommodation needed to ensure price stability (Neri and Siviero, 2019).

These programmes consisted of three Covered Bond Purchase Programmes (CBPP) in 2009, 2011 and 2014 (CBPP1, CBPP2 and CBPP3, respectively), the Securities Market Programme in 2010 and the Asset-Backed Securities Purchase Programme (ABSPP) in 2014. Between 2014 and 2016, these two programmes were embedded in a broader APP, including public sector bonds (PSPP), in 2015, and the corporate sector purchase programme (CSPP), in 2016. After several extensions, on the 1st of November 2019, the ECB officially restarted net purchases under the regular APP, which is composed by the CSPP, PSPP, ABSPP and CBPP3 (Branco *et al*., 2020).

2.2.1. Covered Bond Purchase Programme

Covered bonds (CVB) are bonds issued by credit institutions, which are secured by a group of high-quality assets, including mortgage loans or public sector debt (Pereira, 2016). As only financial institutions hold a large enough pool of loans, these bonds present an important funding channel for financial institutions (Markmann, 2017).

According to the ECB, the main objective of the CBPP was to promote the decline in money market term rates and facilitate funding conditions for credit institutions and enterprises, thus encouraging these institutions to maintain and expand their lending to clients (Bernie *et al*. 2011). This will be achieved through purchases of CVB issued by banks or mortgage agencies. As it was mentioned before, there were three different CBPP, the CBPP1 was announced on May 7th, 2009, starting in July 2009 with a targeted nominal amount of 60 billion Eur (ECB, 2010).[6] The CBPP2 started on November 2011, the initial targeted nominal amount was 40 billion Eur and the purchases were expected to have been fully carried out by October 31st, 2012. However, by April 4th, 2012, the ECB had to slow down the pace of purchases due to the increase of investor's demand for euro area CVB and to the decline of supply in said bonds, thus the nominal amount purchased under the CBPP2 on both the primary and secondary market was 16.4 billion Eur (ECB, 2012).[7] Finally, the CBPP3 was announced on October 2nd, 2014, and as opposed to other programmes, its size was not disclosed. Since its implementation, the ECB is already a significantly less active

[6] For further details regarding the CBPP1, see https://www.ecb.europa.eu/press/pr/date/2010/html/pr100630.en.html
[7] For further details regarding the CBPP2, see https://www.ecb.europa.eu/press/pr/date/2012/html/pr121031_1.en.html

buyer of CVB than it was at the beginning of the programme (European Covered Bond Council, 2017).[8]

Regarding the effectiveness of the programmes, Szczerbowicz (2015), implements an event-based regression to observe the change in money market spreads, CVB spreads, and SB spreads. The author shows that both CBPP1 and CBPP2 were not only effective in reducing the CVB spreads but also in lowering SB market distress. One of the most important findings of this study is the "feedback loop" between both SB purchases programmes and CVB programmes, meaning that SB purchases affect CVB spreads and vice-versa. Similarly, Gibson *et al*. (2015), find that both CBPP1 and CBPP2 to be effective and to have slightly raised CVB prices, reaching the conclusion that central banks can effectively intervene in the case of market malfunction. On the other hand, Markmann (2017), finds that only the CBPP1 was successful in providing stability to the primary market, through an increase of emission activity that allowed banks to obtain the necessary funding to maintain and even increase their loans to the economy. Both the CBPP2 and CBPP3 did not seem to effectively increase CVB emission volume, possibly since at the time these programmes were put in place by the ECB, the market was already expecting the action, and the banking sector was not particularly distressed.

Concerning the eligibility criteria for the CBPP3, which is the programme included in the APP (Ross *et al*., 2019), only bonds fulfilling the following criteria were eligible:

- Eligible for use in Eurosystem credit operations
- Issued by euro area credit institutions, or by a special purpose vehicle incorporated in the euro area

[8] For further details regarding the CBPP3, see https://hypo.org/ecbc/publication-news/covered-bond-purchase-programme-3-implications-primary-secondary-markets/

- At least BBB- credit rating, or equivalent from one of the major credit rating agencies
- Underlying assets that include exposure to private and/or public institutions
- Denominated in Euro and settled in the Eurozone

2.2.2. Securities Market Programme

In May 2010, the ECB announced the SMP to address the severe tension in financial markets that threatened the ability of the Eurosystem to properly set market interest rates of bonds with longer maturity. According to the ECB, the main objective of the programme was to "address the malfunctioning of securities markets and restore an appropriate monetary policy transmission mechanism" (ECB, 2010).[9] Under this programme the ECB coordinated purchases of Eurozone government bonds in the secondary market, carried out by the various National Central Banks (NCB's). In the beginning these purchases focused on Portuguese, Irish and Greek government bonds, which were the most financially distressed countries in the Eurozone. It was only in August 2011 that this programme was extended to Italy and Spain (Ross *et al*., 2019).

The ECB's holdings peaked at 219.5 billion Eur in February 2012. Table 1 presents a breakdown of the Eurosystem's SMP holdings as of December 31st, 2012:

[9] For further analysis, see https://www.ecb.europa.eu/press/pr/date/2010/html/pr100510.en.html

Table 1: SMP holdings breakdown

Source: European Central Bank

Issuer Country	Outstanding Amount		Average Remaining Maturity (Years)
	Nominal Amount (Eur Billion)	Book Value (Eur Billion)	
Ireland	14.2	13.6	4.6
Greece	33.9	30.8	3.6
Spain	44.3	43.7	4.1
Italy	102.8	99.0	4.5
Portugal	22.8	21.6	3.9
Total	218.0	208.7	4.1

The SMP ended in September 2012, but it was quickly replaced by another programme entitled Outright Monetary Transaction (OMT).[10]

Regarding the effectiveness of the SMP, Smith (2020), states that making a thorough and constructive assessment of the SMP is far too difficult to perform because the programme, although similar to other APP, presents some key differences, such as, the concealment of the targeted securities, the amount that was going to be purchased and the duration of the programme itself. Another important aspect was the timing of the programme, most of the purchases were made during the peak of the sovereign debt crisis when sovereign yields in euro area countries were very high and extremely volatile (Esser and Schwaab, 2013), this makes it hard to understand whether yields moved because of the programme or due to other interfering factors. Eser and Schwaab (2013) show that the purchases during the SMP were effective in lowering yields for Spain, Italy, Portugal, Ireland, and Greece. Ghysels *et al*. (2014) develop a multi-frequency component model to assess the impact of SMP purchases and find that it was somewhat successful

[10] For further details regarding the OMT, see https://www.ecb.europa.eu/press/pr/date/2012/html/pr120906_1.en.html

in lowering yields and controlling volatility. Gibson *et al*. (2015) find that the spreads on 10-year SB were modestly reduced and that the "Whatever it takes" statement made by the ECB president at the time, Mario Draghi, was more effective in reducing bond yields than the programme itself.[11]

2.2.3. Corporate Sector Purchase Programme

At the time the CSPP was announced, Europe's real GDP growth was slowing significantly, and the annual Harmonised Index of Consumer Price (HICP) was marginally negative which meant that the governing council of the ECB had to implement policy measures to reach price stability (Cruz *et al*., 2018). Some of these measures included: a reduction in the ECB's policy rate, four Targeted Longer-Term Refinancing Operations (TLTRO) and the CSPP.

The CSPP was announced by the ECB on March 10th, 2016, enabling the Eurosystem to buy investment-grade euro-denominated bonds issued by non-bank corporations established in the Euro area (Deutsche Bundesbank, 2016).[12] According to the ECB, the main objective of the programme was to "further strengthen the pass-through of the Eurosystem's asset purchases to the financing conditions of the real economy" (ECB, 2016).[13]

From the beginning of the programme to September 2017, the Eurosytem was holding around 115 billion Eur in assets. Of the universe of securities available, 15% of which were purchased on the primary market. By the end of the third quarter of 2017 the holding of corporate debt securities accounted for 5% of all purchases made under the ECB's general APP (Bonfim and Capela, 2020).

[11] The speech was delivered in London, on July 26, 2012, at the Global Investment Conference, for more details see https://www.ecb.europa.eu/press/key/date/2012/html/sp120726.en.html

[12] For further details, see https://www.bundesbank.de/en/tasks/monetary-policy/outright-transactions/corporate-sector-purchase-programme-cspp--831132

[13] For further analysis, see https://www.ecb.europa.eu/press/pr/date/2016/html/pr160421_1.en.html

As for the effectiveness of the CSPP, Macchiarelli *et al*. (2017) show that the credit spreads for investment-grade euro-denominated bonds for all sectors declined consistently from the announcement of the programme to its introduction, but on June 2016, due to the uncertainty surrounding the French election and Brexit, yields of corporate bonds spiked and thus supressed the positive effect of the CSPP. However, throughout the year of 2017, the investment-grade euro corporate bond all sector index spread tapered to a low of 40.5 basis points on July 20th 2017. Zaghini (2019), examines the CSPP's first year of activity from June 2016 to June 2017 with a focus on the primary market, and states that the programme had a positive impact on the corporate bond market. By focusing on the Asset Swap (ASW) Spread, the author shows that there was a significant announcement effect which tightened the spread by 36 basis points in eligible and non-eligible bonds and an initial effect on the eligible bonds which were issued at a lower yield than non-eligible. Similarly, Cecchetti (2019) confirms the effectiveness of the CSPP and gauges whether this effectiveness can be attributed to the fact that unconventional measures reduced expected losses by enhancing expectations regarding the credit quality of the issuer or the fact that expansionary measures increase investor's risk appetite. This is achieved by decomposing the excess return of the corporate bonds of companies in the Itraxx Europe index into two sources of risk premium: "the distress risk premium" and the "jump-at-default risk premium". After this decomposition, an event-based study was made around the first announcement of the programme and it was observed that the reduction in risk premia was about 16.7 basis points, with much of this reduction coming from the distress risk premium.

The eligibility criteria for the CSPP suffered a few modifications in 2020 as the ECB adapted the general APP to the economic impact caused by the pandemic:

- Debt instruments issued by corporations which comply with the criteria for marketable asset for Eurosystem credit operations
- Non-financial commercial paper, for companies with sufficient credit rating
- Euro denominated
- Credit rating of at least BBB-/Baa3

2.2.4. Public Sector Purchase Programme

The PSPP was announced in January 2015 and the first purchase took place in March 2015. This programme was an extension of the regular APP, and it was implemented with the intent of supplementing two programmes already in place at the time: the ABSPP and the CBPP3.

Under this programme the ECB would be purchasing bonds issued by euro area central governments, agencies, and local governments (Deutsche Bundesbank).[14] The programme was only supposed to last until September 2016, but it was extended several times until December 2018. The main reason behind this extension was that the ECB wanted to see a sustained convergence towards the objective of a rate of inflation below but close to 2% (Demertzis and Wolff, 2016). The literature concerning the effectiveness of the PSPP is relatively scant when compared to other programmes, Andrade *et al*. (2016), seek to assess the effectiveness of the Expanded Asset Purchase Programme (EAPP), with a focus on the PSPP, by analysing both the announcement effect and the impact of direct purchases of eligible bonds. Regarding the announcement effect, the author found a significant impact on asset prices as average yields for

[14] For more details concerning the PSPP, see https://www.bundesbank.de/en/tasks/monetary-policy/outright-transactions/public-sector-purchase-programme-pspp--831140

SB dropped around 13 basis points after the announcement and an additional 14 basis points after the implementation. CB yields declined around 10 to 13 basis points depending on the rating. Concerning the direct bond purchases, Andrade *et al*. do not find any relevant difference between the change in yields for bonds that were actually purchased by the Eurosystem and bonds not included in the programme. Altavilla *et al*. (2015), found that despite being announced at a time of low financial distress in the Eurozone, the PSPP significantly lowered yields on both targeted and non-targeted assets. The author studied the announcement effect of the purchase programme on SB yields of several European countries and concluded that there was a decrease of around 30, 29 and 22 basis points for 5-, 10-, and 20-year maturities, respectively. The biggest reductions were 80 basis points on Spanish SB yields and 75 basis points on Italian SB yields, both with 10-year maturities.

In terms of eligibility, the PSPP includes securities that have the following characteristics (Ross *et al*., 2019):

- Remaining maturity of 2 to 30 years at the time of purchase
- Euro denominated
- Eligible as collateral for Eurosystem operations
- Yield more than the deposit rate (-0,2% at the time the programme started)

2.2.5. Asset-Backed Securities Purchase Programme

Asset-backed securities (ABS) are a type of financial instrument collateralized by an underlying pool of assets. These assets can be receivables on credit cards, automobile loans, home equity

loans, among others (Bhattacharya and Fabozzi, 1996). Basically, an ABS can be created from any stream of receivables, as long as there is a significant demand and supply for it (Sabarwal, 2005). The ECB announced the ABSPP in September 2014, and between November 2014 and December 2018 the Eurosystem conducted several purchases of senior and guaranteed mezzanine tranches of ABS in both primary and secondary markets. According to the ECB, the main objectives of the ABSPP were to further enhance the transmission of monetary policy, facilitate the provision of credit to the euro area economy and contribute to a sustained adjustment in inflation rates. The ABSPP also helps banks to diversify funding sources and stimulate the issuance of new securities (ECB, 2021).[15]

Regarding the effectiveness of the ABSPP, the literature is very scant, and it is mostly related with the EAPP, which is a programme launched on January 20th, 2015, that included the CBPP3 and the ABSPP. Fendel and Neugebauer (2018), study the announcement effect of the ECB's unconventional monetary policy on 10-year government bond yields of euro area countries. For the ABSPP, the authors find an average yield reduction of 3.8 bps for more solvent euro area countries (Austria, Belgium, Finland, France, Germany, and Netherlands) and 7.9 bps for periphery European countries (Greece, Ireland, Italy, Portugal, and Spain).

In terms of eligibility, the ABSPP includes the following (Ross *et al*., 2019):

- Secured by claims residing in the euro area
- Eligible as collateral for Eurosystem credit operations
- Issuer in the euro area
- Issued by a financial institution
- Euro denominated

[15] For further analysis, see https://www.ecb.europa.eu/mopo/implement/app/html/abspp-faq.en.html

- Credit rating of at least BBB-/Baa3

2.3. Effectiveness of the ECB's response to the Covid-19 Pandemic

Prior to the Covid-19 pandemic, the main advanced economies in the world were experiencing a period of persistently low inflation, which in turn led to central banks fixing their policy rates at historically low levels. This scenario was specifically true for the Eurozone and the ECB, that right before the pandemic had its key interest rates at around -0.5%, thus leaving the ECB with less options to act on a potential crisis moment (Blot *et al*., 2020). As it became increasingly harder to further reduce the policy rates, central banks started to employ a series of unconventional policies that quickly became the norm for monetary policy in the coming years (Aguilar *et al*., 2020).

During March it became clear that Covid-19 would not be limited to China and that it would spread rapidly through Europe, spawning major economic problems. Consequently, the risk premia in financial markets went up which made investors sell riskier and more speculative assets, such as stocks, and gravitate towards safer and more conservative investments (Cheema *et al*., 2020). This change caused a substantial widening of yield spreads in the European Sovereign bond markets, which in turn undermines the ability of less stable European countries to finance appropriate policy responses in the capital markets (Beckmann *et al*., 2020).

In the beginning of March 2020, the ECB responded with a series of measures outlined to improve liquidity and funding conditions. The measures implemented can be divided into two main segments: lending programmes and asset purchases. In terms of the lending programmes, the ECB eased the conditions for the TLTRO III, with the borrowing rate going from around -25 to -75 bps in March and -50 to -100 bps in April. The Pandemic Emergency Long-Term Refinancing Operations (PELTRO) were also introduced in April with an interest rate of -25 bps, as well as the temporary easing of collateral measures and expansion of the range of eligible assets under the

CSPP, to include non-financial commercial paper (Lane, 2020).[16] Regarding the asset purchases, the regular APP was expanded temporarily with an additional 120 billion Eur envelope in 2020, while continuing monthly purchases of 20 billion Eur and reinvestments, and, on March 18th 2020, the ECB announced the PEPP, a temporary asset purchases programme of private and public sector securities, implemented to address the serious risks posed by the Covid-19 pandemic to the monetary policy transmission mechanisms and the outlook for the Euro area (ECB, 2020).[17] Initially the size of the programme was 750 billion Eur, but the overall envelope was subsequently increased by 600 billion Eur on the 4th of June 2020 and by 300 billion Eur on December 10th, 2020, for a total of 1,850 billion Eur. These purchase programmes resulted in an increase of the Eurosytem's balance sheet total assets form 4.6 trillion Eur in the end of 2019 to 6.9 trillion Eur in the end of 2020, a 50% increase that represents approximately 19.4% of 2019 GDP (Blot *et al*., 2021).

In terms of eligibility, the PEPP includes all the securities eligible under the existing regular APP, which were mentioned previously, with a waiver of the eligibility requirements for securities issued by the Greek government and a decrease in the necessary remaining maturity for non-financial commercial paper.

Regarding the effectiveness of the PEPP, Altavilla *et al*. (2021), find that the PEPP, not only compressed average long-term bond yields but also reduced the risk of bond market fragmentation, which was one of the biggest concerns of the ECB. It also points out to the event-study evidence that the impact of the PEPP on yields was stronger than that of the APP. While a standard purchase

[16] For more details regarding the speech of Philip R. Lane, member of the executive board of the ECB, outlining all ECB measures since the start of the pandemic, see https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp201006~e1d38a1ccc.en.html

[17] For further details concerning the PEPP and all the eligibility criteria, see https://www.ecb.europa.eu/mopo/implement/pepp/html/index.en.html

of 500 billion in SB under the PSPP is associated with an approximate 20 basis points decline in the ten-year GDP weighted yield (weighted average of the yields of Germany, Spain, France, and Italy, the four biggest euro area jurisdictions), the same purchase under the PEPP generates a contraction of 25 basis points. This can be attributed to the programme's higher flexibility, in terms of eligible assets, in comparison with the regular APP.

Benigno *et al*. (2021), study the impact of the ECB's expansionary monetary policy by applying an event-based methodology and complementing it with a qualitative analysis. Regarding the event-based methodology, the author utilized several spreads to observe the changes in the borrowing conditions of banks, corporations, and national governments after the announcement of each measure implemented by the ECB. The biggest impacts were observed on March 18th, 2020, the announcement date of the PEPP, the euro area sovereign spread (spread between the composite yield of the 10-year government bonds of the euro area and the swap rate with the same maturity) had a reduction of 23 bps and the Italian sovereign spread contracted 77 bps. For corporations and banks, the effects were not as relevant. To further analyse the impact of the PEPP, the author does a qualitative analysis, where it provides a broader view of the behaviour of the spread between various bond yields and the inflation expectations in the euro area at 5- and 10-year horizons. Overall, after the announcement of the PEPP, both the spread on corporate and bank bond yields, which at the beginning of the pandemic reached levels higher than 250 bps, and the spread on Euro area and Italian sovereign 10-year maturity, was reduced and even reached pre-pandemic levels in the beginning of 2021. In terms of inflation expectations, the authors state that since the beginning of the pandemic, inflation expectations, at both 5- and 10-year horizon, have reached historically low levels at 0.72% and 1.05%, respectively. After the announcement of the PEPP inflation expectations spiked, specially at the long-run component.

Blot *et al*. (2021), point out the differences between the APP and the PEPP and the need to assess them distinctively. While the APP aims to provide favourable financing condition to promote price stability, the role of the PEPP is to ensure homogeneous transmission of monetary policy across countries and counter financial risk on sovereign yields. Regarding the effectiveness of the PEPP, the authors apply a two-step approach by first estimating the relationship between weekly purchases and an indicator of sovereign stress and then using the residual of this first step as a proxy of PEPP exogeneous shocks which in turn is used in the second step to assess the impact on the sovereign spread of each country. Overall, the results show that the PEPP is indeed an effective instrument to reduce spreads, however, its effectiveness varies from country to country, depending on their financial stability, for example, while there was a clear reduction in the sovereign spreads of Italy, Spain, Belgium, Portugal, and Greece, there was almost no impact on the spread of France, Netherlands, Austria, and Finland.

Haan and Moessner (2021), study the impact of the ECB's PEPP announcement on ten-year government bond term premia by decomposing these bond yields into term premia and expected interest rates at the ten-year maturity for eleven euro area countries with very different economical profiles. The authors find that the announcement of the PEPP affected not only government bond yields, but also the term premia of government bonds in countries with higher sovereign risk.

Laine and Nelimarkka (2021), employ structural vector autoregressions to assess the macroeconomic effects of the ECB's pandemic related monetary policy measures. The authors find that the PEPP and the TLTRO significantly alleviated the economic consequences of the pandemic. Due to its size and significance, the PEPP had a greater impact on both the GDP and inflation growth. The authors state that if the ECB hadn't made any additional asset purchases, the

level of GDP at the end of 2021 would have been 4% lower and the level of the price index about 1% lower.

3. Variable Description

Table 2: Definition of core variables and control variables

Variable name	Variable Definition	Source
Dependent variables		
Spread	Spread represents the margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity (option-adjusted spread).	DCM Analytics
Independent variables		
PEPP	Dummy variable equal to 1 if the bond closing date belongs to the PEPP period (March 18, 2020 - December 9, 2021), and 0 otherwise.	Author
PEPP announcement	Dummy variable equal to 1 if the bond closing date belongs to the PEPP announcement period (March 18, 2020 - March 25, 2020), and 0 otherwise.	Author
PEPP purchases	Dummy variable equal to 1 if the bond issue belongs to the PEPP implementation period (March 26, 2020 - December 9, 2021), and 0 otherwise.	Author
Contractual Characteristics		
Tranche Rated	Dummy variable equal to 1 if the bond has a credit rating, and 0 otherwise. Availability of the tranche credit rating provides credibility to the issuance and thus is expected to reduce the spread on such bonds.	DCM Analytics
Tranche Rating	Rating based on the S&P rating at the bond closing date. The rating is converted as follows: AAA=1, AA+=2, AA=3 and so on until D=22. It means that, the higher the value the lower the credit rating. The spread for bonds with a lower credit rating (higher value) is expected to be higher.	DCM Analytics
Time to Maturity	Bond maturity in years. Bonds with longer maturities tend to be riskier than bonds with shorter maturity, which is expected to be translated in a higher spread as investors demand a higher return for being exposed to risk for a longer period of time.	DCM Analytics
Log Transaction size	Logarithm of the bond transaction size in Euro million. Higher transaction size is expected to reduce the spread.	DCM Analytics
Tranche to transaction	The ratio of tranche size to transaction size of the bond. This equals to the tranche value divided by the deal value of each tranche, if the transaction only contains one tranche than the value of the tranche to transaction is 100%. For SB, CB and CVB, the spread and tranche to transaction is expected to have a positive correlation. For ABS the tranche to transaction and spread is expected to have a negative correlation.	DCM Analytics
Callable	Dummy variable equal to 1 if the bond has a call option, and 0 otherwise. Callable bonds can be redeemed by the issuer before maturity. Bonds with these embedded options are expected to have a higher spread.	DCM Analytics
Floating	Dummy variable equal to 1 if the bond has a float rate, and 0 otherwise. Float rate bonds are expected to have a lower spread as the issuers are not protected from the risk of rising interest rates.	DCM Analytics
Number of banks	Number of financial institutions participating in the bond issuance. The higher the number of institutions participating in the deal, the higher the diversification of the transaction risks whcih in turn reduce the spread of the bonds.	DCM Analytics
Number of tranches	Number of tranches per transaction.	DCM Analytics
Macroeconomic Factors		
Volatility	VSTOXX (Euro Stoxx 50 Volatility) index.	Datastream
Country Risk	Moody's country credit rating at closing date. The rating is converted as follows: AAA=1, AA+=2, AA=3 and so on until C=21.	Datastream
EUSA5y-Libor3M	Difference between the five-year Euro swap rate and the 3-month Libor rate. A proxy for the slope of the yield curve.	Datastream

3.1. Core Variables

Table 2 provides a breakdown of the variables utilized in the regression model. The dependent variable in our model is the Option Adjusted Spread (OAS), it was also the dependent variable on previous studies, such as, Branco *et al.* (2020) and Pinto *et al.* (2021). OAS is a measure of yield spread that considers embedded call options in the valuation of the bond. The OAS for a specific bond is computed using price and projections of interest rate volatility to account for the possibility of early redemption, it is expressed as a spread over the treasury curve and can be interpreted as the margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity. The main benefit of using the OAS as our dependent variable is that it allows for a more efficient comparison between bonds with different redemption structures.[18]

For the independent variables we created three dummy variables to account for the PEPP, PEPP announcement and PEPP purchases. Concerning the PEPP dummy, the variable will take the value of one if the bond tranche was issued during the PEPP period which starts on March 18th, 2020, first date of the PEPP announcement, and end on December 9th, 2021, which is the last date with a bond issue on the full sample. The ECB announced the PEPP on March 18, 2020, but only started purchases on March 26, 2020, this means that the dummy of the PEPP announcement will take the value of one if the bond tranche was issued between March 18, 2020, and March 25, 2020, while the dummy of the PEPP purchases will take the value of one if the bond tranche was issued between March 26, 2020, and December 9, 2021.

[18] For more information regarding the Option Adjusted Spread, see California Debt and Investment Advisory Commission (CDIAC) article https://www.treasurer.ca.gov/cdiac/publications/issue-brief/2020/20-10.pdf

3.2. Control Variables

Concerning the control variables, we consider the following contractual characteristics for a bond issue: tranche credit rating, time to maturity, transaction size, number of banks, tranche to transaction, number of tranches, inclusion of a call option and if the bond has a float rate. Table 2 also provides details regarding each variable as well as the expected impact on bond spreads of all these contractual characteristics.

Finally, we consider the following macroeconomic factors: the market volatility, represented by the Euro Stoxx 50 volatility and the yield curve slope, represented by the difference between the five-year Euro Swap rate and the 3-month Libor rate.

4. Hypotheses Development and Sample Selection

4.1. Hypotheses Development

To examine the impact of the ECB's PEPP on sovereign, financial and non-financial borrowing costs, we raised the following hypotheses:

- Hypotheses 1 (H1): The PEPP significantly reduced banks cost of borrowing by reducing securitization and covered bond credit spreads.
  e.g.: Bernie *et al.* (2021), Ross *et al*. (2015), Szczerbowicz (2015)
- Hypotheses 2 (H2): The PEPP significantly reduced sovereign bond credit spreads.
  e.g.: Andrade *et al*. (2016), Altavilla *et al*. (2021), Benigno *et al*. (2021), Blot *et al*. (2021), Fendel and Neugebauer (2018)
- Hypotheses 3 (H3): The PEPP significantly reduced non-financial firms cost of borrowing via the corporate bond market.
  e.g.: Andrade *et al*. (2016), Benigno *et al*. (2021), Pinto *et al*. (2021)
- Hypotheses 4 (H4): The impact of the PEPP is higher for peripherical Euro Area countries (PIIGS) *vis-à-vis* core countries.
  e.g.: Altavilla *et al*. (2015), Blot *et al*. (2021), Fendel and Neugebauer (2018)

All the hypotheses raised above will be tested in the next section by implementing both univariate and multivariate analysis. For the first three hypotheses, we will conduct various regression analyses of the impact of the PEPP on bond spreads using both a full sample and a subsample

composed by bonds that are eligible for purchase under the PEPP. For the H4 we selected from the full sample, bonds that were issued by PIIGS, which include Portugal, Ireland, Italy, Greece, and Spain, that represent the peripherical European countries with a more unstable economic situation and bonds issued by Core euro area countries, which include Germany and France.

4.2. Sample Selection

The sample chosen consists of several individual bond issues in the 2018-2021 period extracted directly from the DCM Analytics database. DCM Analytics provides comprehensive information on the spread and the contractual characteristics of bond securities issued in the debt capital markets (Branco *et al*., 2020). From the several securities available in the software, only bonds with a deal-type code of "corporate bond investment-grade", "corporate bond high-yield", "asset-backed security", "covered bond" and "sovereign bond" are selected. we also require that the issuer country, firm or bank belongs to the Euro Area and that the currency is Euro. Moreover, only bonds with information regarding the spread to benchmark and deal value are included in the sample. After applying these screens, we arrive at a full sample of 4,061 bond tranches with a deal value of €4,675.7 billion and issued by 19 different European countries. This sample contains information on 751 SB issues worth €1,532.0 billion, 2,116 CB worth €2,424.0 billion, 469 CVB worth €359.5 billion, and 725 ABS worth €369.4 billion.

To assess the impact of the PEPP on potentially eligible bonds, a subsample is created by filtering for bonds that comply with the eligibility criteria of the PEPP.[19] For private sector securities (covered and corporate bonds), the ECB requires the deal value to be above €10 million, both the tranche effective rating and the company effective rating must be better than or equal to BBB- and, in terms of maturity, the CB must have a residual maturity, at the time of purchase (18/03/2020), between 28 days and 31 years. For ABS, the tranche effective rating must be better than or equal to BBB- and the securities must be issued by European banks. For public sector securities (sovereign and supranational bonds) there are no restrictions in terms of tranche effective rating

[19] For more details regarding the eligibility criteria of the PEPP, see https://www.ecb.europa.eu/mopo/implement/pepp/html/pepp-qa.en.html

but the residual maturity, at the time of purchase (18/03/2020), must be between 70 days and 31 years. This leaves the subsample with 2,264 bond tranches, approximately 56% of the full sample, with a deal value of €3,203.2 billion and issued by 18 different European countries. The subsample encompasses 702 SB worth €1,390.0 billion, 1140 CB worth €1,499.0 billion, 382 CVB worth €296.8 billion, and 40 ABS worth €17.4 billion.

4.3. Full Sample Univariate Analysis

This section provides some summary statistics for all the different types of bonds comprised in the full sample, which include, CB, CVB, SB and ABS. Table 3 illustrates the distribution of the full sample by type of bond, number of tranches, tranche value, country, and year. In terms of bond issuance, there is a 20,41% increase from 2018 to 2021, ABS and CB issuance increased, approximately, by 52% and 29%, respectively. During the same period CVB decreased significantly by around 38% while SB had a slight increase of 16%.

Regarding the geographic location of the borrower, Panel A shows that 91,70% of all CB issuers are concentrated in five countries, which include Germany (35,06%), France (31,06%), Netherlands (9,43%), Italy (8,21%), and Spain (7,41%). ABS issuers are also highly concentrated, with issuers located in Ireland (38,04%), Germany (23,91%), Italy (12,47%), France (11,75%), and Spain (6,25%) accounting for 92,42% of all ABS issuance volume. CVB and SB issuers are slightly less concentrated with the 5 biggest issuers accounting for 84,57% and 77,23%, respectively, of all issuances. Considering all types of bonds, approximately 75% of all bonds were issued by borrowers located in Germany (27,69%), France (21,03%), Ireland (9,86%), Italy (9,07%), and Spain (7,24%).

Table 3: Distribution of bonds by geographic location of issuer and year at tranche level

Panel A: Geographic location of issuer/borrower	Corporate Bonds			Covered Bonds			Sovereign Bonds			Asset-Backed Securities		
	Number of tranches	Total value [€ Million]	% of total value	Number of tranches	Total value [€ Million]	% of total value	Number of tranches	Total value [€ Million]	% of total value	Number of tranches	Total value [€ Million]	% of total value
Austria	56	31 786.09	1.31%	51	23 740.00	6.60%	21	79 100.00	5.19%	5	2 488.30	0.67%
Belgium	69	65 525.00	2.70%	19	14 250.00	3.96%	33	73 479.00	4.83%	13	3 610.32	0.98%
Cyprus	0	0.00	0.00%	0	0.00	0.00%	11	13 700.00	0.90%	0	0.00	0.00%
Estonia	6	1 855.00	0.08%	2	750.00	0.21%	1	1 500.00	0.10%	0	0.00	0.00%
Finland	80	46 254.37	1.91%	20	14 700.00	4.09%	22	33 588.00	2.21%	8	4 788.60	1.30%
France	614	752 801.60	31.06%	104	112 400.00	31.26%	38	53 820.00	3.53%	89	43 421.27	11.75%
Germany	549	864 428.77	35.66%	171	106 625.00	29.65%	320	218 150.00	14.33%	92	88 346.90	23.91%
Greece	18	9 455.00	0.39%	1	500.00	0.14%	16	40 500.00	2.66%	1	130.00	0.04%
Ireland	46	28 166.61	1.16%	1	750.00	0.21%	11	46 000.00	3.02%	351	140 526.47	38.04%
Italy	239	192 768.80	7.95%	26	18 740.00	5.21%	23	207 425.00	13.62%	81	46 057.58	12.47%
Latvia	1	200.00	0.01%	0	0.00	0.00%	10	6 550.00	0.43%	0	0.00	0.00%
Lithuania	4	1 550.00	0.06%	0	0.00	0.00%	6	9 500.00	0.62%	0	0.00	0.00%
Luxembourg	26	17 510.49	0.72%	3	1 300.00	0.36%	156	522 194.00	34.30%	0	0.00	0.00%
Malta	4	312.50	0.01%	0	0.00	0.00%	0	0.00	0.00%	6	2 439.06	0.66%
Netherlands	193	236 268.66	9.75%	41	39 692.00	11.04%	0	0.00	0.00%	35	13 737.90	3.72%
Portugal	28	11 970.90	0.49%	2	1 000.00	0.28%	12	29 296.50	1.92%	8	808.30	0.22%
Slovakia	3	1 115.00	0.05%	7	3 500.00	0.97%	7	14 500.00	0.95%	0	0.00	0.00%
Slovenia	1	120.00	0.00%	0	0.00	0.00%	18	24 300.00	1.60%	0	0.00	0.00%
Spain	179	161 925.24	6.68%	21	21 625.00	6.01%	46	149 032.19	9.79%	36	23 084.50	6.25%
Total	**2 116**	**2 424 014.03**	**100.00%**	**469**	**359 572.00**	**100.00%**	**751**	**1 522 634.69**	**100.00%**	**725**	**369 439.20**	**100.00%**
Panel B: Year												
2018	432	530 140.60	21.87%	148	106 860.00	29.72%	159	220 460.00	14.48%	176	86 205.75	23.33%
2019	564	644 158.54	26.57%	139	108 462.00	30.16%	157	242 268.69	15.91%	196	104 637.91	28.32%
2020	571	709 891.88	29.29%	90	78 300.00	21.78%	250	532 944.00	35.00%	85	44 776.71	12.12%
2021	549	539 823.01	22.27%	92	65 950.00	18.34%	185	526 962.00	34.61%	268	133 818.83	36.22%
Total	**2 116**	**2 424 014.03**	**100.00%**	**469**	**359 572.00**	**100.00%**	**751**	**1 522 634.69**	**100.00%**	**725**	**369 439.20**	**100.00%**

4.3.1. Descriptive Statistics by Bond Type

We now present some summary statistics of the dependent and independent variables concerning the full set of 4,061 bond issuances. Table 4 presents summary statistics of those variables by bond category, considering the overall period of analysis.

The mean (median) spread of ABS is economically and statistically higher 255.59 bps (165.00 bps) than the average spread of CB 213.82 bps (155.05 bps), CVB 53.73 bps (48.50 bps), and SB 49.19 bps (35.40 bps). The average credit rating does not fully explain the higher average spreads for ABS as the mean credit rating for CB (8.7 | BBB) is worse than the mean credit rating for ABS (6 | A), SB (3 | AA), and CVB (1 | AAA). Credit rating is a measure of risk, so it would be expected that the spread on CB would be higher than the mean spread on ABS due to the higher credit rating. This also does not seem to be true for CVB and SB as the spread on CVB is higher than the spread on SB although the mean credit rating on SB is worse than the credit rating on CVB. Furthermore, the ABS included in our sample do not have any company credit rating available, which also contributes to the higher spread as the credibility of the issuer is much lower. The country risk also contributes to the explanation of the higher average spread for ABS, given that the average country risk for ABS (5.23 | A+) is also much higher than the average country risk for CB (3.71 | AA-), CVB (2.69 | AA), and SB (2.67 | AA).

The average maturity for SB (13.6 years) and ABS (13.1 years) is significantly higher than that of CB (8.2 years) and CVB (9.1 years). The average number of banks participating in CB issuance (7.0) is significantly higher than the average number of banks involved in ABS issuance (2.0), usually the number of banks reflects the complexity of the deal as well as the risk involved in the transaction, and we would expect to see a higher number of banks participating in ABS issuance

due to the higher spread and the worse mean tranche credit rating. The mean (median) tranche value of SB is €1,675.83 million (€600.00 million), which is much higher when compared to the tranche values for CB, €641.17 million (€500.00 million), CVB, €678.99 million (€500.00 million), and ABS, €133.46 million (€26 million), this is expected given the fact that governments can borrow larger amounts. The average tranche to transaction ratio for ABS (31.39%) is much lower than that for CB (77.69%), CVB (94.67%) and SB (92.73%). ABS benefit from the tranching process in the sense that this process allows the creation of one or more classes of securities whose individual rating is higher than the average rating of the underlying collateral asset pool or to generate rated securities from a pool of unrated assets (Fender and Mitchell, 2005), thus providing securities with a diverse range of maturities, risks and returns. For ABS most of the bonds included in the sample are both float rate bonds (100%) and are callable (89.66%) which in both cases leads to a higher spread.

Table 4: Univariate statistics - Pricing features of the full sample at tranche level

Variable of Interest	Type of Bond Issue				Variable of Interest	Type of Bond Issue			
	CB	CVB	SB	ABS		CB	CVB	SB	ABS
Continuous Variable					*Continuous Variable*				
Spread (Bps)					**Time to Maturity**				
Number	2116	469	751	725	Number	2116	469	751	725
Mean	213.82	53.73	49.19	255.59	Mean	8.2	9.1	13.6	13.1
Median	155.05	48.50	35.40	165.00	Median	7	8	10	13
Tranche Credit Rating					**Company Credit Rating**				
Number	2005	467	735	704	Number	1865	395	723	0
Mean	8.69	1	3	6	Mean	8.48	5.74	3.01	0
Median	8	1	1	6	Median	8	5	2	0
Number of Banks					**Tranche Value (€ Million)**				
Number	13876	2422	4495	1293	Number	2116	469	751	725
Mean	7	5	6	2	Mean	641.17	678.99	1675.83	133.46
Median	6	5	5	1	Median	500	500	600	26
Number of Tranches					**Deal Value (€ Million)**				
Number	3498	519	887	5238	Number	2116	469	751	725
Mean	2	1.1	1.2	7.2	Mean	1145.56	766.68	2027.48	509.57
Median	1	1	1	8	Median	750	500	750	410
Tranche to Transaction					**Country Risk**				
Number	2116	469	751	725	Number	2116	469	751	725
Mean	77.69%	94.67%	92.73%	31.39%	Mean	3.71	2.69	2.67	5.23
Median	100.00%	100.00%	100.00%	6.17%	Median	3	2	1	6
Dummy Variables					*Dummy Variables*				
Float Rate					**Callable**				
Number of tranches	2116	469	751	725	Number of tranches	2116	469	751	725
Number of tranches with d=	170	10	64	725	Number of tranches with d=	1517	1	1	650
% of total	8.03%	2.13%	8.52%	100.00%	% of total	71.69%	0.21%	0.13%	89.66%
Tranche Rated					**Company Rated**				
Number of tranches	2116	469	751	725	Number of tranches	2116	469	751	725
Number of tranches with d=	2005	467	735	704	Number of tranches with d=	1866	395	723	0
% of total	94.75%	99.57%	97.87%	97.10%	% of total	88.19%	84.22%	96.27%	0.00%
PEPP Announcement					**PEPP Purchases**				
Number of tranches	2116	469	751	725	Number of tranches	2116	469	751	725
Number of tranches with d=	11	2	9	0	Number of tranches with d=	1003	140	378	335
% of total	0.52%	0.43%	1.20%	0.00%	% of total	47.40%	29.85%	50.33%	46.21%
PEPP					**Elegible**				
Number of tranches	2116	469	751	725	Number of tranches	2116	469	751	725
Number of tranches with d=	1014	142	387	335	Number of tranches with d=	1140	382	702	40
% of total	47.92%	30.28%	51.53%	46.21%	% of total	53.88%	81.45%	93.48%	5.52%

5. Regression Analysis

In this section we implement an OLS regression analysis, which is a generalized linear modelling technique that allows us to estimate the relationship between one or more independent quantitative variables and a dependent variable (Hutcheson, 2011). The specification of the initial model is:

$$\text{Credit spread}_i = \alpha + \beta_1 \text{PEPPi} + \beta_2 \text{PEPP Announcement}_i + \beta_3 \text{PEPP Purchases}_i + \beta_4 \text{Tranche Rated}_i + \beta_5 \text{Tranche Rating*Rated}_i + \beta_6 \text{Time to Maturity}_i + \beta_7 \text{Log Transaction Size}_i + \beta_8 \text{Tranche to Transaction}_i + \beta_9 \text{Callable}_i + \beta_{10} \text{Floating}_i + \beta_{11} \text{Number of Banks}_i + \beta_{12} \text{Number of Tranches}_i + \beta_{13} \text{Volatility}_i + \beta_{14} \text{Country Risk}_i + \beta_{15} \text{EUSA5y-Libor3M}_i + \varepsilon_i$$

The above equation will be estimated using both the full sample and the subsample constructed according to the eligibility criteria of the PEPP, as discussed in section 4.2. this model will allow us to test the first 3 hypotheses, which are related to measuring the impact of the ECB's PEPP on CB, CVB, SB, and ABS bond spreads. To test the 4th hypotheses, we will re-estimate our complete model for sub-samples analysing the impacts of the PEPP for bonds issued in PIIGS (Portugal, Ireland, Italy, Greece, Spain) vis-à-vis core euro area countries (Germany and France).

5.1. Regression Results

5.1.1. The impact of the PEPP on bond yields

Tables 5 presents the results of estimating the equation specified in section 5 using the full sample which is composed by a total of 4,061 bonds. We compose the following Models [1a], [2a], [3a], and [4a] for CB, CVB, SB, and ABS, respectively. Models [1b], [2b], [3b], and [4b] are then re-estimated for the same bonds by replacing the PEPP dummy variable per two variables, capturing the effect of both the announcement (PEPP Announcement) and the implementation (PEPP Purchases).

Table 5: Regression analyses of the PEPP impact on bonds

Dependent variable:	CB		CVB		SB		ABS	
Spread (bps)	[1a]	[1b]	[2a]	[2b]	[3a]	[3b]	[4a]	[4b]
Independent variables:								
PEPP	-27.203 ***		-20.973 ***		-21.978 ***		-18.684 *	
	(0.000)		(0.000)		(0.000)		(0.087)	
PEPP Announcement		-74.559 **		-32.105 **		-28.383 *		
		(0.028)		(0.034)		(0.091)		
PEPP Purchases		-28.164 ***		-21.311 ***		-22.106 ***		-18.684 *
		(0.000)		(0.000)		(0.000)		(0.087)
Tranche Rated	-464.086 ***	-463.937 ***	19.704	20.442	-16.732	-16.705	-736.489 ***	-736.489 ***
	(0.000)	(0.000)	(0.187)	(0.173)	(0.148)	(0.149)	(0.000)	(0.000)
Tranche Rating*Rated	42.852 ***	42.855 ***	6.835 ***	6.817 ***	9.949 ***	8.944 ***	39.949 ***	39.949 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Time To Maturity	1.769 ***	1.769 ***	0.253	0.246	0.308 **	0.307 **	-6.620 ***	-6.620 ***
	(0.000)	(0.000)	(0.152)	(0.163)	(0.021)	(0.021)	(0.000)	(0.000)
Log Transaction Size	-20.278 ***	-20.288 ***	-1.223	-1.362	0.439	0.473	-21.148 **	-21.148 **
	(0.000)	(0.000)	(0.506)	(0.461)	(0.773)	(0.756)	(0.044)	(0.044)
Tranche to Transaction	20.926	20.415	-27.796	-27.846	-3.878	-4.130	-4.518	-4.518
	(0.210)	(0.222)	(0.214)	(0.213)	(0.787)	(0.774)	(0.317)	(0.317)
Callable	-5.303	-5.048	-7.811	-7.694	-4.397	-4.382	40.401 **	40.401 **
	(0.341)	(0.365)	(0.656)	(0.661)	(0.916)	(0.917)	(0.015)	(0.015)
Floating	-4.846	-5.032	-12.437 *	-12.311 *	6.510	6.476		
	(0.596)	(0.582)	(0.079)	(0.079)	(0.274)	(0.276)		
Number of Banks	-1.427 **	-1.420 **	0.638	0.709	-0.742 ***	-0.745 ***	-8.479 *	-8.479 *
	(0.030)	(0.031)	(0.392)	(0.346)	(0.010)	(0.010)	(0.072)	(0.072)
Number of Tranches	22.196 ***	22.065 ***	-17.284	-17.274	-1.209	-1.414	12.147 ***	12.147 ***
	(0.000)	(0.000)	(0.135)	(0.136)	(0.842)	(0.817)	(0.000)	(0.000)
Volatility	3.645 ***	3.817 ***	0.990 ***	1.051 ***	1.035 ***	1.070 ***	1.690 *	1.690 *
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.055)	(0.055)
Country Risk	-2.969 ***	-2.968 ***	3.718 ***	3.741 ***	-2.474 ***	-2.469 ***	-3.445 *	-3.445 *
	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.007)	(0.082)	(0.082)
EUSA5y-Libor3M	-0.160	-0.145	0.059	0.060	0.006	0.010	-0.465 **	-0.465 **
	(0.127)	(0.170)	(0.128)	(0.118)	(0.937)	(0.901)	(0.025)	(0.025)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2 116	2 116	469	469	751	751	725	725
R^2	0.637	0.637	0.526	0.526	0.247	0.247	0.764	0.764
Adjusted R^2	0.643	0.634	0.512	0.512	0.233	0.232	0.760	0.760

In terms of banks cost of borrowing, which is related to H1, Models [2a] and [4a] show that the PEPP was indeed effective in reducing the spread for both CVB and ABS. These results are consistent with the predictions made in H1 and thus we validate this hypothesis. Model [2b] shows that CVB spreads reduce in both the announcement and purchasing periods, by -32.105 bps, with 5% significance level, and by -21.311 bps, with 1% significance level, respectively. Model [4b] does not have any information regarding the impact of the announcement of the PEPP on ABS spreads because there were no ABS issued during the period (18/03/2020 – 25/03/2020). As for the purchasing period, the spreads reduce by -18.684 bps for 10% significance level.

Models [2a] and [2b] show that the following variables do not affect CVB spreads: tranche rated, time to maturity, log transaction size, tranche to transaction, callable, number of banks, number of tranches and EUSA5y-Libor3M. In both models, results show that the interaction between rated bonds and its credit rating (Tranche Rating*Rated) increases CVB spreads by 6.835 bps on [2a] and 6.817 bps on [2b] both with 1% significance level. Floating rate decreases CVB spreads, which is what we expected given that issuers are exposed to the risk of rising interest rates as opposed to fixed rate bonds, by -12.437 and -12.311 bps for 10% significance level. As it was expected, market volatility increases CVB yields by 0.990 and 1.051 bps for 1% significance level, the positive relationship between spreads and volatility can be explained by the fact that borrowers will require a higher return when higher volatility is observed (Ebner, 2009). Country risk represented by the sovereign credit rating provided by Moody's, increased CVB yields by 3.718 and 3.741 bps for 1% significance level.

According to Models [4a] and [4b], the only variable that does not affect ABS spreads is tranche to transaction and the floating rate variable that was eliminated because of multicollinearity. It is also important to note that both models lead to the same exact results when it comes to the impact

of the independent variables in ABS spreads. As we expected, results show that ABS rated by S&P and/or Moody's have a negative impact on ABS spreads by -736.489 bps with 1% significance level (Ammer and Clinton, 2004; Zaghini, 2014). Additionally, the interaction between a rated bond and its credit rating (Tranche Rating*Rated) increased ABS spreads by 39.949 bps with 1% significance level. Time to maturity impacts ABS spreads negatively by -6.620 bps with 1% significance level, meaning that, contrary to what we expected, ABS maturity and spreads have a negative relationship. The logarithm of the transaction volume of the ABS negatively impacts the spread by -21.148 bps with 5% significance level, in line with what was expected from previous literature (Gürtler and Neelmeier, 2016; Vink and Thibeault, 2008). For ABS, the fact that the bonds are callable impacts positively ABS spreads by 40.401 bps with 5% significance level, this is expected given that this option allows the issuer to redeem the bond before maturity, which translates into a higher yield (Schwert, 2020; Pinto *et al*. 2021). The results for both the number of banks and the number of tranches verify what was expected from previous literature (Nadauld and Weisbach, 2012; Firla-Cuchra and Jenkinson, 2006). The number of banks decreases ABS spreads by -8.479 bps for 10% significance level, while the number of tranches increases ABS spreads by 12.147 bps for 1% significance level. In terms of macroeconomic factors, Volatility increases, as expected, the ABS spreads by 1.690 bps for 10% significance level. For country risk, previous literature points out that a better credit rating should reduce bond spreads (Gibson *et al*., 2015), but contrary to what was expected, country risk impacts ABS spreads negatively by -3.445 bps for 10% significance level. Finally, the slope of the Euro swap curve is negatively correlated with bond spreads, meaning that a steeper Euro swap curve corresponds to lower spreads (Pinto *et al*., 2021). For ABS the slope of the Euro swap curve decreases spreads by 0.465 bps for 5% significance level.

Regarding H2, which relates with the effectiveness of the PEPP when it comes to reducing SB spreads, model [3a] shows that the programme reduced SB spreads by -21.978 bps, with 1% significance level, which supports H2. Model [3b] provides information about the announcement and purchasing effect of the PEPP, which reduced SB spreads by -28.383 bps, with 10% significance level, and -22.106 bps, with 1% significance level, respectively. The following variables do not affect SB spreads according to models [3a] and [3b]: tranche rated, log transaction size, tranche to transaction, callable, floating, number of tranches and EUSA5y-Libor3M. In both models, the relationship between a rated bond and its credit rating increases SB spreads by 9.949 bps and 8.944 bps for 1% significance level. Time to maturity increases SB spreads by 0.308 bps and 0.307 bps for 5% significance level, according to preceding literature this is expected as bonds with longer maturity present a higher level of uncertainty in terms of the probability of the interest payments being made by the issuer (Gerlach *et al*., 2010; Gürtler and Neelmeier, 2016). The number of banks participating in the issuance of the bond decreases SB spreads by -0.742 bps and -0.745 bps both for 1% significance level. As discussed previously, both volatility and country risk are expected to increase bond spreads, and although volatility increases, as expected, SB spreads by 1.035 bps and 1.070 bps for 1% significance level, country risk, on the other hand, seems to decrease SB spreads by -2.474 bps and -2.469 bps for 1% significance level.

For H3, which is connected to the PEPP impact in the corporate bond market, regression [1a] allows us to conclude that the PEPP decreases CB spreads by -27.303 bps for 1% significance level. The results for CB are expected and thus we validate H3. In model [1b] We can also see that both the announcement and purchasing effects of the PEPP had a significant impact in CB spreads, -74.559 bps and -28.164 bps for 1% significance level. The variables that do not affect CB spreads according to models [1a] and [1b] are tranche to transaction, callable, floating and EUSA5y-

Libor3M. Observing the independent variables of both models, we note that CB rated by S&P and/or Moody's impact CB spreads negatively by -464.086 bps and -463.937 bps for 1% significance level. The interaction between a bond being rated and its credit rating increases CB spreads by 42.852 bps and 42.855 bps for 1% significance level, which is expected given that, in the scale used in the model, a higher credit rating value equals a lower rating in the credit rating agency scale. Time to maturity increases CB spreads by 1.769 bps for 1% significance level in both models. As expected, both the log transaction size and the number of banks impact CB spreads negatively. For log transaction size, CB spreads reduced by -20.278 bps and -20.288 bps for 1% significance level and for the number of banks spreads declined by -1.427 bps and -1.420 bps for 5% significance level. Although for ABS we expect spreads to increase with the number of tranches as it represents a higher level of uncertainty regarding the quality of each tranche, in the case of CB it is not clear what the impact should be. For the number of tranches in CB we can see that spreads increase by 22.196 bps and 22.065 bps for 1% significance level. Volatility impacts positively CB spreads by 3.645 bps and 3.817 bps for 1% significance level. Country risk is expected to impact CB spreads the same way it impacts other types of bonds, which is positively, meaning that as the credit risk gets worse the spreads of such bonds should increase, but contrary to what we expected, for CB, spreads reduce by -2.969 bps and -2.968 bps for 1% significance level.

Table 6 presents the results of the estimation of the same equation for the sample with bonds that are deemed eligible for the PEPP. The main objective of the following analyses is to confirm some of the conclusions taken from table 5.

Table 6: Regression analyses of the PEPP impact on eligible bonds

Dependent variable:	CB		CVB		SB		ABS	
Spread (bps)	[5a]	[5b]	[6a]	[6b]	[7a]	[7b]	[8a]	[8b]
Independent variables:								
PEPP	-29.720 ***		-19.262 ***		-22.253 ***		-26.454	
	(0.000)		(0.000)		(0.000)		(0.229)	
PEPP Announcement		-84.755 ***		-16.329		-29.537 *		
		(0.000)		(0.222)		(0.086)		
PEPP Purchases		-31.400 ***		-19.143 ***		-22.421 ***		-26.454
		(0.000)		(0.000)		(0.000)		(0.229)
Tranche Rated					-11.193	-11.215		
					(0.469)	(0.468)		
Tranche Rating*Rated	19.609 ***	19.596 ***	1.418	1.423	8.899 ***	8.894 ***	24.990 ***	24.990 ***
	(0.000)	(0.000)	(0.199)	(0.197)	(0.000)	(0.000)	(0.000)	(0.000)
Time To Maturity	4.732 ***	4.740 ***	0.251	0.254 *	0.177	0.170	-12.092 ***	-12.454 ***
	(0.000)	(0.000)	(0.101)	(0.099)	(0.458)	(0.478)	(0.000)	(0.000)
Log Transaction Size	1.772	1.854	-1.243	-1.204	-0.065	-0.022	118.620 **	118.620 **
	(0.617)	(0.599)	(0.484)	(0.500)	(0.967)	(0.989)	(0.028)	(0.028)
Tranche to Transaction	15.517	14.763	-36.777 *	-36.746 *	-5.506	-5.816	39.071	39.071
	(0.218)	(0.240)	(0.064)	(0.065)	(0.734)	(0.720)	(0.166)	(0.166)
Callable	-19.392 ***	-19.066 ***	-9.627	-9.674	-5.197	-5.173	23.873	23.873
	(0.000)	(0.000)	(0.503)	(0.502)	(0.902)	(0.903)	(0.546)	(0.546)
Floating	-55.263 ***	-55.608 ***	-8.601	-8.587	6.490	6.411		
	(0.000)	(0.000)	(0.207)	(0.208)	(0.300)	(0.306)		
Number of Banks	0.153	0.158	0.770	0.754	-0.739 **	-0.743 **	-129.901 *	-129.901 *
	(0.748)	(0.740)	(0.289)	(0.302)	(0.015)	(0.015)	(0.097)	(0.097)
Number of Tranches	4.732 ***	4.489	-19.001 *	-19.006 *	-1.688	-1.916	-0.318	-0.318
	(0.000)	(0.223)	(0.064)	(0.064)	(0.809)	(0.785)	(0.931)	(0.931)
Volatility	3.688 ***	3.940 ***	0.750 ***	0.729 ***	1.023 ***	1.064 ***	-3.495	-3.495
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.133)	(0.133)
Country Risk	-0.497	-0.487	3.076 ***	3.067 ***	-2.268 **	-2.264 **	20.834	20.834
	(0.404)	(0.411)	(0.000)	(0.000)	(0.013)	(0.013)	(0.447)	(0.447)
EUSA5y-Libor3M	-0.090	-0.067	0.037	0.036	-0.022	-0.018	-0.494	-0.494
	(0.234)	(0.378)	(0.301)	(0.311)	(0.793)	(0.832)	(0.155)	(0.155)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1 140	1 140	382	382	702	702	40	40
R^2	0.459	0.463	0.375	0.375	0.247	0.247	0.900	0.900
Adjusted R^2	0.454	0.457	0.354	0.353	0.233	0.232	0.861	0.861

As it was mentioned previously, H1 relates with both CVB and ABS as these constitute one of the main debt financing instruments used by banks. Analysing table 6, we can see that CVB spreads, model [6a], reduce by -19.262 bps for 1% significance level, which is line with what we observed in table 5 and thus confirming that the PEPP was indeed effective in reducing the spreads for CVB. On the other hand, for ABS, model [8a], the results obtained with the eligible sample show that there is no evidence supporting that the PEPP had any impact in ABS spreads, which is opposed to what we saw in table 5 and thus we do not validate H1 according to this new sample. for both SB and CB, models [7a] and [5a], we can see that similar results are obtained for the eligible sample. Regarding SB, the PEPP is, on average, associated with a spread reduction of -22.253 bps, for 1% significance level, which confirms the validation of H2 and for CB, the PEPP reduces spreads by -29.720 bps for 1% significance level, that validates H3.

5.1.2. Impact of the PEPP on PIIGS, Germany and France

Table 7 and 8 presents the results of the regression analyses of the impact of the ECB's PEPP on bond spreads taking into consideration the issuing country. To test H4, we divided the full sample into two categories: PIIGS and Core European countries. The countries included in the PIIGS subsample are Portugal, Ireland, Italy, Greece, and Spain, which represent the peripherical European countries with a more unstable economic situation. The Core subsample includes Germany and France which represent the more economically stable countries of the European Union.

Table 7: Regression analyses of the PEPP impact on CB and CVB spreads for PIIGS *vis-à-vis* core Euro area countries

Dependent variable:	CB (PIIGS)		CB (Core)		CVB (PIIGS)		CVB (Core)	
Spread (bps)	[9a]	[9b]	[10a]	[10b]	[11a]	[11b]	[12a]	[12b]
Independent variables:								
PEPP	-53.326 ***		-17.372 **		-62.823 ***		-18.413 ***	
	(0.000)		(0.026)		(0.001)		(0.000)	
PEPP Announcement				-10.882				-13.303
				(0.794)				(0.350)
PEPP Purchases		-53.326 ***		-17.245 **		-62.823 ***		-18.301 ***
		(0.000)		(0.028)		(0.001)		(0.000)
Tranche Rated	-621.328 ***	-621.328 ***	-484.701 ***	-484.711 ***				
	(0.000)	(0.000)	(0.000)	(0.000)				
Tranche Rating*Rated	50.852 ***	50.852 ***	43.503 ***	43.504 ***	6.283	6.283	0.341	0.344
	(0.000)	(0.000)	(0.000)	(0.000)	(0.168)	(0.168)	(0.782)	(0.780)
Time To Maturity	0.192	0.192	2.250 ***	2.250 ***	-1.088	-1.088	0.101	0.106
	(0.764)	(0.764)	(0.000)	(0.000)	(0.459)	(0.459)	(0.536)	(0.520)
Log Transaction Size	-4.373	-4.373	-26.461 ***	-26.467 ***	7.052	7.052	-0.192	-0.098
	(0.578)	(0.578)	(0.000)	(0.000)	(0.471)	(0.471)	(0.925)	(0.962)
Tranche to Transaction	90.100 **	90.100 **	16.064	16.102	-17.732	-17.732	-27.092	-27.037
	(0.025)	(0.025)	(0.429)	(0.428)	(0.848)	(0.848)	(0.164)	(0.166)
Callable	33.103 ***	33.103 ***	-28.600 ***	-28.636 ***				
	(0.005)	(0.005)	(0.000)	(0.000)				
Floating	-47.011 ***	-47.011 ***	-26.112 **	-26.105 **	-16.895	-16.895	22.166 **	22.195 **
	(0.008)	(0.008)	(0.042)	(0.042)	(0.534)	(0.534)	(0.019)	(0.019)
Number of Banks	-2.151	-2.151	-1.064	-1.067	0.674	0.674	1.127	1.089
	(0.124)	(0.124)	(0.191)	(0.190)	(0.876)	(0.876)	(0.104)	(0.121)
Number of Tranches	42.686 ***	42.686 ***	23.797 ***	23.812 ***	-31.040	-31.040	-10.985	-10.993
	(0.000)	(0.000)	(0.000)	(0.000)	(0.527)	(0.527)	(0.274)	(0.275)
Volatility	4.297 ***	4.297 ***	3.412 ***	3.388 ***	4.223 **	4.223 **	0.892 ***	0.870 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)	(0.014)	(0.000)	(0.000)
Country Risk	0.672	0.672	-7.198 **	-7.200 **	14.136 **	14.136 **	2.744 ***	2.721 ***
	(0.824)	(0.824)	(0.019)	(0.019)	(0.017)	(0.017)	(0.004)	(0.005)
EUSA5y-Libor3M	-0.088	-0.088	-0.266 **	-0.269 **	0.312	0.312	0.021	0.020
	(0.697)	(0.697)	(0.050)	(0.049)	(0.191)	(0.191)	(0.544)	(0.561)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	510	510	1 163	1 163	51	51	275	275
R^2	0.649	0.649	0.663	0.663	0.662	0.662	0.323	0.324
Adjusted R^2	0.640	0.640	0.659	0.659	0.567	0.567	0.295	0.293

Table 8: Regression analyses of the PEPP impact on SB and ABS spreads for PIIGS *vis-à-vis* core Euro area countries

Dependent variable:	SB (PIIGS)		SB (Core)		ABS (PIIGS)		ABS (Core)	
Spread (bps)	[13a]	[13b]	[14a]	[14b]	[15a]	[15b]	[16a]	[16b]
Independent variables:								
PEPP	-35.012 **		-18.447 ***		-28.785 **		18.057	
	(0.020)		(0.000)		(0.036)		(0.156)	
PEPP Announcement		21.991		-20.897				
		(0.724)		(0.256)				
PEPP Purchases		-34.713 **		-18.492 ***		-28.785 **		18.057
		(0.021)		(0.000)		(0.036)		(0.156)
Tranche Rated	24.880	30.115	-4.096	-4.167	-772.296 ***	-772.296 ***	-812.231 ***	-812.231 ***
	(0.657)	(0.593)	(0.760)	(0.756)	(0.000)	(0.000)	(0.000)	(0.000)
Tranche Rating*Rated	-6.697	-7.168	-1.660	-1.611	43.950 ***	43.950 ***	33.992 ***	33.992 ***
	(0.222)	(0.193)	(0.588)	(0.602)	(0.000)	(0.000)	(0.000)	(0.000)
Time To Maturity	-0.394	-0.390	0.781 ***	0.780 ***	-1.496	-1.496	-6.344 ***	-6.344 ***
	(0.507)	(0.512)	(0.000)	(0.000)	(0.342)	(0.342)	(0.000)	(0.000)
Log Transaction Size	-0.585	-0.497	-0.013	0.033	-10.773	-10.773	-20.440	-20.440
	(0.906)	(0.920)	(0.996)	(0.989)	(0.418)	(0.418)	(0.265)	(0.265)
Tranche to Transaction	-31.664	-32.208	-23.456	-23.357	-0.222	-0.222	69.886 ***	69.886 ***
	(0.700)	(0.695)	(0.397)	(0.400)	(0.963)	(0.963)	(0.000)	(0.000)
Callable					18.763	18.763	20.802	20.802
					(0.403)	(0.403)	(0.226)	(0.226)
Floating	29.155	27.850	3.589	3.581				
	(0.302)	(0.325)	(0.524)	(0.526)				
Number of Banks	0.778	0.603	-2.105 **	-2.114 **	14.583 **	14.583 **	-0.509	-0.509
	(0.565)	(0.659)	(0.011)	(0.011)	(0.042)	(0.042)	(0.927)	(0.927)
Number of Tranches	-53.661	-53.331	-8.193	-8.167	-0.860	-0.860	11.034 ***	11.034 ***
	(0.229)	(0.232)	(0.436)	(0.438)	(0.793)	(0.793)	(0.001)	(0.001)
Volatility	1.324 **	1.086	0.739 ***	0.755 ***	1.088	1.088	0.747	0.747
	(0.035)	(0.107)	(0.001)	(0.002)	(0.314)	(0.314)	(0.487)	(0.487)
Country Risk	29.297 ***	29.797 ***	-10.259 ***	-10.297 ***	-52.403 ***	-52.403 ***	24.146 **	24.146 **
	(0.000)	(0.000)	(0.003)	(0.003)	(0.000)	(0.000)	(0.017)	(0.017)
EUSA5y-Libor3M	0.396	0.361	-0.017	-0.015	-0.848 ***	-0.848 ***	0.058	0.058
	(0.209)	(0.256)	(0.849)	(0.868)	(0.002)	(0.002)	(0.794)	(0.794)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	108	108	358	358	477	477	181	181
R^2	0.583	0.587	0.170	0.170	0.789	0.789	0.869	0.869
Adjusted R^2	0.530	0.530	0.141	0.139	0.784	0.784	0.859	0.859

First analysing the results in table 7, for CB, which relates to models [9a], [9b], [10a] and [10b], we find that although the PEPP significantly decreases CB spreads for both subsamples, it seems that the impact is higher for PIIGS, -35.012 bps for 5% significance level, than for Core, -18.447 bps for 1% significance level. Looking at models [9b] and [10b] we have an insignificant impact for the announcement period but for the purchasing period we can see the same trend, meaning that the impact of the purchases made by the ECB during the PEPP lowered CB spreads more for PIIGS than Core, leading us to the validation of H4 for CB.

Regarding CVB, models [11a] and [12a] show that for PIIGS subsample, CVB spreads reduced by -62.823 bps for 1% significance level while for Core the reduction was -18.413 bps for 1% significance level. In terms of the announcement effect, we cannot take any conclusion for CVB given that in the case of PIIGS there were no CVB issued during the specified period and for Core the results are not significant. For the PEPP purchasing period, we get a more significant reduction in CVB spreads for PIIGS than Core, which allows us to validate H4 for CVB.

In table 8 we perform the same regression but for SB and ABS. In the case of SB, models [13a] and [14a], we find that the PEPP has a negative impact for both PIIGS and Core, but the impact is more significant for Core, -18.447 bps for 1% significance level, when compared to PIIGS, -35.012 bps for 5% significance level, which is not in line with what was expected. For ABS, model [16a] does not provide any significant results leading us to believe that the impact of the PEPP on ABS spreads for Core countries was not relevant. For PIIGS, model [15a], the PEPP reduced ABS spreads by -28.785 bps for 5% significance level.

In summary, we validate H4 for CB, CVB and ABS, confirming that there was a more significant spread reduction for bonds issued by PIIGS when compared to Core Euro area countries.

6. Conclusion

This thesis provides a detailed look into the impact of the PEPP, an emergency purchase programme implemented by the ECB during the COVID-19 pandemic, on the borrowing cost for euro area banks, non-financial firms, and governments. We performed a regression analysis of the impact of the PEPP on bond spreads using both a full sample and a subsample. The full sample includes 4,061 bond tranches issued between January 1st, 2018, and December 31st, 2021, with a total deal value of €4,675.7 billion issued by 19 different European countries. The subsample is composed by bonds that comply with the eligibility criteria of the PEPP, which includes 56% of the initial full sample, a total of 2,264 bond tranches with a deal value of €3,203.2 billion issued by 18 different European countries.

The results suggest that the PEPP effectively reduces the spreads of corporate bonds, sovereign bonds, and covered bonds across both samples. Overall, these results are in line with similar studies on the effectiveness of the PEPP, such as Altavilla *et al*. (2021), Benigno *et al*. (2021), Blot *et al*. (2021), Corradin *et al*. (2021). For asset-backed securities the results are mixed when comparing the regression using the eligible and full samples. For the full sample we find that during the purchasing period, the PEPP is, on average, associated with a spread reduction of -18.684 bps for 10% significance level. On the other hand, for the eligible sample we do not find any significant impact, leading us to believe that the PEPP did not contribute to the reduction in ABS spreads. Unfortunately, there is no literature concerning the impact of the PEPP on ABS spreads which would be helpful to reach a more robust conclusion.

Regarding the differences of the impact of the PEPP on PIIGS vis-à-vis core European countries, we clearly saw a more significant reduction in spreads across corporate bonds, covered bonds and

asset-backed securities for PIIGS, which is in line with previous literature, such as Altavilla *et al*. (2015) and Blot *et al*. (2021). For sovereign bonds, contrary to what we expected, the reduction in spreads is more significant for the core European countries, with the PEPP impacting SB spreads negatively by -18.447 bps for 1% significance level.

In conclusion, the PEPP was indeed effective in reducing the general cost of funding for banks, non-financial companies, and governments but further research is obviously needed to verify the results obtained in this thesis. Furthermore, it would be interesting to apply a similar model to an aggregate of tranches at the deal level by using the weighted average between the tranche spread and its weight in the deal size. It's also important to highlight that this is not enough to prove that the programme was an overall success and that it was responsible for the quick rebound we saw in the financial markets after the start of the COVID-19 pandemic. Given the size and impact of the PEPP, it would be interesting to further investigate how this programme might be responsible for the record high inflation prevailing in Europe and how the PEPP might have avoided a short-term recession but cause a bigger problem in the long-term.

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