The Impact of the ECB's PEPP on Euro Area Bond Spreads*

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ABSTRACT

We examine the impact of the European Central Bank's Pandemic Emergency Purchase Programme (PEPP) on euro area banks, non-financial firms, and governments' cost of borrowing. Using a large sample of 751 sovereign bonds, 2,116 corporate bonds, 469 covered bonds, and 725 asset-backed securities, issued in the 2018-2021 period, and subsamples of eligible bonds, we find that the PEPP successfully reduced corporate, covered, and sovereign bond spreads in both the announcement and purchasing periods, consistent with signalling, direct, and portfolio rebalancing channels of monetary policy. For asset-backed securities, the findings are mixed: while we show a spread reduction during the purchasing period for the full sample, we do not find any significant impact for bonds fulfilling eligibility criteria. Finally, we show that the PEPP's impact on bond spreads is significantly higher for those issued in GIIPS *versus* core European countries.

Keywords: Quantitative easing; PEPP; cost of borrowing; bond spreads
JEL Codes: E52; G12; G15; G32

I. Introduction

AT THE TIME OF WRITING THIS PAPER, the coronavirus pandemic had engulfed the world for more than two years. The first COVID-19 infection was reported at the end of 2019 in Wuhan, one of China's largest cities with a population of around 11.5 million, and since then it has spread all over the world. The World Health Organization (WHO) officially declared the SARS-CoV-2 outbreak a public health emergency of international concern on January 30, 2020, and a global pandemic on March 11, 2020.

The spreading of the coronavirus disrupted business activity by producing a sudden deglobalization of the world, in the sense that it pushed countries into a prolonged

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lockdown, thus disrupting supply chains and forcing businesses and production 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 significant 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 2020 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 programmes with the goal of providing liquidity to an increasingly fragile economy. The European Central Bank (ECB) responded to the pandemic by announcing one of the largest asset purchase programmes ever implemented in the euro area, the Pandemic Emergency Purchase Programme (PEPP). Through PEPP, the ECB planned to buy €1,850 billion in assets, including public and corporate debt securities across the eurozone, in addition to the increase in the regular quantitative easing programmes and the European Commission's Support to mitigate Unemployment Risks in Emergency (SURE) programme.[1]

This paper contributes to two strands of the literature. Firstly, we contribute to recent Quantitative Easing (QE) literature that examines the impact of the ECB's PEPP on yield spreads. So far, the literature has used mostly event-based studies, focusing on sovereign bond yields in the secondary market (Altavilla et al., 2021; Benigno et al., 2021; Blot et al., 2021; Haan and Moesner, 2021; Laine and Nelimarkka, 2021). Although these studies present evidence consistent with the PEPP as being effective in reducing bond spreads, they do not provide enough details regarding the impact of direct bond purchases on primary market spreads. Using the primary market, it is not possible to do so. The focus on primary market issues is important because it allows: (i) to use bond categories that are not traded in the secondary market (e.g., covered bonds and asset-backed securities); and (ii) to have more information about the issue, including contractual characteristics.

Secondly, this paper also contributes to the literature that studies the impact of the ECB's asset purchase programmes (APP) on the cost of borrowing of corporates. Abidi and Miquel-Flores (2018), Grosse-Rueschkamp et al. (2019), Todorov (2020), and Rischen and Theissen (2021) document that the ECB's corporate sector purchase programme (CSPP) significantly reduced corporate bond yields in various market segments, while Zaghini (2019) and Arce et al. (2021) show that this reduction was effective not only for eligible, but also for non-eligible bonds, consistent with the portfolio rebalancing channel. Using individual bonds issued by European banks in the 2000-2020 period, Correia and Pinto (2022) show that while there is a significant negative impact of the third covered bond purchase programme (CBPP) on covered bond spreads, the asset-backed securities purchase programme (ABSPP) only reduced spreads for mortgage-backed securities. On the other hand, some authors present contradictory results, with some APP having a contrary effect on bond spreads. Szczerbowicz (2015) and Gibson et al. (2015) show evidence of CBPP1 and CBPP2 as effective mechanisms for

[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

lowering covered bond spreads. However, Gürtler and Neelmeier (2018) point out that while CBPP1 lowered the risk premiums of covered bonds, a similar effect for CBPP2 is not seen. Similarly, Markmann and Zietz (2017) find a 10 to 11 bps tightening of covered bond spreads upon the announcement of CBPP1, while for CBPP2 and CBPP3, the results are mixed. Authors find CBPP2 has an insignificant or a significant positive impact on credit spreads, while for CBPP3 impacts are country driven.

We extend this literature by simultaneously examining the impact of the ECB's PEPP on the primary market spreads of sovereign bonds (SB), corporate bonds (CB), covered bonds (CVB), and asset-backed securities (ABS). To the best of our knowledge, we are the first to conduct this analysis. We use a sample of euro-denominated bonds issued by non-financial firms, banks, and countries in the 2018-2021 period. Our full sample includes 4,061 bonds, of which 725 are ABS, 2,116 are CB, 469 CVB, and 751 SB. To assess the impact of the PEPP on potentially eligible bonds, a subsample was also created with bonds that were eligible for the PEPP according to the ECB's criteria. This subsample contains 40 ABS, 1,140 CB, 382 CVB, and 702 SB, approximately 56% of the full sample.

We start by examining the impact of the PEPP on bond spreads based on the full sample. The results indicate that there has been a significant reduction in corporate, covered, and sovereign bond spreads due to the PEPP, with the implementation period strengthening the reduction in spreads verified during the announcement period. Our results are consistent with both signalling and direct channels of monetary policy for these bond categories. Concerning ABS, we find evidence of the PEPP reducing spreads during the implementation period. Therefore, PEPP was successful in reducing the cost of funding of non-financial firms, banks, and governments in the 2018-2021 period.

Next, we test our hypotheses for bonds that are eligible for the PEPP. Results show, again, that the PEPP significantly reduced bond spreads for corporate, covered, and sovereign bonds, not only during the announcement period, but also during the implementation phase of the programme. On the contrary, we find an insignificant relationship between PEPP dummies and spreads for ABS, meaning that the PEPP led to a reduction of ABS spreads for non-eligible securities only. The absence of statistical significance occurs also for core countries' sub-sample. This may be explained by the fact that the use of ABS as a source of funding at lower cost and with the objective of increasing liquidity and adjusting capital ratios is less important for banks located in core countries. Overall, our results are consistent with a portfolio rebalancing channel of monetary policy for all bond types.

Finally, we examine if the PEPP affected the bond spreads for GIIPS (Greece, Ireland, Italy, Portugal, and Spain) *versus* core European countries (France and Germany) differently. We show that our previous results remain the same for these two subsamples, and that the PEPP affected the spreads of bonds issued by GIIPS or by corporates located in these countries more significantly than those issued in core euro area countries.

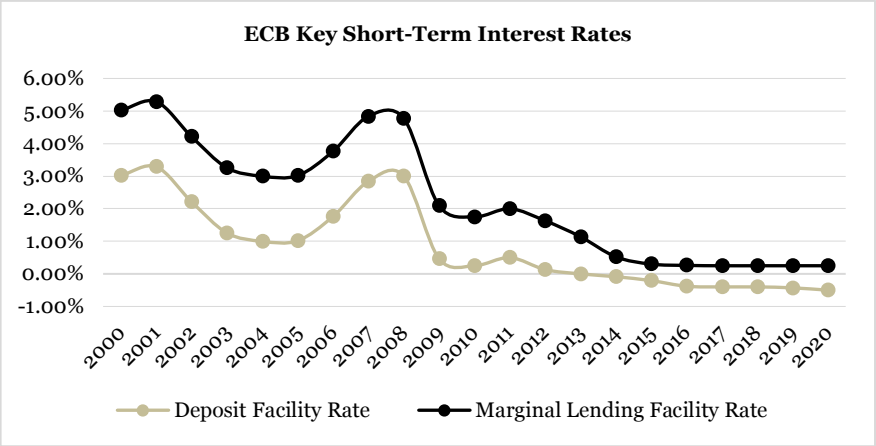
This paper is structured as follows: section 2 reviews the literature and presents the research hypotheses: Section 3 outlines the empirical model and describes the dataset and variables used in our tests. Section 4 presents the results of the ECB's PEPP impact on the pricing of euro area bonds, and section 5 concludes the paper.

II. Literature review and hypotheses

A. Transmission Channels of Unconventional Monetary Policy

The conventional instrument of monetary policy in the most developed economies is the short-term nominal interest rates (Bernanke et al., 2004). The ECB has three key short-term interest rates at its disposal, which are: (*i*) the interest rate on main refinancing operations, used by banks to borrow liquidity from the Eurosystem against collateral on a weekly basis; (*ii*) the rate on the deposit facility, which banks use to make overnight deposits; and (*iii*) the interest rate on the marginal lending facility, which provides 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 can be seen in Figure 1, since the 2008 financial crisis, 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%.

Figure 1
ECB Key Short-Term Interest Rates from 2000-2020



Source: Federal Reserve Economic Data

When the key short-term interest rates reach this level, the ECB's ability to utilise its traditional tools or carry out efficient conventional monetary policy becomes 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

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

(Woodford, 2012). 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 on 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.

According to Andrade *et al.* (2016) and Malliaropulos and Migiakis (2018), quantitative easing affects bond yields through four main channels: (*i*) signalling channel; (*ii*) portfolio rebalancing channel; (*iii*) liquidity (or direct) channel; and (*iv*) 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 (Christensen and Rudebusch, 2012). Although, at first, this might look identical to forward 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 the case that 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 first Large Scale Asset Purchase (LSAP) Programme and the Securities Market Programme (SMP).

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).[3] This basically means that when the ECB buys specific bonds the yield of these bonds reduces. Lower returns will force investors to move towards more risky and higher yielding investments (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). 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 on several key announcements regarding the FED's LSAP and the Bank of England's (BoE) Quantitative easing programmes and find 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.

[3] See https://www.ecb.europa.eu/press/pressconf/2015/html/is150122.en.html#qa

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 affected the liquidity premiums in Treasury Inflation-Protected Securities (TIPS) and inflation swap contracts. Authors find that these purchases temporarily reduced the liquidity premiums in the markets for TIPS and inflation swaps.

Finally, the reanchoring channel is connected to the fact that uncertainty regarding the length of the horizon, during which price stability will be restored, 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 in both the CPI and inflation expectations following quantitative easing announcements. Andrade *et al.* (2016) also find evidence supporting this channel by analysing a survey forecast revealing that after a 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 APP.

B. The ECB's previous Asset Purchase Programmes

In response to the global financial crisis, the ECB implemented a series of non-standard measures, consisting of recurrent bond purchases to lower medium- and long-term yields 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 CBPPs in 2009, 2011 and 2014 (CBPP1, CBPP2 and CBPP3, respectively), the Securities Market Programme (SMP) in 2010, and the ABSPP in 2014. Between 2014 and 2016, these two programmes were embedded in a broader APP, including public sector bonds (public sector purchase programme, PSPP), in 2015, and the CSPP in 2016. After several extensions, on November 1, 2019, the ECB officially restarted net purchases under the regular APP, which is composed of the CSPP, PSPP, ABSPP and CBPP3 (Branco *et al.*, 2020).

B.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 (Correia and Pinto, 2022). 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 would be achieved through purchases of CVB issued by banks or mortgage agencies. CBPP1 was announced on May 7, 2009, and started in July

2009 with a targeted nominal amount of €60 billion (ECB, 2010).[4] CBPP2 started on November 2011, with an initial targeted nominal amount of €40 billion with the purchases of the full amount expected to be completed by October 31, 2012. However, by April 4, 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 on such bonds. Therefore, the nominal amount purchased under the CBPP2 on both the primary and secondary market was €16.4 billion (ECB, 2012).[5] Finally, CBPP3 was announced on October 2, 2014, and as opposed to other programmes, its size was not disclosed (European Covered Bond Council, 2017).[6]

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 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 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 CBPP2 and CBPP3 did not seem to effectively increase CVB emission volume, possibly because at the time that these programmes were put in place by the ECB, the market was already expecting the action, and the banking sector was not particularly distressed. Similarly, Correia and Pinto (2022) find that while both CBPP1 and CBPP3 significantly reduce CVB spreads, the CBPP2 led to an increase in CVB yields.[7]

Considering that the PEPP was intended to reduce covered bond spreads, we hypothesize:

Hypotheses 1 (H1): The PEPP significantly reduced banks' cost of borrowing by reducing covered bond spreads.

B.2. 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 (Fabozzi *et al.*, 2006; Alves and Pinto, 2016). Basically, an ABS can be created from any stream of receivables, as long as there is significant demand and supply for it (Sabarwal, 2005).

[4] For further details regarding CBPP1, see https://www.ecb.europa.eu/press/pr/date/2010/html/pr100630.en.html
[5] For further details regarding CBPP2, see https://www.ecb.europa.eu/press/pr/date/2012/html/pr121031_1.en.html
[6] For further details regarding CBPP3, see https://hypo.org/ecbc/publication-news/covered-bond-purchase-programme-3-implications-primary-secondary-markets/
[7] Concerning the CBPP3, only bonds fulfilling the following criteria were eligible: (*i*) eligible for use in Eurosystem credit operations; (*ii*) issued by euro area credit institutions, or by a special purpose vehicle incorporated in the euro area; (*iii*) at least BBB- credit rating, or equivalent from one of the major credit rating agencies; (*iv*) underlying assets that include exposure to private and/or public institutions; and (*v*) denominated in euro and settled in the eurozone.

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).[8]

Regarding the effectiveness of the ABSPP, the literature is very scant. Hancock and Passmore (2011) find that mortgage-backed securities (MBS) and sovereign bond purchases under the Federal Reserve's LSAP1 led to a tightening of MBS yields. 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 the Netherlands) and 7.9 bps for periphery European countries (Greece, Ireland, Italy, Portugal, and Spain). Correia and Pinto (2022) show that the ABSPP led to a significant reduction in MBS spreads.

Under this framework, we hypothesize:

Hypotheses 2 (H2): The PEPP significantly reduced banks' cost of borrowing by reducing ABS spreads.

B.3. Corporate Sector Purchase Programme

The CSPP was announced by the ECB on March 10, 2016, enabling the Eurosystem to buy investment-grade euro-denominated bonds issued by non-bank corporations established in the euro area.[9] 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).[10]

From the beginning of the programme up to September 2017, the Eurosytem held around €115 billion in assets. Of the universe of securities available, 15% were purchased in 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). Extant literature presents a significant improvement in the funding conditions of non-financial firms after the CSPP announcement. Among others, Grosse-Rueschkamp *et al.* (2019) show that the issuance of eligible corporate bonds after the CSPP announcement has notably lower yields than prior issuance. Abidi and Miquel-flores (2018) present evidence of the announcement of the CSPP decreasing bond yield spreads by 15 bps across the euro area. Both works find that these effects are especially strong for bonds located below, but close to, the 'BBB-Market' cut-off. Considering the primary market issuance of corporate bonds in the first year of purchases, Zaghini (2019)

[8] For further analysis, see https://www.ecb.europa.eu/mopo/implement/app/html/abspp-faq.en.html. Concerning the eligibility of bonds, the ABSPP includes the following criteria: (*i*) secured by claims residing in the euro area; (*ii*) eligible as collateral for Eurosystem credit operations; (*iii*) issuer in the euro area; (*iv*) issued by a financial institution; (*v*) euro denominated; and (*vi*) credit rating of at least BBB-/Baa3.

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

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

finds that the CSPP has a significant impact on yield spreads, directly on purchased and targeted bonds but also indirectly on all other bonds, consistent with the portfolio rebalancing channel. Similarly, Todorov (2020) finds that corporate bond yields drop, on average, 30 bps after the CSPP announcement, which is especially pronounced for bonds with lower ratings and longer maturities. With a focus on Spanish firms, Arce *et al.* (2021) show a significant decrease in bond yields not only for eligible bonds, but also for corporates with below investment-grade credit ratings.[11]

Considering that the PEPP announcement had similar objectives to those pursued with the launch of the CSPP, namely, to reduce spreads not only on targeted bonds, but also on non-eligible bonds (Draghi, 2015; ECB, 2017; Zaghini, 2019), we hypothesize:

Hypotheses 3 (H3): The PEPP significantly reduced non-financial firms' cost of borrowing by reducing corporate bond spreads.

B.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.[12] 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) aim 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 authors present a significant impact on asset prices as average yields for SB dropped around 13 bps after the announcement and an additional 14 bps after the implementation. CB yields declined around 10 to 13 bps depending on the credit rating. Concerning the direct bond purchases, Andrade *et al.* (2016) 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) find 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. Authors study the announcement effect on SB yields of several European countries and find that there was a decrease of around 30, 29 and 22 bps for 5-, 10-, and 20-year maturities, respectively. The largest reductions were: 80 bps for Spanish SB yields and 75 bps for Italian SB yields.[13] Recently, Bernanke (2020)

[11] The eligibility criteria underwent a few modifications in 2020 as the ECB adapted the general APP to the economic impact caused by the pandemic: (*i*) debt instruments issued by corporations which comply with the criteria for marketable assets for Eurosystem credit operations; (*ii*) non-financial commercial paper, for companies with sufficient credit rating; (*iii*) euro denominated; and (*iv*) credit rating of at least BBB-/Baa3.

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

[13] Under the PSPP, eligible bonds have the following characteristics: (*i*) remaining maturity of 2 to 30 years at the time of purchase; (*ii*) euro denominated; (*iii*) eligible as collateral for Eurosystem operations; and (*iv*) a yield higher than the deposit rate.

shows that the US LSAP1 announcement reduced bond spreads: -100 bps for 10-year Treasuries.

C. The effectiveness of the ECB's response to the Covid-19 pandemic

At the beginning of March 2020, the ECB responded with a series of measures outlined to improve liquidity and funding conditions in the euro area. The measures implemented can be divided into two main segments: (*i*) lending programmes; and (*ii*) asset purchases. Concerning the first, 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) was 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. Regarding asset purchases, the regular APP was expanded temporarily with an additional €120 billion envelope in 2020, while continuing monthly purchases of €20 billion and reinvestments. On March 18, 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.[14] Initially the size of the programme was €750 billion, but the overall envelope was subsequently increased by €600 billion on June 4, 2020 and by €300 billion on December 10, 2020, for a total amount of €1,850 billion. These purchase programmes resulted in an increase of the Eurosytem's balance sheet from €4.6 trillion of assets at the end of 2019 to €6.9 trillion at the end of 2020, representing 19.4% of the 2019 euro area's GDP (Blot *et al.*, 2021). Concerning eligibility, the PEPP includes all the securities eligible under the existing regular APP, 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 PEPP's effectiveness, 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. Using an event-study methodology, they show that the impact of the PEPP on yields was stronger than that of the APP. While a standard purchase of €500 billion in SB under the PSPP is associated with an approximate 20 bps 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 bps. 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 authors used 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 18, 2020, the announcement date of the PEPP: euro area sovereign spread (spread between the composite yield of the 10-year euro area government bonds

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

and the swap rate with the same maturity) had a reduction of 23 bps, while 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, authors implement a qualitative analysis, providing a broader view of the spread behaviour 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, as well as the spread on euro area and Italian sovereign 10-year maturity, was reduced reaching pre-pandemic levels at the beginning of 2021.

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 conditions to promote price stability, the role of the PEPP is to ensure homogeneous transmission of monetary policy across countries and counter financial risk of 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 residuals of this first step as a proxy of PEPP exogeneous shocks, which 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: while there was a clear reduction in the sovereign spreads of Italy, Spain, Belgium, Portugal, and Greece, there was almost no impact on the sovereign bond spreads of France, the 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 bond yields into term premia and expected interest rates at the ten-year maturity, for eleven euro area countries. 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. Under this framework, we propose the following hypotheses:

Hypotheses 4A (H4A): The PEPP significantly reduced sovereign bond spreads.

Hypotheses 4B (H4B): The impact of the PEPP is higher for peripherical euro area countries (GIIPS) vis-à-vis core countries.

III. Data, methodology, and variable definition

A. Sample Selection

The sample consists of several individual bond issues in the 2018-2021 period, extracted 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. From the several security types available, 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 the euro. Moreover, only bonds with information regarding the spread to benchmark and deal value are included in the sample. After applying these screens, we have a full sample of 4,061 bond tranches with a deal value of €4,675.7 billion, issued in 19 different European countries. This sample contains information on 751 SB 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. 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, 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 but the residual maturity, at the time of purchase, 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 in 18 different European countries. This eligible subsample encompasses 702 SB worth €1,390.0 billion, 1,140 CB worth €1,499.0 billion, 382 CVB worth €296.8 billion, and 40 ABS worth €17.4 billion.

B. Methodology

To test our hypotheses, we use the model described in equation (1), a reduced-form model similar to existing pricing models (Campbell and Taksler, 2003; Gabbi and Sironi, 2005; Chen *et al.*, 2007; Zaghini, 2019; Marques and Pinto, 2020). We employ OLS regression techniques and adjust for heteroskedasticity, as in Zaghini (2019) and Marques and Pinto (2020).

$$Spread_{i,t} = \alpha_0 + \beta\ PEPP_{i,t} + \gamma\ Contractual\ characteristics_{i,t} + \varphi\ Macroeconomic\ factors_t + \varepsilon_{i,t} \quad (1)$$

where the subscripts refer to bond i at time t. $Spread_{i,t}$ is the dependent variable and it represents the bond spread in basis points, corresponding to the economic cost per tranche based on available information at the time of issuing the bonds; and is defined as the margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity.

The above equation will be estimated using both the full sample and the eligible subsample, as discussed in section 4.2. In addition, to test H4A, we will re-estimate our complete model for subsamples according to whether issuers are in GIIPS (Portugal, Ireland, Italy, Greece, and Spain) *vis-à-vis* core euro area countries (Germany and France). Finally, due to time-varying risk premia and as our analysis is conducted by tranches, we estimate standard errors clustered by year and deal.

C. Variable Definition

C.1. Core Variables

Table 1 provides detailed definitions and sources for all the variables used. The dependent variable in our model is the bond's Option Adjusted Spread (OAS), which 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.

Table 1: Definition of the variables used and their sources

Variable name	Variable Definition	Source
Dependent variable:		
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:		
Core variables		
PEPP	Dummy variable equal to 1 if the bond issuance date belongs to the PEPP period (March 18, 2020 - December 31, 2021), and 0 otherwise.	Authors'
PEPP Announcement	Dummy variable equal to 1 if the bond issuance date belongs to the PEPP announcement period (March 18, 2020 - March 25, 2020), and 0 otherwise.	Authors'
PEPP Purchases	Dummy variable equal to 1 if the bond issuance date belongs to the PEPP implementation period (March 26, 2020 - December 31, 2021), and 0 otherwise.	Authors'
Contractual controls		
Tranche Rated	Dummy variable equal to 1 if the bond has a credit rating, and 0 otherwise.	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.	DCM Analytics
Time to Maturity	Bond maturity in years.	DCM Analytics
Log Transaction size	Logarithm of the bond transaction size in Euro million.	DCM Analytics
Tranche to transaction	The ratio of tranche size to transaction size of the bond.	DCM Analytics
Callable	Dummy variable equal to 1 if the bond has a call option, and 0 otherwise.	DCM Analytics
Floating	Dummy variable equal to 1 if the bond has a floating rate, and 0 otherwise.	DCM Analytics
Number of banks	Number of financial institutions participating in the bond issuance.	DCM Analytics
Number of tranches	Number of tranches per transaction.	DCM Analytics
Macroeconomic controls		
Volatility	VSTOXX (Euro Stoxx 50 Volatility) index. Value obtained for the day of issuance.	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. Value obtained for the day of issuance.	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. Value obtained for the day of issuance.	Datastream

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 1 if the bond was issued after the PEPP announcement, i.e., issued between March 18, 2020, and December 31, 2021. The ECB announced the PEPP on March 18, 2020, but only started purchases on March 26, 2020. Therefore, the dummy *PEPP Announcement* takes the value of 1 if the bond was issued between March 18, 2020, and March 25, 2020, and 0 otherwise. Similarly, the dummy *PEPP Purchases* take the value of one if the bond was issued between March 26, 2020, and December 31, 2021, and 0 otherwise.

C.2. Control Variables

Following earlier studies (Campbell and Taksler, 2003; Gabbi and Sironi, 2005; Carey and Nini, 2007; Chen *et al.*, 2007; Marques and Pinto, 2020), we consider the following contractual characteristics: tranche credit rating, time to maturity, transaction size, number of banks, tranche to transaction, number of tranches, the inclusion of a call option and if the bond has a floating rate. In addition, we control the following macroeconomic factors: market volatility, proxied by the Euro Stoxx 50 volatility and the yield curve slope, computed as the difference between the five-year Euro Swap rate and the 3-month Libor rate, and the country's credit risk.

Table 2: Distribution of Bonds by Geographic Location of Issuer and Year at Tranche Level
Panel A describes the geographic location of the issuer, while Panel B details the bond allocation per year. Data are for primary market bonds with spread and tranche amount available, closed by European issuers during the 2018-2021 period

Panel A: Geographic location of issuer	Corporate Bonds (CB)			Covered Bonds (CVB)			Sovereign Bonds (SB)			Asset-Backed Securities (ABS)		
	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%**

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D. Univariate Analysis

This section provides summary statistics for all the different types of bonds comprised in the full sample (bonds issued between January 1, 2018, and December 31, 2021). Table 2 offers the distribution of the full sample by type of bond, number of tranches and total value per geographic location of the issuer (Panel A) as well as per year (Panel B). In terms of bond issuance, ABS and CB issuance increased, by approximately 52% and 27%, respectively. During the same period CVB decreased significantly by around 38%, while SB had a slight increase of 16% - see Panel B.

Regarding the geographic location of the issuer, Panel A shows that 91.10% of all CB issuers are concentrated in five countries, including Germany (35.66%), France (31.06%), Netherlands (9.75%), Italy (7.95%), and Spain (6.68%). 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 (27.87%), France (20.81%), Ireland (10.07%), Italy (9.09%), and Spain (6.94%).

Table 3 presents some summary statistics of the dependent and independent variables concerning our full sample, by bond category. 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 is 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. 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 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). The

number of banks typically 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. As expected, the mean (median) deal value of SB is €2,027.48 million (€750.00 million), which is much higher when compared to the tranche values for CB, €1,145.56 million (€750.00 million), CVB, €766.68 million (€500.00 million), and ABS, €509.57 million (€410 million). 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 tranching in the sense that this process allows the creation of different classes of securities with different risk-return profiles, which is valuable for investors. For ABS, most of the bonds included in the sample are both floating rate (100%) and callable (89.66%) bonds.

Table 3: Univariate Statistics - Pricing features of the full sample
This table reports summary statistics for a sample of CB, CVB, SB, and ABS, with spread and tranche amount available, closed by European issuers during the 2018-2021 period. Information on the characteristics of bond issuances was obtained from DCM Analytics. For a definition of the variables, see Table 1.

Variable of Interest	Type of Bond				Variable of Interest	Type of Bond			
	CB	**CVB**	**SB**	**ABS**		**CB**	**CVB**	**SB**	**ABS**
Continuous Variables					***Continuous Variables***				
Spread (bps)					**Time to Maturity**				
Number	2 116	469	751	725	Number	2 116	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 Rating					**Tranche to Transaction**				
Number	2 005	467	735	704	Number	2 116	469	751	725
Mean	8.69	1.00	3.00	6.00	Mean	77.69%	94.67%	92.73%	31.39%
Median	8	1	1	6	Median	100.00%	100.00%	100.00%	6.17%
Number of Banks					**Country Risk**				
Number	2 116	469	751	725	Number	2 116	469	751	725
Mean	7.00	5.00	6.00	2.00	Mean	3.71	2.69	2.67	5.23
Median	6	5	5	1	Median	3	2	1	6
Number of Tranches					**Deal Value (€ Million)**				
Number	2 116	469	751	725	Number	2 116	469	751	725
Mean	2	1.1	1.2	7.2	Mean	1 145.56	766.68	2 027.48	509.57
Median	1	1	1	8	Median	750	500	750	410
Dummy Variables					***Dummy Variables***				
Float Rate					**Callable**				
Number of tranches	2 116	469	751	725	Number of tranches	2 116	469	751	725

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Number of tranches with d=1	170	10	64	725	Number of tranches with d=1	1 517	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	2 116	469	751	725	Number of tranches	2 116	469	751	725
Number of tranches with d=1	2 005	467	735	704	Number of tranches with d=1	1 866	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	2 116	469	751	725	Number of tranches	2 116	469	751	725
Number of tranches with d=1	11	2	9	0	Number of tranches with d=1	1 003	140	378	335
% of total	0.52%	0.43%	1.20%	0.00%	% of total	47.40%	29.85%	50.33%	46.21%
PEPP					**Eligible**				
Number of tranches	2 116	469	751	725	Number of tranches	2 116	469	751	725
Number of tranches with d=1	1 014	142	387	335	Number of tranches with d=1	1 140	382	702	40
% of total	47.92%	30.28%	51.53%	46.21%	% of total	53.88%	81.45%	93.48%	5.52%

IV. Regression analysis results

A. The impact of the PEPP on bond spreads: full and eligible samples

Table 4 presents the results of estimating equation (1) using each of the four samples discussed in section 3.4. Our objective is to test H1, H2, H3, and H4A; i.e., examine the PEPP impact on bond primary market spreads via signalling, direct, and portfolio rebalancing channels. Models [1a], [2a], [3a], and [4a] show that the PEPP has a significant negative impact on the spread for all the bonds issued by euro area entities, suggesting that this APP was successful in reducing the cost of funding of non-financial firms, banks, and sovereigns through the direct pass-through transmission channel: the PEPP dummy variable is associated with a 27.20 bps, 20.97 bps, 21.98 bps, and 18.68 bps reduction in spreads for CB, CVB, SB, and ABS, respectively.

Next, we re-estimate these models by replacing the *PEPP* dummy variable per two variables, capturing the effect of both the announcement (*PEPP Announcement*) and the implementation (*CSPP Purchases*) of the programme. Models [1b], [2b], and [3b] show that bond spreads reduce significantly in both the announcement and purchasing periods. The larger reduction in spreads in the announcement period is verified for CB, with a 74.56 reduction in spreads, followed by 32.11 bps for CVB, and 28.38 bps for SB. Regarding ABS, our sample does not contain bonds issued in the announcement period. We thus find that the PEPP led to a significant

reduction in the cost of borrowing of non-financial firms, banks, and countries through the signalling channel of monetary policy.

So far, we corroborate H1, H2, H3, and H4A, as we find a significant and negative impact of the PEPP on spreads for the four bond categories used.

Regarding the remaining pricing determinants, contrary to models [1a] and [1b], models [2a] and [2b] show that the following variables do not affect CVB spreads: tranche rated, time to maturity, log transaction size, number of banks, and number of tranches. In both models, results show that the interaction between rated bonds and their credit rating (Tranche Rating*Rated) increases CVB spreads by 6.84 bps and 6.82 bps in models [2a] and [2b], respectively. As expected, floating rate decreases CVB spreads, while market volatility increases CVB spreads by 0.99 and 1.05 bps, respectively. Additionally, the impact of country risk on credit spreads differ in sign for the CB sample *vis-à-vis* the CVB sample. It is important to mention that the impact of the common pricing determinants on both CVB and SB spreads are similar in terms of sign and magnitude. According to Models [4a] and [4b], the only variable that does not affect ABS spreads is tranche to transaction (the floating rate variable was omitted because of multicollinearity).

As a robustness check, models in Table 4 were re-estimated by including the company rating variable as an additional control, and the results are qualitatively the same.

Table 4 – Regression analyses of the PEPP's impact on bond spreads
This table presents the results of OLS regressions analysing the determinants of primary market spreads. For each independent variable, the first row reports the estimated coefficient, and the second row reports the p-value. Coefficients were estimated based on heteroskedasticity-consistent standard errors clustered by year and deal. ***, **, and * indicate significant difference at the 1%, 5%, and 10% significance levels, respectively. For a definition of the variables, see table 1.

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)

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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	
Adjusted R^2	0.643		0.634		0.512	0.512	0.233		0.232		0.760		0.760	

Table 5 presents the results of estimating models in Table 4 for subsamples composed of bonds that are eligible for the PEPP. The main objective is to validate previous conclusions as well as to analyse if the portfolio rebalancing channel of monetary policy is at work under the PEPP. Results show a significant and negative relationship between the PEPP dummy and bond spreads for CB, CVB, and SB - models [5a], [6a], and [7a] -, which corroborates our previous results. We also find that bond spreads for these three bond types reduced significantly not only during the announcement period, but also during the implementation phase of the programme.

Table 5 – Regression analyses of the PEPP's impact on eligible bond spreads

This table presents the results of OLS regressions analysing the determinants of primary market spreads for securities eligible under the PEPP. For each independent variable, the first row reports the estimated coefficient, and the second row reports the p-value. Coefficients were estimated based on heteroskedasticity-consistent standard errors clustered by year and deal. ***, **, and * indicate significant difference at the 1%, 5%, and 10% significance levels, respectively. For a definition of the variables, see Table 1.

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)			(0.022)				(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	
Adjusted R^2	0.454		0.457		0.354		0.353		0.233		0.232		0.861		0.861	

Overall, we corroborate H1, H3, and H4A. Therefore, for CB, CVB, and SB, our results are consistent with both signalling and direct channels of monetary policy, and in line with the results of Abidi and Miquel-Flores (2018), Grosse-Rueschkamp *et al.* (2019), and Todorov (2020) for the impact of the CSPP on CB. On the contrary, we find an insignificant relationship between PEPP dummies and spreads for ABS, meaning that we do not corroborate H2 for eligible ABS. In addition, as the PEPP reduced spreads not only on targeted bonds, but also on non-eligible bonds, our results are consistent with a portfolio rebalancing channel of monetary policy for all bonds, corroborating the results of Zaghini (2019) and Arce *et al.* (2021), when considering the impact of the CSPP on CB.

B. The impact of the PEPP on bond spreads: GIIPS versus core countries

Tables 6 and 7 present the results of re-estimating the models in Table 4 for GIIPS *versus* core European countries. Our purpose is to test H4B, examining if the PEPP impacted the sovereign and corporate bond spreads issued from these two distinct sets of countries differently. The countries included in the GIIPS 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 eurozone.

We start by examining the results for CB, models [9a] and [10a] show that although the PEPP significantly decreases CB spreads for both subsamples, the impact is higher for GIIPS (-53.33 bps) than for core countries (-17.37 bps). This is corroborated in models [9b] and [10b] for the purchasing period. Regarding CVB, models [11a] and [12a] show that for the GIIPS subsample, CVB spreads reduced by -62.82 bps while for core countries the reduction was -18.41 bps. As for CB, the *PEPP Purchases* dummy has a higher impact on spreads for bonds issued by banks located in GIIPS than for those located in core countries. Similar results were obtained for the subsamples of SB in Table 7: the coefficients of the *PEPP* dummy are significant and negative in both models, but this reduction is greater for sovereign bonds issued by the GIIPS than for debt issued by Germany and France (-35.01 bps *versus* -18.45 bps). Again, the impact of the PEPP during the implementation period is larger in model [13b] *vis-à-vis* model [14b]. Finally, for ABS, while the PEPP led to a 28.79 bps reduction in spreads for securities issued by special purpose vehicles located in GIIPS, the PEPP does not affect the spreads of ABS issued by similar entities located in France and Germany. Overall, we corroborate our H4B: PEPP affected the spreads of bonds issued by GIIPS or by corporates located in these countries more significantly when compared to core euro area countries.

Table 6 – Regression analyses of the PEPP's impact on CB and CVB spreads: GIIPS *versus* core countries

This table presents the results of OLS regressions analysing the determinants of CB and CVB primary market spreads for securities issued in GIIPS *versus* core European countries. For each independent variable, the first row reports the estimated coefficient, and the second row reports the p-value. Coefficients were estimated based on heteroskedasticity-consistent standard errors clustered by year and deal. ∗∗∗, ∗∗, and ∗ indicate significant difference at the 1%, 5%, and 10% significance levels, respectively. For a definition of the variables, see Table 1.

Dependent variable:	**CB (GIIPS)**		**CB (Core)**		**CVB (GIIPS)**		**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	
Adjusted R^2	0.640		0.640		0.659		0.659		0.567		0.567		0.295	0.293	

Table 7 – Regression analyses of the PEPP's impact on SB and ABS spreads: GIIPS *versus* core countries

This table presents the results of OLS regressions analysing the determinants of SB and ABS primary market for securities issued in GIIPS *versus* core European countries. For each independent variable, the first row reports the estimated coefficient, and the second row reports the p-value. Coefficients were estimated based on heteroskedasticity-consistent standard errors clustered by year and deal. ***, **, and * indicate significant difference at the 1%, 5%, and 10% significance levels, respectively. For a definition of the variables, see Table 1.

Dependent variable:	**SB (GIIPS)**		**SB (Core)**		**ABS (GIIPS)**		**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
Adjusted R^2	0.530	0.530	0.141	0.139	0.784	0.784	0.859	0.859

V. Conclusion

This paper provides a detailed analysis of the PEPP's impact on the borrowing cost for euro area banks, non-financial firms, and governments. Using a large sample of 4,061 bonds issued between January 1, 2018, and December 31, 2021, with a total deal value of €4,675.7 billion, we find that the PEPP reduces corporate, covered, and sovereign bond spreads, with the implementation period strengthening the reduction in spreads seen during the announcement period, which is consistent with signalling, direct, and portfolio rebalancing channels of monetary policy. We also find that the ECB's purchases of asset-backed securities under the PEPP led to a reduction of spreads during the implementation period, which is in line with the direct channel of monetary policy. We also find evidence of spread reductions not only for eligible bonds, but also for non-eligible ones, in line with the portfolio rebalancing channel of monetary policy. Overall, these results are in line with similar studies, that focus on sovereign bonds and use secondary market spreads, on the effectiveness of the PEPP, such as Altavilla *et al.* (2021), Benigno *et al.* (2021), Blot *et al.* (2021), Corradin *et al.* (2021).

Regarding the differences in the impact of the PEPP on GIIPS *vis-à-vis* core European countries, we clearly saw a more significant reduction in spreads across corporate bonds, covered bonds, sovereign bonds, and asset-backed securities for GIIPS. Therefore, the PEPP was indeed effective in reducing the cost of funding for banks, non-financial companies, and governments during the Covid-19 pandemic. As avenues for future research, it would be interesting to apply a similar methodology, but at a deal level by using the weighted average spread between the tranche spread and its weight in the deal size. In addition, it would be valuable to examine if the PEPP led

to a change in how non-financial firms and banks choose their borrowing sources, namely if there is an impact on corporate capital structure decisions.

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