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Essays on the Transmission of ECB Unconventional Monetary Policy

Jorge Miguel Braga Ferreira

Orientador: Prof. Doutor António Manuel Pedro Afonso

Tese especialmente elaborada para obtenção do grau de Doutor em Economia

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Resumo

Esta dissertação reúne três artigos que abordam os mecanismos de transmissão e efeitos económicos das políticas monetárias não convencionais adotadas pelo Banco Central Europeu (BCE), nomeadamente: (i) as operações de refinanciamento de prazo alargado direcionadas (em inglês, TLTRO), criadas para estimular a concessão de crédito bancário à economia real (ii) o programa de compras de emergência pandémica (em inglês, PEPP), lançado em resposta à crise provocada pela pandemia de COVID-19 e (iii) o programa de aquisição de títulos de dívida de empresas (em inglês, CSPP), desenhado para facilitar o financiamento das empresas.

No primeiro estudo, avalia-se o impacto dos programas TLTRO I e II sobre o risco das instituições financeiras da área do euro, com especial foco na possível existência de uma dinâmica de tomada de risco (*risk-taking channel*). Neste estudo, é estimada a relação entre a participação no TLTRO e o indicador de distância ao *default* (em inglês, DtD), uma medida de risco de solvência baseada no modelo de opções proposto por Merton (1974). Com base em dados trimestrais de 90 bancos cotados entre 2012 e 2018, os resultados mostram que, embora a presença de liquidez dos TLTRO esteja, por si só, associada a um aumento do risco de incumprimento, os bancos participantes registaram um efeito positivo, sugerindo que a liquidez foi utilizada para reforçar a sua posição financeira. Adicionalmente, verifica-se que a participação no programa não induziu uma alteração significativa na concessão de crédito nem uma realocação para ativos mais arriscados, contrariando preocupações sobre *moral hazard*. Por fim, conclui-se que o impacto dos TLTRO é consistente entre bancos de diferentes dimensões e a concorrência não influenciou significativamente a relação entre a participação na TLTRO e o risco bancário. Assim, a principal conclusão deste estudo é que programas de refinanciamento direcionado podem contribuir para a estabilidade financeira sem incentivar comportamentos de maior risco, desde que sejam acompanhados por critérios claros de elegibilidade e supervisão prudencial eficaz.

O segundo estudo analisa os efeitos do PEPP nos *spreads* da dívida soberana na área do euro à data de emissão, tendo em conta a situação fiscal dos países emissores. A amostra inclui 1.368 obrigações soberanas emitidas entre o primeiro trimestre de 2018 e o primeiro trimestre de 2022. A análise parte do pressuposto de que a credibilidade orçamental dos Estados influencia a eficácia das políticas monetárias, assim como a forma como os mercados reagem a este tipo de intervenções. De facto, os resultados confirmam

que a capacidade do PEPP em reduzir os spreads foi mais limitada nos países com níveis elevados de dívida pública (rácio médio no período anterior à análise superior a 90%). Este resultado sugere que, nestes casos, os receios com a sustentabilidade das finanças públicas continuam a ser predominantes, mesmo perante este tipo de políticas monetárias, na perceção de risco por parte dos investidores. Pelo contrário, nos países com uma dívida pública mais baixa, o programa foi mais eficaz na redução dos *spreads*, embora esse efeito também tenha diminuído quando a dívida aumentou. A elegibilidade dos títulos, por si só, parece não ter sido um fator determinante nos efeitos observados, o que corrobora a ideia de que a credibilidade orçamental é um fator-chave na perceção do risco por parte dos investidores. Neste sentido, o estudo conclui que, para maximizar a eficácia de programas como o PEPP, é essencial uma maior articulação entre política monetária e fiscal, sobretudo em períodos de incerteza acentuada.

No terceiro estudo, avaliam-se os efeitos do CSPP sobre o financiamento empresarial, através da análise dos efeitos sobre os *spreads* das obrigações na sua emissão e da evolução da estrutura de capital das empresas. A amostra inclui 1.275 obrigações de 531 empresas não financeiras da área do euro, emitidas entre 2015 e 2018. Numa primeira fase, analisa-se o impacto da elegibilidade ao programa nos *spreads.* Inicialmente, os títulos elegíveis parecem apresentar spreads mais baixos, mas, após controlar pelas características das obrigações e das empresas, esse efeito desaparece. Na realidade, verifica-se até que as obrigações elegíveis emitidas durante o período do programa apresentaram *spreads* ligeiramente superiores. Uma possível explicação é que os investidores valorizavam o apoio à liquidez e o suporte implícito do BCE, aceitando *spreads* mais altos com a expectativa de maior liquidez no mercado secundário. Em alternativa, as empresas poderão ter aproveitado a oportunidade do programa para emitir obrigações com um maior risco ou com prazos mais longos. Por sua vez, os investidores podem ter reagido de forma estratégica, ao ajustar os prémios de risco na expectativa de uma maior procura e melhores condições de liquidez no mercado secundário.

Na segunda fase deste estudo, examina-se a evolução do rácio de endividamento das empresas no ano da emissão e no seguinte. Os resultados sugerem que a elegibilidade ao CSPP não teve um efeito imediato no nível de endividamento das empresas, mas produziu efeitos relevantes no ano seguinte, sobretudo em empresas com já elevados níveis de endividamento. Nestes casos, observou-se um aumento significativo da dívida, o que sugere que o programa contribuiu para aliviar restrições de financiamento. Adicionalmente, empresas que emitiram obrigações com maturidades mais longas

também aumentaram o endividamento no ano seguinte, o que sugere uma possível utilização estratégica das condições de financiamento favoráveis criadas pelo programa. Assim, conclui-se que o CSPP teve um impacto prolongado e indireto sobre o comportamento financeiro das empresas.

Na sequência da evidência apresentada, esta dissertação defende a necessidade de uma abordagem mais integrada na criação e implementação da política monetária não convencional por parte do BCE. Entre as propostas destacam-se a manutenção de critérios claros de elegibilidade nas operações de refinanciamento, a incorporação sistemática da análise fiscal nos programas de compras de ativos e uma maior utilização dos indicadores de risco baseados em dados de mercado dentro do conjunto tradicional de ferramentas analíticas do BCE.

Classificação JEL: E52; E58; E44; E62; G12; G21; G32; H63; C23; C33; L25

Palavras-chave: Banco Central Europeu (BCE); Política Monetária Não Convencional; TLTRO; PEPP; CSPP; Risco Bancário; Risco Moral (*Moral Hazard*); Canal de Assunção de Risco (*Risk-Taking Channel*); Política Orçamental; *Spreads* das Obrigações Soberanas; *Spreads* das Obrigações Empresariais; Estrutura de Capital das Empresas

Abstract

This dissertation combines three studies that address the transmission mechanisms and economic effects of unconventional monetary policies adopted by the European Central Bank (ECB), namely: (i) Targeted Longer-Term Refinancing Operations (TLTROs), created to stimulate bank lending to the real economy; (ii) the Pandemic Emergency Purchase Programme (PEPP), launched in response to the crisis triggered by the COVID-19 pandemic and (iii) the Corporate Securities Purchase Programme (CSPP), designed to support corporate financing.

The first study focuses on the risk-taking channel of monetary policy by analysing the effects of the ECB's TLTRO on the default risk of Eurozone banks. For the period from 2012 to 2018, covering 90 listed banks from 16 Eurozone countries, the results indicate that while overall TLTROs are associated with higher default risk, banks that participated showed improved financial resilience. The study finds no signs of excessive risk-taking or a move toward riskier assets, which suggests that TLTROs supported financial stability without encouraging moral hazard.

The second study assesses the impact of the ECB's PEPP on sovereign bond spreads at issuance and to what extent the countries' fiscal positions affected its effectiveness. For this study, we consider a sample of 1,368 euro-denominated sovereign bonds issued from 2018 to 2022, and the results suggest that PEPP was more effective in reducing spreads in countries with lower debt ratios. Conversely, spreads remained high in countries with historically large debt levels, which suggests that fiscal fundamentals limited the programme's effectiveness.

The third study examines the effects of the ECB's CSPP on corporate bond spreads at issuance and on the capital structures of firms. We analysed a sample of 1,275 euro-denominated bonds issued between 2015 and 2018. Concerning the bond's spreads, we found that while CSPP eligibility initially is associated with lower issuance spreads, this trend disappears after accounting for bond and firm characteristics. This suggests that the programme's signalling power and perceived credibility played a more important role than the effects of direct bond purchases. Concerning corporate capital structure, we found that CSPP eligibility had no immediate effect on leverage. However, firms that issued longer-term eligible bonds increased their debt ratios in the year after issuance. This indicates delays in capital structure adjustments in response to improved financing conditions.

Based on these findings, the dissertation suggests a more integrated approach in the design and implementation of unconventional monetary policy. Key recommendations include maintaining clear eligibility criteria, including fiscal assessments in asset purchase programmes, monitoring delayed effects on balance sheets, enhancing transparency around program participation and results and formalisation of the use of market-based risk indicators in ongoing supervision. These measures aim to improve the effectiveness and stability of future ECB interventions.

JEL Classification: E52; E58; E44; E62; G12; G21; G32; H63; C23; C33; L25

Keywords: European Central Bank (ECB); Unconventional Monetary Policy; TLTRO; PEPP; CSPP; Bank Risk; Moral Hazard; Risk-Taking Channel; Fiscal Policy; Sovereign Bond Spreads; Corporate Bond Spreads; Corporate Capital Structure

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Chapter 1
Introduction

The Global Financial Crisis (GFC) of 2008-09 and the subsequent sovereign debt crisis in the Eurozone changed the operational frameworks of central banks in advanced economies. In a context of financial and economic instability accompanied by an extended period of ultra-low interest rates, the European Central Bank (ECB) introduced a series of unconventional monetary policy (UMP) tools designed to restore financial stability, enhance monetary policy transmission, and support economic recovery. These tools, which include the Targeted Longer-Term Refinancing Operations (TLTRO), the Pandemic Emergency Purchase Programme (PEPP), and the Corporate Sector Purchase Programme (CSPP), were a significant departure from conventional policies and have since become an integral part of the ECB's instrument set (Draghi, 2014).

Despite the implementation of diverse UMPs in recent years, key questions remain about how these tools are transmitted across financial markets and economic agents. There are concerns about potential spillovers, such as increased risk-taking in the banking sector, distortions in sovereign bond pricing and long-term impacts on firms' capital structures (e.g. Rajan, 2005; Borio and Zhu, 2012). While a growing body of literature has analysed the direct effects of UMPs on lending rates and bond yields (e.g. Altavilla et al., 2020; Benetton and Fantino, 2018; Zaghini, 2019), relatively little is known about how these programmes influence broader financial stability metrics, their interaction with national fiscal policies, or alter the financial behaviour of non-financial corporations.

This dissertation addresses these gaps by examining three of the ECB's UMP programmes: TLTRO, PEPP, and CSPP, and their transmission through the banking system, sovereign bond markets, and corporate finance, respectively. Each chapter of this dissertation presents an original empirical study, supported by panel data and robust econometric methods, that explores the mechanisms, effectiveness, and unintended consequences of these interventions.

The first study (Chapter 2) examines the TLTRO programmes (I and II) and their effects on banks' risk-taking behaviour. While most existing research has focused on credit supply, this chapter expands the analysis to include market-based measures of financial risk, using the Distance to Default (DtD) metric derived from the Merton (1974) model. We find that banks that actively participated in the programme exhibit better risk

profiles, although the overall availability of liquidity from TLTRO is associated with higher default risk. These findings suggest that banks used the liquidity from TLTRO to strengthen financial positions rather than to support excessive risk-taking.

The second study (Chapter 3) assesses the PEPP and its effectiveness in reducing sovereign bond spreads at issuance in the Eurozone. A unique contribution of this chapter is to determine the conditional role of fiscal fundamentals, namely debt ratios and fiscal balances, in shaping the programme's impact. In this analysis, we found that the effectiveness of PEPP in compressing the spreads was more substantial in countries with lower public debt levels. These results underscore the importance of fiscal credibility in determining the success of asset purchase programmes and the need for coordination between fiscal and monetary authorities, mainly in periods of economic distress.

The third study (Chapter 4) examines the effects of the CSPP on corporate bond spreads at issuance and on the capital structure of non-financial corporations. In this study, I found that while CSPP eligibility did not consistently lower spreads after controlling for firm and bond characteristics, firms issuing eligible longer-term bonds experienced a delayed but significant increase in leverage, particularly those with previous high debt levels. These findings suggest that the CSPP influenced firms' financing strategies in a more indirect and gradual manner.

The contribution of this dissertation is threefold. First, it provides new empirical evidence on the transmission of UMP tools through a risk-based perspective by applying the DtD metric, a powerful forward-looking, market-based indicator of financial fragility that remains underused in academic and policy research. Second, it shows that fiscal differences between Eurozone countries significantly affect the effectiveness of UMPs. This highlights the importance of a well-balanced policy mix in designing and assessing these tools. Third, it reveals that policy transmission in corporate finance occurs gradually and is influenced by expectations. How markets anticipate and interpret asset purchase programmes can be just as important as the programmes themselves, thus making credibility, timing and communication crucial for future policy success.

In sum, this research helps us understand how the ECB's unconventional monetary policy programs affect financial institutions, sovereign issuers and corporate borrowers. The findings have significant implications for the design of future monetary interventions, particularly in a context of persistent fiscal fragmentation, low interest rates and weak macroeconomic conditions.

1.1. References

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Chapter 2
Bank's Risk-taking Channel of Monetary Policy and TLTRO: Evidence from the Eurozone*

2.1. Introduction

The Global Financial Crisis (GFC) of 2008–09, along with the European sovereign crisis, altered the operational framework of central banks in most developed countries. Before these crises, central banks operated primarily using short-term interest rates to influence financial conditions and the economy. However, in response to the financial turmoil, central banks reduced their policy interest rates to near-zero levels, limiting their ability to stabilise the financial system in the face of new shocks.

The ineffectiveness of conventional monetary policy tools in stimulating the economy, due to their limited flexibility, prompted central banks to explore unconventional monetary policies. Initially implemented as emergency measures, these unconventional policies have become more common in the past decade. The European Central Bank (ECB) is among the central banks that have adopted unconventional monetary policies, such as the introduction of Targeted Longer-Term Refinancing Operations (TLTRO). Launched in 2014, TLTROs provided long-term financing at favourable terms to banks in the Eurozone, encouraging increased lending to businesses and consumers to boost economic activity. TLTROs played a crucial role in transmitting monetary policy to the real economy, aiding the ECB in achieving its primary goal of price stability.

The TLTRO offers banks longer and cheaper financing compared to other funding sources, making it more appealing to them. However, the amount that participating banks can borrow and the interest rate they pay depend on their outstanding loans to businesses and consumers. These specific programme features can lead to an increase in moral hazard in the financial system, as attractive funding conditions can induce banks to make riskier decisions related to their assets, known as the risk-taking channel of monetary policy. In this article, we assess the presence of the risk-taking channel by estimating the

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impact of TLTRO on banks' level of risk. Through this analysis, we aim to determine if this type of unconventional monetary policy can introduce moral hazard into the European financial system. For our study, we use a sample of Eurozone banks that are participants in the TLTRO and estimate the impact of the programme on their default indicator.

Using 90 listed banks from 16 Eurozone countries, for the period from 2012:Q1 to 2018:Q4, our main results show that TLTRO is linked to an increase in banks' default risk. Still, banks that participated in TLTRO experienced a positive effect on their default risk. The impact of TLTRO participation on default risk remains consistent across banks of different sizes. Furthermore, competition within the banking sector does not appear to influence how banks utilise funds from TLTROs in a way that affects their default risk.

The remainder of the chapter is organised as follows. Section 2.2. briefly reviews the ECB's TLTRO developments. Section 2.3 provides a literature review. Section 2.4 describes the methodology. Section 2.5 presents our dataset. Section 2.6 provides the empirical analysis. Section 2.7 concludes.

2.2. Overview of ECB's TLTRO I and TLTRO II

To contextualise, as a response to the GFC, and after Draghi's "whatever it takes" speech, it was possible to uncover evidence of a new bond-pricing regime following the announcement of the Outright Monetary Transactions (OMT) programme in August 2012 (see Afonso et al., 2018).[1] Moreover, the Governing Council of the ECB decided to conduct a series of TLTROs in June 2014 to support bank lending to households and non-financial firms, thereby enhancing the monetary policy transmission (ECB/2014/34). By providing lower interest rate funding to banks, the ECB reduces the cost of borrowing for them. Consequently, banks have an incentive to increase the supply of loans to households and firms, stimulating the real economy through higher levels of consumption and investment. This is how the ECB can enhance monetary policy transmission to the real economy while simultaneously achieving its inflation targets.

Following its decision, the ECB implemented the first TLTRO series, which consisted of eight quarterly operations starting in September 2014 and maturing in September 2018. In the first two operations of this series, banks were allowed to borrow

[1] The technical framework for the OMT was revealed on 6 September 2012.

up to 7% of the total amount of their loans to the non-financial private sector outstanding at the end of April 2014, excluding household loans for house purchases. In the subsequent six operations, banks could borrow if the outstanding amounts of their eligible loans exceeded a specified benchmark over a specific period. The interest rate on these operations was fixed over their life at Eurosystem's main refinancing operations (MROs) rate prevailing at the time of acceptance, plus a spread of 10 basis points.

The second series of TLTRO (TLTRO-II) was announced in March 2016 to strengthen the accommodative stance of the Eurosystem's monetary policy and incentivise lending (ECB/2016/10). TLTRO-II comprised four quarterly operations with a maturity of four years each. Under this series, banks were able to borrow up to 30% of their net lending to the private sector (excluding loans for house purchases) as of the end of January 2016. Although this new series is considered a continuation of the first programme, it has a different approach to encouraging lending. The MROs prevailing at the time of allotment were the interest rate applied to these operations. TLTRO II, instead of penalising banks that do not reach the stipulated benchmark, provided lower interest rates for banks that exceeded it. Thus, the interest rate applicable to each operation in this series depended on the bank's net lending dynamics. This means that if a bank significantly increased its lending to the real economy, it would benefit from a lower interest rate. In this series, the borrowing rates could be as low as the deposit facility rate.

The total operations of TLTRO I and TLTRO II amounted to around €1.172 billion, with the second series concentrating a larger volume of financing and more participating banks (Figure 2.1). Data from the second series indicates that the change in participation criteria may have been effective in attracting more banks and thus contributing to the ECB's main goal for this programme, which is to encourage bank lending through cheaper funding.

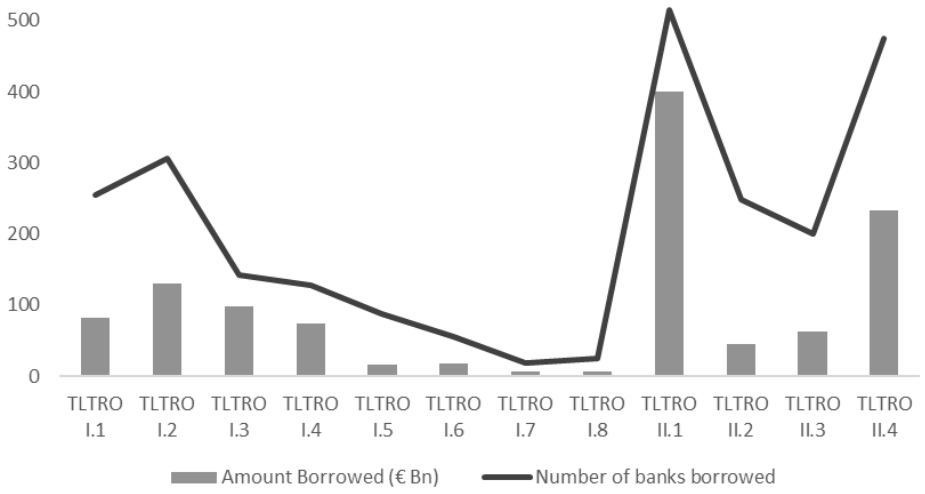

Figure 2.1. Amount borrowed (€ Bn) and the number of banks that participated in each of the TLTRO I and II operations.
Source: European Central Bank (ECB).

Examining the lending activity of Eurozone banks over the period 2011-2019 (Figure 2.2), we can see that lending to non-financial corporations and households started to decelerate in 2012. However, this trend appears to have stopped in 2014, coincidentally the year when TLTRO programmes started. The growth in loans to the real economy recovered significantly from 2016, the year that TLTRO II started.

Additionally, it can be observed that the increase in loan volume was accompanied by a decrease in the average interest rate charged (Figure 2.3), particularly during the period coinciding with the beginning of TLTRO-II, and by some easing of credit standards (Figure A2.1). Examining the growth of bank assets, they registered some improvement during this period, as well as a growth rate in the debt securities held (Figure A2.2), which provides a picture of the investment path of the banks' portfolios. These indicators can illustrate the contribution of the first two ECB TLTRO series to a change in the bank's attitude towards risk, while the programmes seem to stimulate bank lending to the real economy.

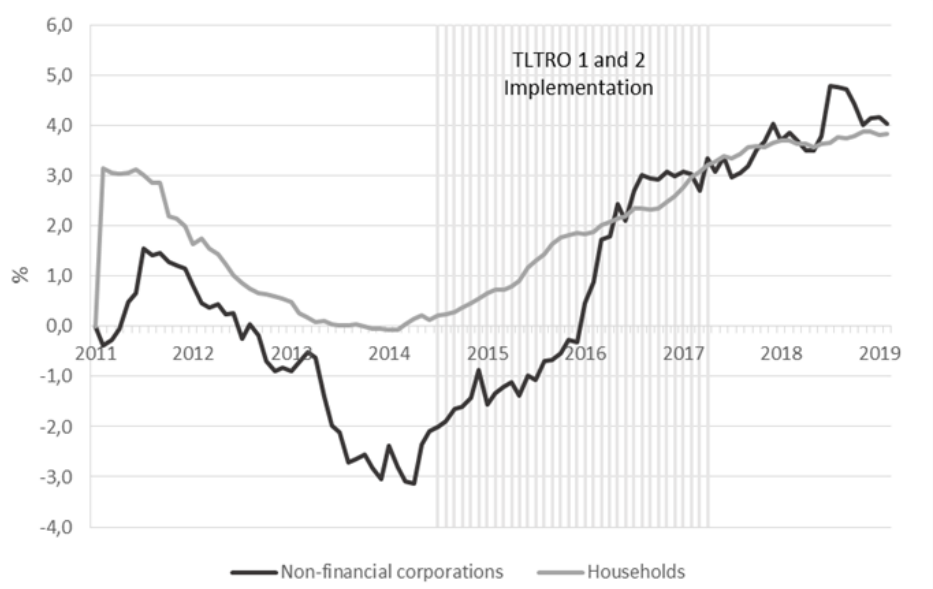

Figure 2.2. Monthly growth rate of Eurozone banks' loans (including house purchase loans).
Source: European Central Bank (ECB) and authors' calculations.

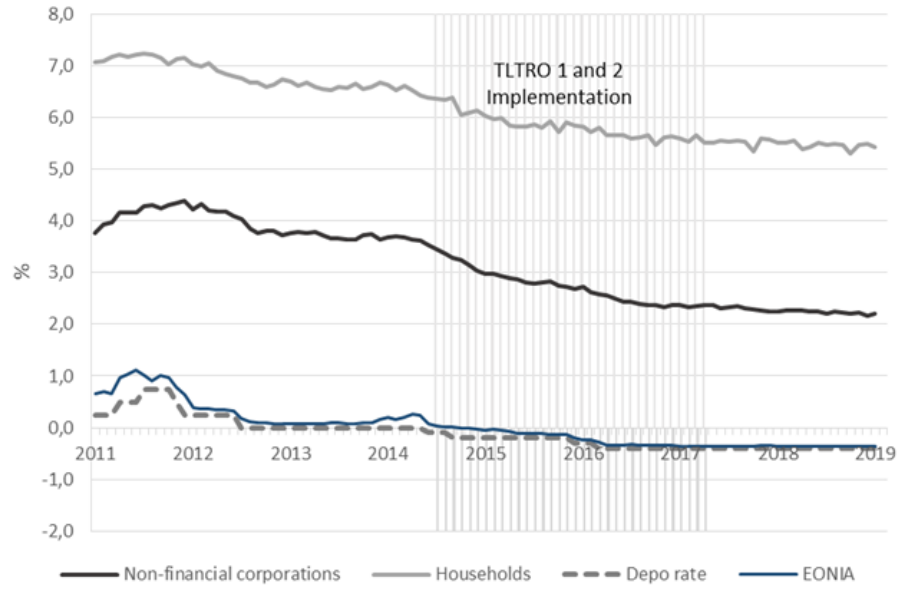

Figure 2.3. Monthly average interest rate charged by Eurozone banks (excluding house purchase loans).
Source: European Central Bank (ECB) and authors' calculations.

According to surveys conducted by the ECB between 2014 and 2016, it is observable that banks applied a significant portion of TLTRO funds to loans to households and businesses (Figure 2.4). However, it should be noted that banks have significantly increased their use of funds from TLTROs for refinancing purposes, replacing other

Eurosystem liquidity operations that do not result in funds directed to the real economy. It is also important to analyse the reasons why banks participated in TLTROs. Additionally, during the period from 2014 to 2016, a significant percentage of participants joined these programmes for profitability reasons, with only a small percentage participating due to insufficient demand for loans (Figure A2.3).

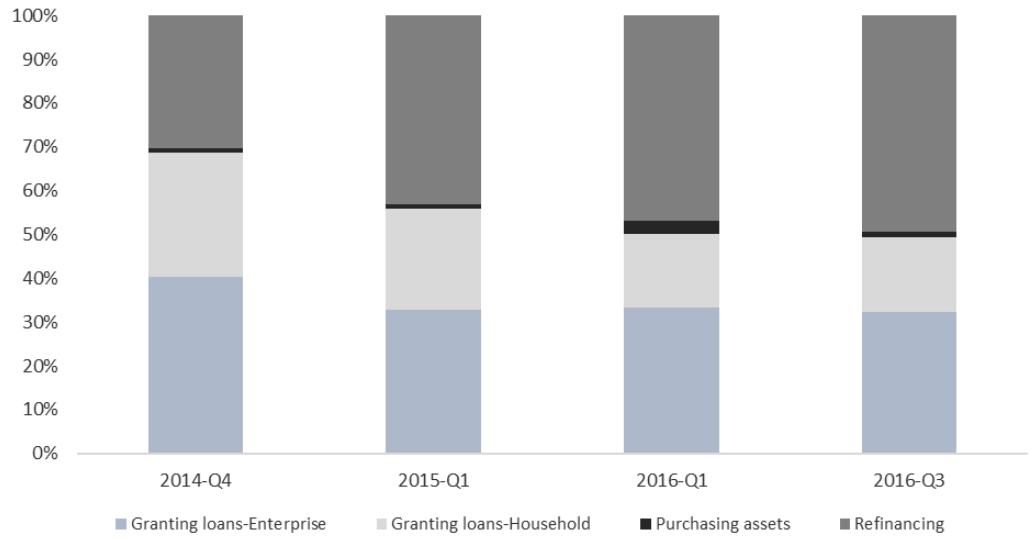

Figure 2.4. Bank's use of TLTRO funds (% of total banks). Based on ECB Surveys that include not only TLTRO I and TLTRO II but also past and future programmes.
Source: European Central Bank (ECB) and authors' calculations.

2.3. Literature overview

The TLTROs are relatively recent operations, so there is still a lack of extensive literature on their effects on banks and the real economy. Most existing studies focus on the impact of the TLTRO on banks' lending activities to assess whether the goal of expanding credit to the real economy is achieved through this programme. Balfoussia and Gibson (2016) employed a financial conditions index within a VAR framework to examine the relationship between financial conditions and real economic activity in the Eurozone, with a particular focus on Greece. Based on their results, they found that financial conditions have significant effects on economic activity, and consequently, the TLTROs, which are implemented to improve financial conditions.

Specifically, Altavilla et al. (2020) examined the pass-through of non-standard policies. They found evidence that TLTRO lowered lending rates for both non-financial

corporations and households, especially on participant banks. Dijk & Dubovik (2018) also noted that the TLTRO lowered interest rates on corporate loans. In turn, Benetton and Fantino (2018) studied Italy, where participant banks of the first two TLTROs lowered the average loan rate to the same firm by around 20 basis points compared to banks that did not participate in the program. Additionally, the authors found evidence that competition in the banking sector plays a significant role in TLTRO pass-through on credit costs, with an increase in concentration leading to a reduction in the decline of credit costs. Andreeva and García-Posada (2019) found that TLTROs have a positive effect on loan margins for safe borrowers, without changes in credit standards. They also found that non-bidders have a positive impact on loan supply by easing credit standards in the competitive environment. Furthermore, Afonso and Sousa-Leite (2020) employed an OLS empirical regression and found a positive relationship between TLTRO and the amount of credit granted to the real economy in the Eurozone. However, in the case of Portugal, the authors did not find a statistically significant impact of the programme on credit granted by banks.

Several studies on TLTROs have found evidence that these programmes generally affect the volume and cost of loans granted to the real economy. Despite these effects being the primary goal of TLTROs, this type of programme, by providing funding at attractive conditions, can inadvertently incentivise banks to take more risks, the so-called risk-taking channel of monetary policy. When banks have access to larger and cheaper funding, they may be more willing to soften their credit policies to increase interest income and financial margins. Additionally, under TLTROs, banks can boost lending to the real economy and borrow more from the ECB at favourable interest rates. This can lead banks to increase credit to obtain cheaper liquidity for their operations. The risk-taking channel may also lead banks to make riskier investments to improve their balance sheet performance. Overall, with these incentives, banks might take excessive risks, exacerbating the issue of moral hazard in the financial system.

Regarding the literature on risk-taking channels, Rajan (2005) was among the first to assess the impact of monetary policy on the increased incentive for intermediary managers to take excessive risks, driven by the "search for yield". The author suggests that "the low rates implicit in liquidity intervention could also create incentive distortions". Dell'Ariccia et al. (2010) generally support the idea that an accommodative monetary policy leads to increased risk-taking by banks in search of yield or through its effects on leverage. Additionally, Borio and Zhu (2012) emphasise the importance of

evaluating the impact of changes in monetary policy on risk perceptions or risk tolerance, as liquidity and risk-taking are closely linked.

Most studies on the risk-taking channel of monetary policy primarily focus on the context of low interest rates, a situation that has been prevalent since the GFC. Ioannidou, Ongena, and Peydró (2009) for Bolivia conducted one of the initial studies in the context of low US interest rates (as the Bolivian banking system is largely dollarised). The authors found that banks not only increase the number of new risky loans but also lower the rates they charge to riskier borrowers. A similar study by Jiménez et al. (2009) found that Spanish banks tend to grant more risky loans and ease their lending standards by providing more credit to borrowers with poor credit histories. A study in Portugal by Bonfim and Soares (2018) also reached similar conclusions. In the case of the US, Dell'Ariccia et al. (2016) found evidence of the risk-taking channel of monetary policy in the country's banking system and observed that ex-ante risk-taking is inversely related to increases in short-term interest rates. Paligorova and Santos (2017) also found that periods of monetary policy easing result in lower loan spreads for riskier firms in the US. Altunbas et al. (2010) took a broader approach by analysing the expected default frequencies of US and European banks. They found that low interest rates contributed to an increase in banks' risk.

Despite the conclusions regarding banks' risk-taking behaviour, it is essential to note that banks' responses to changes in monetary policy are not uniform, and several factors can influence their reactions. Delis and Kouretas (2011) found that the negative relationship between interest rates and bank risk-taking in the Eurozone is more pronounced for banks with higher off-balance items and less significant for banks with higher levels of capitalisation. Buch, Eickmeier, and Prieto (2014) provided evidence that in the US, small domestic banks increase their risk exposure following an expansionary monetary policy shock, while large domestic banks maintain their risk exposure. Dell'Ariccia, Laeven, and Suarez (2016) also found in the US that the effects of risk-taking depend on the level of bank capitalisation. Still, the impact of interest rates on bank risk-taking is less pronounced for poorly capitalised banks. Additionally, Bonfim and Soares (2018) found that in Portugal, the risk-taking channel is more prominent among smaller banks as they tend to lend more to non-financial firms with recent default or no credit history during periods of low interest rates.

Following the previously mentioned literature, we can conjecture that TLTROs, by granting liquidity at very attractive interest rates, may have similar impacts on banks'

risk perception and risk tolerance as found in the case of low policy rates. The relationship between the TLTROs and the presence of bank risk-taking is not directly addressed in the literature, with most research focusing on the effectiveness of these programmes in increasing bank lending to the real economy, as well as their impact on credit costs. However, the loans are only a part of the bank's assets and consequently, only a part in which the presence of the risk-taking channel can be observed. The TLTROs can induce the banks to be more risk-on not only through their credit granted but also through their investment in securities, due to the "search for yield". Crosignani, Faria-e-Castro and Fonseca (2020) found, by focusing on the ECB's three-year Longer-Term Refinancing Operations (LTROs) implemented in December 2011, that the provision of longer-term funding encouraged banks to purchase high-yield short-term securities. As the LTROs are considered the predecessors of the TLTROs, similar results could be expected from the latter.

Our study contributes to the growing body of literature analysing the financial and economic impacts of unconventional monetary policies, with a specific focus on the ECB's TLTROs. While existing studies primarily examine the effects of TLTROs on bank lending practices (Benetton and Fantino, 2018; Dijk & Dubovik, 2018; Andreeva and Garcia Posada, 2019), our research takes a broader approach by exploring the overall risk-taking behaviour of banks. We extend beyond the traditional focus on lending by incorporating a comprehensive analysis of banks' risk profiles, including their investment strategies and balance sheet management. A key element of our study is the DtD metric, which delivers a market-based evaluation of risk by reflecting the perceptions of equity investors. This method provides an alternative perspective beyond traditional accounting-based measures and research that focuses exclusively on lending activities. By focusing on DtD, we provide a novel perspective on understanding how TLTROs affect bank stability.

Our findings shed light on how these programmes influence banks' overall risk tolerance. This comprehensive approach not only complements existing research on the effects of TLTROs on lending but also introduces a new perspective on their influence on banks' risk-taking behaviour, thereby providing a more holistic view of their impact on financial stability. Furthermore, by examining the effects of TLTROs within the context of low-interest rates in the Eurozone, our study contributes to the discussion on whether these programmes exacerbate the risk-taking channel of monetary policy. This

adds to the existing body of literature on this topic (e.g., Jiménez et al., 2009; Bonfim and Soares, 2018; Altunbas et al., 2010).

2.4. Methodology

In this study, the default risk is captured by a distance to default (DtD) measure that is computed according to a Merton (1974) type option-based model defined as follows:

$$DtD_t = \frac{\ln\left(\frac{V_A}{D_t}\right) + \left(r - \frac{1}{2}\sigma_A^2\right)(T-t)}{\sigma_A\sqrt{(T-t)}} \qquad (2.1)$$

where V_A denotes the current value of bank assets, D represents the face value of the bank's debt, σ_A denotes the volatility of the bank's assets, $T-t$ is the time to maturity and r is the expected rate of return on the bank's assets. The DtD is a market-based measure of corporate default risk and is widely used in the literature as a measure of bank default. This indicator is based on market prices, which include the expectations of market participants regarding the underlying, making it a potential comprehensive source of forward-looking information.

Despite the simple assumptions used to derive the DtD, this indicator has been proven as a strong predictor of default. Gropp, Vesala and Vulpes (2006) found evidence that DtD is a complete and unbiased estimator of bank fragility, displaying lead times of 6-18 months in the case of EU banks. Singh et al. (2015) computed and analysed the DtD of a representative set of banks in the European Economic and Monetary Union (EMU) between 2004 and 2013 and found that this indicator has better predictive power than regulatory risk measures. In turn, Harada, Ito and Taka (2013) examined the movements of DtD for failed Japanese banks and found that this indicator has higher predictive power and quality than other measures. Additionally, for EU banks, Koutsomanoli-Filippaki and Mamatzakis (2009) found evidence that the DtD indicator may serve as a warning for both financial instability and inefficient operations.

The DtD measures the distance between a bank's market asset value and its default point, scaled by the standard deviation of its assets, where a lower value indicates a higher probability of a bank's default in the perception of market investors. We calculate the DtD following the KMV method (Crosbie and Bohn, 2003), which is the standard method used in the literature. In this approach, the default point for a bank generally falls between

its total liabilities and its short-term liabilities, rather than when the bank's asset value equals the book value of its total liabilities. The amount of debt D_t is calculated as the sum of the bank's total short-term liabilities, including deposits, plus half of the long-term liabilities, assuming a maturity of one year $(T-t)$. The expected rate of return on the bank's assets, *r*, is equal to the risk-free rate in the economy, which in our case is the one-year German government bond yield. The current value of the bank's assets, V_A, and the volatility of the bank's assets, σ_A, are not directly observed, so we need to calculate these unknown quantities. To estimate them, the KMV (Kealhofer-Merton- Vasicek) approach applies Merton's (1974) idea that the company's equity can be modelled as a call option on the company's assets. The bank's equity value, E_t, can be obtained using the Black and Scholes (1973) option pricing model, as shown in the following equation:

$$E_t = V_t N(d_1) - D_T e^{-r(T-t)} N(d_2), \tag{2.2}$$

where $d_1 = \frac{\ln\left(\frac{V_A}{D_t}\right) + \left(r + \frac{1}{2}\sigma_A^2\right)(T-t)}{\sigma_A \sqrt{(T-t)}}$, $d_2 = d_1 - \sigma_A \sqrt{T-t} = DtD_t$ and N(.) represents the cumulative distribution function of the standard normal distribution. The equity is directly observable on the stock market. We utilise the bank's debt data and the risk-free rate to calculate the unknown variables, namely the market value of assets and their volatility. To relate the observable data to those two variables, the KMV approach shows that the following equation relates equity and asset volatility:

$$\sigma_E = \frac{V_A}{E_t} N(d_1)\, \sigma_A \tag{2.3}$$

Equity volatility can be estimated using historical data. This allows us to create an equation system with the last two equations, enabling us to calculate the unknown variables.[2]

[2] To solve the system of equations, we follow the framework used by Löffler and Posch (2007). We need to assign an initial feasible value for both unknown variables, the asset value, and asset volatility. For the asset value we assume the initial value to be the sum of the market value of equity plus the book value of liabilities. As for the asset volatility, we assume an initial value based on Equation 2.3 by solving it for σ_A and assuming $N(d_1) = 1$ which leads to the following expression: $\sigma_A = \frac{E_t}{A_t}\sigma_E$. The solution to the equation system is obtained when the difference between the model values and the observed values is zero, so we minimise the sum of squared differences between the model equity value and the observed values.

The DtD metric, which is widely recognised for its ability to assess default risk, is particularly relevant in the context of our study because it reflects how TLTROs can influence banks' risk-taking behaviour. TLTROs offer banks targeted liquidity at favourable terms, which can lead to strategic decisions that change their risk profiles and heighten their overall risk exposure. The DtD metric captures these shifts by reflecting market perceptions of the bank's default risk. As banks engage in riskier activities, their asset volatility may increase, and their asset value relative to debt may decrease, both of which would lead to a lower DtD, signalling higher perceived risk by market participants. Thus, while DtD is a market-based measure, its sensitivity to changes in a bank's asset quality and volatility makes it an effective tool for capturing the impact of TLTROs on banks' risk-taking behaviour. By examining how DtD responds to TLTRO implementation, our study can contribute to understanding the broader implications of these programmes for financial stability, namely by addressing concerns about risk-taking implications.

2.5. Data

Our research covers the period from January 2012 to December 2018, examining an unbalanced panel dataset comprising quarterly balance sheet data from 90 Eurozone banks. This information was obtained from Bloomberg, Moody's Analytics BankFocus and was complemented with financial reports from the respective banks. Quarterly data is preferred as it is considered more appropriate for measuring the short-term impact of monetary policy changes over time.

The sample includes only listed banks from 16 Eurozone countries: Belgium (BE), Germany (DE), Estonia (EE), Ireland (IE), Spain (ES), France (FR), Italy (IT), Cyprus (CY), Lithuania (LT), Malta (MT), Netherlands (NL), Austria (AT), Portugal (PT), Slovenia (SI), Slovakia (SK) and Finland (FI). Listed banks are the only ones considered because they have more complete and reliable information available, allowing for a feasible calculation of DtD through the methodology described above. Hence, banks headquartered in these countries, which are actively listed on a stock exchange throughout the research period and have available information, are included. Additionally, banks that had subsequently merged or been acquired, but were independent entities during the period under analysis, were also included. Furthermore, only the parent firms were considered through their consolidated accounts, except for listed subsidiaries of non-

Eurozone banks in the specified countries. For the analysis, only financially healthy banks were considered, defined as those with a positive DtD throughout the period under study. Table A2.0.1 and Table A2.2 provide an overview of the countries and banks included in our analysis.

The specific funding amounts received by banks through the TLTRO programmes are confidential and not publicly disclosed. To provide insight into this matter, we utilised available information from Bloomberg, which we believe offers a reasonable estimate of the actual TLTRO funding received by the banks, considering the confidentiality of such data. For the banks in our sample, their participation was cross-verified by consulting publicly available information, including financial reports. This cross-verification process enhances the accuracy of our dataset by confirming that the identified banks indeed participated in TLTRO transactions. Furthermore, for banks not included in the Bloomberg sample, an investigation was conducted using public information to confirm their potential participation in the programme. In confirmed cases, the information was included.

The TLTRO information used in our analysis is obtained at the bank level. It is represented specifically as the natural logarithm of the outstanding amount of TLTRO funds each bank holds at the end of each quarter. This approach captures the ongoing exposure of banks to TLTRO funding over time, reflecting the cumulative effect rather than just quarterly uptakes. The outstanding amounts incorporate funds borrowed by both the parent bank and its subsidiaries within the Eurozone, ensuring a comprehensive understanding of TLTRO participation. Based on the available data, our sample represents 53% of the total TLTRO I and II tranche amounts, providing a robust foundation for our analysis.[3]

The DtD metric is used to assess a bank's default risk and is calculated quarterly following the methodology outlined in the methodological section. For this methodology, the bank’s market capitalisation and the book value of the bank’s liabilities are sourced from Bloomberg, supplemented with data from the bank’s financial reports. To determine the bank's equity volatility, a crucial parameter in this approach, we compute the annualised volatility using daily prices over the past 12 months. The pricing data used is sourced from Bloomberg, Refinitiv, Moody's Analytics BankFocus, and is selected based

[3] According to information obtained from the ECB and Bloomberg, the total amount allotted under TLTRO I and II amounted to approximately EUR 1,172 billion. Our TLTRO sample represents 52% of the total allotted amount under TLTRO I and 53% under TLTRO II.

on data availability. The risk-free rate is assumed to be the one-year German government bond yield, also obtained from Bloomberg sources.

In our study, we control for several factors that influence individual banks' default risk at different levels. At the bank level, we consider balance sheet characteristics using the CAMEL approach, which includes Capital Adequacy, Asset Quality, Management Capability, Earnings and Liquidity indicators.[4] Additionally, we account for bank size by measuring the log of the total bank's market capitalisation, as larger banks are typically associated with diversified assets that may reduce default risk (Barker and Holdsworth, 1993; Hirtle and Lopez, 1999).[5] We also address banking sector concentration by incorporating the Herfindahl-Hirschman Index (HHI), which reflects the distribution of market share within the sector[6]. Furthermore, we include variables representing Eurozone macroeconomic conditions, such as nominal GDP growth, inflation[7] and interbank interest rate. These factors influence default risk through their impact on loan defaults, profitability, borrower quality, and financing costs. We control for the interbank interest rate because its record-low levels may have contemporarily contributed to a change in default bank risk. Quarterly observations for the macroeconomic control variables were collected from various sources, including Bloomberg and national statistics institutes. For the HHI index, it is important to note that only annual data are available. Therefore, in our analysis, we considered the annual values for each of the four quarters. In turn, the 3-month Euribor serves as a proxy for the interbank rate in our analysis. Table A4 provides the definitions and sources of the variables used in this study.

As mentioned, our study only includes banks listed on stock exchanges to obtain feasible inputs for calculating the DtD metric. This limitation may influence the interpretation of our findings, as they might be representative only of the listed Eurozone banks and not of the entire banking sector. However, it is crucial to acknowledge that listed banks are subject to greater transparency in their disclosures to the public through more detailed financial statements that can be used to obtain reliable bank-specific

[4] This approach provides valuable information about the current conditions and performance of banks (Barker and Holdsworth, 1993; Hirtle and Lopez, 1999).

[5] Larger banks typically have a higher level of asset diversification, which may lead to a significant reduction in firm-specific risk (Demsetz and Strahan, 1997).

[6] According to the existing literature, competition can have an ambiguous impact on a bank's default risk (Caminal and Matutes, 2002; Boyd and De Nicoló, 2005). Greater competition can add pressure on the bank's margin, which can induce them to take more risk (Keeley, 1990; Hellmann, Murdock and Stiglitz, 2000). On the other hand, we can assume that higher competition can lead to lower borrowing costs for entrepreneurs, thereby boosting their potential investment returns.

[7] Higher inflation levels negatively affect the bank's profitability (Boyd, Levine and Smith, 2001; Cetin, 2019) and can attract borrowers of lower quality (Boyd and Champ, 2006).

indicators (Eichler and Sobanski, 2016). Additionally, it is worth noting that most of the largest and systemic banks in the Eurozone are publicly listed, highlighting the significance of our study's results.

2.6. Empirical analysis

2.6.1. Baseline

To address unobserved heterogeneity among banks, we employ a panel data approach that incorporates bank-specific fixed effects into the model. This decision is supported by the results of the Hausman test, which suggests a preference for fixed effects over random effects. Additionally, standard errors are clustered by bank to account for potential correlations within banks over time. The baseline model is expressed as:

$$DtD_{b,c,t} = \alpha DtD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right) + \lambda TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (2.4)$$

where $DtD_{b,c,t}$ represents the distance to default of bank b in country c in quarter t. The bank's distance to default is regressed on its value from four quarters ago to explore how past levels influence the current state, considering potential seasonality or temporal patterns in the data.

To comprehensively analyse the relationship between TLTRO and DtD while addressing potential endogeneity concerns, lagged TLTRO variables are applied. This approach ensures a robust analysis of the causal relationship between TLTRO and DtD, accounting for any contemporaneous correlations and potential endogeneity issues. The analysis includes a participation indicator ($Partic_b$), a dummy variable that equals 1 if the bank participated in the TLTRO programme and 0 otherwise. This dummy variable allows us to differentiate between participating and non-participating banks. However, since this dummy is time-invariant, it is absorbed by the bank-fixed effects in the regression. To capture the dynamic and heterogeneous effects of TLTRO participation, we introduce an interaction term between this dummy variable and a continuous, time-varying variable measuring the log of outstanding TLTRO amount by bank *b* in period *t-1*. The interaction term $\left(Partic_b \times TLTRO_{b,t-1}\right)$ is essential for capturing the differential impact of TLTRO volumes on the DtD of banks that participated in TLTROs relative to

those that did not. Specifically, we assess whether the volume of TLTRO liquidity utilised by participating banks has a unique effect on their financial stability as measured by DtD.

Furthermore, an independent TLTRO variable ($TLTRO_{b,t-1}$) is included to capture not only the direct effect of TLTRO on the banks' DtD, but also potential indirect effects, irrespective of individual bank participation. This inclusion helps mitigate possible omitted variable bias by capturing both direct and indirect effects of TLTRO on banks' financial metrics and market dynamics.

Given that the bank data are consolidated at the group level, some risk measures may be influenced by non-Eurozone activities, particularly for large multinational banks. To address this, we followed an approach similar to Altunbas et al. (2010) by regressing DtD on country-specific macroeconomic indicators, including the inflation rate, interbank interest rate, and nominal GDP ($\rho Z_{c,t}$). This approach reflects the fact that, despite international operations, most of a bank's intermediation activities, such as lending and deposit-taking, are concentrated in its home country, particularly within the Eurozone. Therefore, the risk-taking behaviour of banks related to domestic activity should primarily reflect the economic conditions of the headquarters country. If operations outside the Eurozone accounted for a significant portion of the bank's risk, we would expect a weaker relationship between the home-country variables and the DtD.

Furthermore, the bank's DtD is also regressed on a vector of time-varying control variables at the level of individual bank b, country c, in quarter t represented as $\gamma X_{b,c,t}$. These controls include the natural logarithm of market capitalisation, as well as five financial ratios that capture key elements of the CAMEL approach[8]. Bank-fixed effects, δ_b, are included to control for unobserved characteristics that may affect DtD. The error term in the model is represented by $\varepsilon_{b,c,t}$. Table A2.5 reports the summary statistics of the variables used in the baseline model (Equation 2.4), as well as the variables used in the extensions described below.

The results of the baseline regression (Equation 2.4) are presented in column (I) of Table 2.1. The results show a statistically significant negative impact of TLTRO on the banks' DtD. This suggests that the overall presence of TLTRO is associated with a decrease in the bank's DtD, potentially indicating a weakening of financial health. Although the exact mechanisms that determine this negative impact are not directly

[8] The variables analysed in the study are the common equity to total assets ratio (C), provisions for loan losses to total loans ratio (A), loan-to-deposits ratio (M), operating income to total assets ratio (E) and cash and securities to total deposits ratio (L).

observable in this model, it is reasonable to assume that factors related to TLTROs, such as changes in liquidity conditions, risk-taking behaviour, market dynamics, or the perception of markets about the banking system's stability, contribute to this effect. Most of those factors can have a more pronounced effect on listed banks, which is the focus of this study. In turn, the interaction term between dummy participation and TLTRO has a significant and positive impact on the bank's DtD. This result suggests that banks that actively participated in TLTROs experienced an improvement in their risk profile, contrasting with the broader negative effect of TLTRO on DtD. This positive effect for participating banks implies that these banks may have effectively utilised liquidity from TLTRO to strengthen their financial position. Thus, bank participation in TLTROs appears to have a risk mitigation benefit.

The results also identify other factors influencing DtD, including market capitalisation, liquidity, asset quality, and macroeconomic conditions. Larger banks tend to exhibit a higher DtD, possibly reflecting the benefits of asset diversification (Demsetz and Strahan, 1997), as well as the higher systemic risks (Laeven, Ratnovski, and Tong, 2016) that lead to more intense regulation and supervision by authorities. Banks with stronger liquidity positions can gain market confidence in their risk management (Calomiris et al. 2015), while conservative provisioning, which explicitly anticipates future loan losses, is associated with a higher level of risk-taking discipline (Bushman and Williams, 2012). Moreover, GDP growth, inflation, and interest rates have a positive and statistically significant impact on banks' DtD. This finding supports the view that economic conditions strongly influence the risk-taking behaviour of banks in their home country.

Table 2.1. *Regression results for the Baseline Model and its variations*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.113**	0.121**	0.131**	0.123**	0.088
	(0.044)	(0.048)	(0.050)	(0.057)	(0.064)
$(Partic_b \times TLTRO_{b,t-1})X$	2.839***	0.343	0.003	0.004	0.001
	(0.318)	(0.285)	(0.006)	(0.005)	(0.000)
$TLTRO_{b,t-1}$	-1.747***	-0.242	0.830*	0.985***	0.595
	(0.267)	(1.014)	(0.455)	(0.321)	(0.482)
Market Cap (log)	2.077***	0.765	2.081***	1.824***	2.150***
	(0.464)	(1.178)	(0.473)	(0.465)	(0.505)
Common equity to total assets	0.014	0.011	0.008	0.022	0.018
	(0.031)	(0.030)	(0.035)	(0.031)	(0.033)
Provisions for loan losses to total loans	0.104**	0.090*	0.098*	0.082	0.104*
	(0.049)	(0.049)	(0.054)	(0.050)	(0.054)
Total Loans to total deposits	-0.005	-0.005*	-0.006*	-0.007**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.070	0.064	0.082	0.004	0.038
	(0.085)	(0.094)	(0.081)	(0.109)	(0.095)
Cash and securities to total deposits	0.022**	0.022**	0.024**	0.020*	0.022**
	(0.009)	(0.009)	(0.010)	(0.011)	(0.009)
Inflation	0.241**	0.237**	0.245**	0.346***	0.135
	(0.099)	(0.102)	(0.098)	(0.100)	(0.124)
Interest rate	1.529***	1.555***	1.597***	1.968***	1.459**
	(0.563)	(0.562)	(0.566)	(0.499)	(0.569)
GDP growth	0.199***	0.194***	0.198***	0.195**	0.199**
	(0.065)	(0.066)	(0.065)	(0.093)	(0.074)
Constant	-8.650***	-3.843	-8.742***	-7.684***	-8.833***
	(2.184)	(4.309)	(2.116)	(2.221)	(2.254)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	470	470	470	421	470
R^2	0.0240	0.0601	0.0614	0.1711	0.1312
Within R^2	0.3089	0.3078	0.3043	0.3262	0.3261

This table presents the regression results from the baseline model (Equation 2.4) and its extensions. The dependent variable is the bank's Distance to Default (DtD), a measure of default risk. The independent variables include TLTRO participation and several interaction terms to explore how different factors, such as bank size, lending behaviour, investment strategy, and market competition, influence DtD. Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Market Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). These interactions help to assess the influence of these factors on the relationship between TLTRO participation and DtD. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

In the first extension of the baseline model, we introduce an interaction between the natural logarithm of market capitalisation, $LogMarkCap_{b,c,t}$, and TLTRO participation $(Partic_b \times TLTRO_{b,t-1})$. This interaction was introduced based on the understanding that the size of banks can significantly influence their strategies and attitudes towards risk. The inclusion of this variable aims to capture the possible influence of bank size on their decisions regarding the use of surplus liquidity. This extension led to changes in the significance of certain coefficients, as observed in column II of Table 2.1. The interaction term is not statistically significant, indicating that bank size does not significantly influence the use of TLTRO liquidity in a manner that affects DtD. The lack of statistical significance for the interaction term suggests that the effect of TLTRO participation on banks' default risk is relatively uniform across different bank sizes. The TLTRO and market capitalisation individual variables lose their significance in this extension, which corroborates a uniform response to the programme in terms of default risk, independently of the banks' market capitalisation. Regarding the other control variables, it is worth highlighting the loan-to-deposit ratio, an approximate measure of management quality, which now exhibits a slight negative significance in influencing DtD.

To further explore the potential effects of TLTRO on banks' lending and investment strategies, we extended the baseline equation by introducing additional interaction terms. These interactions are critical to our identification strategy as they allow us to isolate the specific channels through which TLTRO funds might influence banks' risk-taking behaviour. First, to assess the potential impacts on banks' lending strategies and their subsequent impact on risk-taking behaviour, we introduced an interaction term between the bank's total loans-to-assets ratio ($LTA_{b,c,t}$), and TLTRO participation $(Partic_b \times TLTRO_{b,t-1})$. This interaction aims to assess whether TLTRO liquidity has changed the bank's lending activity in a way that potentially affects its risk profile, as measured by the DtD. As shown in column III of Table 2.1, the interaction term between LTA and TLTRO participation is statistically non-significant, indicating that banks' participation in TLTRO did not substantially influence their lending behaviour during the observed period. This suggests that banks did not primarily use TLTRO funds to expand their loan portfolios in a way that would affect their default risk. This also corroborates our findings on the baseline equation, which suggests that banks may use the TLTRO funds to strengthen their financial situation and liquidity by avoiding

excessive risk-taking activities. In contrast to the baseline model's finding, the presence of TLTRO was associated with a slight positive impact on the bank's DtD in this extension. Again, while the exact mechanisms that can drive this positive effect are not directly observed in the model, factors such as improved lending activities may contribute to this effect.

Second, to explore the potential effects of TLTRO on banks' investment behaviour, particularly regarding riskier assets, we introduced an interaction term between the bank's ratio of total trading securities to total assets ($STA_{b,c,t}$) and TLTRO participation $(Partic_b \times TLTRO_{b,t-1})$. Trading securities typically represent more volatile, short-term assets within a bank's portfolio, which can potentially increase overall risk exposure. By interacting TLTRO participation with $STA_{b,c,t}$, we aim to determine whether the presence of TLTRO funds encouraged banks to shift toward riskier investments, thereby affecting their DtD. As indicated in Column IV of Table 2.1, the interaction term is statistically non-significant, indicating that TLTRO participation did not lead banks to increase their allocation to trading securities in a way that significantly impacted their risk profile. Instead, these findings reinforce that banks may have utilised TLTRO funds for more conservative purposes, prioritising financial stability over increased exposure to high-risk, short-term assets.

In our analysis, we introduced an interaction between the Herfindahl-Hirschman Index for the banking sector ($HHI_{c,t}$) and the banks' participation in TLTRO $(Partic_b \times TLTRO_{b,t-1})$. The purpose of this interaction term is to assess whether the level of competition in the banking sector influences how banks utilise TLTRO liquidity. Specifically, we aim to determine whether the availability of TLTRO funds encourages banks to take on additional risk to gain or defend market share. As shown in column V of Table 2.1, the interaction term is statistically non-significant. This result suggests that the competitive environment does not influence how banks utilise TLTRO funds in a way that affects their DtD. These findings reinforce that banks have adopted a more conservative approach to TLTRO liquidity, prioritising financial stability over riskier strategies aimed at increasing market share.

2.6.2. Robustness checks

In this section, we conducted robustness checks to ensure the reliability of our results. More specifically, we assess the implications of the varied model specifications

on the baseline results. The first robustness analysis was based on introducing an exclusion rule by removing countries with just one or two banks from our initial sample (as shown in Table A2.1). This analysis was implemented to verify the accuracy of our results in the presence of possible outliers and minimise the impact of idiosyncratic factors associated with smaller banking systems. This analysis consistently supported the conclusions regarding the TLTRO (see Table A2.6).

In the baseline analysis, we excluded banks that had financial difficulties during the period under analysis (as shown in Table A2.3). To test the robustness of our results, we conducted an analysis that included these distressed banks. Specifically, we identified nine distressed banks, comprising five from Greece and one each from Ireland, Portugal, Belgium and Spain. The purpose of this analysis is to assess the influence of distressed banks on the baseline model's results, particularly regarding TLTRO. The initial findings remained consistent with the inclusion of distressed banks (see Table 2.2), except for extension III, where TLTRO appeared not to be significant, and the interaction term with $LTA_{b,c,t}$ became marginally significant. This suggests that the presence of distressed banks can also affect the relationship between these variables, which justifies further research into the potential mechanisms underlying this effect.

To assess the relative importance of various components in driving risk, we performed a regression analysis on DtD, including assets, liabilities, and stock price volatility. Our findings suggest that equity volatility is the primary driver of risk. To ensure the robustness of this result, we recalculated equity volatility using a 6-month window, compared to the 1-year window applied in the baseline analysis. The results, presented in Table 2.3, indicate that the main findings remain stable, as the key coefficients retain their magnitude and significance across the different volatility windows. This suggests that the impact of equity volatility is robust to the choice of window length.

Additionally, we extended the study period to the year 2019 to cover the announcement and initial implementation of TLTRO III, a programme with more flexible conditions. Regarding TLTRO participation, the results from this extension are in line with those of the primary analysis (see Table A2.7), except for the interaction with the HHI index, which became slightly significant. This, along with some other variations in the significance of certain variables, suggests potential influences of TLTRO III that were not directly examined in this study.

Table 2.2. *Robustness check: Inclusion of distressed banks in the sample*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.088**	0.087**	0.091**	0.088*	0.071
	(0.039)	(0.041)	(0.045)	(0.045)	(0.052)
$(Partic_b \times TLTRO_{b,t-1})X$	2.513***	0.391	0.009*	0.006	0.000
	(0.320)	(0.280)	(0.005)	(0.004)	(0.000)
$TLTRO_{b,t-1}$	-1.663***	-0.648	0.212	0.778**	0.357
	(0.265)	(1.030)	(0.419)	(0.301)	(0.484)
Market Cap (log)	1.593***	0.148	1.643***	1.392***	1.612***
	(0.383)	(1.099)	(0.379)	(0.374)	(0.417)
Common equity to total assets	0.009	0.010	-0.008	0.009	0.011
	(0.031)	(0.030)	(0.037)	(0.030)	(0.034)
Provisions for loan losses to total loans	-0.048	-0.053	-0.024	-0.062	-0.040
	(0.075)	(0.072)	(0.053)	(0.075)	(0.070)
Total Loans to total deposits	-0.011***	-0.011***	-0.012***	-0.013***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Operating income to total assets	0.111	0.096	0.134	0.035	0.098
	(0.100)	(0.096)	(0.095)	(0.112)	(0.101)
Cash and securities to total deposits	0.023**	0.022**	0.027**	0.021*	0.023**
	(0.010)	(0.010)	(0.010)	(0.011)	(0.009)
Inflation	0.280***	0.276***	0.269***	0.363***	0.199**
	(0.079)	(0.080)	(0.075)	(0.061)	(0.091)
Interest rate	1.804***	1.820***	1.894***	2.210***	1.791***
	(0.494)	(0.492)	(0.510)	(0.453)	(0.507)
GDP growth	0.207***	0.204***	0.193***	0.188***	0.217***
	(0.041)	(0.042)	(0.041)	(0.047)	(0.049)
Constant	-5.269**	0.044	-5.253**	-4.312**	-5.324**
	(2.075)	(4.116)	(2.046)	(2.090)	(2.265)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	552	552	552	503	552
R^2	0.0819	0.1650	0.1482	0.3351	0.1361
Within R^2	0.3255	0.3272	0.3326	0.3532	0.3398

This table presents the regression results, including banks that experienced distress, defined as having a negative Distance to Default (DtD) at any point during the study period. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition, influence DtD. Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to total-assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). These interactions help to evaluate the relationship between TLTRO participation and DtD in a sample that accounts for banks under distress. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table 2.3. *Robustness check: Calculation of DtD using equity volatility with a 6-month window*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.060	0.062	0.062	0.042	0.074
	(0.042)	(0.044)	(0.041)	(0.041)	(0.054)
$(Partic_b \times TLTRO_{b,t})X$	2.179***	0.301	0.007	-0.005	-0.000
	(0.592)	(0.423)	(0.008)	(0.008)	(0.001)
$TLTRO_{b,t-1}$	-0.844	0.169	0.854	1.231***	1.437**
	(0.520)	(1.551)	(0.591)	(0.434)	(0.631)
Market Cap. (log)	4.564***	3.413*	4.579***	4.015***	4.512***
	(0.978)	(1.841)	(0.980)	(0.955)	(0.997)
Common equity to total assets ratio	0.038	0.035	0.029	0.046	0.034
	(0.050)	(0.048)	(0.054)	(0.050)	(0.052)
Provisions for loan losses to total loans ratio	0.169**	0.158**	0.161**	0.166**	0.168**
	(0.069)	(0.074)	(0.071)	(0.078)	(0.070)
Total loans to total deposits ratio	-0.009*	-0.009*	-0.010*	-0.011**	-0.009*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Operating income to total assets ratio	-0.192	-0.199	-0.187	-0.179	-0.162
	(0.133)	(0.142)	(0.127)	(0.147)	(0.149)
Cash and securities to total deposits ratio	0.037**	0.037**	0.040**	0.027	0.037**
	(0.014)	(0.015)	(0.015)	(0.017)	(0.015)
Inflation	0.438**	0.434**	0.441**	0.640***	0.475**
	(0.187)	(0.190)	(0.183)	(0.176)	(0.214)
Interest rate	0.607	0.628	0.710	1.440*	0.686
	(0.913)	(0.918)	(0.898)	(0.811)	(0.901)
GDP growth	0.310**	0.305**	0.307**	0.331**	0.311**
	(0.129)	(0.133)	(0.127)	(0.143)	(0.125)
Constant	-17.701***	-13.452*	-17.584***	-15.463***	-17.733***
	(3.999)	(7.076)	(3.912)	(4.163)	(4.054)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	470	470	470	421	470
R^2	0.0360	0.0538	0.0507	0.1536	0.0483
Within R^2	0.3463	0.3463	0.3468	0.3891	0.3458

This table presents the regression results where equity volatility is calculated using a 6-month window. This volatility measure is one of the key inputs used in calculating DtD. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition, influence DtD. Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Furthermore, we conducted robustness checks by examining various lags for the TLTRO variable. We explored a TLTRO variable with no lag and with a lag of 2 periods to capture immediate effects or more persistent delayed responses. When analysing TLTRO without any lag, the results align with our main analysis concerning the bank's participation in TLTRO and its liquidity utilisation (see Table A2.8). While there are slight variations in the sign and significance of the TLTRO variable, as previously noted, these could be attributed to factors not directly addressed in this study. Introducing a lag of 2 periods for the TLTRO variable in our robustness checks showed that the primary analysis findings regarding TLTRO remain valid (see Table A2.9), with only a minor change in the significance of one interaction term, particularly with STA, which becomes slightly positive and significant. This could indicate a delayed impact on the utilisation of TLTRO liquidity in banking lending activities. Further research may be necessary to understand the reasons behind these variations, as changes in market conditions, regulatory frameworks, or bank-specific factors over time can also contribute to these discrepancies.

In summary, the robustness checks carried out in this section confirm the consistency of the relationship between the TLTRO and the bank's DtD observed in our main analysis. Specifically, the results regarding TLTRO participation are consistently aligned with the primary analysis. The results remained robust despite some variations in the significance of certain variables. These variations may imply the presence of distinct dynamics, which could be explored in future research to uncover potential underlying mechanisms.

2.7. Conclusion

This study analyses the impact of TLTROs on the bank's default risk, thus assessing the bank's risk-taking channel of this unconventional monetary policy. Using panel data with bank-fixed effects for 90 listed banks from 16 Eurozone countries during the period from 2012: Q1 to 2018: Q4, we found that while TLTRO was associated with an increase in the bank's default risk, participating in the programme reduced default risk. The results suggest that banks used the liquidity from TLTRO to strengthen and consolidate their financial position.

We extended the baseline model to assess the influence of bank size and operational ratios on the impact of TLTRO. Our findings indicate that the effects of

TLTRO on the default risk are consistent across banks of different sizes. Furthermore, we found no evidence that banks used TLTRO funds to significantly expand lending or invest in short-term high-volatility assets in a way that influenced their DtD. Additionally, we explored the competitive dynamics within the banking sector and found that competition did not influence how banks utilised TLTRO liquidity in a way that affected their default risk. As a robustness check, we included banks that faced financial distress during the study period, and the results remained consistent.

Our findings indicate that TLTRO programmes contributed to strengthening the stability of the Eurozone banking sector without encouraging excessive risk-taking by providing additional liquidity at a more favourable cost. The conclusions of this study contribute to the empirical literature on the effectiveness and impacts of unconventional monetary policies. Future studies could explore additional dimensions, such as the inclusion of unlisted banks, temporal dynamics, underlying mechanisms and broader macro-financial implications to provide a more comprehensive analysis of the effects of TLTROs and their role in banking sector resilience and stability.

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2.9. Appendix

Table A2.1. *Distribution of banks in the sample by country*

Country	Nr. of banks	Country	Nr. of banks
Austria	9	Ireland	2
Belgium	1	Italy	24
Cyprus	2	Lithuania	1
Germany	17	Malta	4
Estonia	1	Netherlands	6
Spain	9	Portugal	3
Finland	4	Slovenia	1
France	5	Slovakia	1
		Total	**90**

Table A2.2. *List of banks included in the sample*

Bank	Country	Bank	Country
Erste Group Bank AG	Austria	BPER Banca SPA	Italy
Raiffeisen Bank International AG	Austria	Mediobanca SPA	Italy
Oberbank AG	Austria	Banca Mediolanum SPA	Italy
Bank für Tirol und Vorarlberg AG	Austria	Credito Emiliano SPA	Italy
BKS Bank AG	Austria	Banca Popolare di Sondrio SPA	Italy
Volksbank Vorarlberg E.Gen.	Austria	FinecoBank SPA	Italy
Wiener Privatbank SE	Austria	Banca Carige SPA	Italy
BAWAG Group AG	Austria	Banco di Desio e Della Brianza SPA	Italy
Autobank AG	Austria	Banca Generali SPA	Italy
KBC Groep NV	Belgium	Banca Ifis SPA	Italy
Bank of Cyprus Holdings PLC	Cyprus	BFF Bank SPA	Italy
Hellenic Bank PLC	Cyprus	Banca Sistema SPA	Italy
LHV Group AS	Estonia	Banca Finnat Euramerica SPA	Italy
Aktia Bank Plc	Finland	Banca Profilo SPA	Italy
Alandsbanken PLC	Finland	Banca Intermobiliare di Investimenti e Gestioni SPA	Italy
Oma Saastopankki Oyj	Finland	Unipol Gruppo SPA	Italy
Fellow Pankki PLC	Finland	Dovalue SPA	Italy
BNP Paribas SA	France	Unione di Banche Italiane SPA	Italy
Crédit Agricole SA	France	Banca Piccolo Credito Valtellinese SPA	Italy
Societé Générale SA	France	Banca Popolare Dell'Etruria	Italy
Rothschild & Co	France	Siauliu Bankas AB	Lithuania
Natixis SA	France	Bank of Valletta PLC	Malta
Deutsche Bank AG	Germany	HSBC Bank Malta PLC	Malta
Commerzbank AG	Germany	Fimbank PLC	Malta
Deutsche Pfandbriefbank AG	Germany	Lombard Bank (Malta) PLC	Malta
Procredit Holding AG	Germany	ING Groep NV	Netherlands
Baader Bank AG	Germany	ABN AMRO Bank NV	Netherlands
Merkur Privatbank KGaA	Germany	Van Lanschot Kempen NV	Netherlands
Umweltbank AG	Germany	Aegon NV	Netherlands
Albis Leasing AG	Germany	NIBC Bank NV	Netherlands
Grenke AG	Germany	BinckBank NV	Netherlands
Wustenrot & Wurttembergische AG	Germany	Banco Comercial Português SA	Portugal
Aareal Bank AG	Germany	Banco BPI SA	Portugal
MLP SE	Germany	Caixa Económica Montepio Geral SA	Portugal
HSBC Trinkaus & Burkhardt AG	Germany	Tatra Banka as	Slovakia
IKB Deutsche Industriebank AG	Germany	Nova Ljubljanska Banka dd	Slovenia
Oldenburgische Landesbank AG	Germany	Banco Santander SA	Spain
Fidor Bank AG	Germany	CaixaBank SA	Spain
DVB Bank SE	Germany	Banco Bilbao Vizcaya Argentaria SA	Spain
Bank of Ireland Group PLC	Ireland	Banco Sabadell SA	Spain
AIB Group PLC	Ireland	Unicaja Banco SA	Spain
Intesa Sanpaolo SPA	Italy	Bankinter SA	Spain
Unicredit SPA	Italy	Renta 4 Banco SA	Spain
Banco BPM SA	Italy	Banco Popular Español SA	Spain
Banca Monte dei Paschi di Siena SPA	Italy	Liberbank SA	Spain

Table A2.3. *List of distressed banks included in the robustness check*

Bank	Country
National Bank of Greece SA	Greece
Piraerus Financial Holdings SA	Greece
Eurobank Ergasias Services and Holdings S.A.	Greece
Alpha Services and Holdings S.A.	Greece
Permanent TSB Group Holdings PLC	Ireland
Attica Bank SA	Greece
Bankia, SA	Spain
BANIF SA	Portugal
Dexia, SA	Belgium

Table A2.4. *Definition of variables*

Variable	Definition	Source data
Distance to Default (DtD)	Risk measure calculated using the Merton (1974) model.	Inputs source from Bloomberg, banks' financial reports, Refinitiv, and Moody's Analytics BankFocus
TLTRO amount	Logarithm net TLTRO balance held by each bank at the end of each quarter, accounting for both disbursements and repayments.	Bloomberg and banks' financial reports
Control Variables		
Bank-level		
Bank size	Logarithm of market capitalisation	Bloomberg and banks' financial reports
Capital adequacy	Common equity to total assets	Bloomberg and banks' financial reports
Asset quality	Provisions for loan losses to total loans	Bloomberg and banks' financial reports
Management quality	Total loans to total deposits	Bloomberg and banks' financial reports
Earnings	Operating income to total assets	Bloomberg and banks' financial reports
Liquidity	Cash and securities to total deposits	Bloomberg and banks' financial reports
Macroeconomic-level		
Inflation	Year-over-year percentage change in the national consumer price index	Bloomberg and national statistics institute
Interest rate	3 month Euribor	Bloomberg
GDP Growth	Year-over-year percentage change in nominal GDP	Bloomberg and national statistics institute
Interaction terms		
Loans to Assets Ratio (LTA Ratio)	Total loans to total assets	Bloomberg
Trading Securities to Assets Ratio (STA Ratio)	Total trading securities to total assets	Bloomberg
Banking sector competition	Herfindahl-Hirschman Index (HHI), which reflects the distribution of market share within the sector	Bloomberg

Table A2.5. *Summary statistics*

Variables	Obs.	Mean	Median	Std.Dev.	Min.	Max.
Distance to Default (DtD)	1.867	5.95469	3.740865	7.190346	0.0003302	80.83521
Lag Distance to Default (4 quarters)	1.589	5.752151	3.524822	7.012374	0.0003302	80.83521
Market capitalization (log)	2.139	3.14345	3.162107	0.9210007	0.634185	4.994155
Total TLTRO (log)	722	3.26282	3.43602	0.9513803	0.0000	4.804725
Lag Total TLTRO (log) (1 quarter)	685	3.253965	3.414973	0.9577218	0.0000	4.804725
Common equity to total assets	2.030	8.068507	7.160363	4.336706	0.0997168	73.42668
Provisions for loan losses to total loans	1.362	0.1994464	0.1503997	1.450826	-38.69471	16.13354
Loan to deposits	1.587	115.3679	112.1317	60.66839	3.403752	519.8318
Operating income to total assets	1.748	0.1259686	0.1337333	0.4982351	-8.462463	7.243107
Cash and securities to total deposits	1.880	29.97032	17.70865	81.86329	0.0610479	2810.157
Inflation	2.520	1.123183	1.1	1.010763	-2.58	4.8
Interest Rate	2.520	-0.0161071	-0.027	0.3094155	-0.331	0.777
GDP growth	2.520	2.734377	2.7	3.258817	-8.8	38.22
Herfindahl-Hirschman Index (HHI)	623	833.8413	519	718.8264	245	3630
Trading securities to total assets (STA)	1.310	5.860341	2.422924	8.549824	0.00000233	44.69165
Loans to total assets (LTA)	1.577	56.88115	63.16272	20.99265	2.259883	91.05274

Table A2.6. *Robustness check: Exclusion of countries with only one or two banks*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.135**	0.142**	0.160**	0.148**	0.111
	(0.054)	(0.056)	(0.060)	(0.062)	(0.073)
$(Partic_b \times TLTRO_{b,t-1})X$	2.470***	0.381	-0.001	0.002	0.001
	(0.376)	(0.284)	(0.005)	(0.004)	(0.000)
$TLTRO_{b,t-1}$	-1.541***	-0.558	0.975**	0.941***	0.228
	(0.249)	(1.035)	(0.430)	(0.343)	(0.532)
Market Cap (log)	1.721***	0.245	1.692***	1.637***	1.726***
	(0.452)	(1.163)	(0.461)	(0.457)	(0.470)
Common equity to total assets	0.002	-0.001	0.001	0.011	0.000
	(0.033)	(0.032)	(0.035)	(0.033)	(0.036)
Provisions for loan losses to total loans	0.100**	0.083*	0.098*	0.096*	0.084*
	(0.047)	(0.046)	(0.050)	(0.048)	(0.049)
Total Loans to total deposits	-0.005	-0.005*	-0.005	-0.006**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.069	0.060	0.086	0.020	0.049
	(0.096)	(0.106)	(0.092)	(0.110)	(0.102)
Cash and securities to total deposits	0.012	0.012	0.012	0.010	0.012
	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
Inflation	0.437***	0.438***	0.448**	0.446***	0.343**
	(0.101)	(0.102)	(0.098)	(0.102)	(0.133)
Interest rate	2.183***	2.201***	2.202***	2.276***	2.095***
	(0.534)	(0.540)	(0.542)	(0.544)	(0.546)
GDP growth	0.307***	0.311***	0.314***	0.276***	0.345***
	(0.086)	(0.085)	(0.085)	(0.084)	(0.078)
Constant	-6.948***	-1.461	-7.106***	-6.919***	-6.433***
	(2.197)	(4.287)	(2.205)	(2.288)	(2.185)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	434	434	434	398	434
R^2	0.0295	0.0788	0.0966	0.1846	0.1850
Within R^2	0.3624	0.3637	0.3578	0.3592	0.3856

This table presents the regression results after excluding countries that have only one or two banks in the sample. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition, influence Distance to Default (DtD). Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). These interactions help to evaluate the relationship between TLTRO participation and DtD in a sample that accounts for banks under distress. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A2.7. *Robustness check: Extension of analysis period to 2019*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.107**	0.115**	0.118**	0.101**	0.051
	(0.043)	(0.047)	(0.046)	(0.048)	(0.056)
$(Partic_b \times TLTRO_{b,t-1})X$	2.986***	0.291	0.004	0.004	0.001*
	(0.049)	(0.272)	(0.005)	(0.004)	(0.000)
$TLTRO_{b,t-1}$	-2.130***	-0.268	0.579	0.849**	0.197
	(0.318)	(-0.268)	(0.431)	(0.343)	(0.440)
Market Cap (log)	2.291***	1.193	2.277***	2.182***	2.351***
	(0.482)	(1.077)	(0.473)	(0.513)	(0.506)
Common equity to total assets	-0.011	-0.013	-0.015	0.004	0.000
	(0.038)	(0.037)	(0.041)	(0.034)	(0.037)
Provisions for loan losses to total loans	0.084	0.071	0.079	0.072	0.083
	(0.053)	(0.054)	(0.055)	(0.055)	(0.058)
Total Loans to total deposits	-0.007***	-0.007***	-0.008***	-0.009***	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.174**	0.173**	0.191***	0.108	0.091
	(0.069)	(0.070)	(0.065)	(0.091)	(0.086)
Cash and securities to total deposits	0.017**	0.017**	0.019**	0.017*	0.017**
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Inflation	0.135*	0.134*	0.135*	0.185**	0.039
	(0.069)	(0.072)	(0.069)	(0.079)	(0.084)
Interest rate	0.250	0.298	0.333	0.531	0.565
	(0.461)	(0.463)	(0.468)	(0.479)	(0.553)
GDP growth	0.089	0.086	0.087	0.030	0.123**
	(0.056)	(0.054)	(0.054)	(0.065)	(0.058)
Constant	-7.700***	-3.843	-7.778***	-7.708***	-8.005***
	(2.077)	(4.309)	(2.069)	(2.363)	(2.152)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	577	577	577	518	577
R^2	0.0206	0.0582	0.0567	0.1353	0.1358
Within R^2	0.2640	0.2620	0.2604	0.2713	0.3071

This table presents the regression results after extending the study period to include data up to 2019, covering the announcement and the initiation of TLTRO III, a programme with more flexible conditions than its predecessors. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition, influence Distance to Default (DtD). Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). These interactions help assess how the introduction of TLTRO III might influence the relationship between TLTRO participation and DtD. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A2.8. *Robustness check: Regressions with TLTRO variable excluding lag*

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.107**	0.110**	0.106**	0.092	0.074
	(0.048)	(0.048)	(0.049)	(0.055)	(0.060)
$(Partic_b \times TLTRO_{b,t})X$	5.841**	0.045	0.006	0.002	0.000
	(2.693)	(0.418)	(0.006)	(0.004)	(0.000)
$TLTRO_{b,t}$	-5.102*	0.574	0.347	0.777**	0.368
	(2.818)	(1.449)	(0.467)	(0.352)	(0.449)
Market Cap (log)	2.064***	1.892	2.104***	1.924***	2.133***
	(0.453)	(1.650)	(0.458)	(0.474)	(0.483)
Common equity to total assets	-0.001	-0.002	-0.007	0.006	-0.000
	(0.031)	(0.032)	(0.036)	(0.029)	(0.031)
Provisions for loan losses to total loans	0.068	0.068	0.062	0.052	0.075
	(0.045)	(0.045)	(0.049)	(0.051)	(0.048)
Total Loans to total deposits	-0.006**	-0.006**	-0.007***	-0.007**	-0.006**
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
Operating income to total assets	0.109	0.110	0.108	0.062	0.066
	(0.090)	(0.095)	(0.088)	(0.107)	(0.099)
Cash and securities to total deposits	0.024**	0.024**	0.027**	0.023*	0.023**
	(0.010)	(0.010)	(0.010)	(0.012)	(0.009)
Inflation	0.225**	0.224**	0.221**	0.303***	0.138
	(0.094)	(0.095)	(0.092)	(0.089)	(0.118)
Interest rate	1.408**	1.418**	1.495**	1.785***	1.343**
	(0.545)	(0.541)	(0.555)	(0.541)	(0.557)
GDP growth	0.171***	0.170***	0.169***	0.134*	0.166***
	(0.049)	(0.048)	(0.048)	(0.078)	(0.053)
Constant	-6.673***	-6.731	-7.320***	-6.926***	-7.360**
	(2.272)	(5.869)	(2.078)	(2.311)	(2.148)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	492	492	492	439	492
R^2	0.0095	0.0789	0.0664	0.1770	0.1406
Within R^2	0.2778	0.2775	0.2821	0.2974	0.2941

This table presents the regression results where the TLTRO participation variable is included without any lag. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition, influence DtD. Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). By considering the TLTRO variable without any lag, the analysis captures the immediate effects of TLTRO participation on DtD. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A2.9. Robustness check: Regressions with the TLTRO variable with a 2-lag period

	(I) Baseline	(II) Bank Size Interaction *(X= LogMarkCap)*	(III) Lending Behavior Interaction *(X= LTA)*	(IV) Investment Behavior Interaction *(X=STA)*	(V) Competition Interaction *(X=HHI)*
$DtD_{b,c,t-4}$	0.127**	0.131**	0.141**	0.134**	0.099
	(0.049)	(0.054)	(0.054)	(0.059)	(0.069)
$(Partic_b \times TLTRO_{b,t-2})X$	3.192***	0.503*	0.006	0.009*	0.001
	(0.415)	(0.254)	(0.006)	(0.005)	(0.000)
$TLTRO_{b,t-2}$	-1.893***	-0.642	0.818	1.292***	0.742
	(0.307)	(0.976)	(0.503)	(0.306)	(0.538)
Market Cap (log)	2.055***	0.211	2.054***	1.789***	2.122***
	(0.537)	(1.065)	(0.534)	(0.518)	(0.569)
Common equity to total assets	0.025	0.017	0.016	0.031	0.032
	(0.038)	(0.035)	(0.042)	(0.038)	(0.038)
Provisions for loan losses to total loans	0.074	0.059	0.057	0.076	0.087
	(0.052)	(0.052)	(0.064)	(0.058)	(0.056)
Total Loans to total deposits	-0.004	-0.004	-0.005*	-0.006	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.213	0.155	0.236	0.047	0.106
	(0.182)	(0.182)	(0.189)	(0.201)	(0.206)
Cash and securities to total deposits	0.025***	0.024**	0.027***	0.024**	0.025***
	(0.009)	(0.009)	(0.009)	(0.011)	(0.009)
Inflation	0.235**	0.226**	0.241**	0.339***	0.129
	(0.103)	(0.106)	(0.099)	(0.103)	(0.123)
Interest rate	1.623**	1.672**	1.703**	2.229***	1.592**
	(0.673)	(0.686)	(0.655)	(0.622)	(0.680)
GDP growth	0.232***	0.228***	0.227***	0.233**	0.233**
	(0.081)	(0.081)	(0.081)	(0.101)	(0.091)
Constant	-9.534***	-2.701	-9.411***	-9.047***	-9.640***
	(2.360)	(4.191)	(2.143)	(2.338)	(2.468)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	447	447	447	401	447
R^2	0.0213	0.0527	0.0556	0.1429	0.1245
Within R^2	0.3276	0.3302	0.3247	0.3488	0.3440

This table presents the regression results where the TLTRO participation variable is included with a lag of 2 periods. The independent variables include TLTRO participation and several interaction terms to explore how different factors such as bank size, lending behaviour, investment strategy, and market competition influence, DtD. Columns I to V display results from different model specifications. Each column introduces a specific interaction term: the natural logarithm of market capitalisation (Log Mark. Cap.), the loans-to-assets ratio (LTA), the trading securities-to-total assets ratio (STA), and the Herfindahl-Hirschman Index (HHI). By considering the TLTRO variable with a lag of 2 periods, the analysis captures more persistent delayed responses of TLTRO participation on DtD. Standard errors are clustered by bank to account for potential autocorrelation within banks over time. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

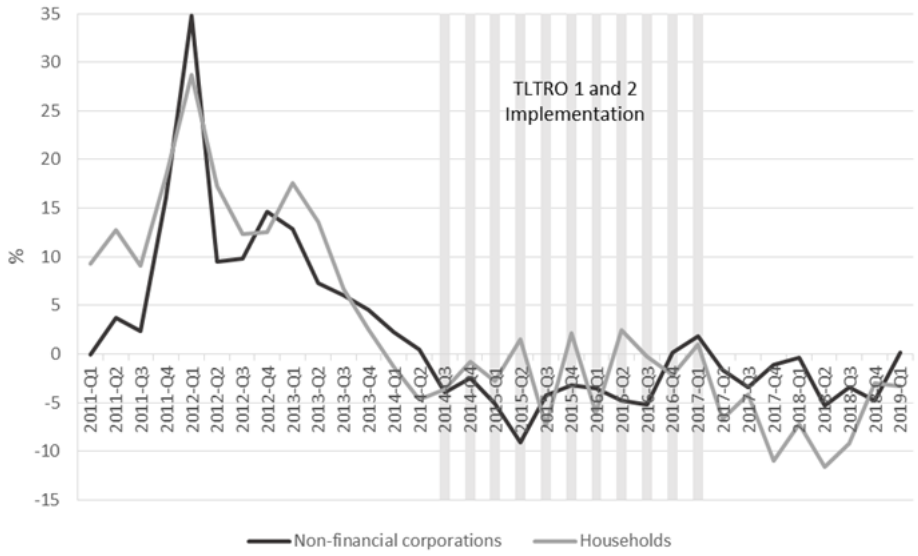

Figure A2.1. Changes in credit standards for loans in the Eurozone (net percentages). (+) Net tightening/ (-) Net easing.
Source: European Central Bank (ECB) and authors' calculations.

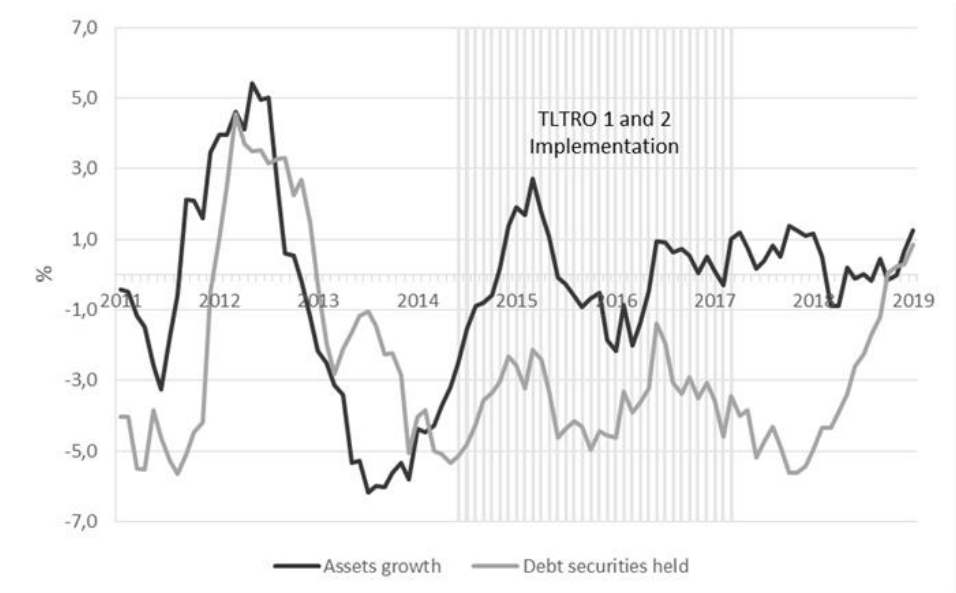

Figure A2.2. Monthly growth rate of Eurozone banks' assets and debt securities held by them.
Source: European Central Bank (ECB).

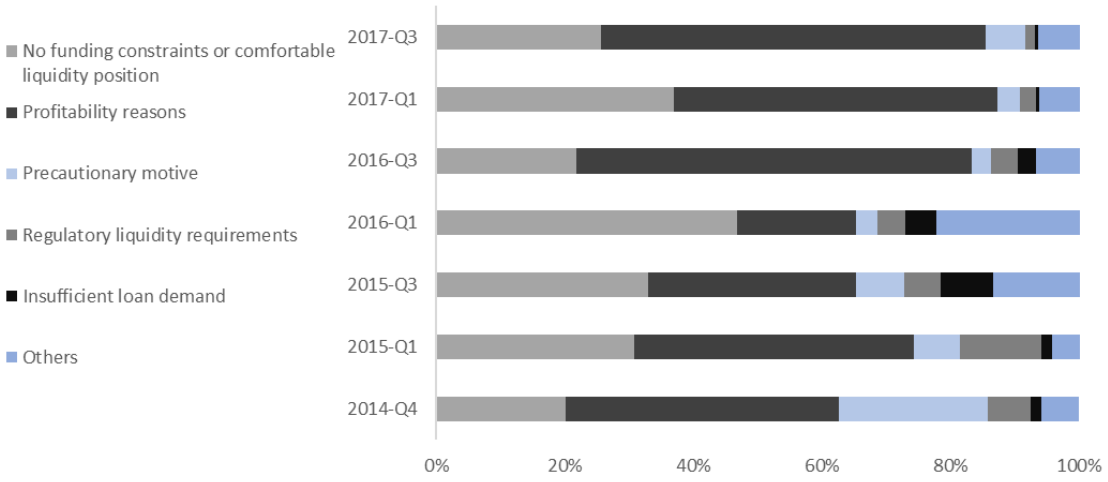

Figure A2.3. Reasons for banks to participate in TLTROs (% of total banks). Based on ECB surveys that include not only TLTRO I and TLTRO II but also past and future programmes. *Source: ECB and authors' calculation.*

Chapter 3
The ECB's Pandemic Emergency Purchase Programme and Fiscal Policy: Synergies or Conflict?*

3.1. Introduction

The COVID-19 pandemic brought significant challenges and uncertainty to the global economy. The financial markets were deeply affected by the increased uncertainty, namely the government bond market, as central banks pursued highly accommodative policies. Several central banks promptly started to implement measures to mitigate the pandemic's effects and maintain financial stability. The European Central Bank (ECB) was not an exception and announced the Pandemic Emergency Purchase Programme (PEPP). This programme allowed the purchase of a broad set of government and corporate bonds to inject liquidity into financial markets and lower funding costs. This programme represented a significant innovation within the context of the monetary central bank's policy strategy, as it was necessary to rapidly address the unprecedented conditions during the pandemic.

Monetary policies are intended to complement fiscal policies, but conflicts can arise in certain circumstances. For instance, in countries with high debt, expansionary fiscal policy can raise concerns about debt sustainability. At the same time, the central bank's actions to stabilise the markets can be seen as supporting unsustainable budgetary practices. This can create conflicts between short-term recovery goals and long-term fiscal discipline. These dynamics highlight the importance of analysing the interaction between monetary and fiscal policies to identify how they work together. In this context, this study aims to determine the extent to which the country's fiscal stance influenced the PEPP's impact on sovereign bond spreads. As the pandemic was a period characterised by exceptional fiscal measures, this study aims to examine whether the PEPP's impact was amplified or offset by the countries' fiscal stance.

For our study, we use a sample of 1,368 Eurozone sovereign bonds issued between 2018:Q1 and 2022:Q1 to assess the impact of the PEPP on their spreads and the extent to

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which the countries' fiscal positions conditioned it. Our main results suggest that PEPP's effectiveness in reducing spreads was strongly conditional on fiscal conditions. PEPP was more effective in low-debt countries than in high-debt countries, where fiscal concerns seem to remain dominant. The remainder of the paper is organised as follows. Section 2 briefly reviews the ECB's PEPP. Section 3 provides a literature review. Section 4 describes the methodology. Section 5 provides the analysis results. Section 6 concludes.

3.2. Overview of the ECB's PEPP

The ECB's Governing Council announced the PEPP on March 18, 2020, to mitigate the economic and financial consequences of the COVID-19 pandemic. As the pandemic caused uncertainty that spread rapidly in the Eurozone, the credit risk premiums on sovereign bonds rose sharply. To address this, the ECB quickly introduced several instruments, including the PEPP, to inject liquidity into financial markets and support an efficient transmission of monetary policy.

The ECB initially set the PEPP at 750 billion euros, which was primarily for tackling market fragmentation in the spring of 2020. In this, the ECB followed flexible purchase strategies that accommodated heterogeneity in purchase flows over time, between asset classes, and among jurisdictions. The total programme size increased to EUR 1,350 billion as of June 4, 2020, and was further increased to EUR 1,850 billion as of December 10, 2020. The PEPP included all assets already covered under the Asset Purchase Programme (APP), as well as certain assets not previously covered, such as Greek government bonds. Also, the minimum remaining maturity threshold for public sector assets was lowered to 70 days from the one-year minimum under the APP. Figure 3.1 shows the evolution of cumulative net purchases under the PEPP.

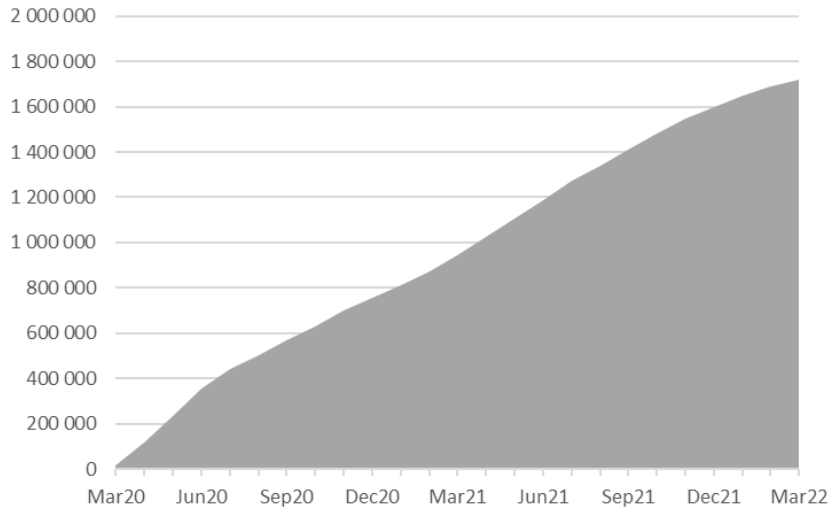

Figure 3.1. Cumulative net purchases under the PEPP (in EUR million at the month end).
Source: European Central Bank (ECB).

The national central banks within the Eurosystem made most of the purchases under the PEPP, with the ECB directly making a small portion. PEPP's risk-sharing principles, aligned with those of the APP, ensured a coordinated approach to managing the risks involved. Although the allocation of purchases of public sector securities between the Eurozone jurisdictions continued to be based on the Eurosystem's capital subscription key, the national central banks had the flexibility to make purchases to avoid tightening financing conditions.

The programme was developed by the ECB Governing Council to last until the end of the COVID-19 crisis phase, with net purchases scheduled to end in March 2022. Nevertheless, the proceeds from maturing PEPP securities are reinvested flexibly until at least the end of 2024, thereby reducing the risks to the transmission mechanism linked to the pandemic.

3.3. Literature overview

The COVID-19 pandemic has forced unprecedented policy responses from central banks, particularly the ECB, through measures such as the PEPP. As this programme was very recent, the literature addressing the impacts of this type of programme on economic and financial stability remains limited. This is a gap in the research, particularly regarding the interactions between the ECB's non-standard monetary policy and the fiscal policies of Eurozone countries during the pandemic.

The financial consequences of the pandemic were different among Eurozone countries due to the heterogeneity of their economic conditions. As stated by Carnazza and Liberati (2021), although the pandemic might be classified as a symmetrical shock, its effects on sovereign bond markets were, however, asymmetrical. The authors demonstrated the existence of significant differences in sovereign bond yields and credit default swap (CDS) spreads among the Eurozone countries, which reflect different levels of sovereign risk and economic resilience. It is therefore sufficient to argue that economic heterogeneity requires us to consider how national fiscal conditions have impacted the effectiveness of the ECB's interventions, including the PEPP. The role played by the PEPP in addressing these disparities has been the subject of a few studies. For example, Moessner and Haan (2022) analysed the effects of PEPP announcements on sovereign bond term premia, as measured by the changes in CDS spreads. They found that countries with greater sovereign risk experienced a more significant reduction in risk premia following PEPP announcements. This means that the PEPP might have been particularly effective in stabilising financial conditions in more exposed countries. Furthermore, as the PEPP also included the purchase of corporate bonds, Demirgüç-Kunt, Horváth, and Huizinga (2020) found that investment-grade firms benefited more from the programme, through increased share prices and lower CDS spreads. However, firms with lower ratings or those severely affected by the pandemic recorded modest increases, highlighting the constraints of the PEPP in reaching all segments of the economy.

Specifically, the interplay between ECB policies, such as the PEPP, and national fiscal policies has been less studied and represents an essential avenue for future research. For example, Corradin, Grimm, and Schwaab (2021) analysed the overall impacts of both ECB unconventional monetary policy and European Union (EU) fiscal policy announcements during the pandemic. They found that the ECB's interventions were more effective in vulnerable countries, but that the EU's fiscal policy announcements could reduce bond yields more evenly across countries. This indicates that the monetary support may have complemented fiscal efforts differently, given the economic situation in each country. Similarly, Fendel, Neugebauer, and Zimmermann (2021) observed that both the ECB's and the European Commission's announcements reduced spreads for high-debt countries, essentially due to increases in the yields of stronger financial countries, such as Germany or the Netherlands.

Despite evidence of synergies, some studies highlight potential conflicts between monetary and fiscal policy. Sargent and Wallace (1981) provide a classical fundamental

analysis of fiscal dominance, in which large deficits pressure central banks to accommodate debt financing, which may undermine inflation control and the maintenance of monetary independence. In the context of Europe's monetary union, Beetsma and Giuliodori (2010) highlight that the absence of centralised fiscal control can promote fiscal profligacy. The overall fiscal discipline can be undermined as national governments, operating under a shared monetary framework, may depend on central bank interventions to contain risk premiums. Based on these insights, Constâncio (2020) highlights the need for a revised European fiscal framework that minimises potential conflicts. According to the author, as fiscal policy takes on a more active role in macroeconomic stabilisation, there is a need to review the fiscal framework to avoid conflicts and ensure effective policy coordination.

Further research has analysed the scope and effectiveness of these monetary policies in response to the pandemic. To cite a few examples, Rebucci, Hartley and Jiménez (2022) provided evidence that QE measures in advanced economies were effective during the COVID-19 pandemic, particularly in influencing government bond yields. Benigno et al. (2022) found evidence of a positive impact on the economic system, the improvement in banks' lending activity, which created opportunities for expansionary fiscal policies in highly indebted eurozone countries. This type of relationship between improved financing conditions and fiscal expansion indicates a strong potential for synergies between monetary policy and fiscal policy in crisis management, an aspect that has not yet been well studied.

Most of the existing literature has examined the PEPP's effectiveness in national markets through the announcement-driven reduction of sovereign risk (e.g., Carnazza and Liberati, 2021; Moessner and Haan, 2022). Additionally, some studies have examined the impact of fiscal policies on sovereign bond spreads, primarily from the perspective of announcements (e.g., Fendel et al., 2021). However, these areas are often analysed separately and focus mainly on short-term announcement effects, rather than the continuous interaction between monetary and fiscal measures during the pandemic period. Even when differences among countries are considered, such as distinctions between high- and low-debt economies, the dynamic relationship between the PEPP purchases and fiscal conditions remains underexplored. This gap is important to address because the PEPP was implemented during a period when national governments were increasing spending, which may have influenced the effectiveness of the ECB's interventions. This study contributes to filling that gap through the model that considers

the relationship between PEPP purchases, fiscal positions and sovereign bond spreads, while distinguishing between high- and low-debt countries.

Another significant contribution of this paper is the distinction between PEPP-eligible and non-eligible bonds, which provides greater clarity on the effects of ECB interventions. Bond eligibility allows the analysis to reflect both the direct impact of PEPP purchases and potential spillover effects on non-eligible bonds. The results of this article contribute to the literature by showing how unconventional monetary policy can complement or contradict fiscal policies in periods of economic distress.

3.4. Methodology

Using a cross-sectional regression approach, this study examines the influence of PEPP purchases and fiscal policies on sovereign bond spreads, allowing for variations across countries. The dataset, however, is not structured as a typical panel, since there is only one observation of each bond at issuance and no further observations are made post-issuance. Instead, a pooled regression model is employed with country (δ_i) and time fixed effects (φ_q) to capture country-specific factors and general macroeconomic trends. To improve the reliability of the estimation, standard errors are clustered at the country level, correcting for possible heteroskedasticity and within-country correlation. This allows a clean and robust estimate of the ECB's impact on sovereign bond spreads while controlling for fiscal and economic conditions. The equation of the baseline model is given as:

$$Spread_{ij} = \alpha_0 + \beta_0 PEPP_{it} + \beta_1 PEPP_{it-1} + \gamma \Delta Fiscal_{it} + \rho(PEPP_{it-1} \times \Delta Fiscal_{it}) + Eligibility_{ij} + \lambda X_{ijt} + \delta_i + \varphi_q + \varepsilon_{ij} \quad (3.1)$$

where $Spread_{ij}$ is the Option-Adjusted Spread (OAS)[9] at issuance for bond j issued by country i. The model assesses the impact of the PEPP interventions on the bond market by analysing variations in risk perception and the cost of borrowing between different countries. To achieve this, it also considers the fiscal position of each country, reflecting

[9] The OAS is the difference between a bond's yield and the risk-free rate, adjusted for embedded options. This metric isolates credit and liquidity risks, serving as a refined measure of the additional risk premium that investors demand to hold a country's debt.

the fiscal policies implemented during the COVID-19 pandemic. This study focuses only on the primary sovereign bond market.[10]

To capture monetary policy effects, the model includes both contemporaneous ($PEPP_{it}$) and lagged ($PEPP_{it-1}$) net PEPP purchases. While contemporaneous purchases reflect immediate effects, lagged purchases account for delayed impacts on spreads and help mitigate endogeneity concerns by ensuring that the effects of monetary interventions are not confounded with contemporaneous market responses.[11] In turn, fiscal policy is measured by the quarter-on-quarter changes ($\Delta Fiscal_{it}$) in the debt-to-GDP ratio and net lending/borrowing as a percentage of GDP.[12] The inclusion of quarterly changes of these indicators allows the model to incorporate the immediate fiscal responses to the evolving challenges and, consequently, the short-term changes that investors consider in their bond pricing decisions. The two chosen fiscal indicators, both with quarterly frequency[13], were selected for their complementary perspectives: the debt-to-GDP captures long-term fiscal sustainability, while the net lending/borrowing ratio reflects short-term fiscal adjustments.[14] In addition, these metrics capture the specific fiscal challenges imposed by the COVID-19 pandemic, a period in which governments implemented both extensive fiscal expansions and significant borrowing.

To capture the combined effects of monetary and fiscal policies on sovereign bond spreads, the model includes an interaction term ($PEPP_{it} \times \Delta Fiscal_{it}$). This term is essential for the identification strategy because it allows an assessment of whether the effectiveness of PEPP purchases varies according to the fiscal stance of countries, especially in periods of dynamic fiscal adjustments. An expansionary fiscal policy can strengthen the positive effects of the PEPP by boosting economic recovery, but can also generate concerns among investors about the sustainability of public debt, attenuating

[10] The spreads at issuance directly reflect governments' borrowing costs and the immediate impact of fiscal and monetary policies, avoiding distortions from secondary market dynamics (Broner et al., 2014; Passadore and Xu, 2022).

[11] Contemporary PEPP purchases are expected to have mixed effects on spreads: they can reduce them immediately by improving liquidity and investor confidence, but also increase them if they are interpreted as a response to market instability. Conversely, lagged PEPP purchases are expected to have a negative impact on spreads, as the cumulative effects of liquidity injections tend to stabilise markets and reduce refinancing risks (Altavilla et al., 2021; Böninghausen et al., 2023).

[12] Fiscal policy indicators reflect the fiscal stance of each country (Bohn, 1998; Corsetti et al., 2012; Afonso and Jalles, 2013) and capture the impact of the measures adopted during the pandemic.

[13] Quarterly frequency, which is in line with the time granularity of the analysis, enables a more accurate identification of fiscal dynamics.

[14] Other measures, such as the primary balance, are typically reported on an annual basis and therefore are less suitable for reflecting short-run fiscal dynamics during the pandemic. Furthermore, the employment of multiple interrelated fiscal measures, such as the primary balance and debt, can lead to multicollinearity, which can yield misleading results.

these benefits (Woodford, 2011; De Grauwe and Ji, 2013; Bech et al., 2014). By modelling this interaction, the study seeks to understand how the dynamic relationship between changes in fiscal policy and PEPP interventions has influenced sovereign bond spreads during the COVID-19 crisis.[15]

To distinguish between direct and indirect effects, the model classifies bonds into eligible or non-eligible categories based on their compliance with the ECB's PEPP purchase criteria ($Eligibility_{ij}$). A bond is considered eligible when it meets the following two core conditions: (i) a minimum investment grade credit rating (BBB- or higher) from at least one of the three main rating agencies (Moody's, Standard & Poor's or Fitch), with the lowest available rating used for the analysis (Greek sovereign bonds are an exception and were eligible for the PEPP, regardless of the rating, due to the waiver from ECB to Greece); and (ii) a maturity of between 70 days and up to 30 years. This differentiation allows for a detailed assessment of the programme's impact. Eligible bonds reflect the direct effects of the ECB's interventions, as they were actively purchased under the PEPP, while ineligible bonds help capture the indirect effects, such as improved market liquidity or reduced systemic risk, which may have amplified the broader impact of monetary policy (Fratzscher et al., 2016; Altavilla et al., 2021; Mudde et al., 2024).[16]

Following the approach of Sironi (2003) and Zaghini (2016, 2019), who extensively analyse the determinants of risk premiums in the primary bond market, we incorporate several control variables (λX_{it}) to consider bond features, market dynamics, domestic economic conditions and Eurozone-specific factors. These controls are essential to isolate the effects of PEPP purchases and fiscal measures, ensuring more robust estimates of the impact of these interventions on sovereign bond spreads.

The analysis includes bond-specific features that may influence the spreads and their eligibility for the programme, following the approach of Zaghini (2019). These characteristics include: the logarithm of the issue amount[17], the initial maturity period (in

[15] The size of this coefficient will tell us the strength of the synergies between monetary and fiscal policy. A more negative value would imply that the PEPP was successful in counterbalancing concerns about fiscal expansion and fostering market stability. A smaller or statistically insignificant coefficient, however, may reveal limited synergies or even possible conflicts, highlighting the need for closer coordination between fiscal and monetary policies.

[16] Based on this distinction, the hypothesis is that PEPP-eligible bonds show negative coefficients, reflecting the direct benefits of liquidity. On the other hand, non-eligible bonds may exhibit more ambiguous effects since they balance the indirect benefits of the programme with the absence of direct support.

[17] Larger issuance tends to be associated with greater liquidity in secondary markets, which can lead to lower spreads. Conversely, bonds with longer maturities tend to have higher spreads, due to the associated greater interest and credit risk (Elton et al., 2002).

years) and the bond's credit rating.[18] The rated and non-rated bonds were differentiated by adding a dummy variable that assumes the value of 1 for the first case and 0 otherwise. For rated bonds, the bond is assigned a numerical score according to the credit quality, with a higher score indicating higher creditworthiness.[19] The model includes an interaction between both variables in order to incorporate these two dimensions of bond rating: if the bond is non-rated, the interaction term equals 0; otherwise, the bond is assigned a numerical score from 1 (D) to 22 (AA), just reflecting its credit quality. Additionally, we control the issuer type by introducing a dummy variable that takes the value of 1 if the bond was issued by the central government and 0 if it was issued by a subnational government. This control is important to ensure that the estimated effects of PEPP purchases and fiscal conditions are not influenced by differences in sovereign issuer types.[20]

The domestic economic conditions are represented in the model by the inflation rate, the nominal GDP growth rate, and the unemployment rate. These three variables capture the specific macroeconomic context of each country that influences investor perceptions of sovereign risk. The bond yields are directly impacted by inflation due to expectations of tighter monetary policies, and therefore, a decrease in the real value of bonds. In turn, nominal GDP growth reflects the country's economic performance, which is a significant consideration in the context of the pandemic. Finally, the unemployment rate indicates the labour market conditions, with higher levels indicating weaker economic fundamentals and greater fiscal pressure on the economy.[21]

We also include the European Economic Sentiment Indicator (ESI)[22] and the 10-year US Treasury yield as control variables. The ESI reflects the level of economic

[18] Investment-grade bonds are expected to have lower spreads, reflecting their lower perceived risk (Huang and Huang, 2012).
[19] Each credit rating level is assigned a numerical score, with AAA/Aaa corresponding to 22, AA+/ Aa1 to 21, AA/Aa2 to 20, and so on, decreasing sequentially to D, which corresponds to 1. This is similar to the approach of Afonso et al. (2012).
[20] Previous studies explain why sub-national governments may face higher risk premiums than central governments. Schuknecht, von Hagen, and Wolswijk (2008) note that sub-national governments, in comparison with central governments, often have smaller tax bases, less fiscal autonomy, and a more mobile tax base, making it harder for them to raise revenue during fiscal crises. In this context, some studies have shown that the spreads of central and subnational governments are interdependent, as subnational entities often rely on fiscal support from the central government. (e.g., Jenkner and Lu, 2014; Bellot, Selva, and Menéndez, 2017).
[21] GDP growth is expected to show a negative coefficient, reflecting the increased perception of sovereign risk during an economic downturn. Contrasting this, both inflation and unemployment are expected to have positive coefficients, as each signals macroeconomic instability and weaker economic fundamentals, respectively.
[22] The ESI is a composite measure from the European Commission's Directorate General for Economic and Financial Affairs, designed to monitor GDP growth across EU member states, the EU, and the Eurozone.

sentiment across the Eurozone. A higher ESI is generally associated with lower spreads, as it indicates lower economic risk. Studies such as that of Afonso and Nunes (2015) underscore the significance of macroeconomic expectations in shaping yield spreads, which reinforces the relevance of the ESI in the analysis. At the same time, the 10-year US Treasury yield captures the evolution of global interest rates, which can affect the sovereign spreads of eurozone countries through global capital movements (Bernoth et al. 2004; Longstaff et al. 2011).

In addition to the baseline model, we estimate extended specifications that incorporate interaction terms to explore the heterogeneous effects of PEPP purchases on sovereign bond spreads. The first extension introduces an interaction of lagged PEPP purchases and a continuous time trend variable ($Time\ trend_t$). This specification captures the gradual evolution of the PEPP's effectiveness, allowing us to test whether its impact intensified, remained stable, or weakened throughout its implementation period (2020-2022).[23]

The second extension examines the role of bond eligibility by interacting lagged PEPP purchases with eligibility status. While the standalone eligibility term accounts for systematic differences between eligible and non-eligible bonds, this interaction helps determine whether the PEPP's effect was stronger for eligible bonds over time. Since the programme specifically targeted eligible securities, this interaction provides insights into whether the PEPP effectively reduced risk premia for the intended bonds.

We further extend the model by incorporating an interaction between lagged PEPP purchases and bond credit ratings. This interaction examines whether riskier bonds benefited more from ECB intervention. Given that higher credit risk typically translates into wider spreads, this interaction allows us to assess whether the PEPP was particularly effective in stabilising borrowing costs for riskier issuers. Another critical extension involves interacting lagged PEPP purchases with bond maturity. This interaction allows us to determine whether the PEPP had a stronger effect on long-term bonds, which are

It combines responses from business and consumer surveys across five sectors: industry (40%), services (30%), consumers (20%), retail (5%), and construction (5%). Balances are calculated as the difference between positive and negative responses, with the ESI standardised to a mean of 100 (long-term) and a standard deviation of 10. Values above 100 indicate stronger-than-average economic sentiment, and data are seasonally adjusted.

[23] This variable is defined as the number of quarters elapsed since the start of the sampling period, providing a continuous, time-dependent measure to capture potential changes in the effectiveness of the PEPP. Accordingly, $Time\ trend_t$ is set to 0 for 2018: Q1 (the first quarter in the dataset), 1 for 2018: Q2, and so on, increasing by 1 each quarter.

more susceptible to market volatility and shifts in risk sentiment. The last extension introduces a triple interaction term between past PEPP interventions, bond eligibility, and the two fiscal indicators: the debt-to-GDP ratio and net lending/borrowing ratio. This specification allows us to measure the PEPP's effectiveness by considering the eligibility status and the country's fiscal position.

The model offers a robust framework to assess how PEPP purchases, fiscal stances and their interactions influence sovereign bond markets. A key innovation is the use of bond-level eligibility data to distinguish direct effects from broader market spillovers. The integration of interaction terms and dynamic fiscal indicators ensures a robust identification strategy, revealing important insights about the synergies and trade-offs of monetary and fiscal policies during the COVID-19 crisis.

3.5. Empirical analysis

3.5.1. Data

The study covers the period from Q1:2018 to Q1:2022, which includes not only the pandemic years but also the pre-pandemic period to establish a normal economic context. Our analysis focuses solely on the period with active purchases under the PEPP, thereby isolating the direct effects of purchases and avoiding potential distortions, such as reinvestments, that may arise later.

This study analyses data on sovereign bond issuance, considering each bond as an individual observation. The sample includes 1,368 euro-denominated sovereign bonds[24] issued by 19 Eurozone countries over the reference period (Table A3.1), with data obtained from Bloomberg. The sample includes nominal and inflation-linked sovereign bonds issued by central, regional and local governments. In addition, only bonds with an OAS available at the time of issue were included in the sample. It is important to highlight that some bonds have negative OAS values, which are attributed to specific market conditions prevailing at the time of analysis. Along with the historically low and even negative interest rate environment in the Eurozone, the ECB's substantial purchases of bonds under the PEPP significantly compressed spreads, especially for high-liquidity sovereign bonds. The ECB's asset purchase programmes were already affecting sovereign

[24] The total dataset includes 1,368 bond issuances, but the fixed effects estimation drops one singleton observation, resulting in N = 1,367 in the regression models.

bond markets even before the pandemic, but the unprecedented scale of PEPP further compressed spreads, particularly for highly liquid bonds. The prevailing environment of historically low interest rates in the Eurozone also played an important role.

The sample selection follows the eligibility criteria of the PEPP, which allows the purchase of regional and local bonds within the same framework as the PSPP (Public Sector Purchase Programme). By including both categories, the study provides a more comprehensive view of the impact of PEPP interventions on sovereign bond yields.[25]

For bond rating classification, this study considers credit ratings assigned by the three major rating agencies, Moody's, Standard & Poor's, and Fitch, when available. To ensure a conservative evaluation, a bond is found to be eligible based on the assumption of the lowest rating assigned by one of the three rating agencies. This approach reduces the risk of over-optimistic assessment and aligns with standard investor practices, which typically employ the most conservative rating for analysing sovereign credit risk. In this case, bonds rated with a minimum rating of BBB- (investment grade) are classified as eligible for the PEPP, and those rated BB+ or lower are ineligible. Due to the ECB's temporary exemption from the minimum rating standards for Greece, the country's sovereign bonds are also considered eligible, despite being rated below investment grade.

To align with the reporting frequency of explanatory variables, we assigned the quarterly macroeconomic and policy variables to bonds based on their issuance date. Although bond issuance occurs on specific dates, quarterly frequency ensures consistency with data reporting practices. It provides a robust representation of the fiscal and monetary environment that influences bond issuance spreads. This approach balances temporal granularity with data availability, ensuring alignment between bond-specific observations and broader macroeconomic trends.

We use net purchases to capture the ECB's active interventions, reflecting the flow of liquidity added to sovereign bond markets, net of redemptions. The data on the PEPP net purchases were obtained from the ECB, which reports these figures on a bimonthly basis. To align the data with the quarterly frequency of the analysis, the bimonthly figures were adjusted proportionally to create quarterly estimates. This adjustment assumes that PEPP purchases were evenly distributed across the months

[25] Although the ECB recognises the eligibility of certain public agencies under the PSPP and, consequently, under the PEPP, we have chosen to exclude bonds issued by public agencies and other quasi-sovereign entities from the sample. This decision ensures a clearer assessment of the PEPP's impact on sovereign yields while avoiding distortions from semi-public institutions that may exhibit different market dynamics.

within the reporting period. While this assumption simplifies the distribution, it allows for consistency in integrating the PEPP data with quarterly fiscal and macroeconomic variables.

To enhance clarity and reflect proportional changes in intervention size, we incorporate the natural logarithm of the PEPP net purchases into the model. By converting the data to a quarterly format and utilising the natural logarithm, the analysis maintains consistency with other variables and effectively illustrates the magnitude and impact of the ECB's interventions.

The fiscal policy indicators, namely the debt-to-GDP ratio and government budget balance, were obtained from Eurostat. These indicators are assigned to bonds based on their issuance date, with the assumption that the quarterly values adequately represent the fiscal stance during that period. The same approach is applied to domestic economic conditions, namely the inflation rate, nominal GDP growth and unemployment rate, which are also reported quarterly and sourced from Eurostat. The definition of the variables used and their sources are described in Table A3.2.

3.5.2. Results

This section presents the results of the regression of Equation 3.1 and its extensions. The summary statistics of the data used are presented in Table A3.3, while Table A3.4 presents the information about bond credit ratings. The PEPP was launched during an unprecedented global crisis, when governments implemented substantial fiscal and monetary measures. Due to the highly specific nature of the conditions surrounding the COVID-19 pandemic, these unique factors may mean that market dynamics during this period deviated from historical patterns and resulted in responses that did not fully align with conventional economic relations. Consequently, the interaction between sovereign spreads, fiscal fundamentals, and monetary interventions during this period should be interpreted considering these unique conditions.

The baseline model analyses the relationship between sovereign bond spreads, PEPP purchases and countries' fiscal situation while controlling for key macroeconomic and financial factors. The results (Table 3.4, Column I) suggest that PEPP purchases alone did not have a statistically significant impact on sovereign bond spreads. Both contemporaneous and lagged PEPP purchase coefficients are not statistically significant, suggesting that any effects of the programme were neither immediate nor persistent over

time. This finding contrasts with studies such as Moessner and Haan (2022), who document a significant decline in term premia following PEPP announcements, which indicates that announcement effects may have been stronger than actual purchase flows. Instead, the results suggest that PEPP's effectiveness depends more on countries' fiscal conditions, especially the debt-to-GDP dynamics. The findings indicate that in countries where the debt ratios were rising, the PEPP purchases were associated with higher, not lower, spreads. This result suggests that PEPP purchases did not mitigate the concerns about fiscal sustainability in countries with weakening debt positions. This result aligns with Benigno et al. (2022), who argue that fiscal fundamentals condition the effectiveness of ECB interventions, especially in the presence of high debt levels. On the contrary, the interaction between lagged PEPP and changes in the net borrowing/lending ratio is not statistically significant, implying that long-term debt accumulation had a stronger impact on shaping PEPP's effectiveness than temporary fiscal balances. Thus, when assessing sovereign risks, the markets appear to be more concerned about structural debt than about temporary fluctuations in the fiscal situation.

Table 3.4. *Results of the Baseline and Extended Models*

	(I)	(II)	(III)	(IV)	(V)	(VI)
$PEPP_{it}$ (log)	0.039	0.044	0.038	0.039	0.041	0.042
	(0.051)	(0.052)	(0.050)	(0.050)	(0.049)	(0.049)
$PEPP_{it-1}$ (log)	0.060	-0.035	0.054	0.055	0.061	0.052
	(0.049)	(0.123)	(0.054)	(0.053)	(0.045)	(0.054)
$\Delta\ debt\ ratio_{it}$	0.009	0.007	0.008	0.008	0.008	0.004
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)	(0.014)
$\Delta\ net\ lend./Borr_{it}$	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)
($PEPP_{it-1}$ x $\Delta\ debt\ ratio_{it}$)	0.005**	0.006***	0.005**	0.005**	0.005**	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
($PEPP_{it-1}$ x $\Delta\ net.\ lend/borr_{it}$)	0.001	0.001	0.001	0.001	0.001	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
$Eligibility_{it}$	0.475*	0.472*	0.439*	0.477*	0.512**	0.435*
	(0.239)	(0.238)	(0.246)	(0.239)	(0.221)	(0.249)
$Issue\ amount_{jt}$ (log)	-0.160	-0.160	-0.160	-0.160	-0.158	-0.157
	(0.151)	(0.151)	(0.151)	(0.151)	(0.152)	(0.152)
$Maturity_{jt}$ (years)	0.031***	0.030***	0.031***	0.031***	0.036***	0.030***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
$Credit\ Rating_{jt}$	-0.007	-0.007	-0.008	-0.009*	-0.009*	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Issuer\ Type_{it}$	0.030	0.031	0.030	0.029	0.040	0.021
	(0.299)	(0.298)	(0.298)	(0.298)	(0.289)	(0.298)
$GDP\ growth_{it}$	0.007	0.009	0.007	0.007	0.006	0.011
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
$Inflation_{it}$	-0.049**	-0.048**	-0.049*	-0.050*	-0.042*	-0.049*
	(0.023)	(0.022)	(0.024)	(0.024)	(0.021)	(0.025)
$Unemployment_{it}$	-0.036	-0.039	-0.043	-0.042	-0.023	-0.027
	(0.042)	(0.043)	(0.046)	(0.044)	(0.040)	(0.050)
ESI_{it}	-0.010	-0.010	-0.010	-0.010	-0.009	-0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$US\ Treasury_{t}$	0.175	0.175	0.176	0.179	0.154	0.176
	(0.143)	(0.143)	(0.144)	(0.143)	(0.150)	(0.144)
($PEPP_{it-1}$ x $Time\ trend_{t}$)		0.007				
		(0.007)				
($PEPP_{it-1}$ x $Eligibility_{it}$)			0.008			0.008
			(0.007)			(0.008)
($PEPP_{it-1}$ x $Credit\ Rating_{jt}$)				0.000		
				(0.000)		
($PEPP_{it-1}$ x $Maturity_{jt}$)					-0.001*	
					(0.000)	
($PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\ debt\ ratio_{it}$)						-0.000
						(0.002)
($PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\ net.\ lend/borr_{it}$)						0.003*
						(0.002)
Constant	0.487	0.508	0.592	0.574	0.251	0.220
	(1.494)	(1.498)	(1.601)	(1.594)	(1.529)	(1.598)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	1,367	1,367	1,367	1,367	1,367	1,367
R^2	0.4397	0.4400	0.4401	0.4399	0.4435	0.4434
Within R^2	0.2801	0.2804	0.2806	0.2803	0.2849	0.2849

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Additionally, the eligibility term is positive and significant. This indicates that eligible bonds had wider spreads, which might well convey an initial perception that they were riskier assets. It suggests that the PEPP did not immediately eliminate risk perceptions related to eligible bonds, meaning that investors may have needed time to fully adapt their asset pricing behaviour to ECB interventions. This finding aligns with Demirgüç-Kunt et al. (2020), whose results indicate that higher-rated investment-grade firms benefited more from ECB corporate bond purchases, suggesting that eligibility alone does not fully eliminate market concerns about credit risk. In addition to PEPP-specific factors, spreads were also influenced by macroeconomic conditions and bond characteristics. Inflation was negatively associated with spreads, probably reflecting a reduction in the real debt burden. Conversely, bonds with longer maturities were associated with wider spreads, supporting the notion that the markets remained cautious about the risks of long-term debt, even in the presence of central bank intervention. Finally, it is also worth noting that the dummy variable for central government issuers is positive but not statistically significant, indicating that the market perceives similar levels of risk between central and subnational issuers.

The findings of the baseline model do not determine whether PEPP's effectiveness changed over time. To address this, Column II of Table 3.4 introduces a time trend interaction, ($PEPP_{it-1}$ x $Time\ trend_t$). The coefficient of this interaction is positive but statistically insignificant, indicating that PEPP's effectiveness did not change over time, but remained constant throughout the programme. This finding contradicts theoretical expectations that monetary interventions could lose their effectiveness as the market adjusts or that their effects accumulate over time. Instead, the consistent stability of the PEPP's effectiveness suggests that its influence may be closely linked to underlying fiscal conditions, specifically the evolution of the debt-to-GDP ratio, rather than the simple passage of time. When analysing the role of eligibility status, we verified that the PEPP's effectiveness was not differentiated between eligible and non-eligible bonds. The results demonstrate that while eligible bonds tend to have higher spreads, the interaction between lagged PEPP purchases and eligibility status is not statistically significant (Table 3.4, Column III). This finding suggests that eligibility status did not influence the impact of PEPP, with eligible bonds not presenting a differentiated effect. Instead, this extension confirms again that rising debt levels played a more significant role in determining how sovereign bond spreads reacted to the ECB's interventions.

Regarding the bond credit rating role, the results of Column IV of Table 3.4 demonstrate that the interaction between this term and lagged PEPP purchases is not statistically significant. This indicates that PEPP's impact on spreads remained consistent at different levels of sovereign credit risk and did not benefit riskier bonds to a greater extent. In this extension, the stand-alone coefficient of the credit rating becomes slightly negative and significant, confirming that bonds with higher ratings generally have lower spreads. Rather than market-perceived risk, the PEPP's effectiveness was influenced, in line with previous findings, by the dynamics of a country's debt ratio.

Bond maturity also plays a significant role in determining the effectiveness of the PEPP. The combined impact of lagged PEPP purchases and bond maturity is negative and significant (Table 3.4, Column V). As indicated by this result, PEPP's effectiveness in reducing the spreads appears to be stronger for longer-maturity bonds. This finding is consistent with previous research, which suggests that central banks' asset purchases have a more substantial impact on longer-duration securities, due to their sensitivity to interest rates and risk premiums (Li and Wei, 2013; Altavilla et al., 2021). In terms of fiscal policy, the results remain essentially unchanged. Additionally, the stand-alone coefficient of the credit rating is also negative and significant, which reinforces that longer-maturity bonds are more sensitive to credit risk, as they are usually more vulnerable to changes in risk perceptions and central bank actions.

As the fiscal conditions, particularly the debt ratio dynamics, appear to have influenced PEPP's effectiveness, we extend our analysis to examine whether this impact varies based on bond eligibility status. The results of this extension (Table 3.4, Column VI) indicate that while the stand-alone eligibility term remains statistically significant, its interaction with lagged PEPP purchases is insignificant. This result supports the previous finding that eligibility status does not influence the PEPP's effectiveness in reducing sovereign spreads. However, the role of eligibility status in shaping PEPP's interaction with fiscal conditions is mixed. Although the PEPP's effectiveness remains influenced by debt ratio dynamics, the introduction of eligibility in this interaction makes the coefficient not significant, which suggests that the PEPP's response to rising debt levels did not depend on eligibility status. In contrast, the addition of eligibility status to the interaction between PEPP purchases and the variation in the net lending/borrowing ratio results in a positive and significant coefficient. This suggests that fiscal imbalances affected PEPP's impact primarily for eligible bonds, rather than as a broad response.

These conclusions suggest that the ECB's intervention has not eliminated perceptions of sovereign credit risk, particularly in the case of PEPP-eligible bonds.

Our earlier results suggest that the PEPP's impact was conditional on the fiscal conditions of countries where the debt stance was deteriorating. To analyse this relationship further, we now evaluate the model through an analysis based on the countries' debt-to-GDP ratios. More specifically, we classify the countries into two distinct groups based on their historical debt levels: (i) high-debt countries, which include Portugal, Spain, Italy, Greece, France, Belgium, and Cyprus; and (ii) low-debt countries, which include the rest of the sample.[26] As shown in column I of Table 3.5, the results suggest that the PEPP's impacts differ across countries with different levels of debt.

In high-debt countries, the coefficient on lagged PEPP purchases is positive and significant, suggesting that the programme did not reduce sovereign spreads but was instead associated with persistent risk perceptions. This suggests that in these countries, PEPP interventions did not fully compensate for the concerns about fiscal sustainability. These findings contrast with those of Corradin et al. (2021), who report that sovereign risk premia declined in vulnerable countries following the ECB monetary announcements. However, our results partially align with the conclusions of Fendel et al. (2021), which find that the spreads in high-debt countries decreased after policy announcements, primarily due to an increase in yields in fiscally stronger countries, rather than a decrease in their yields.

In the case of low-debt countries, contemporary PEPP purchases coincided with rising spreads, possibly indicating that the markets perceived them as a response to emerging risks rather than a stabilisation measure. This interpretation is consistent with Fendel et al. (2021), who argue that investors anticipated a greater fiscal burden for fiscally stronger countries, leading to a temporary increase in their risk premiums. However, in these countries, lagged PEPP purchases are negative and statistically significant, suggesting that the programme eventually led to a reduction in spreads. From this result, we can infer that PEPP's effectiveness was more substantial in markets with better fiscal fundamentals.

[26] We define high-debt countries as those with an average debt-to-GDP ratio exceeding 90% during the pre-pandemic period (2016-2019). See Afonso and Jalles (2013), who report different economic growth effects of debt above and below such a threshold.

Table 3.5. *Results of the Baseline and Extended Models: High- vs Low-Debt Countries*

	(I)		(II)		(III)		(IV)		(V)		(VI)	
	High-debt	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*
$PEPP_{it}$ (log)	-0.067	0.146**	-0.079	0.146**	-0.067	0.153**	-0.064	0.150**	-0.057	0.132**	-0.058	0.144**
	(0.130)	(0.049)	(0.127)	(0.048)	(0.130)	(0.053)	(0.132)	(0.050)	0.125	(0.056)	(0.130)	(0.052)
$PEPP_{it-1}$ (log)	0.249*	-0.085**	0.517	-0.194	0.249*	-0.129***	0.249*	-0.107***	0.233*	-0.056	0.252*	-0.129***
	(0.121)	(0.035)	(0.274)	(0.130)	(0.121)	(0.036)	(0.121)	(0.033)	(0.116)	(0.038)	(0.125)	(0.033)
$\Delta\, debt\, ratio_{it}$	0.027	-0.004	0.038	-0.015	0.027	0.005	0.026	-0.000	0.024	0.004	0.028*	0.001
	(0.016)	(0.018)	(0.021)	(0.024)	(0.015)	(0.021)	(0.016)	(0.019)	(0.015)	(0.015)	(0.013)	(0.020)
$\Delta\, net\ lend./Borr_{it}$	0.003	-0.062**	0.002	-0.059**	0.003	-0.069**	0.003	-0.065**	0.003	-0.054*	0.002	-0.062**
	(0.017)	(0.023)	(0.016)	(0.023)	(0.017)	(0.025)	(0.017)	(0.024)	(0.017)	(0.028)	(0.017)	(0.025)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	0.001	0.008***	-0.001	0.010***	0.001	0.006	0.001	0.007**	0.001	0.006	0.001	0.010*
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)	(0.005)
$(PEPP_{it-1}$ x Δ net. $lend/borr_{it})$	0.000	0.007*	0.000	0.007	0.000	0.008*	0.000	0.008*	0.000	0.006	-0.001	0.007*
	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.001)	(0.004)
$Eligibility_{it}$	0.314	0.536**	0.310	0.517**	0.320	0.347	0.316	0.531**	0.345	0.570**	0.317	0.336
	(0.277)	(0.214)	(0.274)	(0.226)	(0.267)	(0.238)	(0.278)	(0.212)	(0.253)	(0.228)	(0.267)	(0.229)
$Issue\ amount_{jt}$ (log)	0.009	-0.388***	0.011	-0.388***	0.009	-0.385***	0.006	-0.385***	0.008	-0.387***	0.020	-0.385***
	(0.076)	(0.094)	(0.075)	(0.094)	(0.076)	(0.095)	(0.078)	(0.094)	(0.076)	(0.093)	(0.082)	(0.093)
$Maturity_{jt}$ (years)	0.043**	0.018***	0.043**	0.018***	0.043**	0.018***	0.043**	0.018***	0.048**	0.027***	0.043**	0.017***
	(0.016)	(0.005)	(0.016)	(0.005)	(0.016)	(0.005)	(0.016)	(0.005)	(0.013)	(0.005)	(0.016)	(0.005)
$Credit\ Rating_{jt}$	-0.009	-0.011	-0.008	-0.010	-0.008	-0.010	-0.011	-0.014	-0.010	-0.012	-0.008	-0.009
	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
$Issuer\ Type_{it}$	-0.270	0.433**	-0.270	0.432**	-0.271	0.438**	-0.267	0.432**	-0.258	0.444**	-0.284	0.416**
	(0.240)	(0.164)	(0.239)	(0.164)	(0.242)	(0.168)	(0.245)	(0.167)	(0.218)	(0.165)	(0.235)	(0.175)
$GDP\ growth_{it}$	0.008	0.015	0.005	0.017	0.008	0.015	0.008	0.014	0.007	0.018	0.008	0.018
	(0.017)	(0.014)	(0.019)	(0.012)	(0.017)	(0.013)	(0.017)	(0.014)	(0.018)	(0.011)	(0.018)	(0.011)
$Inflation_{it}$	-0.041	0.013	-0.060	0.004	-0.040	0.041**	-0.043	0.025	-0.036	0.012	-0.039	0.050***
	(0.045)	(0.017)	(0.043)	(0.025)	(0.045)	0.015	(0.044)	(0.018)	(0.045)	(0.014)	(0.047)	(0.013)
$Unemployment_{it}$	0.024	-0.076	0.025	-0.103	0.024	-0.105	0.022	-0.092	0.033	-0.034	0.033	-0.129*
	(0.076)	(0.059)	(0.079)	(0.081)	(0.076)	(0.063)	(0.078)	(0.064)	(0.076)	(0.057)	(0.081)	(0.063)
ESI_{it}	-0.009	0.003	-0.009	0.002	-0.009	0.002	-0.009	0.003	-0.008	0.004	-0.008	0.004
	(0.008)	(0.010)	(0.008)	(0.009)	(0.008)	(0.010)	(0.008)	(0.010)	(0.009)	(0.011)	(0.009)	(0.010)
$US\ Treasury_{t}$	0.066	0.150	0.057	0.141	0.066	0.138	0.077	0.149	0.060	0.116	0.061	0.140
	(0.198)	(0.089)	(0.194)	(0.084)	(0.199)	(0.100)	(0.210)	(0.092)	(0.197)	(0.094)	(0.204)	(0.103)
$(PEPP_{it-1}$ x $Time\ trend_{t})$			-0.020	0.009								
			(0.017)	(0.010)								
$(PEPP_{it-1}$ x $Eligibility_{it})$					-0.001	0.031***					-0.003	0.035***
					(0.009)	(0.008)					(0.009)	(0.010)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$							0.000	0.001*				
							(0.001)	(0.000)				
$(PEPP_{it-1}$ x $Maturity_{jt})$									-0.001	-0.001***		
									(0.001)	(0.000)		
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it}$)											0.001	-0.005
											(0.001)	(0.006)
$(PEPP_{it-1}$ x $Elig._{jt}$ x Δ net. $lend/borr_{it})$											0.005	0.001
											(0.003)	(0.002)
Constant	-1.483	0.901	-1.522	1.201	-1.482	1.304	-1.484	1.113	-1.688	0.585	-1.903	1.189
	(1.445)	(1.376)	(1.506)	(1.283)	(1.439)	(1.398)	(1.453)	(1.387)	(1.386)	(1.526)	(1.674)	(1.466)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	823	544	823	544	823	544	823	544	823	544	823	544
R^2	0.4597	0.3757	0.4606	0.3764	0.4597	0.3806	0.4600	0.3764	0.4614	0.3920	0.4637	0.3837
Within R^2	0.3980	0.2494	0.3989	0.2501	0.3980	0.2553	0.3983	0.2502	0.3998	0.2689	0.4024	0.2590

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Countries are classified by historical debt levels: high-debt (Portugal, Spain, Italy, Greece, France, Belgium and Cyprus) and low-debt (all others). Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

In countries with high debt levels, the interaction between lagged PEPP purchases and changes in the debt-to-GDP ratio is not statistically significant. This implies that the PEPP's impact was not affected by changes in the debt ratio. It suggests that in these countries, the markets had probably already incorporated fiscal risks due to their historically high debt. Consequently, the PEPP seems to act more as a stabilising force rather than a reactive measure to fiscal changes. Similarly, the interaction between lagged PEPP purchases and variations in the net lending/borrowing ratio is also insignificant, reinforcing the notion that fiscal balance variations did significantly influence PEPP's effectiveness in these economies.

In contrast, our results indicate that the PEPP's interaction with fiscal indicators becomes significant in low-debt countries, suggesting that fiscal conditions were essential for PEPP's effectiveness. The positive and significant coefficient of the interaction between lagged PEPP purchases and changes in the debt-to-GDP ratio indicates that PEPP's ability to lower spreads decreased as debt levels increased. Furthermore, there is a positive and significant interaction between lagged PEPP purchases and changes in the net lending/borrowing ratio, which demonstrates that the PEPP's effectiveness decreased as fiscal imbalances occurred.

Regarding the other factors that influence sovereign spreads, the eligibility term is positive for both subsamples but is only significant in the low-debt countries. This suggests that eligible bonds were initially seen as riskier assets, indicating that the PEPP did not immediately reduce risk perceptions in these bonds. For high debt, the lack of significance of the eligibility status may be related to the fact that markets already consider concerns about fiscal sustainability and do not make a clear distinction between eligible and ineligible bonds in these countries. Furthermore, both subsamples indicate that maturity remains positively significant, suggesting that longer-term bonds usually have higher spreads due to their increased susceptibility to market volatility. Ultimately, the central government dummy coefficient is positive but not statistically significant in high-debt countries, whereas it is negative and statistically significant in low-debt countries. These results suggest that the market does not clearly distinguish between central and subnational issuers when fiscal sustainability concerns are already notable. In contrast, central government bonds are perceived as safer than subnational ones in low-debt countries, which may reflect the stronger fiscal credibility of central governments in fiscally sound economies.

For both subsamples, we applied the same model extensions as in the full sample analysis. Columns II to VI of Table 3.5 present the corresponding results. The first important finding is the role of eligibility (Table 3.5, Column III). In high-debt countries, neither the eligibility term nor its interaction with PEPP purchases is statistically significant.

This suggests that the distinction between eligible and non-eligible bonds was not a major driver of spreads in these countries. Additionally, the fiscal indicators and their interactions with lagged PEPP purchases are not statistically significant for the high-debt countries. However, in low-debt countries, the results present a different picture. While the eligibility status term remains not statistically significant, the interaction of lagged PEPP purchases with eligibility becomes statistically significant, a different result from the full sample analysis. This suggests that PEPP purchases had a distinct impact on eligible bonds in fiscally more robust economies and may have reflected market responses to the ECB's interventions in lower-risk sovereigns. The positive coefficient indicates that PEPP's effectiveness in reducing spreads may have been weaker for these bonds, possibly because markets interpreted the purchases as a reaction to emerging risks rather than a direct stabilising measure.

Concerning bond credit ratings (Table 3.5, Column IV), the positive and significant interaction between lagged PEPP purchases and credit rating in low-debt countries suggests that the programme was more effective for higher-rated bonds. This implies that markets in fiscally solid countries are more responsive when credit quality is strong. In contrast, in high-debt countries, the interaction term remains positive but statistically insignificant, indicating that differences in bond ratings did not significantly impact PEPP’s effectiveness. This reinforces the idea that fiscal sustainability concerns were the primary market focus, limiting the differentiation based on creditworthiness.

Regarding bond maturity (Table 3.5, Column V), in high-debt countries, the coefficient of the interaction between lagged PEPP purchases and maturity remains negative and statistically insignificant. This suggests that PEPP’s effectiveness does not show a differentiated impact across maturities. However, the stand-alone maturity term remains positive and significant, reinforcing that longer-term bonds have higher spreads in these economies, likely due to a higher perception of fiscal uncertainty. In low-debt countries, the results indicate that while longer-term bonds generally have higher spreads, the PEPP intervention was more effective in reducing their spreads, as evidenced by the negative and significant interaction term.

Including triple interactions in the segmented sample offers additional insights (Table 3.5, Column VI). In countries with high debt, both triple interactions are statistically insignificant, indicating that eligibility did not consistently change PEPP's effectiveness in these countries. Similarly, the interactions between lagged PEPP and variations in debt and net lending/borrowing ratios are also insignificant, as is the direct interaction between the PEPP and eligibility status. These results suggest that in high-debt countries, sovereign spreads were less influenced by PEPP interventions and were primarily driven by broader concerns about fiscal sustainability. Conversely, in low-debt countries, the triple interactions also show no significance, reinforcing that eligibility did not significantly influence PEPP's response to fiscal conditions. Even in stronger fiscal countries, eligible bonds are still perceived by markets as riskier assets, with a positive and statistically significant interaction between lagged PEPP purchases and eligibility. This result supports the view that the PEPP did not immediately eliminate the risk perception associated with eligible bonds. Another important observation for low-debt countries is that the interaction between lagged PEPP purchases and changes in both the debt-to-GDP ratio and the net lending/borrowing ratio becomes positive and statistically significant. This indicates that PEPP's effectiveness in reducing bond spreads decreases as fiscal conditions worsen. Even in fiscally solid countries, markets appear to interpret fiscal deterioration as a warning indicator, thus weakening the ability of PEPP purchases to reduce spreads.

3.5.3. Robustness checks

In this section, we assess the robustness of our findings by examining alternative model specifications. An initial check was the inclusion of the Volatility Index (VIX) to account for global uncertainty. However, it was excluded due to collinearity, which suggests that the model's controls already account for the major drivers of sovereign spreads and capture key sources of endogeneity.

To confirm that our conclusions are not sensitive to the selection of a spread metric, we replaced the ASW with the OAS in the regression. The results (Table 3.6 and Table 3.7) are broadly stable, with the response to the PEPP being stronger in economies with a low debt ratio and weaker in countries with a high debt level, corroborating that the effect of the programme was conditional on fiscal conditions. However, certain linkages that are statistically significant under OAS are not so in the case of ASW,

probably because OAS captures additional liquidity effects, while ASW reflect fundamentally credit risk. The results about eligibility effects and PEPP's dependence on fiscal policy are robust as well, reinforcing our main conclusions.

Additionally, we re-estimate the model by replacing the variation in the net lending/borrowing ratio with the variation in the primary balance-to-GDP ratio, while maintaining variation in the debt ratio. This robustness check (Table A3.5.1 and Table A3.5.2) ensures that our results are not sensitive to the choice of fiscal measures and confirms that PEPP's effectiveness is not solely driven by interest payments on existing debt but also reflects active fiscal policy decisions. In all specifications, the conclusions remain consistent, confirming that the PEPP's effectiveness was mainly influenced by fiscal conditions before interest payments, rather than by overall fiscal deficits. Furthermore, the analysis comparing high- and low-debt countries reveals that the relationship holds in both groups, reinforcing the role of fiscal fundamentals in determining the impact of the PEPP interventions on sovereign bond spreads.

To ensure that our results are not influenced just by the extraordinary market conditions of 2020, the peak of the pandemic, we re-evaluate the model by dropping this year in a robustness check. The findings (Table A3.6.1 and Table A3.6.2) are broadly consistent with our baseline analysis, which confirms that PEPP's effects over sovereign spreads were not simply a temporary reaction to the initial crisis. Although there are some changes in the magnitude and sign of some fiscal interactions' terms, the overall structure of the relationships remains intact. This implies that PEPP's effectiveness was conditional on fiscal conditions during the pandemic, and not just on the emergency phase of the crisis. The distinction between high-debt and low-debt countries remains, reinforcing the conclusion that market perceptions about fiscal sustainability played a central role in shaping PEPP's impact.

Table 3.6. *Robustness Check: Baseline and Extended Models Using ASW Spreads*

	(I)	(II)	(III)	(IV)	(V)	(VI)
$PEPP_{it}$ (log)	0.065	0.066	0.065	0.065	0.066	0.066
	(0.058)	(0.061)	(0.060)	(0.060)	(0.058)	(0.059)
$PEPP_{it-1}$ (log)	0.007	-0.020	0.012	0.014	0.008	0.013
	(0.045)	(0.098)	(0.044)	(0.044)	(0.043)	(0.046)
$\Delta\, debt\, ratio_{it}$	0.017	0.016	0.018	0.019	0.016	0.016
	(0.011)	(0.010)	(0.012)	(0.012)	(0.011)	(0.011)
$\Delta\, net\ lend./Borr_{it}$	-0.019	-0.019	-0.019	-0.019	-0.018	-0.019
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	0.003**	0.003**	0.003***	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	0.001
$(PEPP_{it-1}$ x Δ net. $lend/borr_{it})$	0.002	0.002	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Eligibility_{it}$	0.352*	0.351*	0.384*	0.347*	0.370*	0.382*
	(0.194)	(0.194)	(0.216)	(0.193)	(0.182)	(0.217)
$Issue\ amount_{jt}$ (log)	-0.084	-0.084	-0.083	-0.084	-0.083	-0.081
	(0.090)	(0.090)	(0.090)	(0.090)	(0.090)	(0.091)
$Maturity_{jt}$ (years)	0.019***	0.019***	0.019***	0.019***	0.022***	0.019***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
$Credit\ Rating_{jt}$	-0.012*	-0.012*	-0.012*	-0.010	-0.013**	-0.012*
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
$Issuer\ Type_{it}$	-0.111	-0.111	-0.111	-0.109	-0.107	-0.117
	(0.233)	(0.233)	(0.234)	(0.234)	(0.229)	(0.235)
$GDP\ growth_{it}$	0.011	0.012	0.011	0.011	0.011	0.013
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
$Inflation_{it}$	-0.039	-0.038	-0.039*	-0.038*	-0.035	-0.039*
	(0.022)	(0.022)	(0.021)	(0.021)	(0.024)	(0.021)
$Unemployment_{it}$	-0.044	-0.045	-0.037	-0.033	-0.039	-0.028
	(0.040)	(0.041)	(0.040)	(0.039)	(0.040)	(0.043)
ESI_{it}	-0.010*	-0.010*	-0.010*	-0.009*	-0.009*	-0.008*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$US\ Treasury_{t}$	-0.111	-0.111	-0.112	-0.117	-0.122	-0.108
	(0.233)	(0.123)	(0.122)	(0.120)	(0.128)	(0.122)
$(PEPP_{it-1}$ x $Time\ trend_{t})$		0.002				
		(0.005)				
$(PEPP_{it-1}$ x $Eligibility_{it})$			-0.007			-0.006
			(0.006)			(0.006)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$				-0.000*		
				(0.000)		
$(PEPP_{it-1}$ x $Maturity_{jt})$					-0.000	
					(0.000)	
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it}$)						-0.001
						(0.001)
$(PEPP_{it-1}$ x $Elig._{jt}$ x Δ net. $lend/borr_{it})$						0.001
						(0.001)
Constant	2.874***	2.881***	2.779***	2.726***	2.761***	2.552***
	(0.742)	(0.744)	(0.749)	(0.742)	(0.768)	(0.814)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	1,367	1,367	1,367	1,367	1,367	1,367
R^2	0.3907	0.3907	0.3911	0.3913	0.3917	0.3924
Within R^2	0.1445	0.1445	0.1451	0.1453	0.1459	0.1469

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table 3.7. *Robustness Check: Results of the Baseline Model and Its Extensions by High- vs Low-Debt Countries Using ASW as the Spread Measure*

	(I)		(II)		(III)		(IV)		(V)		(VI)	
	High-debt	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*
$PEPP_{it}$ (log)	-0.097	0.092	-0.105	0.092	-0.098	0.094	-0.097	0.090	-0.091	0.087	-0.090	0.096
	(0.090)	(0.072)	(0.091)	(0.072)	(0.089)	(0.072)	(0.089)	(0.070)	0.088	(0.075)	(0.087)	(0.074)
$PEPP_{it-1}$ (log)	0.229*	-0.057	0.415	-0.124	0.229*	-0.067	0.229*	-0.045	0.219*	-0.046	0.232*	-0.068*
	(0.108)	(0.039)	(0.251)	(0.108)	(0.106)	(0.037)	(0.108)	(0.037)	(0.105)	(0.039)	(0.108)	(0.037)
$\Delta\, debt\, ratio_{it}$	0.014	0.001	0.021	-0.006	0.014	0.003	0.014	-0.001	0.012	0.004	0.015	0.004
	(0.015)	(0.025)	(0.018)	(0.025)	(0.015)	(0.026)	(0.015)	(0.024)	(0.015)	(0.027)	(0.014)	(0.027)
$\Delta\, net\ lend./Borr_{it}$	-0.028	-0.020	-0.028	-0.019	-0.028	-0.022	-0.028	-0.019	-0.027	-0.017	-0.028	-0.024
	(0.016)	(0.023)	(0.017)	(0.023)	(0.015)	(0.023)	(0.016)	(0.023)	(0.015)	(0.025)	(0.016)	(0.024)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	0.002	0.007*	0.000	0.008*	0.002	0.006	0.002	0.007*	0.002	0.006	0.001	0.006
	(0.001)	(0.004)	(0.002)	(0.005)	(0.001)	(0.004)	(0.001)	(0.004)	(0.002)	(0.004)	(0.001)	(0.005)
$(PEPP_{it-1}$ x $\Delta\, net.\, lend/borr_{it})$	0.001	0.004	0.002	0.004	0.001	0.004	0.001	0.004	0.002	0.004	0.001	0.005
	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
$Eligibility_{it}$	0.170	0.576**	0.168	0.564**	0.214	0.532*	0.170	0.578**	0.190	0.588**	0.212	0.536*
	(0.199)	(0.245)	(0.198)	(0.251)	(0.227)	(0.274)	(0.198)	(0.248)	(0.187)	(0.243)	(0.229)	(0.278)
$Issue\ amount_{jt}$ (log)	0.022	-0.219	0.023	-0.219	0.025*	-0.218	0.022	-0.220	0.021	-0.219	0.034	-0.218
	(0.036)	(0.137)	(0.036)	(0.137)	(0.013)	(0.137)	(0.035)	(0.137)	(0.036)	(0.138)	(0.039)	(0.138)
$Maturity_{jt}$ (years)	0.025*	0.015*	0.025*	0.015*	0.025*	0.015*	0.025*	0.015*	0.028*	0.018***	0.025*	0.015*
	(0.013)	(0.007)	(0.013)	(0.007)	(0.013)	(0.007)	(0.013)	(0.007)	(0.011)	(0.006)	(0.013)	(0.007)
$Credit\ Rating_{jt}$	-0.009	-0.020	-0.009	-0.020	-0.009	-0.020	-0.008	-0.018	-0.010	-0.021	-0.008	-0.021
	(0.009)	(0.014)	(0.009)	(0.014)	(0.008)	(0.014)	(0.007)	(0.014)	(0.008)	(0.014)	(0.009)	(0.014)
$Issuer\ Type_{it}$	-0.452**	0.320	-0.452**	0.319	-0.457***	0.321	-0.452***	0.320	-0.444***	0.324	-0.463***	0.328
	(0.123)	(0.306)	(0.122)	(0.305)	(0.120)	(0.307)	(0.121)	(0.305)	(0.112)	(0.309)	(0.124)	(0.305)
$GDP\ growth_{it}$	-0.001	0.018**	-0.003	0.020**	-0.001	0.019**	-0.001	0.019**	-0.001	0.020**	-0.003	0.018*
	(0.013)	(0.007)	(0.014)	(0.008)	(0.013)	(0.007)	(0.014)	(0.007)	(0.014)	(0.007)	(0.014)	(0.008)
$Inflation_{it}$	0.011	-0.009	-0.002	-0.015	0.014	-0.003	0.012	-0.015	0.014	-0.010	0.011	-0.004
	(0.050)	(0.016)	(0.050)	(0.015)	(0.050)	0.013	(0.050)	(0.015)	(0.050)	(0.015)	(0.050)	(0.016)
$Unemployment_{it}$	0.003	-0.062	0.004	-0.079	0.005	-0.069	0.004	-0.054	0.009	-0.047	0.015	-0.064
	(0.081)	(0.059)	(0.083)	(0.076)	(0.079)	(0.056)	(0.081)	(0.052)	(0.081)	(0.059)	(0.085)	(0.056)
ESI_{it}	-0.010*	-0.002	-0.010*	-0.003	-0.011*	-0.002	-0.010*	-0.002	-0.009	-0.002	-0.009	-0.003
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.007)	(0.005)	(0.007)
$US\ Treasury_{t}$	-0.241	-0.072	-0.247	-0.077	-0.247	-0.075	-0.243	-0.071	-0.245	-0.084	-0.237	-0.075
	(0.167)	(0.057)	(0.165)	(0.052)	(0.163)	(0.059)	(0.161)	(0.058)	(0.165)	(0.058)	(0.169)	(0.060)
$(PEPP_{it-1}$ x $Time\ trend_{t})$			-0.014	0.005								
			(0.015)	(0.007)								
$(PEPP_{it-1}$ x $Eligibility_{it})$					-0.010	0.007					-0.008	0.007
					(0.009)	(0.008)					(0.007)	(0.011)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$							-0.000	-0.000				
							(0.000)	(0.000)				
$(PEPP_{it-1}$ x $Maturity_{jt})$									-0.000	-0.001		
									(0.000)	(0.000)		
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it})$											-0.001	0.001
											(0.001)	(0.005)
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, net.\, lend/borr_{it})$											0.002	-0.001
											(0.002)	(0.002)
Constant	1.865	2.899**	1.838	3.083**	1.872	2.992**	1.865	2.787**	1.737	2.782*	1.445	3.044**
	(1.183)	(1.259)	(1.227)	(1.360)	(1.152)	(1.213)	(1.180)	(1.236)	(1.137)	(1.249)	(1.266)	(1.194)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	823	544	823	544	823	544	823	544	823	544	823	544
R^2	0.5110	0.2396	0.5117	0.2398	0.5118	0.2398	0.5110	0.2397	0.5121	0.2410	0.5165	0.2400
Within R^2	0.3349	0.0727	0.3359	0.0729	0.3361	0.0729	0.3349	0.0728	0.3365	0.0744	0.3425	0.0731

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Countries are classified by historical debt levels: high-debt (Portugal, Spain, Italy, Greece, France, Belgium and Cyprus) and low-debt (all others). Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

3.6. Conclusion

This study analyses the impact of the PEPP on Eurozone sovereign bond spreads by considering the role of a country's fiscal stance. We employ a cross-sectional regression model with country and time fixed effects to examine 1,368 euro-denominated sovereign bonds issued by 19 Eurozone countries between Q1:2018 and Q1:2022. We found that the PEPP's impact on sovereign spreads was not uniform, and it depended on country-specific fiscal conditions. In our base model analysis, we observed that fiscal fundamentals, specifically debt ratio dynamics, were key to determining the effectiveness of PEPP. In countries with rising debt-to-GDP ratios, PEPP's purchases are accompanied by an increase in spreads, indicating that concerns about fiscal sustainability have prevailed over the effects of the programme. The results also show that the markets were more reactive to debt accumulation than to short-term fiscal balances, implying that structural debt was a primary concern for the market. The results of the base model also showed that eligibility did not influence PEPP's effectiveness and that there was no evidence that PEPP favoured lower-rated or riskier bonds. We found a stronger effect of the PEPP on longer-term bonds, which are more sensitive to risk and policy signals.

For a more detailed analysis, we divided the sample between countries with historical high and low levels of debt. In high-debt countries, PEPP purchases did not reduce spreads and were associated with persistent risk perceptions. For these countries, the results suggest that markets were already pricing in fiscal risks, and the PEPP had a limited marginal impact. However, the results for low-debt countries suggest that the PEPP was more effective, resulting in a reduction of the spread. This implies that the programme was more effective in fiscally sound economies. However, as debt and deficits rose, the effectiveness of PEPP was weakened, suggesting that rising fiscal imbalances remained a concern even in lower-risk markets. For eligible bonds, PEPP's effectiveness in reducing bond spreads appears to be weaker in countries with more robust fiscal positions, likely because markets perceive purchases as a reaction to emerging risks rather than a direct stabilising measure. Furthermore, the results indicate that PEPP's effectiveness was stronger for higher-rated bonds and those with longer maturities in countries with low debt levels. Finally, the distinction between central and subnational issuers only appears relevant in fiscally strong countries, where central government bonds are perceived as safer.

Our findings indicate that the PEPP effects were not uniform but directly linked to the country's fiscal credibility. Despite the exceptional context of a pandemic and the unprecedented ECB intervention, these results highlight the importance of the countries' fiscal fundamentals in the effectiveness of unconventional monetary policies designed to stabilise sovereign bond markets. These findings add to the broader literature on the interactions of monetary and fiscal policy. They indicate that, in determining the success of unconventional monetary interventions, the credibility of fiscal policy is a crucial factor in assessing their effectiveness. Future research could explore the mechanisms behind these differentiated effects and assess their persistence beyond the crisis period.

3.7. References

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3.8. Appendix

Table A3.1. *Breakdown of the sample by country*

Country	Nr. Bonds	Issued Amount (€ Mn)
France	368	829 398,4
Germany	317	828 295,9
Belgium	276	176 236,8
Spain	88	595 814,8
Netherlands	76	175 545,3
Italy	48	788 020,5
Austria	38	131 134,5
Ireland	30	83 443,9
Malta	24	3 097,4
Portugal	22	89 188,2
Finland	14	56 386,0
Lithuania	14	8 952,0
Greece	12	49 688,6
Slovenia	10	15 207,5
Cyprus	9	9 600,0
Slovakia	9	24 286,0
Latvia	7	5 287,3
Luxembourg	5	8 200,0
Estonia	1	1 500,0
Total	**1 368**	**3 879 283,0**

Table A3.2. *Description of the model's variables*

Variable	Definition	Source data
$Spread_{ij}$	The bond's Option-Adjusted Spread (OAS) at issuance, which represents the difference between its yield and the reference risk-free rate, adjusted for the value of any embedded options	Bloomberg
$PEPP_{it}$	The natural logarithm of the quarterly net purchase amounts under the ECB's PEPP	European Central Bank (ECB)
$Eligibility_{it}$	Binary variable indicating whether the bond meets the ECB's criteria for PEPP eligibility (1 = eligible, 0 = not eligible based on rating)	European Central Bank (ECB)
Fiscal stance variables $(\Delta\, Fiscal_{it})$		
$\Delta\, debt - to - GDP\ ratio_{it}$	The change in the ratio of debt-to-GDP ratio from one quarter to the next. The ratio itself represents the government's consolidated gross debt as a percentage of GDP	Eurostat
$\Delta\, net\ lending/borrowing_{it}$	The change in the ratio of general government net lending (+) or net borrowing (-) to GDP (seasonally adjusted data, with exception of Italy's data) from one quarter to the next	Eurostat
Control Variables (λX_{ijt})		
Bonds features		
$Issue\ amount_{jt}$	The natural logarithm of the bond's issued amount	Bloomberg
$Maturity_{jt}$	Bond's initial maturity period (in years)	Bloomberg
$Credit\ Rating_{jt}$		
$Rated_{jt}$	Binary variable indicating whether the bond has a credit rating at issuance (1 = rated, 0 = not rated)	Bloomberg
$Rating_{jt}$	A numerical score assigned to the bond based on its credit quality, with higher values indicating better creditworthiness	Bloomberg
Domestic economic factors		
$GDP\ growth_{it}$	Quarterly YoY GDP growth rate at market prices of the bond's issuing country (seasonally adjusted)	Eurostat. The author's calculation of YoY growth rate
$Inflation_{it}$	Quarterly YoY percentage change in the Harmonised Index of Consumer Prices (HICP) of the bond's issuing country	Eurostat
$Unemployment_{it}$	Quarterly unemployment rate of the bond's issuing country (seasonally adjusted data)	Eurostat
Eurozone-specific factors		
ESI_{it}	End-of-quarter Economic Sentiment Indicator (ESI) of the bond's issuing country (seasonally adjusted data)	Eurostat
Global financial markets factors		
$US\ Treasury_{t}$	The market yield on U.S. Treasury securities with a 10-year constant maturity (not seasonally adjusted) on the bond's issue date	Federal Reserve Bank of St. Louis Data (FRED)

Table A3.3. *Summary statistics*

Variables	Obs.	Mean	Median	Std.Dev.	Min.	Max.
$Spread_{ij}$ (OAS in %)	1 368	-0.525	-0.555	0.863	-2.402	3.507
$PEPP_{it}$ (natural logarithm)	886	4.154	4.467	0.655	1.38	4.783
$\Delta\, debt - to - GDP\ ratio_{it}$ (%)	1 368	0.938	-0.2	3.571	-5.4	15.9
$\Delta\, net\ lending/borrowing_{it}$ (%)	1 368	-0.777	0.0	3.944	-30.5	13.7
$Issue\ amount_{jt}$ (natural logarithm)	1 368	8.183	7.903	1.086	5.326	10.793
$Maturity_{jt}$ (in years)	1 368	18.39	13.0	15.767	3.0	100.0
$Rating_{jt}$ (numerical score)	682	19.279 (AA-)	20.0 (AA)	2.953	7.0 (B-)	22.0 (AAA)
$GDP\ growth_{it}$ (%)	1 368	2.665	3.215	7.193	-20.71	23.427
$Inflation_{it}$ (%)	1 368	1.741	1.4	2.001	-2.2	11.7
$Unemployment_{it}$ (%)	1 368	6.648	6.2	3.112	2.9	20.5
ESI_{it} (Index)	1 368	100.774	102.1	10.973	64.1	123.6
$US\ Treasury_t$ (%)	1 368	1.658	1.59	0.783	0.52	3.22

Table A3.4. *Average Credit Ratings for Central and Subnational Government Bonds by Country*

Country	Nr. Rated Bonds	Central Government	Subnational Government
Austria	36	AA+	AA+
Belgium	104	AA-	AA-
Cyprus	9	BB+	-
Estonia	1	AA-	-
Finland	10	AA+	-
France	46	AA	AA
Germany	303	AAA	AAA
Greece	11	BB-	-
Ireland	26	A+	-
Italy	14	BBB-	-
Lithuania	14	A	-
Luxembourg	5	AAA	-
Latvia	7	A-	-
Malta	24	A+	-
Spain	43	BBB+	A-
Portugal	10	BBB	BBB-
Slovenia	10	A	-
Slovakia	9	A	-
Total	682	A	AA-

This table reports the average of the available credit ratings for the rated sovereign bonds, by issuer type (central vs. subnational government) and country.

Table A3.5.1. *Robustness Check: Baseline and Extended Models Using the Variation in the Primary Balance-to-GDP*

	(I)	(II)	(III)	(IV)	(V)	(VI)
$PEPP_{it}$ (log)	0.039	0.043	0.038	0.039	0.041	0.042
	(0.051)	(0.052)	(0.050)	(0.050)	(0.049)	(0.049)
$PEPP_{it-1}$ (log)	0.060	-0.031	0.055	0.056	0.062	0.053
	(0.050)	(0.122)	(0.054)	(0.053)	(0.046)	(0.054)
$\Delta\, debt\, ratio_{it}$	0.010	0.007	0.009	0.009	0.008	0.005
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)	(0.014)
$\Delta\, net\ lend./Borr_{it}$	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	0.005**	0.006***	0.005**	0.005**	0.005**	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	0.002
$(PEPP_{it-1}$ x $\Delta\, primary\ balance_{it})$	0.001	0.001	0.001	0.001	0.001	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
$Eligibility_{it}$	0.474*	0.471*	0.438*	0.476*	0.511**	0.434*
	(0.239)	(0.238)	(0.246)	(0.239)	(0.221)	(0.249)
$Issue\ amount_{jt}$ (log)	-0.161	-0.161	-0.161	-0.161	-0.159	-0.158
	(0.151)	(0.151)	(0.151)	(0.151)	(0.151)	(0.152)
$Maturity_{jt}$ (years)	0.030***	0.030***	0.031***	0.031***	0.036***	0.030***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
$Credit\ Rating_{jt}$	-0.007	-0.007	-0.008	-0.009*	-0.009*	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Issuer\ Type_{it}$	0.032	0.032	0.032	0.031	0.042	0.022
	(0.298)	(0.298)	(0.298)	(0.298)	(0.289)	(0.297)
$GDP\ growth_{it}$	0.007	0.009	0.007	0.007	0.006	0.011
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
$Inflation_{it}$	-0.049**	-0.048**	-0.049*	-0.050*	-0.042*	-0.049*
	(0.023)	(0.023)	(0.024)	(0.024)	(0.021)	(0.025)
$Unemployment_{it}$	-0.035	-0.038	-0.042	-0.041	-0.022	-0.026
	(0.041)	(0.042)	(0.046)	(0.044)	(0.039)	(0.049)
ESI_{it}	-0.010	-0.010	-0.010	-0.010	-0.009	-0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$US\ Treasury_{t}$	0.176	0.176	0.176	0.179	0.154	0.177
	(0.142)	(0.142)	(0.144)	(0.143)	(0.150)	(0.144)
$(PEPP_{it-1}$ x $Time\ trend_{t})$		0.007				
		(0.007)				
$(PEPP_{it-1}$ x $Eligibility_{it})$			0.008			0.008
			(0.007)			(0.008)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$				0.000		
				(0.000)		
$(PEPP_{it-1}$ x $Maturity_{jt})$					-0.001*	
					(0.000)	
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it})$						-0.000
						(0.002)
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, primary\ balance_{it})$						0.003*
						(0.002)
Constant	0.473	0.493	0.578	0.559	0.235	0.210
	(1.488)	(1.493)	(1.596)	(1.590)	(1.523)	(1.590)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	1,367	1,367	1,367	1,367	1,367	1,367
R^2	0.4399	0.4402	0.4403	0.4401	0.4437	0.4435
Within R^2	0.2803	0.2807	0.2809	0.2806	0.2852	0.2849

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A3.5.2. *Robustness check: Baseline and Extended Models (High vs. Low-debt Countries) Using the Variation in the Primary Balance-to-GDP Ratio*

	(I)		(II)		(III)		(IV)		(V)		(VI)	
	High-debt	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*
$PEPP_{it}$ (log)	-0.060	0.152**	-0.073	0.152**	-0.060	0.159**	-0.058	0.156**	-0.050	0.137**	-0.051	0.151**
	(0.133)	(0.051)	(0.132)	(0.050)	(0.134)	(0.055)	(0.136)	(0.052)	(0.128)	(0.058)	(0.133)	(0.054)
$PEPP_{it-1}$ (log)	0.247*	-0.090**	0.521	-0.200	0.247*	-0.136***	0.247*	-0.114***	0.230	-0.060	0.249	-0.135***
	(0.126)	(0.038)	(0.283)	(0.129)	(0.126)	(0.039)	(0.125)	(0.036)	(0.120)	(0.040)	(0.131)	(0.035)
$\Delta\, debt\, ratio_{it}$	0.026	-0.005	0.038	-0.016	0.026	0.004	0.025	-0.001	0.023	0.003	0.028*	-0.000
	(0.016)	(0.017)	(0.021)	(0.023)	(0.016)	(0.020)	(0.016)	(0.019)	(0.015)	(0.015)	(0.014)	(0.019)
$\Delta\, net\ lend./Borr_{it}$	0.005	-0.068**	0.004	-0.066**	0.005	-0.076**	0.005	-0.072**	0.005	-0.058*	0.004	-0.069**
	(0.017)	(0.025)	(0.017)	(0.025)	(0.017)	(0.027)	(0.017)	(0.025)	(0.018)	(0.030)	(0.017)	(0.026)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	0.001	0.008***	-0.001	0.011***	0.001	0.006	0.001	0.007**	0.001	0.006	0.000	0.010*
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)	(0.005)
$(PEPP_{it-1}$ x $\Delta\, primary\ balance_{it})$	0.000	0.008*	0.001	0.008*	0.000	0.009*	0.000	0.008*	0.000	0.007	-0.001	0.008*
	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.005)	(0.002)	(0.004)
$Eligibility_{it}$	0.313	0.535**	0.309	0.516**	0.319	0.343	0.315	0.530**	0.345	0.570**	0.317	0.333
	(0.277)	(0.214)	(0.275)	(0.226)	(0.267)	(0.238)	(0.279)	(0.212)	(0.253)	(0.228)	(0.268)	(0.229)
$Issue\ amount_{jt}$ (log)	0.008	-0.388***	0.010	-0.388***	0.008	-0.386***	0.005	-0.385***	0.007	-0.387***	0.019	-0.385***
	(0.075)	(0.093)	(0.074)	(0.093)	(0.075)	(0.094)	(0.077)	(0.094)	(0.075)	(0.093)	(0.081)	(0.093)
$Maturity_{jt}$ (years)	0.043**	0.018***	0.043**	0.018***	0.043**	0.018***	0.043**	0.018***	0.048**	0.026***	0.043**	0.017***
	(0.016)	(0.005)	(0.016)	(0.005)	(0.016)	(0.005)	(0.016)	(0.005)	(0.013)	(0.005)	(0.016)	(0.005)
$Credit\ Rating_{jt}$	-0.008	-0.011	-0.008	-0.010	-0.008	-0.010	-0.011	-0.015	-0.010	-0.012	-0.008	-0.009
	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
$Issuer\ Type_{it}$	-0.268	0.433***	-0.269	0.433**	-0.269	0.438**	-0.265	0.433**	-0.255	0.444**	-0.283	0.416**
	(0.238)	(0.164)	(0.236)	(0.164)	(0.240)	(0.168)	(0.242)	(0.166)	(0.216)	(0.165)	(0.233)	(0.175)
$GDP\ growth_{it}$	0.008	0.014	0.005	0.017	0.008	0.015	0.008	0.014	0.007	0.017	0.008	0.018
	(0.017)	(0.013)	(0.019)	(0.012)	(0.017)	(0.013)	(0.017)	(0.013)	(0.017)	(0.011)	(0.018)	(0.011)
$Inflation_{it}$	-0.042	0.015	-0.061	0.006	-0.041	0.043**	-0.044	0.027	-0.037	0.013	-0.040	0.052***
	(0.045)	(0.017)	(0.044)	(0.025)	(0.044)	(0.015)	(0.044)	(0.018)	(0.044)	(0.015)	(0.047)	(0.013)
$Unemployment_{it}$	0.025	-0.080	0.026	-0.107	0.025	-0.110	0.023	-0.097	0.035	-0.037	0.035	-0.133*
	(0.076)	(0.059)	(0.079)	(0.081)	(0.076)	(0.063)	(0.078)	(0.064)	(0.076)	(0.057)	(0.081)	(0.063)
ESI_{it}	-0.009	0.003	-0.009	0.002	-0.009	0.002	-0.009	0.002	-0.008	0.004	-0.007	0.004
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.009)	(0.010)
$US\ Treasury_t$	0.069	0.153	0.059	0.144	0.068	0.140	0.080	0.151	0.063	0.118	0.063	0.142
	(0.198)	(0.090)	(0.195)	(0.086)	(0.199)	(0.101)	(0.210)	(0.093)	(0.197)	(0.095)	(0.204)	(0.104)
$(PEPP_{it-1}$ x $Time\ trend_t)$			-0.021	0.009								
			(0.017)	(0.010)								
$(PEPP_{it-1}$ x $Eligibility_{it})$					-0.001	0.032***					-0.003	0.035***
					(0.009)	(0.008)					(0.009)	(0.010)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$							0.000	0.001*				
							(0.001)	(0.000)				
$(PEPP_{it-1}$ x $Maturity_{jt})$									-0.001	-0.001***		
									(0.000)	(0.000)		
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it}$)											0.001	-0.005
											(0.002)	(0.006)
$(PEPP_{it-1}$ x $Elig._{jt}$ x $primary\ balance_{it})$											0.005	0.001
											(0.003)	(0.002)
Constant	-1.557	0.927	-1.591	1.229	-1.556	1.339	-1.558	1.154	-1.761	0.605	-1.987	1.221
	(1.459)	(1.370)	(1.519)	(1.282)	(1.453)	(1.392)	(1.467)	(1.380)	(1.403)	(1.522)	(1.681)	(1.456)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	823	544	823	544	823	544	823	544	823	544	823	544
R^2	0.4599	0.3763	0.4608	0.3769	0.4600	0.3813	0.4602	0.3771	0.4616	0.3923	0.4640	0.3844
Within R^2	0.3982	0.2501	0.3992	0.2508	0.3982	0.2561	0.3985	0.2510	0.4001	0.2694	0.4028	0.2598

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Countries are classified by historical debt levels: high-debt (Portugal, Spain, Italy, Greece, France, Belgium and Cyprus) and low-debt (all others). Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A3.6.1. *Robustness check: Baseline and Extended Models Excluding Year 2020*

	(I)	(II)	(III)	(IV)	(V)	(VI)
$PEPP_{it}$ (log)	0.152	0.161	0.122	0.135	0.151	0.139
	(0.145)	(0.159)	(0.138)	(0.147)	(0.122)	(0.126)
$PEPP_{it-1}$ (log)	-0.031	-0.097	-0.011	-0.020	-0.021	-0.028
	(0.142)	(0.272)	(0.135)	(0.141)	(0.121)	(0.119)
$\Delta\, debt\, ratio_{it}$	0.009	0.009	0.010	0.009	0.010	0.009
	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)
$\Delta\, net\ lend./Borr_{it}$	0.006	0.006	0.005	0.005	0.005	0.006
	(0.018)	(0.018)	(0.018)	(0.018)	(0.020)	(0.019)
$(PEPP_{it-1}$ x $\Delta\, debt\, ratio_{it})$	-0.000	-0.000	0.000	-0.000	0.000	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
$(PEPP_{it-1}$ x $\Delta\, net.\, lend/borr_{it})$	-0.003**	-0.003**	-0.003**	-0.003**	-0.003*	-0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
$Eligibility_{it}$	0.461**	0.460*	0.423*	0.464**	0.506**	0.428*
	(0.203)	(0.203)	(0.214)	(0.206)	(0.179)	(0.208)
$Issue\ amount_{jt}$ (log)	-0.163	-0.163	-0.163	-0.163	-0.167	-0.160
	(0.172)	(0.172)	(0.171)	(0.172)	(0.164)	(0.171)
$Maturity_{jt}$ (years)	0.032***	0.032***	0.032***	0.032***	0.041***	0.032***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
$Credit\ Rating_{jt}$	-0.006	-0.006	-0.007	-0.008	-0.008	-0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$Issuer\ Type_{it}$	0.044	0.043	0.044	0.042	0.070	0.026
	(0.379)	(0.379)	(0.378)	(0.378)	(0.345)	(0.375)
$GDP\ growth_{it}$	-0.002	-0.001	0.000	-0.001	0.002	0.005
	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)	(0.015)
$Inflation_{it}$	-0.016	-0.014	-0.020	-0.018	-0.009	-0.017
	(0.032)	(0.032)	(0.031)	(0.032)	(0.030)	(0.029)
$Unemployment_{it}$	0.025	0.024	0.005	0.012	0.069	-0.002
	(0.083)	(0.083)	(0.102)	(0.096)	(0.087)	(0.101)
ESI_{it}	-0.009	-0.009	-0.008	-0.009	-0.005	-0.009
	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)	(0.008)
$US\ Treasury_{t}$	0.038	0.036	0.035	0.040	0.035	0.017
	(0.169)	(0.170)	(0.173)	(0.171)	(0.163)	(0.180)
$(PEPP_{it-1}$ x $Time\ trend_{t})$		0.004				
		(0.011)				
$(PEPP_{it-1}$ x $Eligibility_{it})$			0.012			0.017
			(0.011)			(0.012)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$				0.000		
				(0.000)		
$(PEPP_{it-1}$ x $Maturity_{jt})$					-0.002**	
					(0.001)	
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, debt\, ratio_{it}$)						0.008***
						(0.002)
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\, net.\, lend/borr_{it})$						-0.002
						(0.006)
Constant	0.370	0.388	0.501	0.468	-0.458	0.602
	(1.412)	(1.419)	(1.509)	(1.521)	(1.438)	(1.472)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	908	908	908	908	908	908
R^2	0.4128	0.4129	0.4137	0.4130	0.4255	0.4170
Within R^2	0.2754	0.2755	0.2765	0.2756	0.2910	0.2805

This table presents the regression results from the baseline model (Equation 3.1) and its extensions, analyzing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads.The dependent variable is the sovereign bond spread, reflecting market risk perception. The independent variables include PEPP purchases and several interaction terms to explore how different factors influence PEPP's effectiveness. Columns I to VI display results from different model specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time, testing whether its effectiveness has increased or decreased over the course of the programme's implementation; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings to determine if riskier bonds benefited more; V) Investigates whether the impact of PEPP varied across bonds with different maturities, testing if shorter or longer-term bonds experienced larger spread reductions, VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects. Statistical significance is indicated by *p < 0.1, **p < 0.05, ***p < 0.01.

Table A3.6.2. *Robustness check: Baseline and Extended Model (High vs. Low-debt Countries) Excluding Year 2020*

	(I)		(II)		(III)		(IV)		(V)		(VI)	
	High-debt	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*	*High-debt*	*Low-debt*
$PEPP_{it}$ (log)	0.866	0.508	1.046*	0.676*	0.902*	0.508	1.091*	0.529	1.161**	0.421	0.874**	0.566*
	(0.447)	(0.310)	(0.443)	(0.320)	(0.446)	(0.293)	(0.472)	(0.398)	(0.428)	(0.255)	(0.292)	(0.259)
$PEPP_{it-1}$ (log)	-0.498	-0.445	3.137	-0.806*	-0.610	-0.445	-1.147	-0.147	-1.416	-0.056	-0.970	-0.478
	(0.745)	(0.312)	(1.647)	(0.391)	(0.684)	(0.330)	(0.715)	(0.329)	(1.175)	(0.295)	(0.772)	(0.285)
$\Delta\ debt\ ratio_{it}$	0.409**	0.109	0.559***	-0.023	0.374**	0.109	0.345**	0.089	0.567***	0.084	0.264*	0.089
	(0.132)	(0.139)	(0.138)	(0.164)	(0.114)	(0.149)	(0.122)	(0.135)	(0.124)	(0.119)	(0.121)	(0.129)
$\Delta\ net\ lend./Borr_{it}$	-0.373	0.120*	-0.447	0.141**	-0.302	0.120*	-0.234	0.098	-0.508	0.105*	-0.049	0.124*
	(0.383)	(0.065)	(0.396)	(0.061)	(0.352)	(0.061)	(0.384)	(0.070)	(0.530)	(0.051)	(0.385)	(0.056)
$(PEPP_{it-1}$ x $\Delta\ debt\ ratio_{it})$	-0.047***	-0.004	-0.060***	0.016	-0.043***	-0.004	-0.040**	0.001	-0.062***	-0.002	-0.033**	0.012
	(0.011)	(0.020)	(0.011)	(0.024)	(0.010)	(0.022)	(0.011)	(0.020)	(0.010)	(0.018)	(0.013)	(0.021)
$(PEPP_{it-1}$ x $\Delta\ net.\ lend/borr_{it})$	0.030	-0.022	0.037	-0.025*	0.023	-0.022	0.017	-0.018	0.043	-0.019*	-0.001	-0.014
	(0.037)	(0.012)	(0.038)	(0.011)	(0.034)	(0.012)	(0.037)	(0.013)	(0.051)	(0.010)	(0.036)	(0.015)
$Eligibility_{it}$	0.237	0.159	0.247	0.148	-0.855	0.159	0.233	0.162	0.317	0.211	-0.815	0.429
	(0.260)	(0.193)	(0.255)	(0.203)	(0.849)	(1.283)	(0.309)	(0.192)	(0.316)	(0.172)	(1.526)	(1.340)
$Issue\ amount_{jt}$ (log)	0.143	-0.588***	0.140	-0.592***	0.144	-0.588**	0.119	-0.601***	-0.082	-0.570**	0.150	-0.599***
	(0.133)	(0.176)	(0.133)	(0.179)	(0.133)	(0.189)	(0.131)	(0.176)	(0.137)	(0.182)	(0.127)	(0.184)
$Maturity_{jt}$ (years)	0.044**	0.010**	0.044**	0.010**	0.044**	0.010*	0.045**	0.009*	-0.257***	0.026	0.045**	0.011**
	(0.018)	(0.004)	(0.018)	(0.004)	(0.018)	(0.004)	(0.018)	(0.004)	(0.027)	(0.034)	(0.018)	(0.004)
$Credit\ Rating_{jt}$	-0.006	0.016	-0.006	0.017	-0.007	0.016	-0.196***	0.194***	-0.004	0.013	-0.007	0.004
	(0.013)	(0.020)	(0.013)	(0.020)	(0.013)	(0.020)	(0.050)	(0.054)	(0.015)	(0.018)	(0.014)	(0.033)
$Issuer\ Type_{it}$	-0.695	0.763**	-0.694	0.770**	-0.715	0.763**	-0.742	0.745**	-0.149	0.730**	-0.750	0.803***
	(0.402)	(0.270)	(0.399)	(0.273)	(0.407)	(0.272)	(0.410)	(0.271)	(0.501)	(0.277)	(0.422)	(0.243)
$GDP\ growth_{it}$	0.060**	0.002	0.071***	-0.017	0.058**	0.002	0.050**	0.003	0.057*	-0.000	0.056**	-0.008
	(0.019)	(0.023)	(0.017)	(0.023)	(0.018)	(0.027)	(0.015)	(0.020)	(0.023)	(0.020)	(0.016)	(0.022)
$Inflation_{it}$	-0.053	0.018	-0.131**	0.058	-0.041	0.018	-0.013	0.028	-0.043	0.006	-0.020	0.053
	(0.054)	(0.074)	(0.050)	(0.076)	(0.052)	(0.070)	(0.049)	(0.070)	(0.082)	(0.060)	(0.043)	(0.065)
$Unemployment_{it}$	0.024	0.006	-0.034	-0.081	0.045	0.006	0.113	-0.031	0.022	0.016	0.046	-0.073
	(0.131)	(0.177)	(0.141)	(0.164)	(0.125)	(0.185)	(0.113)	(0.172)	(0.208)	(0.178)	(0.108)	(0.176)
ESI_{it}	-0.010	0.007	0.009	-0.003	-0.008	0.007	-0.005	0.005	-0.000	0.004	-0.011	0.006
	(0.015)	(0.014)	(0.019)	(0.014)	(0.016)	(0.014)	(0.017)	(0.013)	(0.022)	(0.014)	(0.017)	(0.011)
$US\ Treasury_t$	-0.008	-0.124	-0.031	-0.141	-0.008	-0.124	0.038	-0.150	0.109	-0.149	-0.057	-0.102
	(0.489)	(0.426)	(0.496)	(0.423)	(0.483)	(0.425)	(0.463)	(0.437)	(0.417)	(0.398)	(0.531)	(0.438)
$(PEPP_{it-1}$ x $Time\ trend_t)$			-0.097**	0.023								
			(0.031)	(0.018)								
$(PEPP_{it-1}$ x $Eligibility_{it})$					0.112	0.000					0.121	-0.007
					(0.080)	(0.141)					(0.144)	(0.132)
$(PEPP_{it-1}$ x $Credit\ Rating_{jt})$							0.019**	-0.018***				
							(0.006)	(0.005)				
$(PEPP_{it-1}$ x $Maturity_{jt})$									0.031***	-0.002		
									(0.003)	(0.003)		
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\ debt\ ratio_{it}$)											0.006	-0.015*
											(0.003)	(0.007)
$(PEPP_{it-1}$ x $Elig._{jt}$ x $\Delta\ net.\ lend/borr_{it})$											-0.007	-0.009
											(0.019)	(0.011)
Constant	-5.057	2.472	-31.107	2.741	-4.704	2.473	-2.073	-0.171	1.449	2.543	-0.571	2.618
	(11.438)	(2.874)	(16.355)	(2.598)	(10.903)	(2.024)	(10.832)	(2.440)	(16.222)	(2.825)	(10.477)	(1.850)
Country and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	260	165	260	165	260	165	260	165	260	165	260	165
R^2	0.3962	0.3507	0.3974	0.3532	0.3972	0.3507	0.4095	0.3590	0.4997	0.3541	0.4047	0.3572
Within R^2	0.3582	0.2533	0.3595	0.2562	0.3593	0.2533	0.3723	0.2628	0.4682	0.2572	0.3673	0.2607

This table reports regression results from the baseline model (Equation 3.1) and its extensions, analysing the impact of the Pandemic Emergency Purchase Programme (PEPP) on sovereign bond spreads. The dependent variable is the spread, reflecting market risk perception. Countries are classified by historical debt levels: high-debt (Portugal, Spain, Italy, Greece, France, Belgium and Cyprus) and low-debt (all others). Regressors include PEPP purchases and interaction terms to explore heterogeneity in policy effectiveness. Columns I–VI show different specifications: I) Estimates the general effect of PEPP on sovereign bond spreads, controlling for macroeconomic factors; II) Examines whether the impact of the PEPP has evolved over time; III) Assesses whether eligible bonds responded differently to PEPP purchases compared to non-eligible bonds; IV) Explores the role of sovereign credit risk by interacting PEPP purchases with bond ratings; V) Investigates whether the impact of PEPP varied across bonds with different maturities. VI) Introduces a three-way interaction to assess whether PEPP was most effective in eligible bonds of countries with different debt levels, capturing fiscal policy effects, Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Chapter 4
Corporate Financing Effects of the ECB's CSPP: Evidence from Bond Spreads and Firm Leverage*

4.1. Introduction

In 2016, the European Central Bank (ECB) launched the Corporate Sector Purchase Programme (CSPP) as part of its Asset Purchase Programme (APP). The primary goal of this programme was to lower corporate financing costs and stimulate investment by purchasing investment-grade bonds issued by non-financial corporations in the Eurozone. Consequently, the CSPP represented a change in the ECB's approach by expanding its focus to the private corporate bonds.

Several studies have provided consistent evidence that CSPP contributed to a reduction in corporate bond spreads, particularly in the immediate period of its implementation. These effects are largely attributable to mechanisms such as increased demand for eligible securities and portfolio rebalancing by investors. However, most existing literature focuses on the impact of CSPP at the market level, particularly on the pricing of bonds at issuance or in secondary markets. In contrast, little focus was placed on how the CSPP affected corporate behaviour over time, particularly in terms of firms' capital structure decisions. In this context, this study addresses this gap by analysing the impact of the CSPP on both bond pricing and firm-level leverage. Specifically, we examine whether eligible bonds under the CSPP were priced differently in the primary market and whether firms that issued such bonds adjusted their debt ratios in the short and medium term. This study provides evidence of the broader and potentially longer-lasting effects of the CSPP on firms' financing decisions, an area that remains underexplored in empirical literature.

For our study, we use a sample of 1,275 Eurozone corporate bonds issued between 2015:Q1 and 2018:Q4 to assess the impact of the ECB's CSPP on primary market bond spreads and subsequent changes in firms' capital structures. We adopt a two-stage empirical approach: first, we analyse whether CSPP eligibility influenced bond pricing at issuance, and then we assess whether eligible issuance translated into changes in firms'

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financial leverage during the issuance year and the year after. Our findings indicate that while CSPP eligibility is initially associated with lower bond spreads, this effect disappears once firm and bond characteristics are controlled for, suggesting broader market effects likely driven by signalling rather than direct pricing. Furthermore, we find no evidence of widespread increases in leverage among firms that issued eligible bonds. However, results suggest the programme may have eased financing constraints for more indebted issuers over time. The remainder of the paper is structured as follows. Section 2 provides a brief overview of the CSPP. Section 3 presents the literature review. Section 4 describes the empirical methodology. Section 5 discusses the results. Section 6 concludes.

4.2. Overview of the ECB's CSPP

In March 2016, the ECB decided to extend its APP to include the CSPP. This programme consisted of the purchase of European corporate bonds, both on the primary and secondary markets[27]. The main goal was to provide better funding conditions for firms across the Eurozone, encouraging them to increase investment and create additional jobs, thereby stimulating the economy of the Eurozone. The goal of these actions was to establish the necessary conditions for inflation to stabilise at levels near but below 2% in the medium term. The purchases under CSPP, coordinated by the ECB, were carried out by the national central banks (NBCs) acting on behalf of the Eurosystem.

In terms of eligibility, this programme required that the issuers of the bonds be non-bank corporations established in the Eurozone. Their debt instruments needed to be denominated in euros, have a minimum credit assessment of BBB- (investment grade) and have a minimum remaining maturity of six months and a maximum remaining maturity of 30 years. Consequently, this programme excluded credit institutions, investment firms, comparable banks, and asset management vehicles.

By launching the CSPP, the ECB had two main objectives. The first was to signal their continuous commitment to stimulating the economy. The second goal was to impact the prices of assets. In the context of this last goal, the ECB aimed not only to lower the yields of the bonds eligible for the programme but also to influence the prices of non-eligible corporate bonds through the portfolio rebalancing channel. By purchasing large

[27] Under CSPP, the NCBs may purchase eligible corporate bonds in the primary and secondary markets, while public sector bonds may only be purchased in the secondary markets.

amounts of bonds, the ECB generated a scarcity of eligible bonds in the market, which induced investors to reallocate their holdings to other, riskier bonds. The rising demand for these riskier non-eligible bonds led to higher prices and lower yields for these assets.

The total amount of CSPP holdings consistently increased from June 2016 to December 2019, reaching €184,505 million by the end of 2019. The secondary market holdings represented the majority of CSPP holdings during this period, despite primary market holdings increasing over time (Figure 4.1). The predominance of secondary market holdings suggests that the ECB actively purchased existing corporate bonds to influence market conditions and liquidity, thereby stabilising their prices. In turn, the steady increase in primary market holdings, although smaller, also demonstrates the ECB's support for corporate issuers.

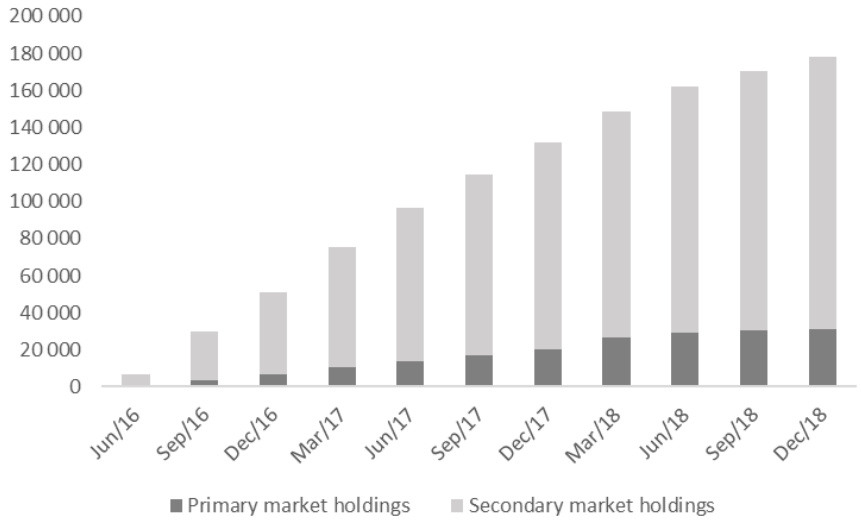

Figure 4.1. The breakdown of holdings under the CSPP (€ Mn).
Source: European Central Bank (ECB). Note: Holdings at amortised cost and figures reported net of redemptions.

The data on CSPP holdings by country highlight a significant and steady concentration in France and Germany during the analysed period (Table A4.1). This concentration suggests a consistent investment strategy by the ECB, reflecting confidence in the economic and corporate stability of these countries. Sectors such as utilities, infrastructure and transportation, and automotive represent the primary shares of CSPP holdings (Table A4.2), reflecting the strategic focus on countries like France and Germany mentioned earlier. Additionally, the data on the credit rating distribution of

CSPP holdings from 2017 to 2019 shows a shift toward higher-rated securities. The share of A-rated assets was 45% at the end of 2019 (Table A4.3), reflecting a growing focus on moderately secure investments. The share of BBB-rated assets, although trending downward from 2017 to 2019, remained significant, demonstrating the ECB's role in supporting lower-rated assets.

4.3. Literature overview

The CSPP targeted corporate bonds, which reflects a more direct approach by the ECB to promote private sector investment. While the broader effects of the APP have been extensively studied, research focusing on the CSPP remains limited, partly due to its constraints in firm-level data availability. Although most CSPP-related studies focus on impacts at the market level, some recent work has begun to explore firm-level responses to unconventional monetary policy more generally. For example, Altavilla et al. (2022) examine how negative interest rates affect firm debt structures in the Eurozone, while Nocera and Pesaran (2023) study the impact of the Federal Reserve's large-scale asset purchases on the capital structure of U.S. non-financial firms. However, direct evidence on the CSPP's effects at the firm level remains scarce.

A critical transmission mechanism of the CSPP is the portfolio rebalancing effect. By increasing the demand for CSPP-eligible bonds, the ECB not only reduced their yields but also incentivised investors to transfer funds to non-eligible or riskier bonds. This spillover effect, documented by Zaghini (2019) and Abidi and Miquel-Flores (2018), amplified the CSPP's effect by indirectly lowering yields across broader market segments. For example, Zaghini (2019) examined the impact of CSPP during its first year and found an indirect effect on non-eligible bond yields, in addition to a direct impact on eligible bond yields. This mechanism highlights the programme's ability to influence market conditions beyond its direct scope.

Further research by Rischen and Theissen (2021) found that the CSPP contributed to a reduction in under-pricing in the Eurozone market bond, which had been high since the financial crisis. This suggests that the programme has led to an improvement in market efficiency. Similarly, De Santis et al. (2018) reported that CSPP eased corporate financing conditions by reducing bond spreads and improving supply conditions in the primary market. Notably, they observed an increase in bank lending to corporates without access to the bond market, demonstrating the programme's broader financial market effects.

Additionally, Betz and De Santis (2019) found that CSPP increased the issuance of debt securities and encouraged banks to reallocate their loan supply toward corporates that had no access to bond markets.

Several studies about the CSPP have focused mainly on its immediate impact on bond yield spreads, particularly during the initial years of the programme. This body of research consistently finds that the CSPP effectively lowered corporate bond yields, primarily through channels such as portfolio rebalancing. Despite some studies having started to explore the broader financial implications, the literature on the medium- and long-term effects of the CSPP remains limited. Additional research is needed to assess whether its impact on borrowing costs and, more generally, on corporate financing behaviour has been maintained over time. Addressing this gap is essential for a more comprehensive understanding of the CSPP's effectiveness and its role in supporting the firm's resilience and broader economic recovery. This study addresses that gap by examining the CSPP's effect on corporate bond spreads at issuance and its short- to medium-term influence on firms' capital structure decisions. Using a two-stage empirical approach, we assess both bond pricing at issuance and subsequent changes in corporate leverage, providing new evidence on the programme's broader implications for firm behaviour.

4.4. Methodology

For our study, we use a cross-sectional econometric approach to examine the impact of the ECB's CSPP on corporate bond spreads at issuance. Since the analysis focuses exclusively on the primary bond market, where each bond is observed only once at issuance, we adopt a pooled OLS estimation strategy. The model also includes firm-fixed effects (μ_i) and quarter fixed effects (τ_t) to control for unobserved heterogeneity across issuers and macroeconomic conditions over time. Additionally, the standard errors are clustered at the firm and quarter level to account for potential within-firm and within-quarter correlation of residuals. The baseline model equation is given by:

$$Spread_{ijt} = \alpha + \beta_1 CSPP_{eligible_{ijt}} + \beta_2 CSPP_{period_t} + \beta_3 \left(CSPP_{eligible_{ijt}} \times CSPP_{period_t} \right) + \eta F_{jt} + \theta I_{it} + \varphi W_t + \mu_i + \tau_t + \epsilon_{ijt} \quad (4.1)$$

where, $Spread_{ijt}$ represents the Option-Adjusted Spread (OAS) at issuance for bond *j* issued by firm *i* at quarter *t*. The OAS is defined as the difference between the yield on a

corporate bond and the yield on a comparable maturity government bond, considering the value of any embedded options.[28] This study focuses only on the primary sovereign bond market.[29] The term ηF_{jt} includes the set of bond features, θI_{it} is the set of issuing firm features, and φW_t is the set of variables about macroeconomic conditions. The error term is represented by ϵ_{ijt}.

In this model, the impact of the CSPP on corporate bond spreads is assessed through dummy variables. The first dummy, $CSPP_{eligible_{ijt}}$, takes the value of 1 if the bond is eligible for the programme and 0 otherwise. This variable captures the direct pricing effect of CSPP eligibility, isolating the impact on bonds that were explicitly targeted for purchase.[30] To determine eligibility, a bond must satisfy two primary conditions: (i) a minimum investment grade credit rating (BBB- or higher) and (ii) a maturity of between 6 months and up to 30 years. The other dummy variable, $CSPP_{period_t}$, assumes the value of 1 if the bond was issued during the active CSPP period and 0 otherwise. As bonds issued during the active CSPP period may have benefited from more favourable market conditions, such as lower interest rates and increased liquidity driven by the programme, we include this time dummy to capture the overall impact of the CSPP during its implementation phase. Additionally, we introduce an interaction between these two dummy variables to capture the direct effect of the programme on bonds that were both eligible for purchase and issued during the active CSPP window. This term isolates the additional impact of the CSPP beyond general market trends or differences between eligible and non-eligible bonds.

For the selection of control variables, we base our approach on the econometric framework initially proposed by Sironi (2003) and later extended by Zaghini (2016, 2019), which analyses the determinants of risk premia in the euro-area primary bond market. According to this approach, the spread of a bond relative to a risk-free rate is

[28] The OAS adjusts for the value of embedded options in bonds, providing a more accurate measure of yield spreads. Additionally, it allows for standardised comparisons across bonds with different options.

[29] By concentrating on primary market bonds, we can more clearly assess the CSPP's impact on bond yields at the time of issuance, thus reflecting the programme's effects without the noise of secondary market trading. Additionally, this approach ensures a more accurate evaluation of CSPP eligibility and the immediate pricing conditions of new bonds (Mäkinen et al., 2020).

[30] The central identification assumption of this study is that CSPP eligibility is plausibly exogenous, conditional on bond and firm characteristics. Eligibility is determined by fixed ECB criteria (e.g., currency denomination, investment-grade rating, issuer incorporation), which firms cannot easily manipulate at the time of issuance. Moreover, the inclusion of firm and quarter fixed effects, together with detailed bond-level controls, helps mitigate concerns of omitted variable bias and reverse causality.

determined by three sources of risk: bond features, issuer characteristics, and market conditions.

Regarding the bond features, we include variables that reflect the characteristics that might influence their eligibility and attractiveness under the programme. Based on Zaghini's (2019) approach, we consider the amount issued (logarithm of the bond issued amount in a single tranche) [31], the time of maturity at the origination (number of years)[32] and the bond rating grade.[33] These features also cover the main criteria defined for CSPP eligibility. To construct the bond credit rating variable, we proceed in two steps. First, we include a dummy variable that distinguishes between rated and non-rated bonds, taking the value 1 if the bond is rated and 0 otherwise. Second, for rated bonds, we assign a numerical score reflecting the credit quality, with higher values indicating higher creditworthiness.[34] The final bond credit rating variable is the interaction between the rating dummy and the numerical score.[35]

In turn, the set of issuing firm features is designed to capture their financial health and structural features that may affect bond spreads. These factors include a firm's size, leverage, and profitability and liquidity indicators. The natural logarithm of total assets is used to measure a firm's size, the debt ratio (total debt divided by total assets) is used to determine leverage, and profitability is proxied by return on assets (ROA) and liquidity by current ratio (current assets divided by current liabilities). Each of these variables helps to reflect the firm's risk profile and its perceived creditworthiness.[36]

Finally, to control for macroeconomic conditions, we include country-specific year-on-year (YoY) GDP growth and inflation rates, which directly capture domestic

[31] It's expected that bond spreads are negatively related to the issued amount. Larger issuance sizes are typically associated with greater bond liquidity, which tends to lower the spread. Longstaff et al. (2005) found that the non-default component of bond spreads is negatively related to bond-specific liquidity measures, such as the outstanding principal amount. In turn, Chen et al. (2007), using several liquidity indicators, found that an improvement in liquidity generates a significant reduction in yield spreads.

[32] Longer maturities expose investors to more interest rates and credit risks, leading to higher spreads to compensate for these risks (Elton et al., 2002).

[33] Investment-grade bonds, which are considered lower risk, are expected to have lower spreads than non-investment-grade bonds (Huang and Huang, 2012).

[34] Credit ratings are converted into numerical scores for the analysis, with the highest rating (AAA/Aaa) assigned a score of 22, followed by AA+/Aa1 as 21, AA/Aa2 as 20, and so on, decreasing sequentially down to D, which is assigned a score of 1.

[35] As a result, the variable will assume the value of 0 for non-rated bonds and a numerical score between 1 (D) and 22 (AA) for rated bonds.

[36] Larger firms are generally perceived as having lower credit risk (Titman and Wessels, 1988; Petersen and Rajan, 1994), while higher leverage suggests greater financial risk and consequently higher yield spreads (Myers, 1977; Nakashima and Saito, 2009). Higher profitability reduces the likelihood of financial distress, which lowers credit spreads (Campbell et al., 2008).

economic performance that may affect bond pricing at issuance.[37] Other broad measures of economic risk are excluded, as firm and time fixed effects already absorb common macroeconomic shocks and euro-area-wide monetary policy influences. This approach ensures that only relevant cross-country macroeconomic differences are explicitly controlled for in the model.

To explore whether the impact of the CSPP on bond spreads varies across different types of firms and bond structures, we extend the baseline model (equation 4.1) by introducing triple interaction terms between CSPP eligibility, the programme period, and key firm- and bond-specific characteristics. Specifically, we interact the CSPP variables with the logarithm of total assets, the debt ratio, the bond credit rating score and bond maturity at issuance. These extensions allow us to identify potential heterogeneity in the programme's effect based on underlying structural features. Firm size, proxied by log assets, reflects financial resilience, with smaller firms potentially benefiting more from central bank support. The debt ratio captures leverage-related risk, where more leveraged firms may experience greater spread reductions if the CSPP improves market access or reduces funding costs. The credit rating reflects perceived credit quality, with riskier firms possibly benefiting more from increased demand. Lastly, maturity, measured in years at issuance, reflects the bond's duration and interest rate sensitivity. As longer-term bonds are generally more exposed to market risk, the CSPP may have had a differentiated impact depending on the bond tenor.

In the second stage, we analyse the extent to which the CSPP impacted corporate capital structure, thereby assessing the real effects of the programme on firms' financing behaviour. We focus on leverage as it helps us understand whether firms are taking advantage of better market access and financing conditions to increase their debt, refinance existing obligations, or restructure their balance sheet. The way firms respond to leverage gives us valuable insights into whether the CSPP has impacted their risk-taking, financial flexibility, or ability to manage debt sustainably.

Since the leverage model is based on panel data, where firms are observed across multiple periods, we estimate the leverage equation using a fixed effects panel regression. This approach controls for time-invariant firm characteristics (λ_i), helping to isolate the

[37] Higher nominal GDP growth indicates stronger economic activity and tends to reduce default risk, thus narrowing bond spreads. In contrast, higher inflation can lead to higher interest rates, increasing borrowing costs and putting pressure on firm profitability, which can result in wider bond spreads.

causal impact of CSPP eligibility on leverage. The error term is represented by ϵ_{it}. The leverage equation is given by:

$$\Delta Leverage_{it} = \alpha + \beta_1 CSPP_{elig._{it}} + \beta_2 CSPP_{period_t} + \beta_3 \left(CSPP_{elig._{it}} \times CSPP_{period_t}\right) + \gamma X_{ict} + \rho Z_{ct} + \lambda_i + \epsilon_{it} \quad (4.2)$$

where $\Delta Leverage_{it}$ is the year-on-year change of the firm's debt ratio of firm *I*, defined as the difference in the total debt-to-assets between year *t* and *t-1*. The debt ratio, calculated as total debt divided by total assets, is a broadly used measure of financial leverage in the corporate finance literature (Frank and Goyal, 2009; Rajan and Zingales, 1995) and provides a consistent basis for comparing a firm's dependence on external debt over time. We use the annual change in leverage as the dependent variable, in line with studies that assess the determinants and effects of changes in leverage rather than static levels (Lemmon, Roberts, and Zender, 2008; Flannery and Rangan, 2006). The interaction term ($CSPP_{eligible_{it}} \times CSPP_{period_t}$) captures whether firms that issued CSPP-eligible bonds increased their leverage in comparison to non-eligible firms during the programme period. $CSPP_{eligible_{it}}$ takes the value 1 if firm *i* issued a CSPP-eligible bond in year *t* and $CSPP_{period_t}$ equals 1 if year *t* falls within the period during which the programme was active, based on the bond's issue date. This specification ensures that we capture the impact of CSPP precisely when the firm accesses bond markets.

As control variables, we include a set of firm-specific factors (γX_{it}) including firm size (log of total assets), leverage (debt ratio), profitability (ROA) and liquidity (current ratio), all of which may affect capital structure decisions.[38] On the macroeconomic side (ρZ_{ct}), we control for the nominal GDP growth and the inflation rate in the firm's country, to account for the broader financing environment.[39]

[38] A firm's characteristics are expected to influence capital structure decisions. Larger firms are generally more diversified and face lower default risk, which allows them to maintain higher leverage ratios (Titman and Wessels, 1988; Rajan and Zingales, 1995). More profitable firms tend to rely more on internal financing and therefore have a lower leverage, in line with the pecking order theory (Myers and Majluf, 1984). Firms with higher liquidity usually use less external debt, as they can finance their operations internally. In contrast, higher leverage may reflect agency costs or constrained access to equity financing (Jensen, 1986).

[39] The interest rate is a key control, as it affects the cost of borrowing and thus firms' leverage decisions (Bernanke and Gertler, 1995). Inflation influences the real value of debt and may lead firms to adjust their capital structure accordingly (Fischer, 1993). Higher GDP growth typically signals better economic conditions and improved access to credit, which can support both increased investment and higher leverage. These conditions stimulate corporate expansion and make debt financing more attractive (Levine and Renelt, 1992; Korajczyk and Levy, 2003).

In addition to the baseline model, we extend the analysis to test for heterogeneous effects across different types of firms and bond features. Consistent with the first part of the study, we examine interactions with firm size, initial leverage, bond credit rating and bond maturity at issuance, to explore whether the real effects of the CSPP varied depending on firm- and bond-specific characteristics.

4.5. Empirical analysis

4.5.1. Data

The research covers the period between 2015:Q1 and 2018:Q4, which includes the programme's first phase of asset purchases that occurred between 8 June 2016 and 19 December 2018. To avoid distortions, we exclude both the reinvestment-only phase (January to October 2019) and the second phase of CSPP (November 2019 to June 2022). The last exclusion is necessary to ensure that our results accurately reflect conditions under normal circumstances, thereby avoiding any potential biases caused by the COVID-19 pandemic.

This study focuses exclusively on the primary market, where each bond constitutes a single cross-sectional observation. Our sample comprises 1,275 euro-denominated bonds issued by 531 firms incorporated in 18 Eurozone countries (Table A4.5).[40] Table A4.6 and Table A4.7 provide further details on the sectoral classification and credit rating profile of the corporate bonds included in the sample. Following the CSPP eligibility criteria defined in Decision (EU) 2016/948 (ECB 2016), we exclude from the sample all securities that fall structurally outside the programme's scope, such as asset-backed securities (ABS), structured notes, convertible and covered bonds, as well as issues by credit institutions[41] and public sector entities.[42] To construct the CSPP eligible dummy, we also apply the programme's minimum credit quality and maturity requirements: the bonds must have a residual maturity of between 6 months and 30 years

[40] The number of observations used in the regressions is lower than the total sample due to the inclusion of firm fixed effects, which drop firms with only one bond issuance and due to missing values in key firm-level financial data (primarily for calculating the debt ratio). While we cannot entirely rule out sample selection, the excluded observations appear to be randomly distributed across sectors and periods, which mitigates concerns about systematic bias.

[41] Credit institutions and entities supervised under the European banking supervision framework are not eligible under the CSPP and are therefore excluded from the sample.

[42] Issuers that are eligible under the PSPP are not eligible under the CSPP. We exclude all securities issued by public sector entities that structurally fall outside the programme's scope, such as government agencies, municipalities, and quasi-governmental institutions eligible under PSPP.

and be rated investment grade by at least one of the leading credit rating agencies. Unrated bonds are considered ineligible as they do not fulfil the ECB's credit quality requirements.

The OAS information and the corresponding bond-level data were obtained from Bloomberg. In cases where the OAS data was not available on the issuance date, we use the first available observation within a short window after issuance (a frame of 30 days), to ensure that spreads still reflect early market pricing. This approach allows us to preserve a broader sample and avoid potential selection bias that could arise from excluding otherwise valid bonds due to temporary data limitations. We limit our sample to bonds with available OAS and firm-level information, excluding those issued by firms for which no financial data is available, as these controls are essential for our identification strategy. Additionally, we excluded a small number of bonds with negative OAS values, as these likely reflect technical pricing distortions driven by exceptional demand rather than actual credit risk.

For our analysis, we use a quarterly frequency[43], which aligns with the availability of macroeconomic indicators and helps capture the market context at the time of bond issuance. Accordingly, for each bond, we apply the relevant indicators from the corresponding quarter to reflect the conditions at the time of issuance. In contrast, firm-level indicators are based on annual financial statements, using the most recently available annual data at the time of issuance, thus reflecting the information that would have been available to investors at that time. We focus on annual data to ensure consistency and comparability across firms, given the variation in reporting frequencies and disclosure practices across jurisdictions. For bonds issued by corporate treasury or financing subsidiaries, we use the consolidated financial data of the parent firm, as it more accurately reflects the issuer's overall credit profile and financial health. Finally, for the firm indicators, we obtained the data from Moody's Orbis database and from the firm's annual reports, when available. For macroeconomic variables, we collected data from various sources, including Bloomberg, the ECB Statistical Data Warehouse, and national statistical institutes.

Credit rating classification in this study follows a conservative methodology that aligns with typical market conventions. When multiple credit ratings are available from the leading agencies (Moody's, S&P, and Fitch), we use the lowest rating to determine a bond's status. This approach minimises the possibility of overstating credit quality and

[43] Quarterly data is considered more appropriate for measuring the short-term impact of monetary policy changes over time.

aligns with the standard approach adopted by institutional investors when assessing credit risk. Bonds rated with a minimum rating of BBB- (investment grade) are classified as eligible for the programme, and those rated BB+ or lower are ineligible.

For the second stage of the analysis, which examined the CSPP's impact on firms' capital structure, we focused on the same set of firms and bond issuances used in the bond spread analysis. If a firm issued bonds in multiple years, each issuance is treated as a distinct observation. Maintaining a consistent firm sample across both stages of the analysis ensures coherence in assessing the programme's pricing and real effects. The data sources for bonds, firm-level and macroeconomic controls are identical to those used in the first stage. The year-on-year change in the debt ratio, the dependent variable in this stage, is calculated using firm-level financial data from Moody's Orbis database, complemented by annual reports where available. The debt ratio is calculated as the sum of short-term debt and long-term debt divided by total assets. This standard leverage measure captures a firm's overall leverage in relation to its asset base, allowing for comparisons between firms over time.

4.5.2. Results

This section presents the results of the regression of Equation 4.1. The summary statistics of the data used are presented in Table A4.8. According to the results presented in Table 4.1, the CSPP eligibility effect disappears when controls are introduced. The initial significant negative coefficient of CSPP eligibility suggests that eligible bonds show lower spreads before controls (Column I of Table 4.1). However, as this effect disappears after the introduction of controls, it may be an indication that the lower spreads were caused by the features of the eligible bonds or firms, rather than by eligibility itself. This finding aligns with Zaghini (2019) and De Santis (2018), who demonstrate that CSPP contributed to overall market liquidity, suggesting that eligibility status alone may not fully explain pricing advantages once bond and issuer fundamentals are controlled for.

Importantly, the interaction between CSPP eligibility and CSPP period is consistently positive and statistically significant. This result contradicts the initial expectation that the programme would lower primary market spreads through direct eligibility effects. Economically, the estimated coefficients imply that CSPP-eligible bonds issued during the active programme period were priced at approximately 52 to 78

basis points higher than their non-eligible counterparts, depending on the model specification. This contrasts with Abidi and Miquel-Flores (2018), who found a negative yield effect for eligible bonds.

Rather than indicating a failure of the CSPP, this result is likely reflecting indirect effects. One possible interpretation is that investors primarily prized the programme's liquidity support and implicit ECB backing, which generated a form of "premium pricing" where investors accept higher spreads in anticipation of secondary market liquidity. Alternatively, this result may reflect the strategic behaviour of issuers, who may have taken advantage of the programme window to issue riskier or longer-term bonds. Investors, in turn, were willing to accept them at relatively higher spreads, given the expectation of sustained demand and liquidity under the programme.

Finally, the results from Column IV of Table 4.1 demonstrate lower spreads during the CSPP period. This suggests that the programme has improved general market conditions, even if not through direct eligibility.

Table 4.2 shows the results of Equation 4.1 with the triple interaction of firm- and bond-specific features. According to the results presented in Column II of Table 4.2, the triple interaction with the logarithm of the firm's total assets is not statistically significant. This suggests that CSPP did not have a differential effect on eligible bonds based on firm size during the programme period. This finding contrasts with Altavilla et al. (2022), who document heterogeneous firm-level responses to unconventional monetary policy tools, particularly among smaller and financially constrained firms.

However, the positive and significant interaction between CSPP eligibility and firm size suggests that eligible bonds issued by larger firms were associated with higher spreads. This may reflect a form of market "premium pricing," where investors, anticipating higher liquidity and ECB support, were more willing to accept bonds with higher spreads, particularly from well-known issuers. Alternatively, this result may reflect issuer behaviour, where larger firms that issued CSPP-eligible bonds, regardless of timing, may have taken advantage of their eligibility status to place more complex or higher-risk instruments, as they knew that eligibility alone could increase market demand. Both arguments support the interpretation that the CSPP had indirect effects on issuance behaviour and market segmentation, rather than uniformly reducing spreads of all eligible bonds.

Columns III and IV of Table 4.2 show no evidence that CSPP differentially affected spreads based on the firm's prior leverage ratio or the bond's credit quality. These

results indicate that the programme's impact did not systematically vary across different risk profiles or financial structures, further supporting the notion that CSPP effects operated through market-wide dynamics rather than issuer-specific channels.

In Column V of Table 4.2, we see that the triple interaction term with the bond's maturity at issuance is not statistically significant. However, the negative and significant coefficient in the interaction between CSPP eligibility and bond maturity indicates that bonds with longer maturity benefited more from the programme's eligibility, regardless of whether they were issued during the programme's active period. This finding may reflect credibility or signalling effect, suggesting that investors viewed eligible long-term bonds as safer or more liquid due to the expected backing from the ECB. This aligns with the findings of Elton et al. (2002) and Longstaff et al. (2005), who show that bonds with longer maturities typically exhibit higher spreads due to increased exposure to interest rate and liquidity risk, which can be mitigated by credible institutional backing. The fact of being eligible might have acted as a quality signal, increasing confidence and reducing the required risk premium even before or after the official purchase period began. Otherwise, issuers might have intentionally issued longer-dated bonds, knowing that their eligibility would attract stronger demand, based on the expectation of continued market support.

Overall, the findings indicate that the impact of the CSPP on the primary was not significantly influenced by firm- or bond-specific characteristics during the programme period. Instead, the evidence suggests that the programme may have influenced the market more broadly due to its signalling power and credibility, which appeared to surpass the effects of direct purchases.

Table 4.1. *Results of the Baseline Model*

	(I)	(II)	(III)	(IV)
$CSPP_{eligible_{ijt}}$	-0,747***	-0.233	-0.309	-0.334
	(0.175)	(0.301)	(0.277)	(0.282)
$CSPP_{period_t}$	-0.089	-0.070	-0.345	-0.378*
	(0.262)	(0.207)	(0.204)	(0.205)
$(CSPP_{eligible_{ijt}} \times CSPP_{period_t})$	0.783***	0.426	0.524**	0.538**
	(0.256)	(0.250)	(0.222)	(0.224)
$Issue\ amount_{jt}$ (log)		-0.106	-0.153	-0.162
		(0.141)	(0.142)	(0.145)
$Coupon_{jt}$		0.687***	0.684***	0.682***
		(0.065)	(0.057)	(0.057)
$Maturity_{jt}$ (years)		0.018***	0.020***	0.019***
		(0.006)	(0.005)	(0.005)
$Credit\ rating_{jt}$		0.002	0.009	0.010
		(0.018)	(0.020)	(0.021)
$Total\ assets_{it}$ (log)			0.050	0.046
			(0.423)	(0.427)
ROA_{it}			0.003	0.004
			(0.004)	(0.005)
$Debt\ ratio_{it}$			-1.563	-1.521
			(1.171)	(1.165)
$Current\ ratio_{it}$			-0.062	-0.061
			(0.052)	(0.050)
$GDP\ growth_t$				0.021
				(0.013)
$Inflation_t$				0.100
				(0.067)
Constant	2.293***	1.099	1.905	1.845
	(0.181)	(1.262)	(3.826)	(3.866)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes
No. of observations	1,034	1,034	948	948
R^2	0.9072	0.9461	0.9529	0.9531
Within R^2	0.0514	0.4489	0.4879	0.4900

This table presents the regression results from the baseline model (Equation 4.1), assessing the impact of the Corporate Sector Purchase Programme (CSPP) on corporate bond spreads at issuance. The dependent variable is the option-adjusted spread (OAS). Column I includes only the main CSPP variables. In Column II, bond-specific controls are added. Column III introduces firm-level controls, while Column IV adds macroeconomic variables. All regressions include firm and quarter fixed effects, with standard errors clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table 4.2. *Results of the Baseline Model with Firm- and Bond-Level Triple Interactions*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.334	-4.101**	-0.930*	-1.497*	0.048
	(0.282)	(1.519)	(0.478)	(0.761)	(0.282)
$CSPP_{period_t}$	-0.378*	-2.159	-0.145	-0.476*	-0.391*
	(0.205)	(1.491)	(0.506)	(0.270)	(0.219)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	0.538**	-0.112	0.275	-0.184	0.221
	(0.224)	(0.238)	(0.473)	(0.510)	(0.227)
$Issue\ amount_{jt}$ (log)	-0.162	-0.186	-0.136	-0.163	-0.185
	(0.145)	(0.151)	(0.146)	(0.146)	(0.154)
$Coupon_{jt}$	0.682***	0.677***	0.688***	0.678***	0.691***
	(0.057)	(0.054)	(0.062)	(0.057)	(0.061)
$Maturity_{jt}$ (years)	0.019***	0.021***	0.015*	0.021***	0.021**
	(0.005)	(0.005)	(0.007)	(0.005)	(0.007)
$Credit\ rating_{jt}$	0.010	0.009	0.010	-0.019	0.008
	(0.021)	(0.019)	(0.022)	(0.021)	(0.021)
$Total\ assets_{it}$ (log)	0.046	-0.353	0.181	0.142	0.145
	(0.427)	(0.556)	(0.283)	(0.392)	(0.395)
ROA_{it}	0.004	0.005	0.005	0.004	0.004
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)
$Debt\ ratio_{it}$	-1.521	-1.486	-2.448	-1.504	-1.523
	(1.165)	(1.170)	(1.465)	(1.169)	(1.166)
$Current\ ratio_{it}$	-0.061	-0.069	-0.059	-0.061	-0.061
	(0.050)	(0.051)	(0.056)	(0.050)	(0.049)
$GDP\ growth_t$	0.021	0.015	0.020	0.016	0.020
	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)
$Inflation_t$	0.100	0.115	0.120	0.099	0.089
	(0.067)	(0.075)	(0.070)	(0.074)	(0.068)
$(CSPP_{eligible_{ijt}}$ x $Y)$		0.529**	1.681	0.103	-0.035*
		(0.194)	(1.351)	(0.061)	(0.019)
$(CSPP_{period_t}$ x $Y)$		0.256	-0.547	0.024	0.005
		(0.213)	(1.246)	(0.026)	(0.006)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		-0.112	0.678	0.030	0.032
		(0.238)	(1.177)	(0.035)	(0.019)
Constant	1.845	4.837	1.050	1.252	1.305
	(3.866)	(4.818)	(3.350)	(3.540)	(3.678)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	948	948	948	948	948
R^2	0.9531	0.9540	0.9543	0.9535	0.9537
Within R^2	0.4900	0.5007	0.5032	0.4954	0.4966

This table presents extended regression results based on the baseline model (Equation 4.1), which includes all bond-specific, firm-level, and macroeconomic controls. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

We now present the results of the second stage of the analysis, which examines whether the CSPP had real effects on corporate financing behaviour, specifically on firms' leverage. The dependent variable is the annual change in the firm's debt ratio (*Δ debt ratio*), allowing us to capture adjustments in capital structure following bond issuance. Table 4.3 presents the results of the baseline model and its extensions. In this case, the dependent variable captures changes in the leverage during the year of bond issuance (*t*).

According to Column I of Table 4.3, CSPP eligibility did not affect changes in the debt ratio in the issuance year. This finding is consistent with the capital structure literature, which suggests that leverage adjustments tend to be gradual and influenced by firm-specific fundamentals rather than short-term policy shocks (Frank and Goyal, 2009; Flannery and Rangan, 2006). Additionally, the results suggest that the CSPP's impact on leverage did not vary by firm size or by bond credit rating (Columns II and IV, respectively, of the Table 4.3).

Regarding the triple interaction with the initial debt level (Column III of Table 4.3), the coefficient is negative but statistically insignificant, indicating no robust evidence that the CSPP's impact on leverage varied depending on firms' prior leverage levels. However, the interaction between CSPP eligibility and the CSPP period is positive and marginally significant. The coefficient corresponds to an increase of approximately 0.09 percentage points in the debt ratio, suggesting a modest but measurable rise in leverage among firms issuing CSPP-eligible bonds during the programme's active period.

In contrast, the results from Column V show that the triple interaction with bond maturity at issuance is negative and statistically significant. This suggests that firms issuing eligible longer-maturity bonds experienced smaller increases in leverage during the issuance year compared to those issuing shorter-term bonds. These firms may not have used the CSPP as an opportunity to increase their debt. Instead, firms likely allocated liquidity to refinance short-term obligations, rebalance the debt maturity structure or maintain low financing costs over a longer horizon, without immediately increasing their overall debt levels. This finding is consistent with the agency-based view of capital structure, which suggests that firms aim to mitigate risk and maintain financial discipline under external monitoring (Jensen, 1986). This also relates to Rajan and Zingales (1995), who argue that leverage decisions reflect firm-specific trade-offs between risk, control, and access to capital markets. These findings support the notion that the CSPP had a supportive rather than a distortive impact on firms' behaviour.

Table 4.4 presents the results of the leverage model, where the dependent variable is the change in the firm's debt ratio in the year following bond issuance ($t+1$). This allows us to assess possible delays in the effects of CSPP eligibility on leverage.

As in the year of issuance, there are no statistically significant effects of CSPP eligibility on changes in leverage in $t+1$ (Column I of Table 4.4). This result suggests that CSPP did not induce a broad-based increase in leverage, even with a one-year lag. Additionally, the programme's impact does not appear to vary by firm size and bond credit rating in the following year (Columns III and IV, respectively, of Table 4.4), which is consistent with the results observed for the bond issue year.

Regarding prior leverage levels, while no significant effect of CSPP eligibility is observed in the issuance year (Column III of Table 4.3), the results indicate important delayed effects in the following year (Column III of Table 4.4). Specifically, during the CSPP period, firms with higher leverage tended to reduce their debt ratios. However, this deleveraging trend was inverted among firms with higher initial debt ratios that issued CSPP-eligible bonds during the programme period. These firms experienced a significant increase in leverage in $t+1$, which suggests that the CSPP may have eased financing constraints, particularly for more indebted firms. Although this contrasts with Nocera and Pesaran (2023), who find that large-scale asset purchases have greater effects on industries with available debt capacity, it still reflects their broader conclusion that unconventional monetary policy can lead to delayed and lasting increases in leverage by making it easier for firms to access financing. The estimated effect corresponds to an increase of approximately 0.56 percentage points in the debt ratio, indicating a moderate but economically meaningful effect.

Finally, the interaction between CSPP eligibility and bond maturity becomes slightly positive and significant in the year following the bond issuance (Column V of Table 4.4), whereas it was negative and significant in the year of issuance (Column V of Table 4.3). The evidence suggests that firms that issued longer-term CSPP-eligible bonds experienced greater increases in leverage in the period immediately following issuance. This change suggests that firms delayed their leverage expansion to benefit from improved financial conditions, consistent with the pecking order described in Myers and Majluf (1984), which suggests that firms turn to external financing when market conditions reduce information friction, and the cost of borrowing is lower.

Table 4.3. *Effects of CSPP Eligibility on Changes in Leverage During the Year of Bond Issuance: Baseline Model with Firm- and Bond-Level Interactions*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.009	0.123	-0.014	0.154	0.021
	(0.010)	(0.165)	(0.030)	(0.146)	(0.025)
$CSPP_{period_t}$	0.012	-0.040	0.009	0.014	0.014
	(0.015)	(0.119)	(0.033)	(0.015)	(0.016)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	0.012	-0.008	0.087*	-0.005	-0.009
	(0.018)	(0.183)	(0.045)	(0.120)	(0.021)
$Issue\ amount_{jt}$ (log)	-0.009	-0.009	-0.012	-0.010	-0.011
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
$Coupon_{jt}$	0.002	0.002	0.003	0.002	0.004
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$Maturity_{jt}$ (years)	-0.000	-0.000	0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Credit\ rating_{jt}$	0.001	0.001	0.001	0.002	0.000
	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)
$Total\ assets_{it}$ (log)	-0.046	-0.029	-0.053	-0.045	-0.040
	(0.059)	(0.058)	(0.057)	(0.060)	(0.060)
ROA_{it}	-0.001	0.001	0.000	0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
$Current\ ratio_{it}$	-0.001	-0.001	-0.003	-0.001	-0.001
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
$Debt\ ratio_{it}$	-1.016***	-1.016***	-0.924***	1.020***	-1.016***
	(0.121)	(0.157)	(0.129)	(0.124)	(0.121)
$GDP\ growth_t$	-0.007	-0.007	-0.006	-0.007	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Inflation_t$	0.022**	0.022**	0.020**	0.022**	0.021**
	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
$(CSPP_{eligible_{ijt}}$ x $Y)$		-0.018	0.016	-0.013	-0.003**
		(0.021)	(0.127)	(0.009)	(0.001)
$(CSPP_{period_t}$ x $Y)$		0.008	-0.006	-0.001	0.000
		(0.017)	(0.079)	(0.002)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		0.002	-0.229	0.002	0.002
		(0.025)	(0.152)	(0.007)	(0.001)
Constant	0.766	0.642	0.797*	0.759	0.731
	(0.445)	(0.450)	(0.425)	(0.452)	(0.457)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	887	887	887	887	887
R^2	0.8315	0.8319	0.8424	0.8323	0.8324
Within R^2	0.5351	0.5361	0.5653	0.5374	0.5375

This table presents extended regression results based on the leverage model (Equation 4.2), which examines the year-on-year change in the firm's debt ratio as the dependent variable. All specifications include bond-specific, firm-level, and macroeconomic controls. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05, and ***p < 0.01.

Table 4.4. *Effects of CSPP Eligibility on Changes in Leverage in the Year Following Bond Issuance: Baseline Model with Firm- and Bond-Level Interactions*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	0.004	0.101	-0.056	-0.297	-0.044
	(0.036)	(0.297)	(0.089)	(0.262)	(0.032)
$CSPP_{period_t}$	-0.001	0.203	0.103**	-0.004	-0.012
	(0.025)	(0.185)	(0.043)	(0.025)	(0.027)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	-0.013	-0.090	-0.212**	0.147	0.007
	(0.022)	(0.293)	(0.084)	(0.172)	(0.029)
$Issue\ amount_{jt}$ (log)	0.015	0.015	0.024	0.016	0.019
	(0.012)	(0.013)	(0.017)	(0.012)	(0.013)
$Coupon_{jt}$	-0.004	-0.003	-0.004	-0.003	-0.008
	(0.008)	(0.007)	(0.008)	(0.011)	(0.008)
$Maturity_{jt}$ (years)	-0.000	0.000	-0.001	-0.000	-0.001
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
$Credit\ rating_{jt}$	-0.000	-0.000	-0.001	-0.003	0.000
	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)
$Total\ assets_{it}$ (log)	0.358	0.339	0.356*	0.343	0.357
	(0.224)	(0.224)	(0.197)	(0.224)	(0.226)
ROA_{it}	0.002	0.003	0.003	0.002	0.002
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
$Current\ ratio_{it}$	0.007	0.008	0.010	0.008	0.008
	(0.010)	(0.010)	(0.008)	(0.010)	(0.010)
$Debt\ ratio_{it}$	-0.086	-0.087	-0.251	-0.077	-0.087
	(0.367)	(0.405)	(0.356)	(0.377)	(0.369)
$GDP\ growth_t$	0.004	0.004	0.000	0.004	0.004
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
$Inflation_t$	-0.009	-0.010	-0.002	-0.009	-0.007
	(0.015)	(0.015)	(0.017)	(0.015)	(0.015)
$(CSPP_{eligible_{ijt}}$ x $Y)$		-0.014	0.171	0.022	0.004**
		(0.038)	(0.283)	(0.017)	(0.002)
$(CSPP_{period_t}$ x $Y)$		-0.030	-0.258***	0.001	0.001
		(0.026)	(0.079)	(0.003)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		0.013	0.564**	-0.011	-0.002
		(0.040)	(0.263)	(0.010)	(0.002)
Constant	-2.642	-2.506	-2.631*	-2.552	-2.645
	(1.540)	(1.546)	(1.337)	(1.533)	(1.558)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	866	866	866	866	866
R^2	0.5740	0.5757	0.6113	0.5767	0.5758
Within R^2	0.0313	0.0351	0.1161	0.0374	0.0352

This table presents extended regression results based on the leverage model (Equation 4.2), where the dependent variable is the year-on-year change in the firm's debt ratio in the year following bond issuance (t+1). All explanatory variables, including CSPP eligibility and control variables, are measured at time t, corresponding to the year of bond issuance. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05, and ***p < 0.01.

4.5.3. Robustness checks

To address concerns about omitted variable bias and potential endogeneity, we initially included a broader set of controls in our specification. These included industry classification dummies[44], a country risk dummy[45] and several market and macroeconomic variables, namely the VSTOXX Index (implied market volatility), the Economic Policy Uncertainty (EPU) Index, the interbank interest rate and the Real Effective Exchange Rate (REER) of the euro.[46] However, these variables were excluded from the final model due to multicollinearity. This suggests that the firm and time-fixed effects, together with baseline controls, already absorb the key variation at both the firm and market levels. This outcome increases confidence that our estimates are not biased by unobserved heterogeneity or omitted macro-financial factors.

To ensure that extreme observations do not drive the baseline results, we perform a robustness check by excluding the top and bottom 1% of the dependent variable distribution. This is applied to both stages of the analysis, where the models are re-estimated using the exact specifications as in the baseline. In all cases, the main coefficients of interest remain stable in sign and significance, confirming that the results are not sensitive to outliers, which reinforces the robustness of our conclusions (Table A4.9 to Table A4.12).

Finally, we re-estimate the second-stage regressions using the level of the debt ratio as the dependent variable, instead of its year-on-year change. This alternative specification serves to confirm that the findings are not sensitive to the method used to measure leverage. The findings, presented in Table 4.5 and Table 4., remain qualitatively consistent with the baseline model, reinforcing our conclusions.

[44] For industry classification, we include dummy variables that indicate the industry to which the firm belongs (1 if firm i belongs to a specific sector and 0 otherwise).

[45] The country risk dummy captures firms legally incorporated in the Eurozone but classified by Bloomberg as exposed to non-Eurozone jurisdictional risk. It takes the value 1 for such firms and 0 for all others. While macroeconomic variables are based on the country of incorporation, this dummy controls for external risk exposures that may affect firm-level financial conditions.

[46] The VSTOXX Index reflects implied market volatility in the Eurozone and serves as a proxy for investor uncertainty. The EPU Index (Baker et al., 2016) captures economic policy uncertainty. Both are typically associated with higher risk premiums. The interbank interest rate influences short-term borrowing conditions, while the REER reflects euro competitiveness and may indirectly affect corporate bond pricing.

Table 4.5. *Robustness Check for Table 4.3: Using the Level of the Debt Ratio (Year of Bond Issuance)*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.009	0.122	-0.014	0.151	0.021
	(0.026)	(0.159)	(0.030)	(0.138)	(0.024)
$CSPP_{period_t}$	0.012	-0.041	0.009	0.014	0.014
	(0.013)	(0.116)	(0.033)	(0.014)	(0.014)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	0.012	-0.006	0.087*	-0.004	-0.010
	(0.018)	(0.161)	(0.045)	(0.118)	(0.021)
$Issue\ amount_{jt}$ (log)	-0.009	-0.009	-0.012	-0.010	-0.011
	(0.010)	(0.009)	(0.011)	(0.009)	(0.010)
$Coupon_{jt}$	0.002	0.002	0.003	0.002	0.004
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$Maturity_{jt}$ (years)	-0.000	-0.000	0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Credit\ rating_{jt}$	0.001	0.001	0.001	0.002	0.000
	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)
$Total\ assets_{it}$ (log)	-0.045	-0.028	-0.053	-0.044	-0.039
	(0.062)	(0.061)	(0.057)	(0.063)	(0.063)
ROA_{it}	0.001	0.001	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Current\ ratio_{it}$	-0.001	-0.001	-0.003	-0.001	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$GDP\ growth_t$	-0.007	-0.007	-0.006	-0.007	-0.007
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)
$Inflation_t$	0.022**	0.022**	0.020**	0.022**	0.021**
	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)
$(CSPP_{eligible_{ijt}}$ x $Y)$		-0.018	0.016	-0.012	-0.003**
		(0.020)	(0.127)	(0.009)	(0.001)
$(CSPP_{period_t}$ x $Y)$		0.008	-0.006	-0.001	-0.000
		(0.016)	(0.079)	(0.002)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		0.002	-0.229	0.001	0.002
		(0.021)	(0.152)	(0.007)	(0.001)
Constant	0.751	0.626	0.797*	0.741	0.716
	(0.477)	(0.470)	(0.425)	(0.479)	(0.488)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	887	887	887	887	887
R^2	0.9368	0.9370	0.9409	0.9371	0.9371
Within R^2	0.0250	0.0271	0.0885	0.0295	0.0300

This table presents regression results from a robustness check based on the leverage model. Unlike the baseline specification (Equation 4.2), the dependent variable here is the level of the firm's debt ratio, rather than its year-on-year change. All specifications include the same bond-specific, firm-level, and macroeconomic controls as in the baseline model, except for the exclusion of lagged leverage, which is omitted to avoid endogeneity. Column I presents the base specification, while Columns II to V introduce triple interaction terms to test for heterogeneity by firm and bond characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05, and *p < 0.01.

Table 4.6. *Robustness Check for Table 4.4: Using the Level of the Debt Ratio (Year after Bond Issuance)*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	0.007	0.294	-0.105	-0.118	-0.010
	(0.021)	(0.219)	(0.067)	(0.126)	(0.023)
$CSPP_{period_t}$	0.025	0.224	0.097**	0.030	0.019
	(0.019)	(0.135)	(0.044)	(0.023)	(0.022)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	-0.014	-0.166	-0.096	0.135	-0.016
	(0.016)	(0.192)	(0.061)	(0.114)	(0.024)
$Issue\ amount_{jt}$ (log)	0.005	0.007	0.010	0.006	0.007
	(0.009)	(0.009)	(0.011)	(0.010)	(0.009)
$Coupon_{jt}$	-0.003	-0.003	-0.002	-0.002	-0.006
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
$Maturity_{jt}$ (years)	0.000	0.000	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Credit\ rating_{jt}$	0.000	0.001	0.000	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
$Total\ assets_{it}$ (log)	0.279**	0.296**	0.293**	0.259**	0.283**
	(0.104)	(0.112)	(0.101)	(0.104)	(0.105)
ROA_{it}	0.001	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Current\ ratio_{it}$	0.005	0.005	0.004	0.005	0.005
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
$GDP\ growth_t$	-0.002	-0.002	-0.003	-0.002	-0.002
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
$Inflation_t$	0.010	0.009	0.013	0.010	0.011
	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)
$(CSPP_{eligible_{ijt}}$ x $Y)$		-0.041	0.316	0.008	0.001
		(0.029)	(0.198)	(0.008)	(0.001)
$(CSPP_{period_t}$ x $Y)$		-0.029	-0.191	-0.001	0.001
		(0.018)	(0.119)	(0.002)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		0.023	0.222	-0.009	0.000
		(0.026)	(0.176)	(0.008)	(0.001)
Constant	-1.665**	-1.796**	-1.693**	-1.538**	-1.702**
	(0.712)	(0.776)	(0.666)	(0.707)	(0.720)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	895	895	889	895	895
R^2	0.9232	0.9240	0.9295	0.9238	0.9234
Within R^2	0.0848	0.0951	0.1871	0.0924	0.0878

This table presents regression results from a robustness check based on the leverage model. Unlike the baseline specification (Equation 4.2), the dependent variable here is the level of the firm's debt ratio in the year following bond issuance (t+1), rather than its year-on-year change. All explanatory variables, including CSPP eligibility and the control variables, are measured at time t, corresponding to the year of bond issuance. Lagged leverage is excluded to avoid endogeneity. Column I presents the baseline specification, while Columns II to V introduce triple interaction terms to test for heterogeneity in the CSPP's effects across firm and bond characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and *p < 0.01.

4.6. Conclusion

This study examines the effects of the ECB's CSPP on corporate bond spreads at issuance and subsequent changes in firms' capital structure. Using a two-stage cross-sectional empirical approach and a sample of 1,275 Eurozone corporate bonds issued between 2015:Q1 and 2018:Q4, we estimate fixed effects regression models that account for firm and time variation.

Regarding the impact of CSPP on bond spreads, our results show that the programme's eligibility is initially associated with lower bond spreads at issuance. However, this effect is not observed when we for control firm- and bond-specific characteristics, suggesting that pricing differences may reflect issuer and bond fundamentals rather than eligibility itself. Nonetheless, the results highlight the programme's broader market effects, likely driven by its signalling power and perceived credibility, rather than direct purchases.

Regarding leverage, we found no evidence of broad-based increases in the year of issuance. However, in the year following issuance, the highly indebted firms that issued CSPP-eligible bonds significantly increased their leverage, which suggests that the programme helped ease the financing constraints for these firms over time. Additionally, firms that issued longer-maturity eligible bonds showed an expansion of their balance sheet under improved financial conditions, after an initially more conservative leverage behaviour.

Overall, our findings suggest that CSPP improved the firm's financing ability and market functioning without promoting excessive leverage or risk-taking. These results highlight that the credibility and structure of such programmes may influence investors' expectations and firms' behaviour, thus contributing to the growing literature on the transmission of unconventional monetary policy at the firm level. Future research could explore longer-term firm outcomes, such as investment, default risk, and employment, and compare the first phase of the CSPP with its second phase, which was launched as part of the ECB's response to the COVID-19 crisis.

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4.8. Appendix

Table A4.1. *Country of risk distribution of CSPP holdings*

Sector	2017:Q3	2018:Q1	2018:Q3
France	29%	30%	30%
Germany	25%	25%	25%
Italy	11%	12%	12%
Spain	11%	10%	10%
Netherlands	6%	6%	6%
Belgium	5%	5%	5%
Switzerland	3%	4%	4%
Other (euro area)	6%	6%	6%
Other (non-euro area)	3%	3%	3%

Source: European Central Bank (ECB). It is based on the internal classification of the country of risk. Data as of end-Q3 2018. Holdings with maturity <6 months excluded. Totals may not sum to 100% due to rounding.

Table A4.2. *Sector distribution of CSPP holdings*

Sector	2017:Q3	2018:Q1	2018:Q3
Utilities	16%	15%	15%
Infrastructure and transportation	12%	11%	11%
Automotive and parts	10%	9%	9%
Telecommunications	9%	9%	9%
Energy and basic resources	7%	6%	6%
Real estate	6%	6%	6%
Construction & Materials	6%	6%	6%
Beverages	5%	6%	6%
Technology	5%	5%	5%
Health care and life science	5%	5%	5%
Chemicals	5%	5%	4%
Food	4%	4%	4%
Insurance	3%	3%	3%
Other sectors	8%	9%	9%

Source: European Central Bank (ECB). It is based on the internal classification of the economic sector. Nominal CSPP holdings as of end-Q3 201; excludes holdings with maturity <6 months. Totals may not sum to 100% due to rounding.

Table A4.3. *Credit rating distribution of CSPP holdings*

Sector	2017:Q3	2018:Q1	2018:Q3
AA	10%	11%	11%
A	41%	43%	45%
BBB	49%	46%	44%

Source: European Central Bank (ECB). Note: According to data compiled by the ECB using credit ratings from Fitch, Moody's, and S&P, bonds are categorised based on first-best asset ratings, with classifications such as 'AA' (AA− or above), 'A' (A− to A+), and 'BBB' (BBB+ or below).

Table A4.4. *Description of the model's variables*

Variable	Definition	Source data
$Spread_{ijj}$	The bond's Option-Adjusted Spread (OAS) at issuance reflects the yield difference between the corporate bond and a comparable risk-free government bond, accounting for the value of any embedded options	Bloomberg
$CSSP_{eligible_{ijt}}$	Binary variable indicating whether the bond meets the ECB's criteria for CSSP eligibility (1 = eligible, 0 = not eligible based on rating)	European Central Bank (ECB)
$CSSP_{period_t}$	Binary variable indicating whether the bond was issued during the active CSPP period (1 = active CSPP period, 0 = otherwise)	European Central Bank (ECB)
Control Variables		
Bonds features		
$Issue\ amount_{jt}$	The natural logarithm of the bond's issued amount	Bloomberg
$Maturity_{jt}$	Bond's initial maturity period (in years)	Bloomberg
$Credit\ Rating_{jt}$		
$Rated_{jt}$	Binary variable indicating whether the bond has a credit rating at issuance (1 = rated, 0 = not rated)	Bloomberg
$Rating_{jt}$	A numerical score assigned to the bond based on its credit quality, with higher values indicating better creditworthiness	Bloomberg
Issuing firm features		
$Total\ Assets_{it}$	The natural logarithm of the firm's total assets at the end of the quarter	Bloomberg/Moody's Orbis
$Debt\ ratio_{it}$	The firm's debt ratio, calculated as total debt divided by total assets, measured at the end of the quarter	Bloomberg/Moody's Orbis
$Return\ on\ Assets_{it}$	The firm's return on assets (ROA), calculated as net income divided by average total assets, measured at the end of the quarter	Bloomberg/Moody's Orbis
$Current\ ratio_{it}$	The firm's current ratio, calculated as current assets divided by current liabilities, measured at the end of the quarter	Bloomberg/Moody's Orbis
Market and macroeconomic factors		
$GDP\ growth_t$	Quarterly YoY GDP growth rate at market prices for the firm's country (seasonally adjusted)	Eurostat
$Inflation_t$	Quarterly YoY percentage change in the Harmonised Index of Consumer Prices (HICP) for the firm's country	Eurostat

Table A4.5. *Number of Corporate Bonds in the Sample, Grouped by Issuer's Country of Legal Incorporation*

Country of Incorporation	Nr. of Bonds
France	365
Netherlands	197
Germany	184
Italy	135
Spain	119
Luxembourg	76
Belgium	49
Finland	44
Austria	27
Portugal	23
Ireland	18
Greece	8
Malta	8
Slovenia	8
Slovakia	6
Estonia	3
Lithuania	3
Latvia	2
Total	**1,275**

Table A4.6. *Number of Corporate Bonds in the Sample, Grouped by the Sector of the Issuing Firm*

Sector of Activity	No. of Bonds
Industrials	296
Utilities	254
Consumer Discretionary	174
Materials	152
Communication Services	113
Consumer Staples	111
Healthcare	67
Information Technology	49
Energy	41
Real Estate	18
Total	**1 275**

Table A4.7. *Number of Corporate Bonds in the Sample, Grouped by Credit Rating*

Rating Category	Nr. of Bonds
Rated Bonds	**915**
CCC+	19
B-	36
B	65
B+	39
BB-	43
BB	50
BB+	47
BBB-	100
BBB	153
BBB+	120
A-	100
A	49
A+	70
AA-	22
AA	2
Non-Rated Bonds	**360**
Total	**1 275**

Table A4.8. *Summary statistics*

Variables	Obs.	Mean	Median	Std.Dev.	Min.	Max.
$Spread_{ijt}$ (OAS in %)	1 275	2.218	1.523	2.032	0.016	18.578
$Issue\ amount_{jt}$ (log)	1 275	8.441	8.699	0.547	6.477	9.477
$Coupon_{jt}$ (%)	1 275	2.691	2.000	2.031	0.000	12.500
$Maturity_{jt}$ (years)	1 275	8.557	7.000	6.180	0.667	60.500
$Credit\ rating_{jt}$ (numerical score)	915	13.3 (BBB-)	14.0 (BBB)	3.3	6.0 (CCC+)	20.0 (AA)
$Total\ assets_{it}$ (log)	1 274	6.791	6.909	0.995	0.431	8.584
ROA_{it} (%)	1 249	2.705	2.646	7.462	-70.124	72.533
$Debt\ ratio_{it}$	1 208	0.511	0.330	1.466	0.000	13.922
$Current\ ratio_{it}$	1 243	1.577	1.113	3.571	0.004	55.568
$GDP\ growth_t$ (%)	1 275	3.283	3.100	2.025	-0.570	36.240
$Inflation_t$ (%)	1 275	0.938	1.000	0.748	-0.900	4.800
$\Delta\ Debt\ ratio_{it}$	1 119	0,021	0.012	0.127	-0.874	1.332
$\Delta\ Debt\ ratio_{it+1}$	1 090	0.003	-0.001	0.132	-1.283	0.826

Table A4.9. *Robustness Check for Table 4.1: Excluding Outliers from OAS at Issuance*

	(I)	(II)	(III)	(IV)
$CSPP_{eligible_{ijt}}$	-0.756***	-0.205	-0.199	-0.230
	(0.189)	(0.191)	(0.174)	(0.172)
$CSPP_{period_t}$	-0.341	-0.247	-0.274*	-0.322*
	(0.249)	(0.159)	(0.154)	(0.158)
$(CSPP_{eligible_{ijt}} \times CSPP_{period_t})$	0.767***	0.364**	0.352**	0.364**
	(0.217)	(0.132)	(0.120)	(0.125)
$Issue\ amount_{jt}$ (log)		-0.043	-0.051	-0.062
		(0.087)	(0.085)	(0.087)
$Coupon_{jt}$		0.651***	0.652***	0.646***
		(0.053)	(0.005)	(0.051)
$Maturity_{jt}$ (years)		0.018***	0.019***	0.018***
		(0.006)	(0.005)	(0.005)
$Credit\ rating_{jt}$		0.003	0.004	0.005
		(0.014)	(0.013)	(0.013)
$Total\ assets_{it}$ (log)			-0.408	-0.395
			(0.408)	(0.414)
ROA_{it}			-0.002	-0.003
			(0.010)	(0.010)
$Debt\ ratio_{it}$			-0.800	-0.794
			(0.797)	(0.816)
$Current\ ratio_{it}$			-0.050	-0.045
			(0.057)	(0.051)
$GDP\ growth_t$				0.066***
				(0.022)
$Inflation_t$				0.131*
				(0.062)
Constant	2.135***	0.627	3.963	3.672
	(0.193)	(0.652)	(2.914)	(2.989)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes
No. of observations	821	821	816	816
R^2	0.8942	0.9546	0.9549	0.9558
Within R^2	0.0702	0.6010	0.6042	0.6117

This table presents the regression results from the baseline model (Equation 4.1), assessing the impact of the Corporate Sector Purchase Programme (CSPP) on corporate bond spreads at issuance. To ensure that extreme values do not drive the results, the analysis accounts for potential outliers in the option-adjusted spread (OAS) by excluding extreme values. The dependent variable is the OAS. Column I includes only the main CSPP variables. In Column II, bond-specific controls are added. Column III introduces firm-level controls, while Column IV adds macroeconomic variables. All regressions include firm and quarter fixed effects, with standard errors clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A4.10. *Robustness Check for Table 4.2: Excluding Outliers from OAS with Triple Interactions*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.230	-3.389**	-0.145	-1.689*	0.022
	(0.172)	(1.268)	(0.235)	(0.952)	(0.249)
$CSPP_{period_t}$	-0.322*	-1.709	0.065	-0.311	-0.333
	(0.158)	(1.212)	(0.372)	(0.200)	(0.192)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	0.364**	0.197	-0.003	-0.267	0.004
	(0.125)	(0.167)	(0.372)	(0.542)	(0.007)
$Issue\ amount_{jt}$ (log)	-0.062	-0.085	-0.061	-0.056	-0.078
	(0.087)	(0.086)	(0.090)	(0.086)	(0.088)
$Coupon_{jt}$	0.646***	0.646***	0.648***	0.639***	0.652***
	(0.051)	(0.050)	(0.052)	(0.052)	(0.055)
$Maturity_{jt}$ (years)	0.018***	0.019***	0.018**	0.020***	0.019**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)
$Credit\ rating_{jt}$	0.005	0.005	0.003	-0.011	0.004
	(0.013)	(0.012)	(0.014)	(0.021)	(0.013)
$Total\ assets_{it}$ (log)	-0.395	-0.483	-0.295	-0.056	-0.283
	(0.414)	(0.405)	(0.364)	(0.086)	(0.423)
ROA_{it}	-0.003	-0.003	-0.002	-0.004	-0.002
	(0.010)	(0.011)	(0.009)	(0.010)	(0.010)
$Debt\ ratio_{it}$	-0.794	-0.699	-0.401	-0.745	-0.846
	(0.816)	(0.738)	(0.660)	(0.799)	(0.822)
$Current\ ratio_{it}$	-0.045	-0.048	-0.044	-0.043	-0.046
	(0.051)	(0.052)	(0.054)	(0.051)	(0.051)
$GDP\ growth_t$	0.066**	0.059**	0.064**	0.059**	0.067***
	(0.022)	(0.024)	(0.024)	(0.023)	(0.022)
$Inflation_t$	0.131*	0.142*	0.142**	0.124*	0.122*
	(0.062)	(0.067)	(0.064)	(0.062)	(0.064)
$(CSPP_{eligible_{ijt}}$ x $Y)$		0.441**	-0.196	0.115	-0.023
		(0.170)	(0.463)	(0.074)	(0.017)
$(CSPP_{period_t}$ x $Y)$		0.197	-1.033	-0.002	0.004
		(0.167)	(1.010)	(0.019)	(0.007)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		-0.047	0.914	0.043	0.021
		(0.218)	(1.156)	(0.037)	(0.019)
Constant	3.672	4.439	2.819	3.651	2.998
	(2.989)	(2.898)	(2.601)	(3.107)	(3.102)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	816	816	816	816	816
R^2	0.9558	0.9570	0.9563	0.9565	0.9563
Within R^2	0.6117	0.6225	0.6163	0.6179	0.6163

This table presents extended regression results based on the baseline model (Equation 4.1), which includes all bond-specific, firm-level, and macroeconomic controls. To ensure the robustness of the results, the analysis accounts for potential outliers in the option-adjusted spread (OAS) by excluding extreme values. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Table A4.11. *Robustness Check for Table 4.3: Excluding Outliers from Year-on-Year Change in Debt Ratio (Year of Bond Issuance)*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.008	0.173	-0.048*	0.090	0.019
	(0.018)	(0.121)	(0.027)	(0.084)	(0.022)
$CSPP_{period_t}$	0.022*	0.034	0.015	0.019	0.023*
	(0.011)	(0.088)	(0.026)	(0.013)	(0.011)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	0.020	0.066	0.052*	-0.099	-0.007
	(0.013)	(0.142)	(0.028)	(0.116)	(0.019)
$Issue\ amount_{jt}$ (log)	0.002	0.003	0.001	0.001	-0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
$Coupon_{jt}$	-0.003	-0.003	-0.002	-0.004	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$Maturity_{jt}$ (years)	0.000	0.000	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Credit\ rating_{jt}$	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
$Total\ assets_{it}$ (log)	0.014	0.028	0.012	0.024	0.026
	(0.065)	(0.062)	(0.062)	(0.060)	(0.062)
ROA_{it}	-0.001	-0.001	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Current\ ratio_{it}$	0.001	0.001	-0.000	0.001	0.001
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
$Debt\ ratio_{it}$	-0.920***	-0.922***	-0.962***	-0.918***	-0.925***
	(0.090)	(0.087)	(0.101)	(0.093)	(0.088)
$GDP\ growth_t$	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$Inflation_t$	0.016**	0.016**	0.017**	0.016**	0.015**
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
$(CSPP_{eligible_{ijt}}$ x $Y)$		-0.025	0.114*	-0.006	-0.003**
		(0.017)	(0.061)	(0.005)	(0.001)
$(CSPP_{period_t}$ x $Y)$		-0.001	0.017	0.001	0.000
		(0.013)	(0.058)	(0.002)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		-0.006	-0.098	0.007	0.003*
		(0.020)	(0.062)	(0.008)	(0.001)
Constant	0.211	0.094	0.240	0.151	0.133
	(0.460)	(0.441)	(0.446)	(0.430)	(0.441)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	816	816	816	816	816
R^2	0.8463	0.8477	0.8491	0.8487	0.8489
Within R^2	0.4657	0.4704	0.4753	0.4740	0.4748

This table presents extended regression results based on the leverage model (Equation 4.2), which examines the year-on-year change in the firm's debt ratio as the dependent variable. To ensure that the extreme values do not drive the results, the analysis accounts for potential outliers in the dependent variable by excluding extreme values. All specifications include bond-specific, firm-level, and macroeconomic controls. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05, and ***p < 0.01.

Table A4.12. *Robustness Check for Table 4.4: Excluding Outliers from Year-on-Year Change in Debt Ratio (Year After Bond Issuance)*

	(I)	(II) *Y = Total assets (log)*	(III) *Y = Debt ratio*	(IV) *Y = Bond Credit Rating*	(V) *Y = Bond Maturity*
$CSPP_{eligible_{ijt}}$	-0.001	-0.042	0.010	-0.268*	-0.049*
	(0.022)	(0.146)	(0.027)	(0.131)	(0.026)
$CSPP_{period_t}$	-0.023	0.113	0.082**	-0.018	-0.031*
	(0.016)	(0.089)	(0.037)	(0.017)	(0.017)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t})$	-0.021	-0.130	-0.066*	0.298	0.012
	(0.018)	(0.165)	(0.035)	(0.196)	(0.027)
$Issue\ amount_{jt}$ (log)	0.004	0.003	0.003	0.006	0.008
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
$Coupon_{jt}$	-0.002	-0.002	-0.003	0.001	-0.005
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$Maturity_{jt}$ (years)	-0.000	-0.000	0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Credit\ rating_{jt}$	0.001	0.001	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
$Total\ assets_{it}$ (log)	0.039	0.016	0.045	0.013	0.029
	(0.093)	(0.097)	(0.083)	(0.082)	(0.089)
ROA_{it}	0.003	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Current\ ratio_{it}$	-0.000	-0.001	-0.000	-0.000	-0.000
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Debt\ ratio_{it}$	-0.140*	-0.148	-0.015	-0.143	-0.141
	(0.080)	(0.085)	(0.101)	(0.083)	(0.081)
$GDP\ growth_t$	-0.005	-0.005	-0.005	-0.004	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$Inflation_t$	-0.003	-0.003	-0.004	-0.002	-0.001
	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)
$(CSPP_{eligible_{ijt}}$ x $Y)$		0.005	-0.227**	0.018*	0.004**
		(0.021)	(0.283)	(0.009)	(0.002)
$(CSPP_{period_t}$ x $Y)$		-0.020	-0.094	-0.001	0.001
		(0.013)	(0.059)	(0.001)	(0.001)
$(CSPP_{eligible_{ijt}}$ x $CSPP_{period_t}$ x $Y)$		0.016	0.123	-0.020	-0.003
		(0.023)	(0.075)	(0.013)	(0.002)
Constant	-0.224	-0.053	-0.306	-0.065	-0.172
	(0.658)	(0.687)	(0.592)	(0.581)	(0.635)
Firm and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	816	816	816	816	816
R^2	0.6086	0.6107	0.6156	0.6274	0.6139
Within R^2	0.0453	0.0503	0.0623	0.0912	0.0581

This table presents extended regression results based on the leverage model (Equation 4.2), where the dependent variable is the year-on-year change in the firm's debt ratio in the year following bond issuance (t+1). To ensure that extreme values do not drive the results, the analysis accounts for potential outliers in the dependent variable by excluding extreme values. All explanatory variables, including CSPP eligibility and control variables, are measured at time t, corresponding to the year of bond issuance. Column I replicates the baseline specification. Columns II to V introduce triple interaction terms to explore the effects of the CSPP based on firm- and bond-specific characteristics. Specifically, Column II includes an interaction with firm size (log of total assets), Column III with financial leverage (debt ratio), Column IV with bond credit quality (credit rating), and Column V with bond maturity at issuance. All regressions include firm and quarter fixed effects, and standard errors are clustered at the firm and quarter level. The sample excludes firms with missing accounting data and firms with only one bond issue, which are dropped by the fixed effects estimator. Statistical significance is indicated by *p < 0.1, **p < 0.05 and ***p < 0.01.

Chapter 5
Policy Implications and Broader Lessons for the Eurozone

5.1. Overview of the dissertation's main contributions

The primary focus of this dissertation is to evaluate the impact and the transmission of the three unconventional monetary policies of the ECB during the times of economic distress: Targeted Longer-Term Refinancing Operations (TLTRO), Pandemic Emergency Purchase Programme (PEPP), and Corporate Sector Purchase Programme (CSPP). Each of these monetary policy tools targets a specific transmission channel: bank lending, sovereign bond markets and corporate finance.

The results show that these interventions are generally effective, but they do not work independently. Their effectiveness depends on the institutional and structural features of banks, firms and countries. This finding aligns with the broader literature on the conditional effectiveness of monetary policy (e.g, Beetsma and Giuliodori, 2010; Gutiérrez-Diez and Pál, 2023). It also highlights the need to rethink the coordination of monetary, fiscal and prudential policies in the Eurozone. This is in line with the proposal by Blanchard et al. (2021), who argue for a more integrated and flexible policy framework capable of dealing with the structural asymmetries within the Eurozone.

5.2. Key policy lessons

The findings of this dissertation highlight several important policy lessons about the design, implementation and effectiveness of unconventional monetary policies implemented by the ECB during times of financial and economic difficulty.

First, while unconventional monetary policies have contributed to stabilising financial markets and improving access to financing, their impacts are not uniform. For instance, in the TLTRO programme, eligible banks that participated exhibit improvements in financial resilience, which suggests that effective liquidity provision can enhance stability in the banking sector. However, the overall liquidity created by these interventions also led to increased perceived default risk among non-participating banks. This indicates that monetary support may have adverse effects if not backed by proper safeguards, as noted in studies by Borio and Zhu (2012) and Altunbas et al. (2010). Similarly, the PEPP was more successful in lowering sovereign bond spreads in countries

with stronger fiscal positions. This asymmetry suggests that the credibility of national fiscal policies is crucial in the transmission of ECB interventions. This supports Constâncio's (2020) argument that fiscal policy has become an important stabilisation tool as the benefits of monetary support have diminished. In countries with high debt levels, the ECB's intervention did not reduce sovereign bond spreads, indicating that fiscal concerns remained dominant. This also illustrates the limits of monetary policy in the presence of fiscal vulnerability. This concern is shared by Blanchard et al. (2021), who argue that rigid fiscal rules can hinder effective macroeconomic coordination. They support more flexible fiscal rules that consider country-specific debt dynamics and support monetary transmission. Finally, with the CSPP, firms that issued longer-maturity bonds under the programme increased their debt ratios one year after issuance. This suggests that the impact on the corporate balance sheet occurs gradually. This finding aligns with evidence from Fabiani et al. (2024) and Karasoy Can (2025), who show that the structure and maturity of corporate debt significantly affect the timing and intensity of monetary policy transmission.

Second, the findings highlight the importance of aligning fiscal and monetary policies. Monetary policy cannot fully counter the effects of structural fiscal weaknesses, as evidenced by PEPP's diminished impact in fiscally vulnerable countries. This is in line with Lane (2020), who emphasises that fiscal fundamentals significantly influence the transmission of asset purchase programmes. In countries with stronger fiscal fundamentals, evidence shows that both spread reduction and monetary transmission were more effective. This relationship highlights the need for expansionary fiscal measures to remain credible and well-targeted. This view is shared by Constâncio (2020) and Blanchard et al. (2021), who argue for closer policy alignment within the Eurozone to improve macroeconomic stability. When designing asset purchase programmes, monetary authorities such as the ECB must consider the fiscal context. Furthermore, coordination between the ECB and national fiscal authorities, especially during crises, is crucial for restoring confidence and the effectiveness of the policy mix (Blanchard et al., 2021; Buti and Messori, 2021).

Third, the analysis shows that prudential and supervisory safeguards are important when using unconventional monetary policy tools. There is no evidence that, under the TLTRO framework, banks significantly increased their risk exposure, particularly through lending. This finding suggests that regulatory frameworks and supervisory oversight effectively prevented excessive risk-taking and mitigated moral hazard. It also

supports the idea that monetary policy and macroprudential supervision are complementary and should be jointly adjusted. In this context, monetary authorities and regulators can benefit from using forward-looking, market-based risk indicators like Distance to Default (DtD). These indicators can offer valuable insights by helping to identify changes in risk perceptions that traditional balance-sheet indicators may not capture (Gropp et al., 2006; Singh et al., 2015).

When combined, these lessons suggest that the effectiveness of ECB unconventional monetary interventions relies on both the instruments used and the overall policy environment in which they are applied. Strong fiscal fundamentals, stable financial systems and consistent regulations across the Eurozone are needed for the transmission mechanism to work effectively.

A key point from this dissertation is that monetary, fiscal and prudential policies should be jointly developed, rather than separately. The ECB's programmes interact with institutional and national conditions in complex ways. To illustrate this, the diagram below (Figure 5.1) shows how different policy areas must work together for unconventional monetary policy to be successfully transmitted.

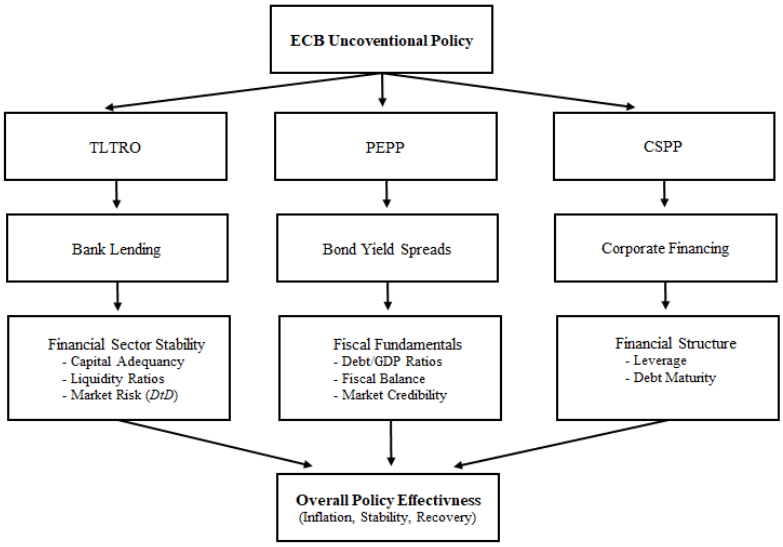

Figure 5.1. Framework for the Effectiveness of ECB Unconventional Instruments under Fiscal and Financial Constraints.

This framework illustrates how each ECB unconventional programme (TLTRO, PEPP, and CSPP) affects specific financial markets and depends on individual institutional and macroeconomic conditions. The effectiveness of these policies

ultimately depends on fiscal soundness, financial sector stability and the resilience of corporate balance sheets.

5.3. Recommendations for future ECB programme design

Based on the findings of this dissertation, several practical recommendations can be made for the future design and implementation of unconventional monetary programmes by the ECB. These suggestions are mainly based on the dissertation's findings, but selected references from the literature are included to support and provide context for the proposed policy directions.

First, future refinancing operations, such as the TLTRO, should focus on a high degree of targeting and conditionality. The results indicate that when participation criteria and performance benchmarks are clearly defined, access to central bank liquidity often leads to greater financial stability without encouraging excessive risk-taking. Clear eligibility rules ensure that monetary support effectively reaches the real economy through productive lending channels.

Second, fiscal analysis should be included in the design of asset purchase programmes. The heterogeneous effects of the PEPP show that the impact of monetary interventions critically depends on the fiscal situation of each country. To enhance the programme's effectiveness and reduce unintended distortions, asset purchase allocations should consider fiscal fundamentals, such as debt levels and fiscal balances. Additionally, the ECB could benefit from closer coordination with European fiscal institutions, including the European Stability Mechanism (ESM) and the European Commission, to align policy signals and reduce financial market fragmentation within the Eurozone.

Third, the delayed transmission effects of certain monetary programmes should be considered. The analysis of the CSPP showed that changes in corporate balance sheets, such as increased leverage, often occur in the periods following programme participation. This highlights the need for post-intervention monitoring frameworks to track important financial indicators over time, including debt ratios and maturity structures. This monitoring would help identify and reduce potential accumulations of financial vulnerabilities.

Fourth, transparency in programme participation and results should be promoted to improve policy effectiveness and public accountability. Making data on programme uptake, such as TLTRO volumes at the bank level or bond eligibility under CSPP, available to researchers and the public would allow for better assessments of the

programme. This would reinforce market discipline and encourage informed debate on policy design (Dincer et al., 2022).

Finally, the ECB should expand and formalise the role of forward-looking, market-based risk indicators within its traditional set of analytical tools. Indicators such as DtD, credit default swap (CDS) spreads and equity-based risk measures can provide timely information on changes in the perception of financial risk and systemic vulnerability. The continuous use of these indicators in the ECB's regular monitoring practices would enhance its ability to detect early signs of stress and respond proactively (Gropp, Vesala & Vulpes, 2006; ECB, 2017; Singh and Gómez-Puig, 2024).

In summary, these recommendations suggest a more interconnected, data-based and forward-looking approach to unconventional monetary policy. By improving the alignment between liquidity provision, fiscal realities, and financial supervision, the ECB can maximise the effect of its interventions while protecting financial stability throughout the Eurozone.

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