THE IMPACT OF SOVEREIGN DEBT PURCHASE PROGRAMMES. A CASE STUDY: THE SPANISH-TO-PORTUGUESE BOND YIELD SPREAD

2024

BANCO DE ESPAÑA
Eurosistema

Documentos de Trabajo
N.º 2422

Fernando Cerezo, Pablo Girón, María T. González-Pérez and Roberto Pascual

THE IMPACT OF SOVEREIGN DEBT PURCHASE PROGRAMMES. A CASE STUDY: THE SPANISH-TO-PORTUGUESE BOND YIELD SPREAD

THE IMPACT OF SOVEREIGN DEBT PURCHASE PROGRAMMES. A CASE STUDY: THE SPANISH-TO-PORTUGUESE BOND YIELD SPREAD (*)

Fernando Cerezo

BANCO DE ESPAÑA

Pablo Girón

BANCO DE ESPAÑA

María T. González-Pérez

BANCO DE ESPAÑA

Roberto Pascual

BANCO DE ESPAÑA

(*) The authors would like to thank Juan Ayuso, Emiliano González, Ricardo Gimeno, Emilio Rodríguez, Alberto Fernández and Jesús Ibáñez, all participants at the Bank of Spain internal seminar, and Banco Santander, for their suggestions and helpful comments. Banco de España, Alcalá, 48, 28014, Madrid, Spain. Emails: fernando.cerezo@bde.es, pablo.giron@bde.es, mgonzalezperez@bde.es, roberto.pascual@bde.es.

Documentos de Trabajo. N.º 2422

June 2024

https://doi.org/10.53479/36797

ISSN: 1579-8666 (on line)

Abstract

This paper studies the impact of the sovereign bond purchase programmes implemented by the ECB since 2014, focusing on the dynamics of Spain to Portugal's sovereign bond yield spread. The analysis confirms that, although fundamental fiscal, macroeconomic, and financial factors effectively explain the bond yield spread dynamics for most of the period, the ECB asset purchase programmes and the stock of long-term debt outstanding in bonds in both countries contribute to explaining the bond yield spread dynamics observed since 2020.

Keywords: bond yield differentials, asset purchase programmes, quantitative easing, quantitative tightening, credit risk, liquidity risk, Eurosystem.

JEL classification: E43, E51, E58, C3.

Resumen

Este documento estudia el impacto de los programas de compra de bonos soberanos implementados por el Banco Central Europeo desde 2014, centrándose en la dinámica del diferencial de rendimiento de los bonos soberanos de España y Portugal. El análisis confirma que, si bien los factores fundamentales fiscales, macroeconómicos y financieros explican la dinámica del diferencial de rendimiento de los bonos durante la mayor parte del período, los programas de compra de activos de los bancos centrales y el *stock* de deuda a largo plazo en circulación en bonos contribuyeron en ambos países a explicar la dinámica de los diferenciales de rendimiento de los bonos observada desde 2020.

Palabras clave: diferenciales de rendimiento de bonos, programas de compra de activos, *quantitative easing, quantitative tightening,* riesgo de crédito, riesgo de liquidez, Eurosistema.

Códigos JEL: E43, E51, E58, C3.

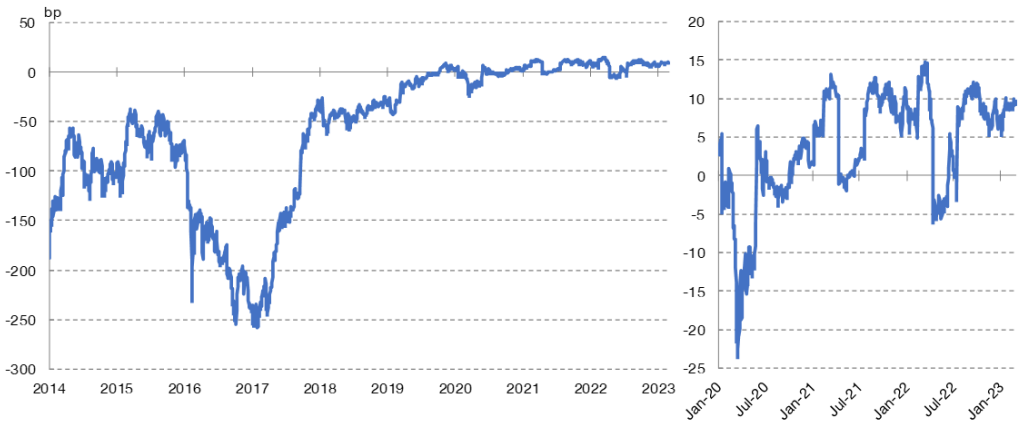
1 Introduction

Since central banks have implemented large-scale asset purchase programmes, many research studies have shown a keen interest in studying the impact and effectiveness of such instruments on financial markets in general and on fixed income markets in particular. This study aims to analyze the performance of both Spain's and Portugal's sovereign bond yields and the impact of the Eurosystem asset purchase programmes on the bond yield spread between them.

Studying the Spain to Portugal bond yield differential dynamics constitutes a novel and attractive case study. Both countries are comparable to international investors due to similarities such as their membership in a common monetary area, their economic sector composition, and their geographical situation. This allows us to isolate the effect of asset purchase programmes from other factors. Moreover, the spread has been evolving since the implementation of the ECB purchase programmes, first in favor of Spain until 2017 and then favoring Portugal, showing a change in its sign within this period, which makes a case for the analysis of the different factors that may have influenced it throughout the analyzed period; see Figure 1. This paper aims to identify these factors.

A broad set of articles identifies credit and liquidity risks as the primary determinants of sovereign bond yield differentials since other factors, such as exchange rate risk, taxation, and capital flow controls, do not apply in a monetary union. Recent literature finds large-scale asset purchase programmes impacting bond markets through different channels (see Section 2). Following this research line, we study the impact of ECB asset purchase programmes in the Spain-to-Portugal 10-year sovereign bond yield differential. The rest of the article is outlined as follows. Section 3 provides a brief overview of the ECB purchases programmes since 2009, with the acquisition of covered bonds, to 2023, with the ongoing implementation of the Asset Purchase Programme (APP) and Pandemic Emergency Purchase Programme (PEPP). Section 4 describes the variables used in our analysis. Section 5 tests whether credit and liquidity risks explain the recent evolution of the Spain-to-Portugal bond yield differential. Furthermore, this section delves into finding empirical evidence regarding the influence of Eurosystem purchases and each country's debt structure and issuance on the bond yield spread dynamics. It examines the impact of these purchases on the spread, controlling for the proportion of securities held by the central bank relative to the long-term debt stock of each jurisdiction. Finally, Section 6 concludes.

Figure 1: Spread between the Spanish and Portuguese 10-year sovereign bond yields.



Source: Bloomberg

2 Literature Review: the drivers of sovereign bond yields.

Much of the literature studies the determinants of sovereign bond yield differentials in advanced and emerging economies and, more recently, in the European Monetary Union (EMU), where a cross-country heterogeneous monetary policy is absent. Several financial and macroeconomic factors and the central bank purchase programs can affect sovereign bond yields through different channels. Codogno et al. (2003) find four main factors driving bond-yield differential prior to the EMU: the exchange rate risk, different tax treatments and controls on capital movements, liquidity risk, and credit (or default) risk. However, only two remained relevant once the EMU started: the credit and liquidity risks.[1]

Credit risk, one of the main determinants of sovereign bond yield spreads, is directly related to debt sustainability, which depends on budget surpluses/deficits, future economic activity, and interest rates, which are also affected by domestic and international factors. Hence, the fiscal soundness of a country, like the government deficit or debt-to-GDP ratios, is set among the variables that explain bond yield differentials. Several works study their impact on EMU sovereign yield spreads, such as Haugh et al. (2009), Bernoth et al. (2012), Bernoth and Erdogan (2012), Afonso et al. (2015), Giordano et al. (2013), Costanini et al. (2014), Afonso and Nunes (2015), Paniagua et al. (2017) and Matei (2022), to name a few. These authors find evidence in favor of a non-linear relationship between fiscal performance and yield differentials (the effects on the latter tend to be greater at higher levels of indebtedness) and the importance of expected deficits instead of current ones (due to the forward-looking behavior of financial markets).

Other variables related to credit and default risk that may help explain bond yield differentials are sovereign ratings and Credit Default Swaps (CDS). Regarding the first, rating agencies assess the default risk of a country, thus providing a piece of similar information to the one contained in the standard macroeconomic statistics of a given country. Cantor and Packer (1996) claim that these series contain additional information that makes them strongly correlated with yield differentials. Thus, Afonso et al. (2012) find a two-way causality relationship between sovereign credit ratings and bond spreads; Vries and Hann (2014) show that this relationship changes over time; and Böninghausen and Zabel (2015) state that rating downgrade and negative outlooks have a stronger effect on bond yield differentials, while the upgrades' impact is much more limited.[2] We may expect that the CDS dynamics inform about a country's credit risk similarly to sovereign yields (see Arce et al. (2013)). However, their low liquidity for some countries could affect their price and make them less representative and less comparable between jurisdictions. However, they have been used in the literature to measure credit quality and explain sovereign bond yield differentials in the Euro area, for example, Beber et al. (2009), Paniagua et al. (2017), and Schwarz (2019).

In relation to credit risks, forecasts play a significant role in shaping investors' decisions regarding acquiring or disposing of financial assets. In this context, sovereign bond yields would be influenced by expectations related to various monetary and fiscal policy variables. Papers such as Chun (2011) include economic forecasts as part of dynamic arbitrage-free models for bond yields.

Liquidity risk has also been extensively analyzed as a determinant of sovereign yield differentials. The evidence about its role as a bond yield driver is mixed. Some papers find its impact

[1] Regarding liquidity risk, the theory states that the return demanded by investors is expected to be lower for bonds that can be traded quickly and at low cost. Credit or default risk relates to the possibility that the issuer (in this case, a country) may not honor their obligations in part or in full.

[2] Although, as will be seen later, rating upgrades can explain some developments on the yield differential between Spain and Portugal.

non-significant in euro-area countries, see Hagen et al. (2011) and Bernoth et al. (2012), while others see a significant but limited effect on differentials, weaker than the credit risk, or only prevailing in specific countries or period; see Gómez-Puig (2016), Beber et al. (2009), Favero et al. (2010), Barbosa and Costa (2010), Costanini et al. (2014), Paniagua et al. (2017), Schwarz (2019). Most works use liquidity measures based on transaction costs (bid-ask spreads), trading volumes, or outstanding amounts of bonds.

Alternatively, there is an extensive list of other factors that have been found important to explain yield differentials, including global determinants like the general level of uncertainty, see Baker and Wurgler (2012), Cesare et al. (2012), Dergiades et al. (2015), Georgoutsos and Migiakis (2018), contagion effects, see Beetsma et al. (2013), Santis (2014), Kohonen (2014), or global financial conditions, see Maltritz (2013).

More recently, the literature warns about the potential effect of purchase programmes on bond yield differentials. There is a general consensus that securities purchase programmes are effective in lowering bond yields. Several studies have analyzed and quantified this impact and the various transmission channels through which it occurs (e.g., Li and Wei (2013), Krishnamurthy et al. (2018), Arrata and Nguyen (2017), Blattner and Joyce (2016), Costain et al. (2022), Andrade et al. (2016)). Many of these studies build on the work of Vayanos and Vila (2009) and Vayanos and Vila (2021), which propose a model of the term structure of bond rates that result from the interaction of investors and risk-averse arbitrageurs, showing how asset purchase programmes reduce bond yields by reducing bond risk premia.

From a theoretical perspective, purchase programmes affect bond yields through various transmission channels, although empirical evidence may be difficult to obtain. According to the theoretical framework by Vayanos and Vila, one transmission channel through which purchase programmes can reduce sovereign yields is the "duration risk channel," also referred to as the "asset valuation channel." By purchasing large quantities of bonds, particularly those with longer maturities, central banks remove assets with high duration from the market (i.e., assets with higher price sensitivity to interest rate changes). The duration risk is reflected in bond prices through a term premium, compensating for bearing risk related to interest rate changes.

Through asset purchase programmes, central banks thus reduce the aggregate amount of duration risk that the market has to absorb, leading to lower bond yields. Under this approach, the reduction in yields would be more significant the longer the duration and the greater the number of bonds purchased under the programme. As a result, sovereign yield curves tend to flatten. This effect depends not only on the absolute volume of purchases but also on the remaining debt stock and its associated duration risk after central bank purchases (i.e., the free float), as well as its expected future evolution. Studies, such as Blattner and Joyce (2016) and Equiza et al. (2023), investigate the implications of a shock in the net debt supply, such as purchase programmes, on sovereign yields. In particular, Equiza et al. (2023) develop a forward-looking model where a purchase shock equivalent to 10% of Euro Area GDP reduces the 10-year average yield of the four largest jurisdictions by 59 basis points.

Following a similar approach, other studies, such as Schlepper et al. (2017), refer to the existence of a "scarcity effect". This is related to the reduction in the free float after central bank purchases, causing a supply shortage for certain assets and leading to a price increase and lower yields, in this case, due to factors such as liquidity and demand rather than duration.

In addition, purchase programmes can lower yields through their impact on the central bank's communication strategy and forward guidance. This is known as the "signaling effect." According to this theory, demonstrated in studies such as Bhattari et al. (2023) or Jeanne and Svensson (2007), purchase programmes can increase the investor's confidence in the central

bank's commitment to keeping interest rates low for a long period. Since the central bank assumes the risk associated with the securities it acquires from the markets, it will incur losses if interest rates rise suddenly. As a result, the signaling channel affects the expectation of future market interest rates, driving them down and lowering bond yields since the very announcement of the programme. Through this approach, purchase programmes can also lower bond yields by aligning the central banks and the market's expectations of future inflation, bringing them closer to the goal of price stability and reducing the inflation break-evens of bonds. This is referred to as the "re-anchoring channel" (e.g., Andrade et al. (2016), Gürkaynak et al. (2005)). Finally, as purchase programmes lower bond yields of safer assets, the "portfolio rebalancing channel" induces investors to rebalance their portfolios to increase exposure to riskier assets with higher expected returns, expanding the impact of the programmes to assets that are not necessarily eligible for purchases (Albertazzi et al. (2021)). The research on the effectiveness and transmission of non-conventional monetary policies remains a crucial area, particularly after the extraordinary stimulus implemented by central banks in response to the COVID-19 pandemic. In this regard, Costain et al. (2022) contributes by introducing a "default risk extraction channel." This channel suggests that through central bank asset purchases, the anticipated quantity of defaultable bonds and the probability of sovereign default can be diminished, decreasing the compensation investors require to absorb default risk.

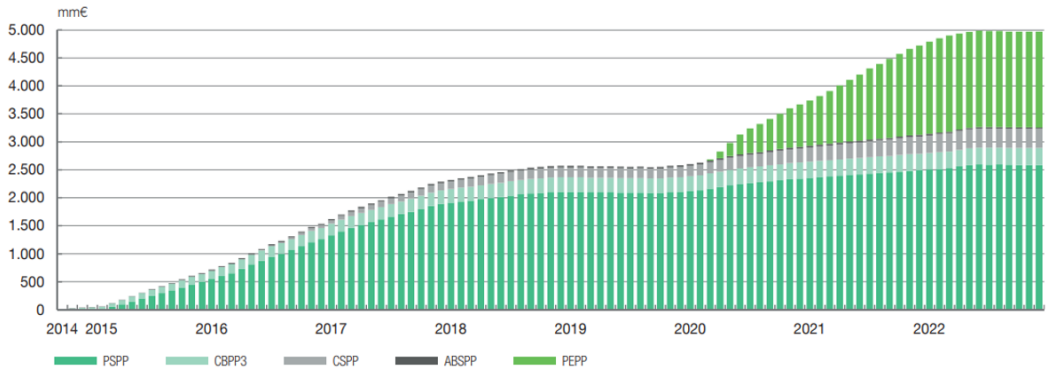
Also, regarding the Euro area, there is evidence in the literature favoring ECB Quantitative Easing programmes affecting the sovereign bond spread level and volatility in the region in previous turmoil episodes. Arce et al. (2013) find that Eurosystem debt purchases affected the fundamental value of euro-area bonds during the Sovereign Debt Crisis after controlling for counterparty and liquidity risk, financing costs, volatility, and flight-to-quality factors. Recent work by Belke et al. (2021) also finds that "[PSPP] central bank bond buying (in the euro area) is likely to increase risk spreads, or at least to make them more variable."

3 The ECB purchase programmes

Central banks established purchase programmes as a non-conventional monetary policy instrument to attain their central mandates (maintaining price stability and ensuring the effective functioning of the financial system), especially during periods of low interest rates and inflation. In 2009, as a means of boosting credit flow to households, the ECB launched its first covered bond purchase programme (CBPP1), which ended in 2010 and was reinitiated again in 2011 (CBPP2). The ECB expanded its purchases to include public sector bonds under the Securities Markets Programme (SMP) in 2010 and, later, under the Outright Monetary Transactions (OMT) since 2012. In 2014, the ECB launched its largest programme, the Asset Purchase Programme (APP). The APP consists of different portfolios for several asset types, such as covered bonds (CBPP3), corporate sector bonds (CSPP), asset-backed Securities (ABSPP), and public sector bonds (PSPP). The PSPP portfolio, which consists of bonds from central governments, recognized agencies, regional and local governments, international organizations, and multilateral development banks located within the Eurozone, is the largest portfolio of the APP, accounting for approximately 80% of the total holdings, mainly in the form of Euro Area central government sovereign bonds. In total, the APP has increased the Eurosystem's balance sheet by over €3,000 billion until July 2022, when the Governing Council announced the end of net purchases under this programme; see Figure 2.

In March 2020, the ECB launched the Pandemic Emergency Purchase Programme (PEPP) to respond to the COVID-19 pandemic and support the smooth transmission of monetary policy and credit supply to the private and public sectors. The Governing Council increased the initial €750 billion envelope to a total of €1,850 billion, predominantly allocated to public sector bonds. The PEPP entailed only minor additions to eligible assets, but it introduced greater

Figure 2: Cumulative purchases under the APP and PEPP. Source: ECB.



Source: ECB

flexibility in purchases over time across asset classes and among jurisdictions. Net purchases under the PEPP concluded at the end of March 2022, and the maturing principal payments will be reinvested until at least the end of 2024.

The Eurosystem allocates the purchases of public sector bonds among jurisdictions based on the capital key of the respective national central banks. The capital key serves as a measure of each country's relative weight within the European Union, as determined by its population and Gross Domestic Product. The recalibration of the capital key occurs every five years or in the event of a new member joining the European Union. As of January 2023, the capital key for Spain and Portugal was 11.83% and 2.32%, respectively. This metric has remained consistent over the recent years.

4 Data

Table 1 includes the economic and financial indicators we use in the analysis. The daily 10-year sovereign bond yield for Spain and Portugal[3] is obtained from Bloomberg. We estimate an adjusted bond yield differential using the benchmark bonds provided by the supplier. We perform this calculation because there are sudden changes in the original spread at specific points in time unrelated to the bond yield underlying performance. Since 2020, these can be spotted in May 2020, April 2021, and April 2022; see Figure 3.

The abrupt movements in the bond yield differential can be partially explained by a more frequent review of the reference bond in Spain than in Portugal.[4] This first implies that the actual maturity days do not coincide.[5] There is also a significant difference in the reference bond coupons for Spain and Portugal.[6] To illustrate this relationship, Figure 4. relates the maturity

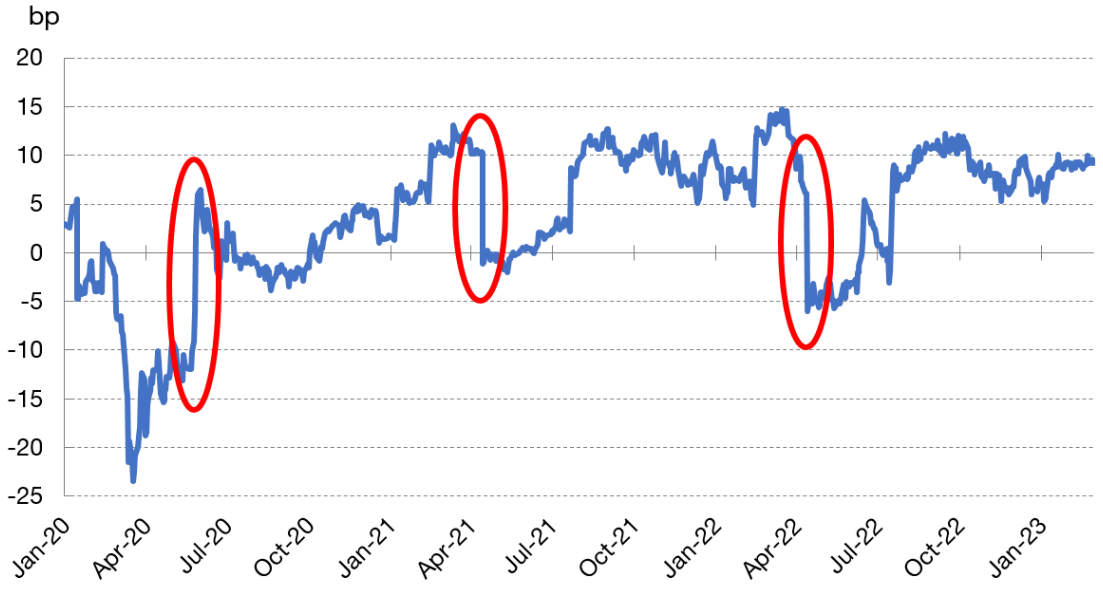
[3]We use the 10-year maturity because it is widely considered the benchmark when studying long-term developments of sovereign markets (as Codogno et al. (2003) states, this is "the most actively traded maturity in the eurozone government securities market." (page 508), and "are highly standardized products." (page 509). We also checked the Spanish-Portuguese spreads built with the 1, 3, 5, and 7-year sovereign bonds, but the change on their sign happened at almost the same time (see Figure 15).

[4]The bonds used as benchmarks depend on the data provider. Although we use Bloomberg data, we have also checked the benchmarks chosen by Refinitiv. In both cases, since 2014, there have been two reference changes per year in Spain, compared to one per year in Portugal.

[5]For example, using Bloomberg references, as of February 28th, 2023, the Spanish government bond matures in October 2023, while the Portuguese matures in July of the same year. The difference is, therefore, 107 days.

[6]For example, using Bloomberg references, on February 28th, 2023, there is a difference of 90 bps between the coupons of the 10-year bond benchmark in both countries (2.55% for Spain and 1.65% for Portugal).

Figure 3: Spread between the Spanish and Portuguese 10-year sovereign bond yields. Source: Bloomberg.



Source: Bloomberg

(measured in days) and coupon differentials (measured in basis points) of the benchmark 10-year bonds with the yield spread in both countries. The extreme movements in the yield differential match the days when a new bond with a longer maturity replaces the reference bond for one of the countries.

Given this evidence, the reference bond yields are corrected to represent a comparable duration.[7] We label these series as "adjusted benchmark bonds." To calculate them, we interpolate the government bond yield curve using the benchmark bonds for every maturity between one and thirty years and the Svensson (1994) yield curve model, which can be described with the following formula (1), where i denotes the spot rate, m is the maturity, t is the trading day, and the β_i and the τ_i are the parameters that define the shape of the curve. The 10-year duration bond for each country in that curve is then used to calculate the adjusted spread daily series analyzed in this note.[8] Figure 5 displays the original and the adjusted spreads.

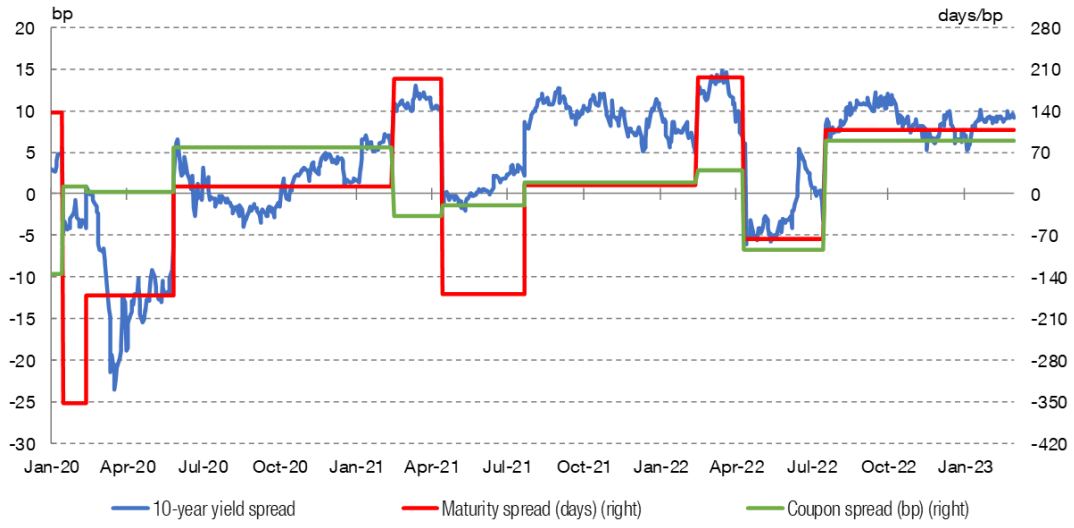
$$\begin{aligned} i_t(m) &= \beta_{0t} + \beta_{1t}\frac{1-e^{-m/\tau_{1t}}}{m/\tau_{1t}} + \beta_{2t}\left(\frac{1-e^{-m/\tau_{1t}}}{m/\tau_{1t}} - e^{-m/\tau_{1t}}\right) + ... \\ &+ \beta_{3t}\left(\frac{1-e^{-m/\tau_{2t}}}{m/\tau_{2t}} - e^{-m/\tau_{2t}}\right) + \varepsilon_t \end{aligned} \tag{1}$$

Among the potential drivers of the dynamics of this differential, we consider the role of credit risk and liquidity risk measures. Based on previous studies, we use some of the most common indicators that were found relevant. Specifically, we employ the debt-to-GDP ratios, a sovereign rating index, and 10-year Credit Default Swaps (CDS) for credit risk, and four differ-

[7] The duration of a bond is the weighted average of its future cash flows. This value accounts for its time to maturity and the coupon rate.

[8] Other works follow a different approach to compare bonds with different residual maturities. For example, Barbosa and Costa (2010) introduce a dummy variable with this difference (measured in days) between one of the euro area countries they study and the German bond. Bernoth and Erdogan (2012) calculate the spread with the yield of the primary issue, where the total maturity and residual maturity coincide.

Figure 4: Spread between the 10-year sovereign bond yields, maturity and coupon of the reference bonds (ES-PT).



ent indicators of the benchmark 10-year sovereign bonds for liquidity risk (bid-ask spread, price range, volatility, and Roll measure). Given that various global factors found relevant in the literature, like financing conditions, market sentiment, and instability, are not expected to influence our dependent variable, measured in terms of spreads, we have chosen to exclude them from the scope of our analysis.

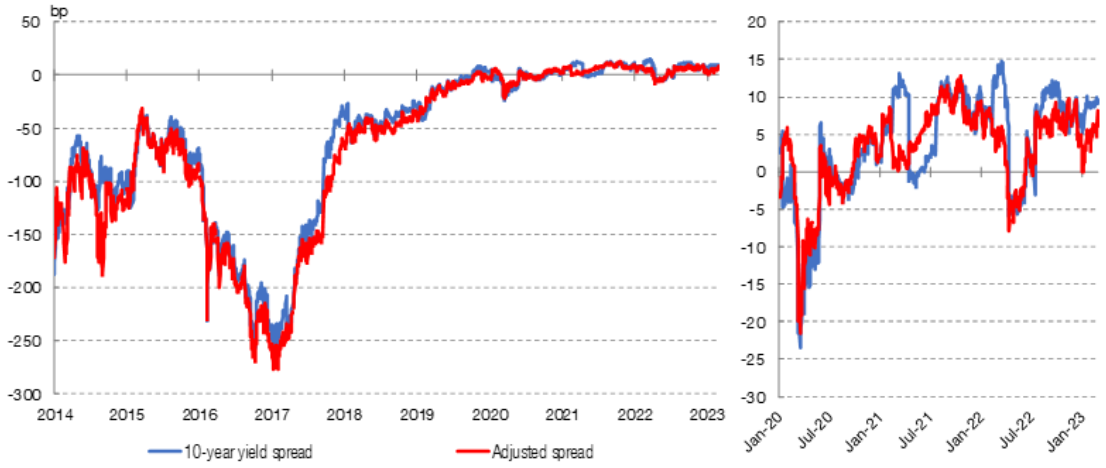
The first variable of credit risk measures the level of public indebtedness of a country in relative terms, and it was obtained from Bloomberg. We calculate the sovereign rating index as an average of Fitch, Moody's, Standard & Poors, and DRBS long-term domestic issuer ratings. All agencies use similar scales, so the rating in one of them has an equivalent in the others. We use a linear scale from 1 to 21, where lower values reflect worse ratings, and 21 corresponds to AAA. Each unitary change in its value implies a unitary change in the rating. Ratings data are obtained from Refinitiv and CDS data from Datastream. Measuring liquidity risk is challenging, as different indicators sometimes provide contradictory signals. Besides, data availability for smaller economies and long periods is scarce. To measure liquidity, we constructed a simple aggregated measure[9] based on four indicators: bid-ask spread, price range (intraday price variation), volatility (20days standard deviation of daily price changes), and Roll estimator (Roll (1984)) (autocovariance of daily returns over a 5-day window).

Due to the importance of the asset purchase programmes and the structure of the debt stock of each country, we employ various measures in our qualitative and quantitative analysis. The most important variable is the ratio between the Eurosystem bond holdings acquired by the PSPP and the PEPP programmes (considering only public bonds in the latter) and the long-term total debt outstanding in bonds, which we label as "CBBH." This variable measures the relative footprint of the Eurosystem programmes on each country. We obtain data for this ratio from Bloomberg, the International Monetary Fund (IMF), the ECB, and the Bank of Spain.[10] We also consider the structure of each country's sovereign debt, obtaining the total long-term and short-term outstanding debt, including securities, loans, and other non-tradable. Finally, we measure

[9] For each indicator, we first calculate the Spain-Portugal spread in comparable units by calculating the logarithm of the ratio (ES/PT) and finally, we calculate the median of the four indicators for each given date.

[10] Eurosystem holdings of Portugal have been interpolated using the quarterly relationship between data available at amortized cost and at face value. Specific details are available upon request.

Figure 5: 10-year Sovereign Bond yield differential (ES-PT), original and adjusted.



Source: Bloomberg and own ellaboration.

the net government long-term debt bond issuance in Spain and Portugal, subtracting from each country's gross issuance the purchases made by the Eurosystem. The data for these two last measures are obtained from public national sources (Bank of Spain and IGCP –Portuguese Treasury and Debt Management Agency) and the ECB.

Our daily data covers the period from January 2014 (when the Eurosystem launched the APP) to February 2023. The monthly series are available from January 2014 to December 2022. The quantitative analysis employs monthly data. The use of this frequency is standard in the literature and allows us to maintain consistency in the analysis, avoiding potential "day of the week" effects and the presence of outliers.

Our study focuses on the determinants of bond yield spreads and develops an in-sample analysis to shed some light on the recent evolution of the Spain-Portugal sovereign bond yield spread. Future research will include out-of-sample analysis to build on predictive models to forecast the Spain-to-Portugal sovereign bond yield spread dynamics.

Table 2 includes main descriptive statistics for the variables in Table 1 that we use in the quantitative analysis. For the sake of simplicity in the notation, we label the 10-year bond yield as r^x (x: Spain and Portugal, respectively), the Spain-to-Portugal bond yield differential as Dr, the bid-ask spread for the 10-year bond yield as BAS^x, the bid-ask spread differential as DBAS, the bond-yield average rating in each of the countries as $Rating^x$, the Spain-to-Portugal bond rating as DRating, the CDS for each country as CDS^x, the CDS differential as DCDS, the ECB holding of Spanish and Portuguese bonds to long debt outstanding as $CBBH^{ES}$ and $CBBH^{PT}$, respectively and DCBBH for the differential. The Debt-to-GDP ratio in each country is set as $DGDP^x$, respectively and the gap between this ratio in Spain and Portugal as DDGDP. The average signs of Spain to Portugal differentials are the expected. All of them, except the Rating index, show a negative sign over the whole period. The gap of adjusted bond yields, bid-ask spreads, ratings, CDSs, and debt-to-GDP ratios point toward Spain's lower Sovereign bond yield. In contrast, the negative sign of the CBBH spread indicates that the footprint of the Eurosystem purchase programmes in Portugal has been higher on average. The following section will elaborate on this descriptive analysis.

[Include here Table 2]

5 Empirical analysis

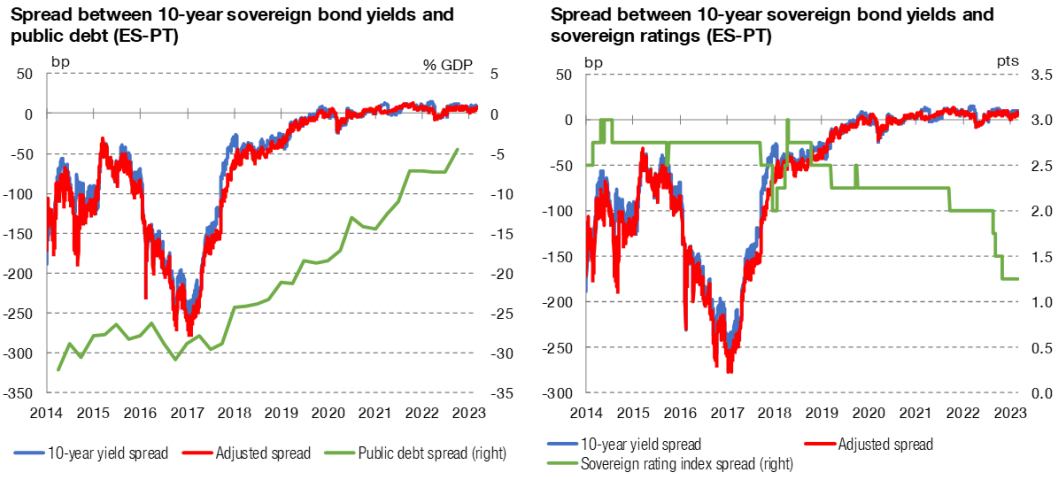
5.1 A qualitative approach

(a) Credit and liquidity risk

We study the time-varying dynamics for potential credit and liquidity risk drivers detailed in the previous section. Figure 6 shows a progressive reduction in debt-to-GDP and sovereign rating differentials in favor of Portugal by more than 20 percentage points in the first case and halving in the second. The CDS spread illustrated in Figure 7 (left) moves similarly to the yield differential until 2020. Regarding liquidity factors, Figure 7 (right) depicts the evolution of the aggregated liquidity indicator, which shows the relative illiquidity of the Portuguese bond in the period 2015-2018 and a significant improvement from 2019 onwards, bringing it to a level comparable to the Spanish market, even though liquidity conditions have been favorable to Spain for most of that period.

Therefore, all four indicators show a similar trend, with the gap between both countries steadily narrowing throughout the period. Economic expectations could add a more comprehensive understanding of the dynamics behind the Spain-to-Portugal spread to the set of indicators. However, high-frequency economic forecast data is usually unavailable or unreliable, especially for smaller economies like Portugal. For this reason, these indicators are only considered as part of the qualitative analysis. To assess the specific case of Spain-Portugal yield differential,

Figure 6: Spread between 10-year sovereign bond yields and public debt differential (left) and sovereign ratings differential (right).



Source: Bloomberg, Refinitiv, own elaboration.

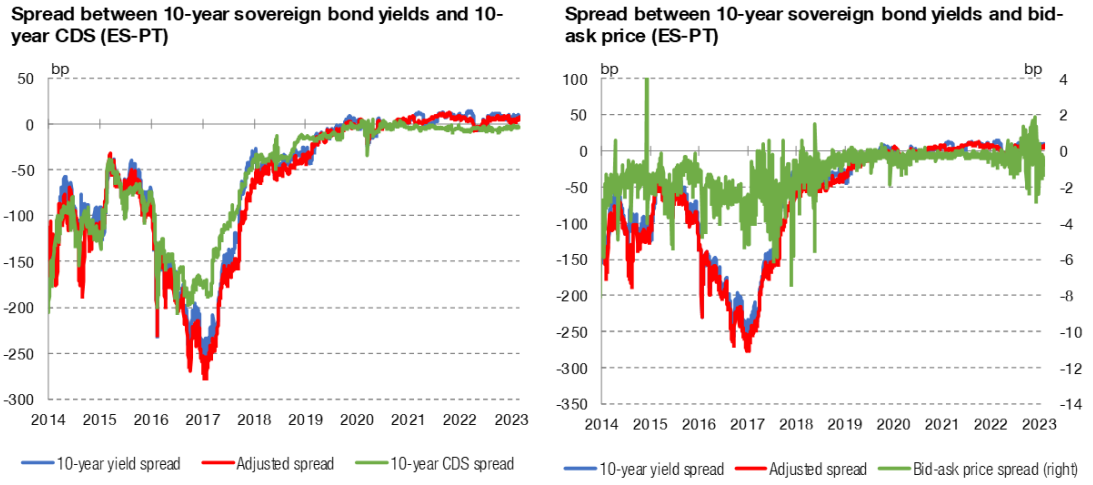
we consider that ECB monetary policy expectations would have a neutral effect, given that both countries belong to the Eurozone and are subject to the same monetary policy framework. As a result, fiscal situation emerges as the primary factor capable of explaining potential divergences in yields.

As seen previously, Portugal's macroeconomic fundamentals progressively converge with Spain's. This view is reinforced when economic expectations are taken into account. The three panels in Figure 8 bring projections from the European Commission about debt-to-GDP ratios, public deficit, and economic growth for the immediate years ahead. First, the expected debt-to-GDP ratio differential up to 2022 has consistently narrowed, culminating in recent estimations

alluding to a potential inflection point. Second, the anticipated Portuguese public deficit has remained beneath that of Spain, a pattern harmonizing with the convergence seen in Figure 6 (left). Lastly, while projections for economic growth may appear more volatile since the COVID-19 pandemic, a consensus resonates regarding Portugal's faster recovery and promising growth outlook. In summary, expectations align with the findings from previously analyzed credit and liquidity risk indicators, showing Portugal's weaker economic performance at the beginning of the period and a trend toward convergence since 2017. The more favorable trajectory for Portugal's current and anticipated macroeconomic conditions will likely enhance investor confidence and willingness to acquire Portuguese public debt, thus putting downward pressure on the yield demanded for such debt instruments.

(b) The footprint of purchase programmes and bond issuance on sovereign debt stock and yields.

Figure 7: Spread between 10-year sovereign bond yields and CDS differential (left) and differential in the bid-ask spread (right).



Source: Bloomberg, Datastream, own elaboration.

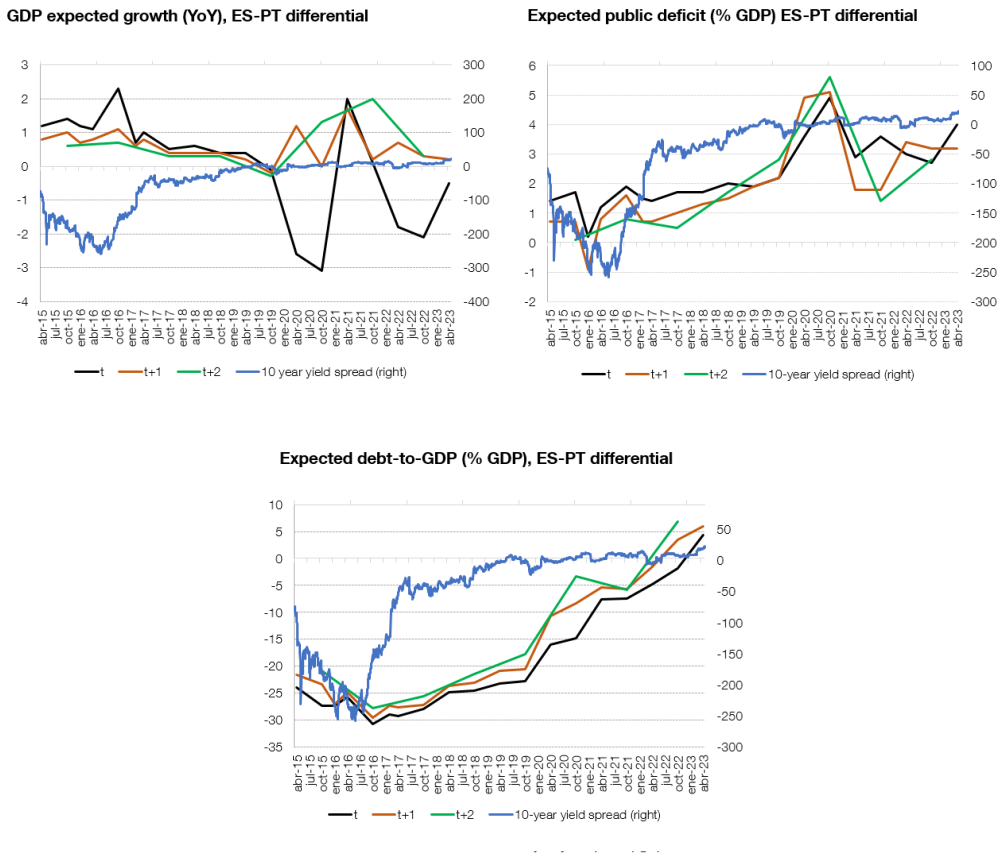
Unlike other central banks, the Eurosystem purchases sovereign assets of several jurisdictions under a single monetary policy strategy and inflation target. Purchases are made guided by the capital key of each jurisdiction, although a certain amount of flexibility is allowed under the PEPP on the basis of market and financing conditions. Given that capital keys remain relatively stable over time while debt issuance per jurisdiction may differ significantly, the footprint of Eurosystem purchases in the debt stock of each jurisdiction can be different, leading to sovereign yield changes in relative terms across jurisdictions.

This section aims to analyze the structure and evolution of each country's debt supply and the footprint of Eurosystem purchase programmes to determine how they can help to explain further the evolution of the sovereign yields spread between the two countries.

Over the last decade, Portugal's debt structure has been significantly influenced by direct funding from international organizations such as the International Monetary Fund (IMF) and the European Union (EU).[11]Consequently, and supported by greater fiscal discipline imposed,

[11]From 2011 to 2014, Portugal received financial assistance in the form of loans worth 76.7 billion euro: 26.4 bn. from International Monetary Fund (IMF), 26 bn. from the European Financial Stability Facility (EFSF) and 24.3 bn. from the European Stability Mechanism (ESM).

Figure 8: European Commission projections: macroeconomic and fiscal indicators. Spain and Portugal.



Source: European Commission.

among other factors, by the conditionality of the aid received, the amount of debt issued has decreased in recent years. Meanwhile, Spain's public finances have been less dependent on official loans.[12]

Additionally, both countries are beneficiaries of further assistance provided by the European Commission since 2020 in the framework of the European instrument for temporary support to mitigate unemployment risks in an emergency[13] (SURE) and the Recovery and Resilience Facility[14] (RRF).

The debt structure of each country highlights these differences in access to various funding sources. Figure 9 shows that, as of the end of 2022, 20% of Portugal's central state outstanding debt accounted for official loans, while 59% were debt securities and 55% were PGBs (central government medium and long-term negotiable bonds). The proportion of non-tradable securities, such as saving certificates, is also significant. In Spain, official loans account for only 6% of total state debt, while medium and long-term debt securities are 89%.

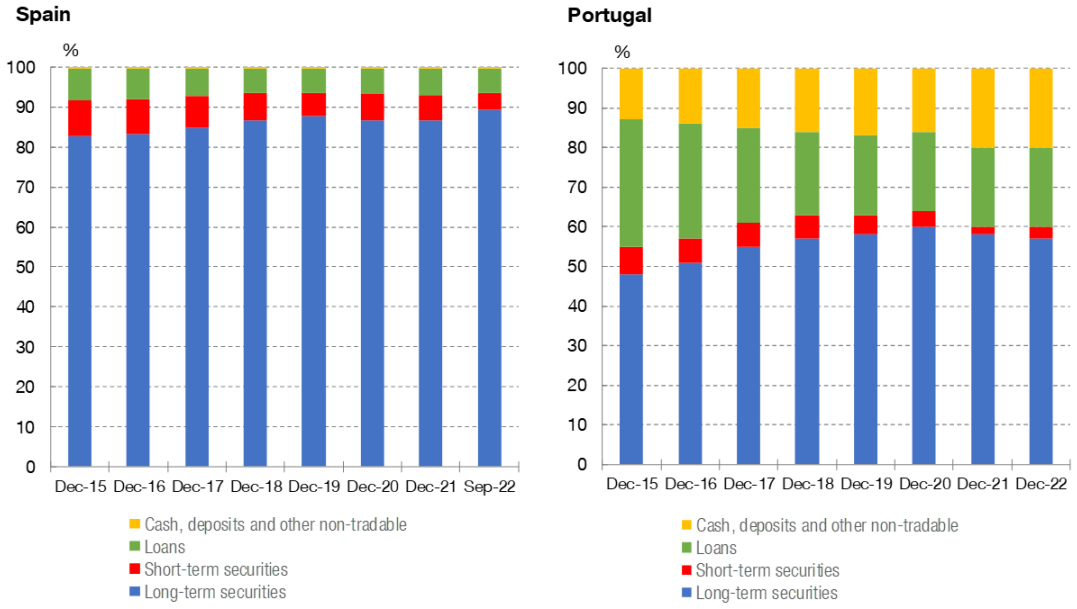
The differences between domestic and non-resident holders in both countries are also worth noting since greater exposure to foreign investors could impact the evolution of yield spreads.

[12] Spain received loans from the EFSF for 41.34 billion euros in 2012 and 2013.

[13] As of January 2023, Portugal has received loans up to 6.2 billion euros under the SURE assistance. Spain has received 21.3 billion.

[14] As of January 2023, Portugal has received loans up to 1.12 billion euros under the RRF, plus 4.06 billion in grants. Spain has received 33 billion euros in RRF grants.

Figure 9: Sovereign debt by instrument.



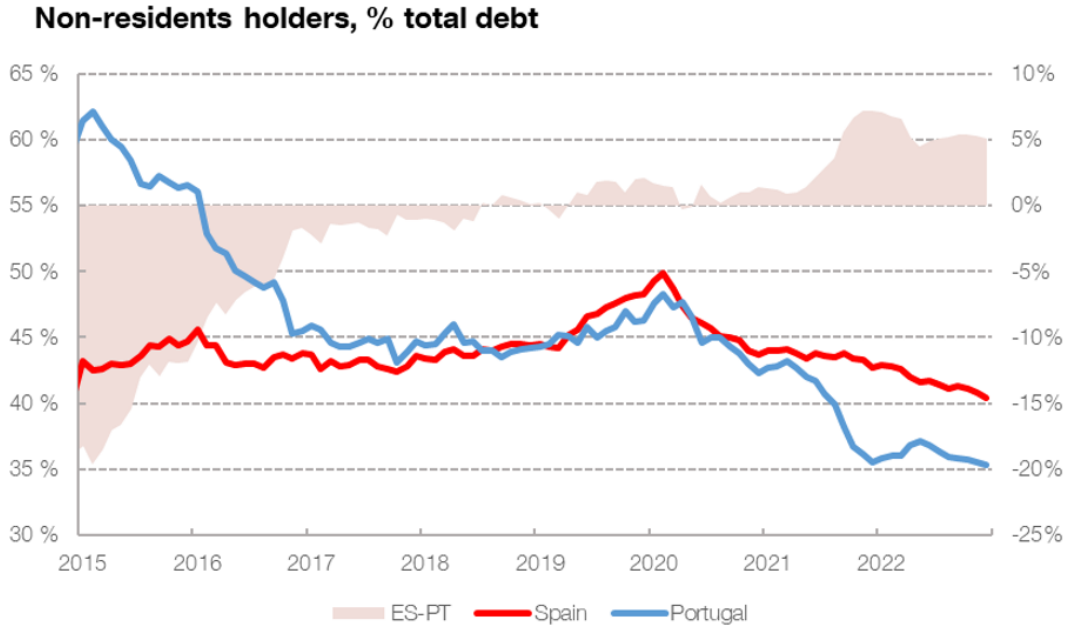
Source: Bank of Spain, Portuguese Treasury and Debt Management Agency.
Note: Data only includes central government debt.

Overall, since the implementation of the ECB purchase programmes, most of the countries in the Eurozone have seen a reduction in the proportion of foreign investors in their outstanding debt, as many of these assets were bought by national central banks as part of the quantitative easing policies (Anaya et al. (2023), Koijen et al. (2017)). As per Spain and Portugal, both countries currently witness national investors comprising more than half of their respective public debts. However, the evolution of debt holders' composition has been different in each economy throughout the period. In Portugal, the proportion of national holders has risen steadily while in Spain it has been flatter, even though it is also higher now than at the beginning of the period. Therefore, as of the end of 2022, Spain exhibits a slightly greater proportion of international investors due to a decrease in foreign investor participation in Portuguese sovereign bonds in recent years. This reduction occurred especially in two different periods: firstly, from 2015, when foreign investors held 66% of the debt, dropping to 47% in 2017, probably due to concerns over a potential credit rating downgrade; and secondly, from 2020 (47%) to 2022 (35%), coinciding with a reduction in sovereign bond issuance and an increase of national central bank purchases under the PEPP programme and, more recently, a shift towards retail-oriented instruments, such as saving certificates, which are allocated mainly among national retail investors.[15]

Hence, disparities in the composition of debt holders may have contributed to the divergent trajectories of sovereign bond yields. See Figure 10. However, it is challenging to clearly determine the effect of the proportion of foreign holders in sovereign bond yields. First, greater exposure to foreign investors would leave sovereign bond yields more exposed to international shocks rather than national fundamentals. Besides, a significant part of the shift in the proportion of bondholders is due to the implementation of the asset purchase programmes, that moved assets from foreign holders to national central banks and that, as we already analysed, are effective in lowering bond yields. However, some studies also point out how an increasing foreign ownership of national debt in bonds can lead to lower yields, see Conterius et al. (2023) and Arslanalp and Poghosyan (2014).

[15] Portugal to cut bond, T-bill sales in favor of retail debt (Reuters, March 31, 2023).

Figure 10: Sovereign debt by holders. Spain and Portugal.



Source: Spanish Treasury, Bank of Portugal.

The proportion of bonds to total debt and macroeconomic factors can also be seen through recent years' bond issuance of both countries. To analyze it, the purchases made by the Eurosystem have been deducted from the debt issuance to show the amount of new bonds the market would have to absorb each year. As depicted in Figure 11, the debt issued net of purchases by the Eurosystem was negative (with the central bank purchasing more than it was issued) for Spain in 2016, 2017, 2020, and 2021. However, in 2022, the issuance of debt increased, and it is expected to do so again in 2023,[16] in the context of monetary policy normalization along with still high public spending in the aftermath of the COVID crisis. In the case of Portugal, the net supply of bonds was negative from 2020 to 2022, when purchases from the Eurosystem greatly exceeded the issuance of sovereign bonds.

To analyze net debt issuance in relative terms, Figure 12 compares both jurisdictions' debt issuance net of Eurosystem's purchases as a percentage of total central state outstanding debt.[17] This comparison reveals a change in the trend between periods 2016-2017 and 2021-2022. In 2016, net issuance in Spain was significantly lower than in Portugal, but this trend has gradually reversed. By 2021, Spain's net issuance exceeded Portugal's, and the gap widened in 2022.

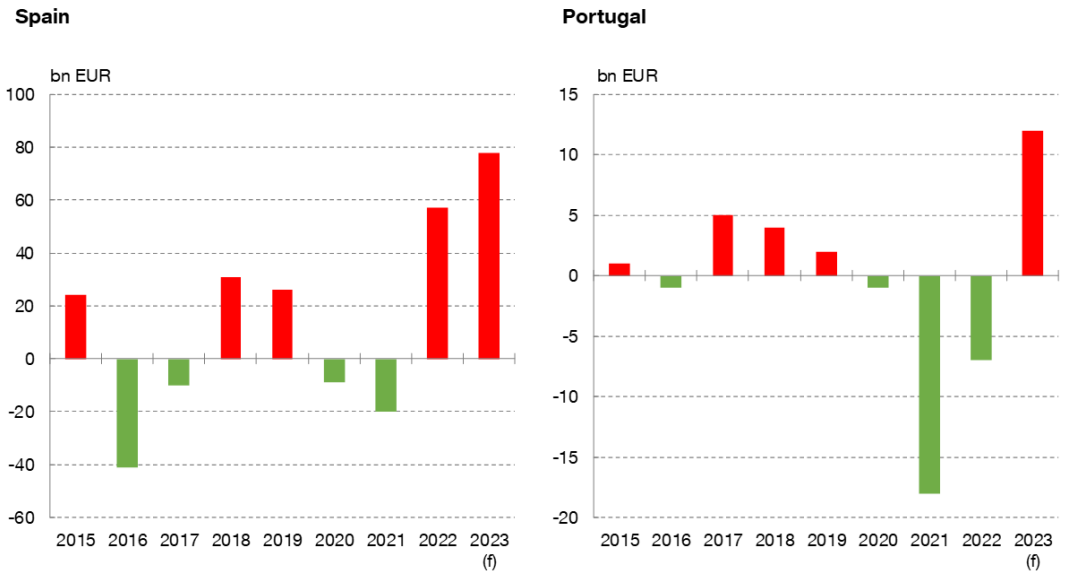
The addition of the ES-PT yield spread to Figure 12 highlights that 2016 was the year with the most favorable spread for Spain and the lowest net debt issuance compared to Portugal. In 2019, with Spain's net debt issuance at a higher level than Portugal's, the spread turned positive for the first time in this period. In 2021 and 2022, the spread remained mostly in positive territory, slightly widening in a context of broadly higher issuance from Spain.

The greater amount of debt issued by Spain and its lower GDP growth, especially after the beginning of the COVID-19 pandemic, has increased its outstanding debt in bonds relative to

[16]Data for 2023 obtained from National Treasuries issuance forecasts and assuming APP QT of 15bn EUR per month in Q2 and 20bn/month in Q3 and Q4. For Spain, we forecast an estimated issuance of 63bn EUR (75bn forecasted by the National Treasury minus 12bn expected from NGEU funds). For Portugal, 9.8bn EUR issuance is forecasted for 2023.

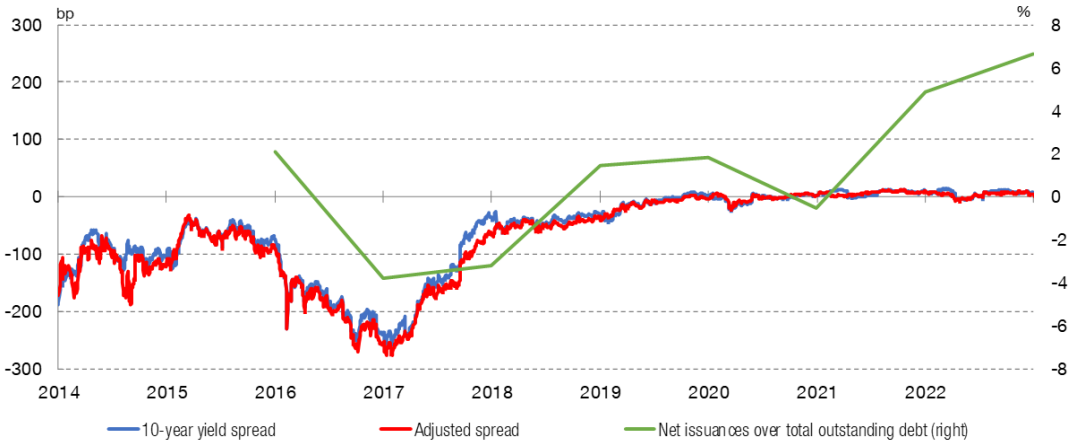
[17]Net issuance after Eurosystem's purchases over the total stock of medium and long-term debt (maturity higher than one year).

Figure 11: Government debt issuance net of Eurosystem purchases. Spain and Portugal.



Source: Bank of Spain, Portuguese Treasury and Debt Management Agency, ECB.

Figure 12: Spread between 10-year government yields and net debt issuance as percentage of total outstanding debt (ES-PT).



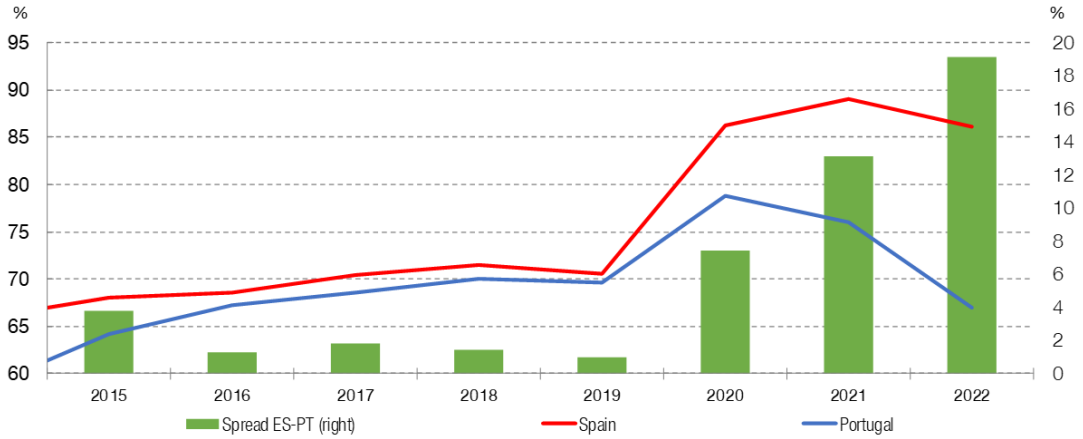
Source: Bloomberg, Bank of Spain, Portuguese Treasury and Debt Management Agency, ECB.

Portugal, as demonstrated by Figure 12. From 2016 to 2022, Spain's amount of outstanding debt in bonds increased from 68% to 86% of its GDP, while in Portugal, it remained at similar levels, from 64% to 67% of its GDP. Unlike what the total debt-to-GDP ratio revealed in Figure 6, this ratio points up a significant difference: the proportion of debt in bonds is considerably higher in Spain, and this disparity has become more pronounced since the outbreak of the COVID-19 pandemic. This highlights the importance of this ratio to analyze the supply side of the drivers of the yield spread.

As the Eurosystem aligns its purchases with the respective share of the capital key of each jurisdiction, an increasing stock of outstanding debt in bonds should result in a lower proportion of Eurosystem holdings. Figure 14 displays these holdings as a percentage of total outstanding

bond debt and yield spread. The proportion of Eurosystem holdings remained mostly stable until 2019 when the Eurosystem began to hold an increasing proportion of Portuguese debt stock compared to Spain, and the gap has widened since then. The creation of the PEPP and a lower level of bond issuances from Portugal in that period explain that change in the trend. As of the end of 2022, the proportion of Eurosystem holdings of Portuguese bonds is around 12% higher than that of Spain. Following this trend, the yield spread has remained mostly positive since mid-2019, with only occasional exceptions primarily due to reference changes. The relation between Eurosystem holdings and the sovereign yield spread seems clear for most of the period, except for 2016-2017. In 2016, the eligibility of Portugal's bonds for the PSPP was at risk due to a possible credit rating downgrade in the context of macroeconomic instability in Portugal, widening the yield spread strongly in favor of Spain. That rating downgrade did not happen, and by the end of 2017, Portugal's credit rating was upgraded twice, returning the yield spread to the level it was in 2015. Therefore, during this period, the expected evolution of Eurosystem bond holdings partly drove the spread rather than the actual holdings at that time.

Figure 13: Long-term outstanding debt securities as percentage of GDP. Spain and Portugal.



Source: Bloomberg, ECB.

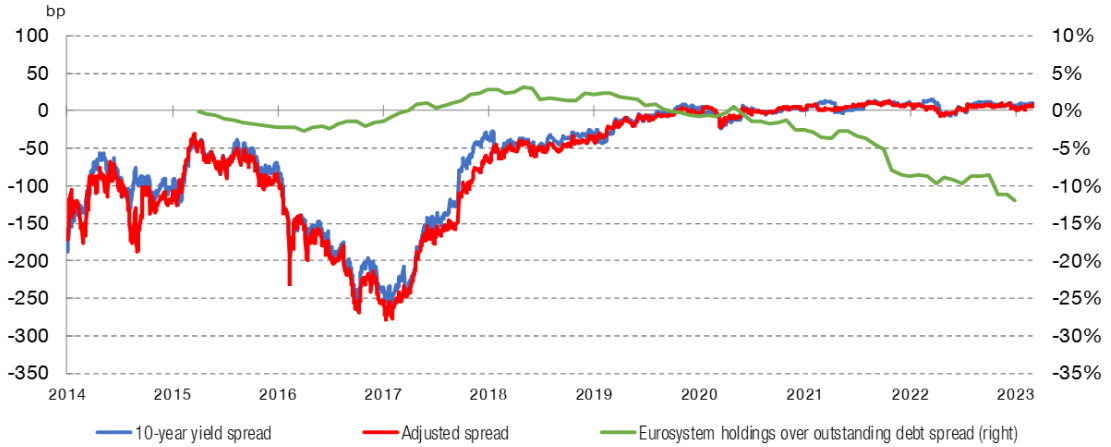
5.2 A quantitative approach

This section examines the relationship between the adjusted ES-PT sovereign bond yield spread ($r_t^{ES} - r_t^{PT}$) and credit and liquidity risk factors and the ECB asset purchase programmes, as described in Table 1. The literature finds empirical evidence in favor of a long-term stable relationship between the CDS and the bond yield differentials. We find evidence of a stable, long-lasting relationship between the two for the Spain-to-Portugal differentials. We use monthly data from 01/2015-12/2022 to estimate the model (2) assuming $\varepsilon_t \sim N(0, \sigma_\varepsilon)$, which the ADF test at 95% confidence level confirms, see Table 3. Estimation results confirm a credit-risk channel in the bond markets since an increase in the CDS spread leads to a rise in the bond yield spread—standard errors in brackets.

$$
\begin{aligned}
r_t^{ES} - r_t^{PT} \quad &= \underset{(0.023)}{0.053} + \underset{(0.000)}{0.013}(CDS_t^{ES} - CDS_t^{PT}) + \hat{\varepsilon}_t \qquad (2)\\
\text{where:} \quad & RMSE = 0.169, R^2 = 0.96, n = 96,\\
& ADF(\text{p-value}) = -3.30(0.001)
\end{aligned}
$$

Given the long-term stable relationship between the two differentials in (2), we estimate the VECX(1) model (3) that studies the short-term relationship between these and other traditional bond yield differential drivers, such as the bid-ask, the bond Ratings and ECB Spain-to-Portugal

Figure 14: Spread between 10-year sovereign bond yields and Eurosystem holdings as percentage of long-term outstanding debt (ES-PT).



Source: Bloomberg, ECB, Bank of Spain, IMF, own elaboration.

bond holding spreads. The main goal of this exercise is to test if there is a stable short-term relationship between changes in the bond yield and CDS differentials and the abovementioned factors. Table 3 includes the estimation results for the model (3) using the same sample. For the sake of simplifying notation, $Dr_t = r_t^{ES} - r_t^{PT}$, and $DCDS_t = CDS_t^{ES} - CDS_t^{PT}$. DBAS is the bid-ask spread differential between the bonds, $DBAS_t = BAS_t^{ES} - BAS_t^{PT}$, $DLIQ$ is the Spain-to-Portugal bond liquidity differential according to the second liquidity risk proxy, and $DRating_t = Rating_t^{ES} - Rating_t^{PT}$. Finally, $DCBBH_t$ is the difference between the Eurosystem bond holding to long-term debt outstanding in Spain and Portugal,

$$\begin{bmatrix} \Delta Dr_t \\ \Delta DCDS_t \end{bmatrix} = B_1 \hat{\varepsilon}_{t-1} + B_2 \begin{bmatrix} \Delta Dr_{t-1} \\ \Delta DCDS_{t-1} \end{bmatrix} + B_3 \begin{bmatrix} \Delta DX_t \\ \Delta DRating_t \\ \Delta DCBBH_t \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \tag{3}$$

where: $E_t = [\epsilon_{1t}; \epsilon_{2t}]' \sim N(0, \Omega)$, $\hat{\varepsilon}_t = Dr_t - \hat{\alpha} - \hat{\beta} DCDS_t$, and $X = DBAS, DLIQ$.

Estimation results in Table 3 confirm that the bond yield differential changes over time with some memory (0.613). The bond yield differential changes to correct deviations from its long-term stable relationship with the CDS differential (-0.34). Thus, when the bond yield differential exceeds the amount set by the long-term relationship with the CDS differential ($\hat{\varepsilon}_{t-1} > 0$), this decreases the month after to recover the relationship of equilibrium. Likewise, the CDS spread at time t reacts to deviations from equilibrium ($\hat{\varepsilon}_{t-1} \neq 0$)) to recuperate such a relationship. The credit risk channel is essential to understanding the bond yield differential dynamics in the long term. Does a similar result arise in the short term? Short-term bond yield differential dynamics respond to an upward movement in the CDS spread in the previous month with an opposite sign (-0.007). This response aligns with the long-term equilibrium recovery path mentioned above. The CDS spread is a mean reversal (-0.702), tending to increase (decrease) when the bond yield differential increased (decreased) the previous month (69.094). Another significant factor explaining the bond yield and CDS spread differential dynamics is the bond liquidity risk basis. Finally, changes in the bond rating spread and ECB bond-holding differential emerge as significant explanatory factors if the whole sample is considered. However, this period includes different interest rates and economic activity regimes, which calls for a time-varying analysis of this model to confirm or challenge the results obtained. As a robustness check, we restimate the model using an alternative proxy for bond market liquidity gap, Liq, obtaning similar results.

[Include here Table 3]

Figure 16 includes 90% CI for the recursively estimated parameters of the VECX(1) model in (3), using a rolling window of two years.[18] On average, most results in Table 3 hold. However, some significant differences have emerged since 2020. On average, the bond yield differential retains memory. However, these characteristics disappear from 2020 to the first half of 2021 and during the last part of 2022. See Panel (i) in Figure 16. Since 2021, bond yield differential Dr has responded to lagged movements in the CDS gap and contemporary changes in the BAS[19] differentials (credit and liquidity risk, respectively). See panels (iii) and (vii). Additionally, bond rating differentials played some role as a risk source to explain Dr only between 2020 and 2021 (i.e., a drop in DRating relates to a higher bond yield gap favoring Portugal). See Panel (ix). However, we do not find this relationship as intense or long-lasting in explaining CDS spread movements in the same period. See Panel (x). Note that the liquidity risk (BAS and Liq spreads) related to contemporary movements in the bond yield differential do not explain the CDS differential. However, the dispersion in the estimation of this sensitivity is very high. See Panel (viii). Note that bond yield differential short-term movements follow to recover its long-term stable relationship with the DCDS, except between 2021 and 2022. See Panel (v). In this period, and primarily during 2020, lower DCBBH related to higher bond yield differential, favoring Portugal's bond prices. See Panel (ix).

Recursive estimation results show significant differences in the intensity and role of traditional bond yield differential drivers since 2020. Until 2020, the Spain-to-Portugal bond yield differential eventually responded to the CDS gap, moved to recover their long-term relationship, did not respond to changes in the relative bond rating, reported some sensitivity to the bonds' credit liquidity gap, and to changes in the DCBBH (only in 2017). However, the sensitivity weakened or became unconfirmed for some explanatory variables since 2020. This suggests other factors are key in explaining the bond yield spread's magnitude and sign in this period. Previous research papers have found evidence of asset purchase programmes affecting bond yield differentials. We test this hypothesis to see if the ECB footprint impact through PSPP and PEPP explains the Spain-to-Portugal bond yield differential. In 2020, the bond yield differential responded to changes in relative liquidity risk, bond ratings, and the DCBBH, favoring Portuguese bond prices. Thus, in 2020, the credit risk differential lost its role. In 2021, changes in lagged DCDS, DRating, DLIQ and DBAS (credit and liquidity risk differentials) came back to explain Dr. In 2022, the bond yield differential primarily responds to changes in the credit risk differential between the bonds. Overall, while on average, credit and liquidity risk differentials contribute to explaining changes in the bond yield spread, the DCBBH and the liquidity risk gap emerged as the main drivers of the Spain-to-Portugal bond yield gap in 2020. This result aligns with those reported by the literature on the effect of Eurosystem debt purchases and QE programmes on the bond yield spread in the Eurozone. Nevertheless, unlike that literature, we provide evidence of critical drivers for Spain's bond yield differential dynamics relative to Portugal rather than using Germany as a benchmark in this paper. Statistical results confirm the significant role of the ECB's asset purchase programmes in explaining the dynamics of the ES-PT bond yield differential in 2020.

[Include here Figure 16]

To help illustrate the ECB's PSPP and PEPP role, we estimate the linear OLS correlation between the (adjusted) bond yield differentials and the DCBBH using the data since 2020 with-

[18] Figure 17 includes estimation results if using the alternative definition of bond market liquidity, LIQ. The statistical analysis report similar results.

[19] As a robustness check, we restimate the model using an alternative bond liquidity proxy that averages (i) bid-ask spread, price range (intraday price variation), volatility (20days standard deviation of daily price changes), and Roll estimator (Roll (1984)) (autocovariance of daily returns over a 5-day window); and obtain the same qualitative results.

out considering other variables. See model (4), standard errors in brackets. Both variables are negatively correlated, such that higher Spanish bond holding by the Eurosystem tends to reduce the bond yield differential in favor of the Portuguese bond yield, which becomes closer or even lower than the Spanish one. Figure 18 includes the series.

$$\begin{aligned} Dr_t &= \underset{(0.013)}{-0.005} \underset{(0.205)}{-0.691}\, DCBBH_t + \varepsilon_t \qquad (4) \\ \text{where:} &\qquad RMSE = 0.048, R^2 = 0.23, n = 36. \end{aligned}$$

[Include here Figure 18]

Given the statistical evidence favoring the Eurosystem debt purchase and QE programmes' role in explaining the ES-PT sovereign bond yield spread since 2020, we explore what moves the bond holding ratio differential (i.e., DCBBH). This variable represents the difference between the two ratios, i.e., the Eurosystem bond holdings (PSPP+PEPP) to long-term total debt outstanding in bonds for Spain and Portugal, respectively. It is reasonable to assume that various bond supply and demand factors affect this ratio. To deepen on this reasoning, and as a benchmark exercise, we calculate what would have been the Eurosystem bond holding ratio if we fixed the long-term total debt outstanding in bonds to its value in January 2020 for both countries. Figure 19 shows that assuming constant (long-term) debt outstanding since 2020, the Eurosystem bond holding ratio for the two countries should have reduced, making the 10-year bond spread closer to zero up to date. Overall, these results provide empirical evidence favoring the significant role of the Eurosystem bond purchases in explaining ES-PT sovereign bond yield differential, especially after 2020, while higher long-term bond outstanding in ES relative to PT may contribute to a higher Eurosystem's footprint in Portugal bond market vs. to Spain's. Figure 19 implies a much lower Spain-to-Portugal bond yield spread if lower relative long-term bond issuance in Spain. Under this assumption, and given the relationship between DCBBH and Dr in (4), the ES-PT bond yield differential should have been significantly lower in December 2022 (+1.6 b.p. vs +7.6 b.p.), or even non-statistically different than zero.

[Include here Figure 19]

6 Conclusions

The implementation of asset purchase programmes by several central banks during recent years and the beginning of their withdrawal in recent times have raised important questions about their effect and effectiveness on financial markets. In particular, the impact of such measures on the yields of sovereign bonds has been analyzed by several studies, some focused on the Euro Area. This article relates to this literature, using the spread between the Spanish and the Portuguese 10-year sovereign bonds as a case study.

The study of the Spain-to-Portugal bond yield differential is an interesting case. Both countries share several economic, political, and geographic similarities, so the effects of asset purchase programmes can be isolated from other factors. We adjust the Spain to Portugal bond yield spread to control for changes in the bond references, and find that the yield spread has shown a negative sign since the beginning of the ECB Asset Purchase Programmes in 2014, meaning that the Spanish sovereign 10-year bond yield was lower than the Portuguese benchmark. This differential has been steadily narrowing since 2017, in line with the improvement of macroeconomic fundamentals in the Portuguese economy. Besides, the sign turned to positive values at the end of 2019 and has remained at that level for most of the time since then. After analyzing the leading macroeconomic indicators that drive sovereign bond spreads, drivers different than fiscal soundness, credit risk, and liquidity conditions contribute to explaining the sign of the bond yield spread.

Introducing the large-scale purchase programmes as a bond yield differential explanatory variable, we find that bond buying by the European Central Bank has had a significant impact on reducing bond yields. More specifically, it deepens the importance of yield spreads of the debt structure and the footprint of purchase programmes in the debt stock of each jurisdiction. Focusing on the case of Spain and Portugal, the latter has a significantly lower amount of its debt in bonds, both in absolute and relative terms, due to the access to alternative financing sources (i.e., official loans) and lower debt issuance in recent years. This gap has widened since the outbreak of the COVID-19 pandemic, when the issuance of bonds in Spain has been significantly higher than Portugal's, even after netting Eurosystem purchases. Given that the Eurosystem's purchases are guided mainly by the capital key, this has implied a higher footprint of the Eurosystem on Portugal's debt securities, contributing to the reduction of its sovereign bond yield. This finding aligns with prior literature and contributes to research on the effect of asset purchase programmes in financial markets, finding evidence of ECB footprint in the bond market even when the German bond is not taken as numeraire.

The analysis confirms that, as stated before, macroeconomic and financial fundamentals help explain the evolution of the sovereign bond yield spread for most of the period since 2014. However, results have been less robust since 2020. Instead, the footprint of Eurosystem purchase programme (PSPP and public sector purchases of the PEPP) over the long-term total outstanding debt in bonds helps to explain the dynamics observable after that year. To support this conclusion, the calculation of the sovereign spread assuming constant debt outstanding since 2020 shows that it would be closer to zero in recent times. This study contributes to the literature that explains the effects of Eurosystem purchase programmes and debt issuance on Eurozone sovereign bond yields, focusing on a specific case where more than the well-known fundamentals that usually help to understand their relationship may be required. This paper provides empirical evidence leaning the Eurosystem bond purchase programme's footprint on the bond yield differential between the two countries.

Considering the current process of monetary policy normalization, the quantitative tightening, and the expected levels of sovereign debt issuances in the coming years, it will be interesting to analyze what is going to happen in the near future, specifically with the Spanish and Portuguese bond yield differential, and generally with the spreads among the rest of the countries. Besides, the role of asset purchase programmes in the bond yields through each transmission channel could also be analyzed separately as part of an extended analysis. Ongoing research lines in progress include exploring the role of expected public debt on bond yield differentials (in line with works by Haugh et al. (2009); Bernoth et al. (2012), among others), as well as the role of expected asset purchases on the sovereign bond yield gap dynamics.

References

Afonso, António, Michael G. Arghyrou and Alexandros Kontonikas. (2015). "The determinants of sovereign bond yield spreads in the EMU". ECB Working Paper Series, 1781, European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1781.en.pdf

Afonso, António, Davide Furceri and Pedro Gomes. (2012). "Sovereign credit ratings and financial markets linkages: Application to European data". *Journal of International Money and Finance*, 3(31), pp. 606-638. https://doi.org/10.1016/j.jimonfin.2012.01.016

Afonso, António, and Ana Sofia Nunes. (2015). "Economic forecasts and sovereign yields". *Economic Modelling*, 44, pp. 319-326. https://doi.org/10.1016/j.econmod.2014.03.012

Albertazzi, Ugo, Bo Becker and Miguel Boucinha. (2021). "Portfolio rebalancing and the transmission of large-scale asset programmes: Evidence from the Euro area". *Journal of Financial Intermediation*, 48, 100896. https://doi.org/10.1016/j.jfi.2020.100896

Anaya, Pablo, Katharina Cera, Giorgios Georgiadis and Christoph Kaufmann. (2023). "Do global investment funds have a stabilising effect on euro area government bond markets?". *ECB Financial Stability Review*, May 2023. https://www.ecb.europa.eu/press/financial-stability-publications/fsr/focus/2023/html/ecb.fsrbox202305_03~25d1bfc398.en.html

Andrade, Philippe, Johannes Breckenfelder, Fiorella De Fiore, Peter Karadi and Oreste Tristani. (2016). "The ECB's asset purchase programme: an early assessment". ECB Working Paper Series, 1956, European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1956.en.pdf

Arce, Oscar, Sergio Mayordomo and Juan Ignacio Peña. (2013). "Credit-risk valuation in the sovereign CDS and bond markets: Evidence from the euro area crisis". *Journal of International Money and Finance*, 35, pp. 124-145. https://doi.org/10.1016/j.jimonfin.2013.01.006

Arrata, William, and Benoît Nguyen. (2017). "Price impact of bond supply shocks: Evidence from the eurosystem's asset purchase programme". Banque de France Working Paper 623. https://publications.banque-france.fr/en/price-impact-bond-supply-shocks-evidence-eurosystems-asset-purchase-program

Arslanalp, Serkan, and Tigran Poghosyan. (2014). "Foreign investor flows and sovereign bond yields in advanced economies". IMF Working Paper WP/14/27, International Monetary Fund. https://www.imf.org/external/pubs/ft/wp/2014/wp1427.pdf

Baker, Malcolm, and Jeffery Wurgler. (2012). "Comovement and predictability relationships between bonds and the cross-section of stocks". *The Review of Asset Pricing Studies*, 2, pp. 57-87. https://doi.org/10.1093/rapstu/ras002

Barbosa, Luciana, and Sonia Costa. (2010). "Determinants of sovereign bond yield spreads in the euro area in the context of the economic and financial crisis". *Economic Bulletin - Banco de Portugal*, 16(3), Articles. https://www.bportugal.pt/sites/default/files/anexos/papers/ab201010_e.pdf

Beber, Alessandro, Michael W. Brandt and Kenneth A. Kavajecz. (2009). "Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market". *The Review of Financial Studies*, 22, pp. 925-957. https://doi.org/10.1093/rfs/hhm088

Beetsma, Roel, Massimo Giuliodori, Frank de Jong and Daniel Widijanto. (2013). "Spread the news: The impact of news on the European sovereign bond markets during the crisis". *Journal of International Money and Finance*, 34, pp. 83-101. https://doi.org/10.1016/j.jimonfin.2012.11.005

Belke, Ansgar, Daniel Gros and Farzaneh Shamsfakhr. (2021). "Central bank purchases of sovereign bonds in the euro area, the random walk hypothesis, and different measures of risk". *Oxford Economic Papers*, 73(4), pp. 1471-1492. https://doi.org/10.1093/oep/gpab016

Bernoth, Kerstin, and Buruc Erdogan. (2012). "Sovereign bond yield spreads: A time-varying coefficient approach". *Journal of International Money and Finance*, 31(3), pp. 639-656. https://doi.org/10.1016/j.jimonfin.2011.10.006

Bernoth, Kerstin, Jürgen von Hagen and Ludger Schuknecht. (2012). "Sovereign risk premiums in the European government bond market". *Journal of International Money and Finance*, 31(5), pp. 975-995. https://doi.org/10.1016/j.jimonfin.2011.12.006

Bhattari, Saroj, Gauti B. Eggertsson and Bulat Gafarov. (2023). "Time consistency and the duration of government debt: A model of quantitative easing". *The Review of Economic Studies*, 90(4), pp. 1759-1799. https://doi.org/10.1093/restud/rdac063

Blattner, Tobias, and Michael A. S. Joyce. (2016). "Net debt supply shocks in the euro area and the implications for QE". ECB Working Paper Series, 1957, European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1957.en.pdf

Böninghausen, Benjamin, and Michael Zabel. (2015). "Credit ratings and cross-border bond market spillovers". *Journal of International Money and Finance*, 53, pp. 115-136. https://doi.org/10.1016/j.jimonfin.2014.12.007

Cantor, Richard, and Frank Packer. (1996). "Determinants and impact of sovereign credit ratings". *Economic Policy Review*, 2(2), pp. 37-54. https://moodle2.units.it/pluginfile.php/259644/mod_resource/content/0/9610cant.pdf

Cesare, Antonio Di, Giuseppe Grande, Michele Manna and Marco Taboga. (2012). "Recent estimates of sovereign risk premia for Euro-area countries". Bank of Italy Occasional Papers, 128. https://www.bancaditalia.it/pubblicazioni/qef/2012-0128/index.html?com.dotmarketing.htmlpage.language=1&dotcache=refresh

Chun, Albert Lee. (2011). "Expectations, bond yields and monetary policy". *The Review of Financial Studies*, 24, pp. 208-247. https://doi.org/10.1093/rfs/hhq090

Codogno, Lorenzo, Carlo Favero and Alessandro Missale. (2003). "Yield spreads on EMU government bonds". *Economic Policy*, 18(37), pp. 503-532. https://doi.org/10.1111/1468-0327.00114_1

Conterius, Simeon, Alexandr Akimov, Jen-Je Su and Eduardo Roca. (2023). "Do foreign investors have a positive impact on the domestic government bonds market? A panel pooled mean group approach". *Economic Analysis and Policy*, Vol. 77, pp. 863-875. https://doi.org/10.1016/j.eap.2022.12.031

Costain, James, Galo Nuño and Carlos Thomas. (2022). "The term structure of interest rates in a heterogeneous monetary union". Documentos de Trabajo, 2223, Banco de España. https://repositorio.bde.es/handle/123456789/22545

Costanini, Mauro, Matteo Fragetta and Giovanni Melina. (2014). "Determinants of sovereign bond yield spreads in the EMU: An optimal currency area perspective". *European Economic Review*, 70, pp. 337-349. https://doi.org/10.1016/j.euroecorev.2014.06.004

De Santis, Roberto A. (2014). "The euro area sovereign debt crisis: Identifying flight-to-liquidity and the spillover mechanisms". *Journal of Empirical Finance*, 26, pp. 150-170. https://doi.org/10.1016/j.jempfin.2013.12.003

De Vries, Tim, and Jakob de Hann. (2014). "Credit ratings and bond spreads of the GIIPS". *Applied Economics Letters*, 23, pp. 107-111. https://doi.org/10.1080/13504851.2015.1054063

Dergiades, Theologos, Costas Milas and Theodore Panagiotidis. (2015). "Tweets, google trends, and sovereign spreads in the GIIPS". *Oxford Economic Papers*, 67, pp. 406-432. https://doi.org/10.1093/oep/gpu046

Equiza, Juan, Ricardo Gimeno, Antonio Moreno and Carlos Thomas. (2023). "Evaluating central bank asset purchases in a term structure model with a forward-looking supply factor". Documentos de Trabajo, 2303, Banco de España. https://repositorio.bde.es/handle/123456789/25046

Favero, Carlo, Marco Pagano and Ernst-Ludwig von Thadden. (2010). "How does liquidity affect government bond yields?". *The Journal of Financial and Quantitative Analysis*, 45, pp. 107-134. https://doi.org/10.1017/S0022109009990494

Georgoutsos, Dimitris A., and Petros M. Migiakis. (2018). "Risk perceptions and fundamental effects on sovereign spreads". Bank of Greece Working Paper 250. https://www.bankofgreece.gr/Publications/Paper2018250.pdf

Giordano, Raffaela, Marcello Pericoli and Pietro Tommasino. (2013). "Pure or wake-up-call contagion? Another look at the EMU sovereign debt crisis". *International Finance*, 16(2), pp. 131-160. https://doi.org/10.1111/j.1468-2362.2013.12033.x

Gómez-Puig, Marta. (2016). "Size matters for liquidity: Evidence from EMU sovereign yield spreads". *Economics Letters*, 90, pp. 156-162. https://doi.org/10.1016/j.econlet.2005.07.020

Gürkaynak, Refet S., Brian Sack and Eric Swanson. (2005). "Do actions speak louder than words? The response of asset prices to monetary policy actions and statements". *International Journal of Central Banking*, 1. https://www.ijcb.org/journal/ijcb05q2a2.htm

Hagen, Jürgen von, Ludger Schuknecht and Guido Wolswijk. (2011). "Government bond risk premiums in the EU revisited: The impact of the financial crisis". *European Journal of Political Economy*, 27, pp. 36-43. https://doi.org/10.1016/j.ejpoleco.2010.07.002

Haugh, David, Patrice Ollivaud and David Turner. (2009). "What drives sovereign risk premiums? An analysis of recent evidence from the Euro area". OECD Economics Department Working Papers, 718. https://doi.org/10.1787/18151973

Jeanne, Olivier, and Lars E. O. Svensson. (2007). "Credible commitment to optimal escape from a liquidity trap: The role of the balance sheet of an independent central bank". *American Economic Review,* 97, pp. 474-490. https://doi.org/10.1257/aer.97.1.474

Kohonen, Anssi. (2014). "Transmission of government default risk in the Eurozone". *Journal of International Money and Finance*, 47(C), pp. 71-85. https://doi.org/10.1016/j.jimonfin.2014.04.006

Koijen, Ralph, Francois Koulishcher, Benoit Nguyen and Motohiro Yogo. (2017). "Euro-area quantitative easing and portfolio rebalancing". *American Economic Review: Papers & Proceedings*, 107, pp. 621-627. https://doi.org/10.1257/aer.p20171037

Krishnamurthy, Arvind, Stefan Nagel and Annette Vissing-Jorgensen. (2018). "ECB policies involving government bond purchases: Impact and channels". *Oxford Review of Finance*, 22, pp. 1-44. https://doi.org/10.1093/rof/rfx053

Li, Canlin, and Min Wei. (2013). "Term structure modeling with supply factors and the Federal Reserve's large-scale asset purchase programmes". *International Journal of Central Banking*. https://www.ijcb.org/journal/ijcb13q1a1.htm

Maltritz, Dominik. (2013). "Determinants of sovereign yield spreads in the Eurozone: A Bayesian approach". *Journal of International Money and Finance*, 31(3), pp. 657-672. https://doi.org/10.1016/j.jimonfin.2011.10.010

Matei, Iuliana. (2022). "Does pandemic risk affect yield spreads in the EMU?". *International Economics*, 172, pp. 431-450. https://doi.org/10.1016/j.inteco.2021.09.002

Paniagua, Jordi, Juan Sapena and Cecilio Tamarit. (2017). "Sovereign debt spreads in EMU: The time-varying role of fundamentals and market distrust". *Journal of Financial Stability*, 33, pp. 187-206. https://doi.org/10.1016/j.jfs.2016.06.004

Roll, Richard. (1984). "A simple implicit measure of the effective bid-ask spread in an efficient market". *The Journal of Finance*, 39, pp. 1127-1139. https://doi.org/10.1111/j.1540-6261.1984.tb03897.x

Schwarz, Krista. (2019). "Mind the gap: Disentangling credit and liquidity in risk spreads". *Review of Finance*, 3(23), pp. 557-597. https://doi.org/10.1093/rof/rfy034

Svensson, Lars E. (1994). "Estimating and interpreting forward interest rates: Sweden 1992-1994". NBER Working Paper Series, 4871, National Bureau of Economic Research. https://doi.org/10.3386/w4871

Vayanos, Dimitri, and Jean-Luc Vila. (2009). "A preferred-habitat model of the term structure of interest rates". NBER Working Paper Series, 15487, National Bureau of Economic Research. https://doi.org/10.3982/ECTA17440

Vayanos, Dimitri, and Jean-Luc Vila. (2021). "A preferred-habitat model of the term structure of interest rates". *Econometrica*, 89, pp. 77-112. https://doi.org/10.3982/ECTA17440

Table 1: Variable description and data sources

Variable	Description	Source
Adjusted bond spread	Spanish 10-year bond yield spread against the Portuguese bond, adjusted using the benchmark bond curve.	Bloomberg + own calculations
Bid-ask spread	Spanish 10-year bond yield bid-ask spread minus the Portuguese bond yield bid-ask spread.	Bloomberg
Liq spread	Spain-to-Portugal gap between two bond liquidity proxies. These are estimated as the average value of four: (i) bid-ask spread, (ii) price range (intraday price variation), (ii) volatility (20-day standard deviation of daily price changes) and a (iv) Roll estimator (Roll, 1984)	Bloomberg + own calculations
Rating spread	Spain-to-Portugal gap for the average Fitch, Moody's, S&P and DRBS ratings for each country.	Refinitiv
CDS spread	Spanish 10-year bond credit default swap minus the Portuguese 10-year bond credit default swap.	Datastream
Debt-to-GDP spread	Spanish public debt to GDP ratio (%) minus the Portuguese public debt to GDP ratio (%).	Bloomberg
Sovereign debt by instrument	Total long-term and short-term outstanding debt, including securities, loans and other non-tradable.	Banco de España, IGCP
Net debt issuance	Government total long-term debt issuance, net of Eurosystem purchases	Banco de España, IGCP, ECB
Central Banks' bond holding differential (DCBBH)	Spain-to-Portugal differential for the ratio for Eurosystem bond holdings (PSPP+PEPP) to long-term total debt outstanding in bonds ratio (face value).	Bloomberg, IMF, ECB, Banco de España

Table 2: Descriptive statistics. Variables starting with D represents Spain-to-Portugal spreads (Dr, DBAS, DLIQ, DRating, DCDS, DCBBH, DDGDP). Two stars state for sample mean significantly different than zero at 95% confidence.

Variable	frequency	sample	mean	s.e.	p25	p50	p75	min	max	n
r^{ES}	daily	01/Jan/14 - 28/Feb/23	1.50	0.96	0.61	1.60	2.01	0.04	4.38	2,389
r^{PT}	daily	01/Jan/14 - 28/Feb/23	2.21	1.42	0.60	2.23	3.31	-0.01	6.10	2,389
Dr	daily	01/Jan/14 - 28/Feb/23	-0.66**	0.77	-1.11	-0.45	0.01	-2.77	0.13	2,389
BAS^{ES}	daily	01/Jan/14 - 28/Feb/23	0.009	0.008	0.005	0.007	0.010	0.001	0.132	2,389
BAS^{PT}	daily	01/Jan/14 - 28/Feb/23	0.021	0.015	0.008	0.018	0.029	0.003	0.241	2,389
DBAS	daily	01/Jan/14 - 28/Feb/23	-0.011**	0.013	-0.019	-0.008	-0.002	-0.195	0.104	2,389
DLIQ	daily	02/Jan/15 - 28/Feb/23	-0.133**	0.277	-0.270	-0.060	0.050	-1.570	0.770	2,128
$Rating^{ES}$	daily	01/Jan/14 - 28/Feb/23	14.56	0.68	14.00	15.00	15.25	13.00	15.25	2,389
$Rating^{PT}$	daily	01/Jan/14 - 28/Feb/23	12.14	0.99	11.25	12.25	13.00	10.50	14.00	2,389
DRating	daily	01/Jan/14 - 28/Feb/23	2.42**	0.38	2.25	2.50	2.75	1.25	3.00	2,389
CDS_{ES}	daily	01/Jan/14 - 28/Feb/23	67.77	32.72	38.70	58.42	99.66	23.06	156.37	2,389
CDS_{PT}	daily	01/Jan/14 - 28/Feb/23	124.01	87.82	44.58	84.49	200.28	28.11	362.33	2,389
DCDS	daily	01/Jan/14 - 28/Feb/23	-56.24**	59.40	-101.45	-34.06	-4.84	-205.96	5.92	2,389
$CBBH^{ES}$	monthly	1M/15 -12M/22	0.23	0.11	0.16	0.24	0.32	-0.00	0.38	96
$CBBH^{PT}$	monthly	1M/15 -12M/22	0.24	0.13	0.17	0.22	0.35	0.00	0.49	96
DCBBH	monthly	1M/15 -12M/22	-0.02**	0.04	-0.03	-0.01	0.01	-0.12	0.03	96
$DGDP^{ES}$	quarterly	1Q/14 - 3Q/22	107.39	7.78	102.00	104.20	115.03	98.20	125.70	35
$DGDP^{PT}$	quarterly	1Q/14 - 3Q/22	128.56	5.70	124.88	131.00	132.90	116.60	138.30	35
DDGDP	quarterly	1Q/14 - 3Q/22	-21.17**	8.30	-28.20	-23.90	-14.28	-32.10	-4.50	35

Table 3: Estimation results. Standard deviations in brackets. Sample: 01/2015-12/2022. We reestimate the model (5) using two alternative proxies for the bond market liquidity differential, $X = DBAS$ and $DLiq$.

$$\begin{bmatrix} \Delta Dr_t \\ \Delta DCDS_t \end{bmatrix} = B_1 \hat{\varepsilon}_{t-1} + B_2 \begin{bmatrix} \Delta Dr_{t-1} \\ \Delta DCDS_{t-1} \end{bmatrix} + B_3 \begin{bmatrix} \Delta DX_t \\ \Delta DRating_t \\ \Delta DCBBH_t \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \tag{5}$$

Panel A: liquidity proxy based on the bid-ask yield spread

	ΔDr_t	$\Delta DCDS_t$
$\hat{\varepsilon}_{t-1}$	-0.342^{***}	-11.780^{***}
	(0.069)	(6.737)
ΔDr_{t-1}	0.613^{***}	69.094^{***}
	(0.082)	(8.027)
$\Delta DCDS_{t-1}$	-0.007^{***}	-0.702^{***}
	(0.001)	(0.081)
$\Delta DBAS_t$	8.996^{***}	803.625^{***}
	(2.215)	(217.972)
$\Delta DRating_t$	-0.079	-3.920
	(0.124)	(12.181)
$\Delta DCBBH_t$	-2.209	-19.326
	(1.767)	(173.841)

Panel B: liquidity index spread $DLiq$ that averages (i) bid-ask spread, price range (intraday price variation), volatility (20days standard deviation of daily price changes), and Roll estimator (Roll (1984)) (autocovariance of daily returns over a 5-day window)

	ΔDr_t	$\Delta DCDS_t$
$\hat{\varepsilon}_{t-1}$	-0.354^{***}	-13.208^{***}
	(0.084)	(6.540)
ΔDr_{t-1}	0.438^{***}	51.113^{***}
	(0.084)	(8.157)
$\Delta DCDS_{t-1}$	-0.004^{***}	-0.487^{***}
	(0.001)	(0.082)
$\Delta DLiq_t$	0.286^{***}	29.186^{***}
	(0.057)	(5.496)
$\Delta DRating_t$	-0.184	-13.239
	(0.117)	(11.409)
$\Delta DCBBH_t$	-0.729	91.556
	(1.658)	(161.116)

Figure 15: Spread between the Spanish and Portuguese sovereign bond yields at various maturities. Source: Bloomberg.

Figure 16: Recursive estimation of the VECX(1) model using monthly data and a 2-year overlapped rolling window. Estimation results (90% confidence interval for the model parameters.)

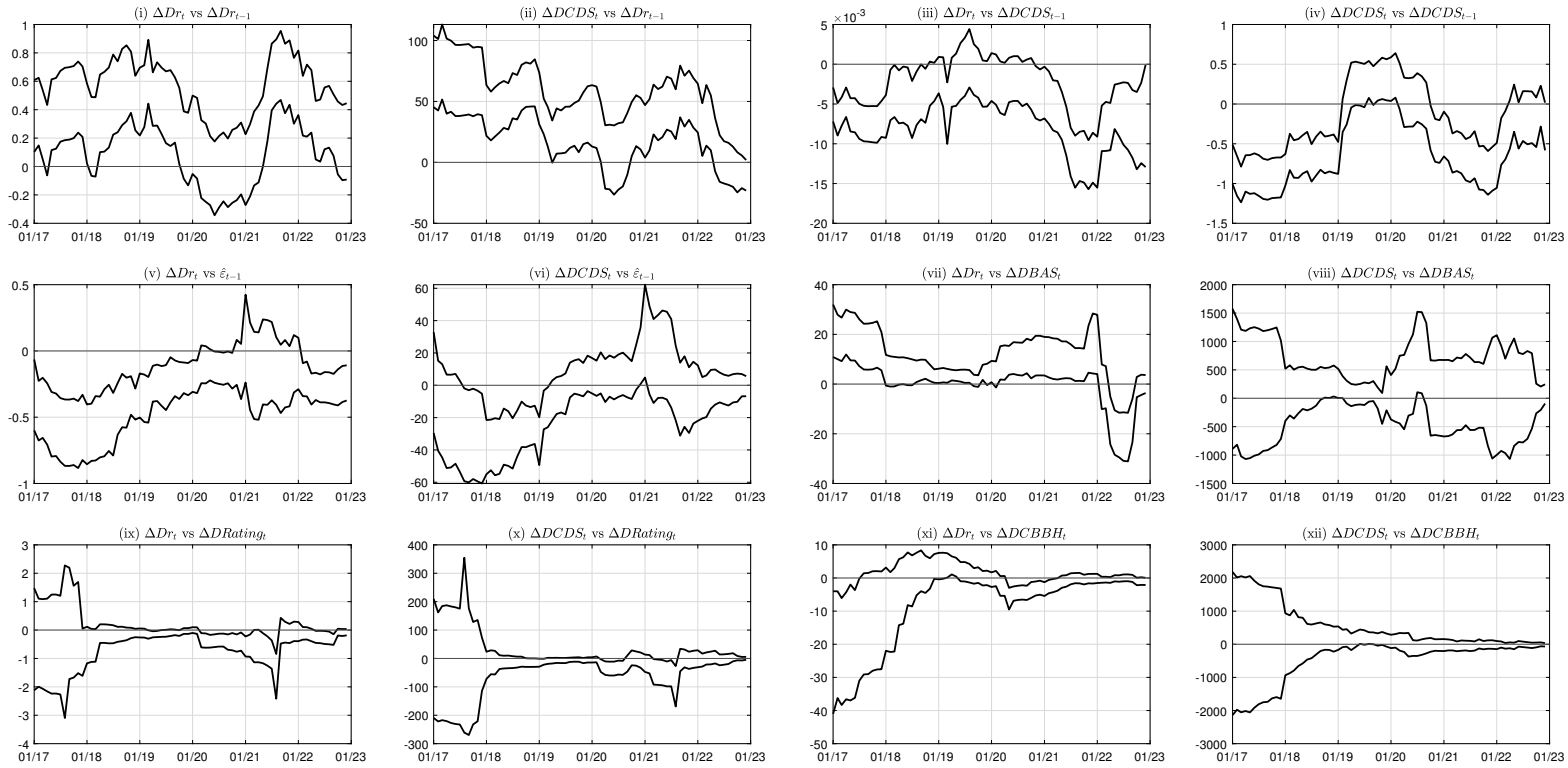


Figure 17: Recursive estimation of the VECX(1) model using monthly data and a 2-year overlapped rolling window. Estimation results (90% confidence interval for the model parameters.)

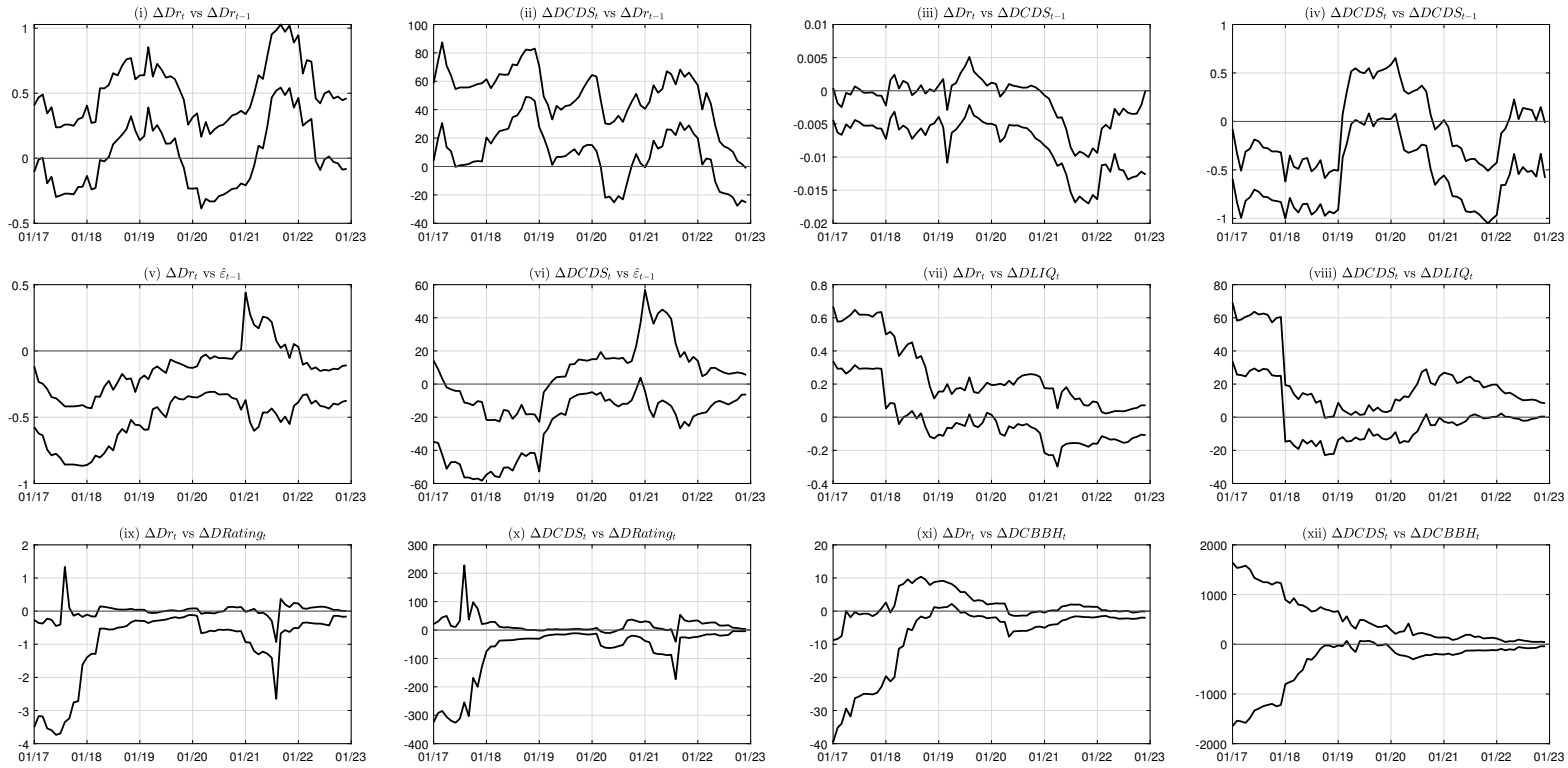


Figure 18: Adjusted Spain-to-Portugal bond yield spread and the fitted bond yield spread using the Eurosystem bond holdings differential as a regressor. Units: b.p.

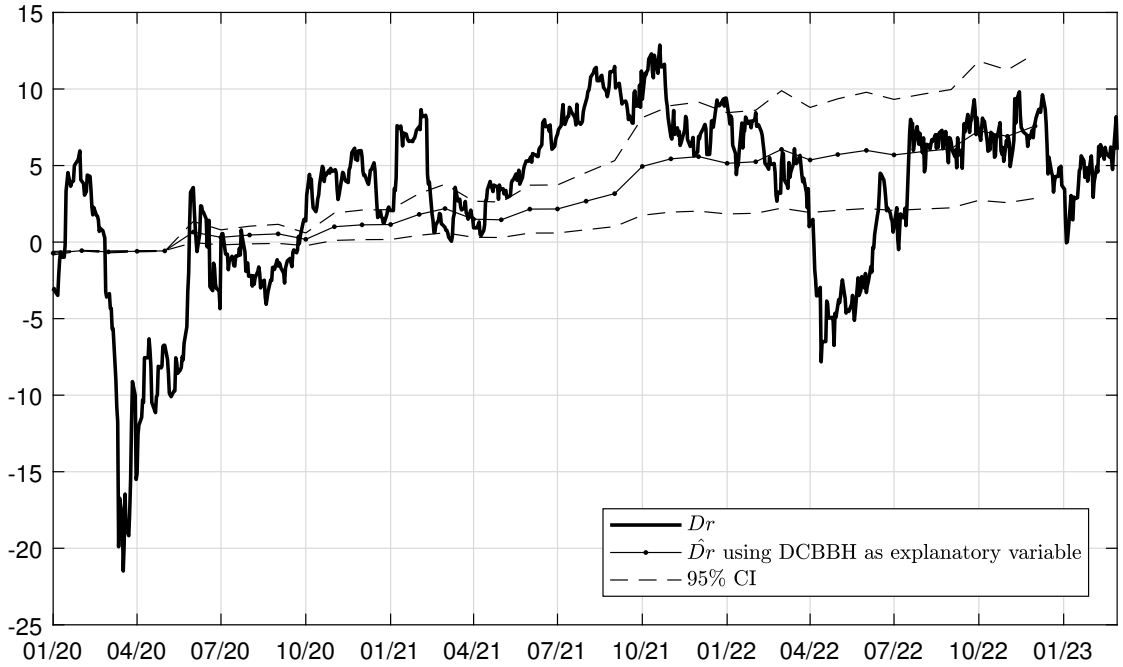
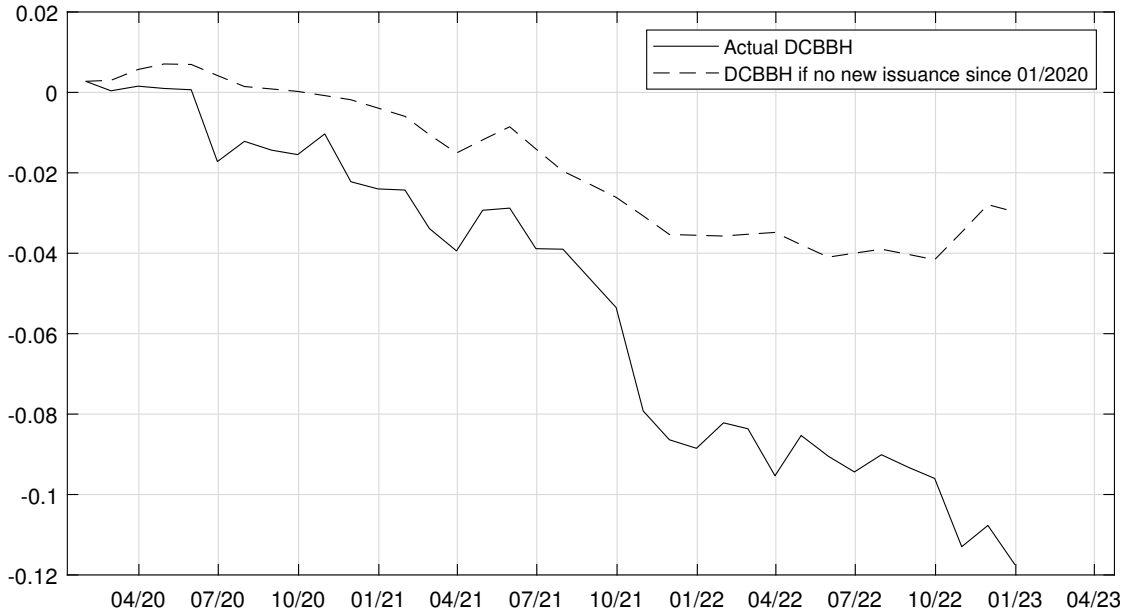


Figure 19: Actual DCBBH vs. DCBBH if the long-term total debt outstanding remains equal to its value from January 2020 until December 2022. This is, if no new issuances in Spain and Portugal since 01/2020. Units: %.



Source: Bloomberg, own elaboration.

BANCO DE ESPAÑA PUBLICATIONS

WORKING PAPERS

2241 JULIO GÁLVEZ and GONZALO PAZ-PARDO: Richer earnings dynamics, consumption and portfolio choice over the life cycle.
2242 MARINA DIAKONOVA, CORINNA GHIRELLI, LUIS MOLINA and JAVIER J. PÉREZ: The economic impact of conflict-related and policy uncertainty shocks: the case of Russia.
2243 CARMEN BROTO, LUIS FERNÁNDEZ LAFUERZA and MARIYA MELNYCHUK: Do buffer requirements for European systemically important banks make them less systemic?
2244 GERGELY GANICS and MARÍA RODRÍGUEZ-MORENO: A house price-at-risk model to monitor the downside risk for the Spanish housing market.
2245 JOSÉ E. GUTIÉRREZ and LUIS FERNÁNDEZ LAFUERZA: Credit line runs and bank risk management: evidence from the disclosure of stress test results.
2301 MARÍA BRU MUÑOZ: The forgotten lender: the role of multilateral lenders in sovereign debt and default.
2302 SILVIA ALBRIZIO, BEATRIZ GONZÁLEZ and DMITRY KHAMETSHIN: A tale of two margins: monetary policy and capital misallocation.
2303 JUAN EQUIZA, RICARDO GIMENO, ANTONIO MORENO and CARLOS THOMAS: Evaluating central bank asset purchases in a term structure model with a forward-looking supply factor.
2304 PABLO BURRIEL, IVÁN KATARYNIUK, CARLOS MORENO PÉREZ and FRANCESCA VIANI: New supply bottlenecks index based on newspaper data.
2305 ALEJANDRO FERNÁNDEZ-CEREZO, ENRIQUE MORAL-BENITO and JAVIER QUINTANA: A production network model for the Spanish economy with an application to the impact of NGEU funds.
2306 MONICA MARTINEZ-BRAVO and CARLOS SANZ: Trust and accountability in times of pandemic.
2307 NATALIA FABRA, EDUARDO GUTIÉRREZ, AITOR LACUESTA and ROBERTO RAMOS: Do renewable energies create local jobs?
2308 ISABEL ARGIMÓN and IRENE ROIBÁS: Debt overhang, credit demand and financial conditions.
2309 JOSÉ-ELÍAS GALLEGOS: Inflation persistence, noisy information and the Phillips curve.
2310 ANDRÉS ALONSO-ROBISCO, JOSÉ MANUEL CARBÓ and JOSÉ MANUEL MARQUÉS: Machine Learning methods in climate finance: a systematic review.
2311 ALESSANDRO PERI, OMAR RACHEDI and IACOPO VAROTTO: The public investment multiplier in a production network.
2312 JUAN S. MORA-SANGUINETTI, JAVIER QUINTANA, ISABEL SOLER and ROK SPRUK: Sector-level economic effects of regulatory complexity: evidence from Spain.
2313 CORINNA GHIRELLI, ENKELEJDA HAVARI, ELENA MERONI and STEFANO VERZILLO: The long-term causal effects of winning an ERC grant.
2314 ALFREDO GARCÍA-HIERNAUX, MARÍA T. GONZÁLEZ-PÉREZ and DAVID E. GUERRERO: How to measure inflation volatility. A note.
2315 NICOLÁS ABBATE, INÉS BERNIELL, JOAQUÍN COLEFF, LUIS LAGUINGE, MARGARITA MACHELETT, MARIANA MARCHIONNI, JULIÁN PEDRAZZI and MARÍA FLORENCIA PINTO: Discrimination against gay and transgender people in Latin America: a correspondence study in the rental housing market.
2316 SALOMÓN GARCÍA: The amplification effects of adverse selection in mortgage credit suply.
2317 METTE EJRNÆS, ESTEBAN GARCÍA-MIRALLES, METTE GØRTZ and PETTER LUNDBORG: When death was postponed: the effect of HIV medication on work, savings and marriage.
2318 GABRIEL JIMÉNEZ, LUC LAEVEN, DAVID MARTÍNEZ-MIERA and JOSÉ-LUIS PEYDRÓ: Public guarantees and private banks' incentives: evidence from the COVID-19 crisis.
2319 HERVÉ LE BIHAN, DANILO LEIVA-LEÓN and MATÍAS PACCE: Underlying inflation and asymmetric risks.
2320 JUAN S. MORA-SANGUINETTI, LAURA HOSPIDO and ANDRÉS ATIENZA-MAESO: The numbers of equality regulation. Quantifying regulatory activity on non-discrimination and its relationship with gender gaps in the labour market.
2321 ANDRES ALONSO-ROBISCO and JOSÉ MANUEL CARBÓ: Analysis of CBDC Narrative of Central Banks using Large Language Models.
2322 STEFANIA ALBANESI, ANTÓNIO DIAS DA SILVA, JUAN F. JIMENO, ANA LAMO and ALENA WABITSCH: New technologies and jobs in Europe.
2323 JOSÉ E. GUTIÉRREZ: Optimal regulation of credit lines.
2324 MERCEDES DE LUIS, EMILIO RODRÍGUEZ and DIEGO TORRES: Machine learning applied to active fixed-income portfolio management: a Lasso logit approach.

2325 SELVA BAHAR BAZIKI, MARÍA J. NIETO and RIMA TURK-ARISS: Sovereign portfolio composition and bank risk: the case of European banks.

2326 ANGEL-IVAN MORENO and TERESA CAMINERO: Assessing the data challenges of climate-related disclosures in european banks. A text mining study.

2327 JULIO GÁLVEZ: Household portfolio choices under (non-)linear income risk: an empirical framework.

2328 NATASCHA HINTERLANG: Effects of Carbon Pricing in Germany and Spain: An Assessment with EMuSe.

2329 RODOLFO CAMPOS, SAMUEL PIENKNAGURA and JACOPO TIMINI: How far has globalization gone? A tale of two regions.

2330 NICOLÁS FORTEZA and SANDRA GARCÍA-URIBE: A Score Function to Prioritize Editing in Household Survey Data: A Machine Learning Approach.

2331 PATRICK MACNAMARA, MYROSLAV PIDKUYKO and RAFFAELE ROSSI: Taxing consumption in unequal economies.

2332 ESTHER CÁCERES and MATÍAS LAMAS: Dividend Restrictions and Search for Income.

2333 MARGARITA MACHELETT: Gender price gaps and competition: Evidence from a correspondence study.

2334 ANTON NAKOV and CARLOS THOMAS: Climate-conscious monetary policy.

2335 RICARDO BARAHONA, STEFANO CASSELLA and KRISTY A. E. JANSEN: Do teams alleviate or exacerbate the extrapolation bias in the stock market?

2336 JUAN S. MORA-SANGUINETTI and ANDRÉS ATIENZA-MAESO: "Green regulation": A quantification of regulations related to renewable energy, sustainable transport, pollution and energy efficiency between 2000 and 2022.

2401 LAURA HOSPIDO, NAGORE IRIBERRI and MARGARITA MACHELETT: Gender gaps in financial literacy: a multi-arm RCT to break the response bias in surveys.

2402 RUBÉN DOMÍNGUEZ-DÍAZ, SAMUEL HURTADO and CAROLINA MENÉNDEZ: The medium-term effects of investment stimulus.

2403 CLODOMIRO FERREIRA, JOSÉ MIGUEL LEIVA, GALO NUÑO, ÁLVARO ORTIZ, TOMASA RODRIGO and SIRENIA VAZQUEZ: The heterogeneous impact of inflation on households' balance sheets.

2404 JORGE ABAD, GALO NUÑO and CARLOS THOMAS: CBDC and the operational framework of monetary policy.

2405 STÉPHANE BONHOMME and ANGELA DENIS: Estimating individual responses when tomorrow matters.

2406 LAURA ÁLVAREZ-ROMÁN, SERGIO MAYORDOMO, CARLES VERGARA-ALERT and XAVIER VIVES: Climate risk, soft information and credit supply.

2407 JESÚS FERNÁNDEZ-VILLAVERDE, JOËL MARBET, GALO NUÑO and OMAR RACHEDI: Inequality and the zero lower bound.

2408 PABLO BURRIEL, MAR DELGADO-TÉLLEZ, CAMILA FIGUEROA, IVÁN KATARYNIUK and JAVIER J. PÉREZ: Estimating the contribution of macroeconomic factors to sovereign bond spreads in the euro area.

2409 LUIS E. ROJAS and DOMINIK THALER: The bright side of the doom loop: banks' sovereign exposure and default incentives.

2410 SALOMÓN GARCÍA-VILLEGAS and ENRIC MARTORELL: Climate transition risk and the role of bank capital requirements.

2411 MIKEL BEDAYO and JORGE E. GALÁN: The impact of the Countercyclical Capital Buffer on credit: Evidence from its accumulation and release before and during COVID-19.

2412 EFFROSYNI ADAMOPOULOU, LUIS DÍEZ-CATALÁN and ERNESTO VILLANUEVA: Staggered contracts and unemployment during recessions.

2413 LUIS FÉRNANDEZ LAFUERZA and JORGE E. GALÁN: Should macroprudential policy target corporate lending? Evidence from credit standards and defaults.

2414 STÉPHANE BONHOMME and ANGELA DENIS: Estimating heterogeneous effects: applications to labor economics.

2415 LUIS GUIROLA, LAURA HOSPIDO and ANDREA WEBER: Family and career: An analysis across Europe and North America.

2416 GERALD P. DWYER, BILJANA GILEVSKA, MARÍA J. NIETO and MARGARITA SAMARTÍN: The effects of the ECB's unconventional monetary policies from 2011 to 2018 on banking assets.

2417 NICOLÁS FORTEZA, ELVIRA PRADES and MARC ROCA: Analysing the VAT cut pass-through in Spain using web-scraped supermarket data and machine learning.

2418 JOSÉ-ELÍAS GALLEGOS: HANK beyond FIRE: Amplification, forward guidance, and belief shocks.

2419 DANIEL ALONSO: Stabilisation properties of a SURE-like European unemployment insurance.

2420 FRANCISCO GONZÁLEZ, JOSÉ E. GUTIÉRREZ and JOSÉ MARÍA SERENA: Shadow seniority? Lending relationships and borrowers' selective default.

2421 ROBERTO BLANCO, MIGUEL GARCÍA-POSADA, SERGIO MAYORDOMO and MARÍA RODRÍGUEZ-MORENO: Access to credit and firm survival during a crisis: the case of zero-bank-debt firms.

2422 FERNANDO CEREZO, PABLO GIRÓN, MARÍA T. GONZÁLEZ-PÉREZ and ROBERTO PASCUAL: The impact of sovereign debt purchase programmes. A case study: the Spanish-to-Portuguese bond yield spread.