A European Safe Asset? Not Without the Investors*

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Abstract

We study bonds issued by the European Union (EU) as joint and several liabilities of its member countries and show that they pay higher interest rates than comparably safe and large sovereign issuers. The spread reflects their greater sensitivity to adverse market shocks, which becomes particularly pronounced during periods of monetary tightening. Using novel data, we document that EU bonds have a small investor base because they are excluded from major fixed-income indices due to their lack of formal sovereign status. This exclusion lowers expected prices during crises, making EU bonds unattractive to investors with liquidity needs, such as mutual funds and foreign central banks. Expectations of state-contingent purchases by the European Central Bank (ECB) can substantially compress this premium even when not directed at EU bonds. A demand-based asset pricing framework suggests that the spread would be negligible if the EU were recognized as a fully sovereign issuer and a new safe asset would arise.

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1 Introduction

The European Union (EU) has been issuing debt jointly guaranteed by its member countries for several decades. Through various institutions and legal frameworks, more than €1.6 trillion of AAA-rated bonds have been issued as of 2025. Although this figure represents only 10% of European GDP, it is comparable in size to the sovereign debt of major member states such as Germany and France. The issuance of these bonds surged in response to the COVID-19 crisis, and recent political momentum has reinvigorated efforts to develop a safe asset for the entire Union, aimed at financing common priorities.

Despite such ambitious plans, EU bonds trade at significant spreads relative to comparable sovereign issuers, around 50 basis points, with little evidence of compression even as their outstanding volume has doubled. Their prices are more sensitive to bad news and react more strongly to shifts in monetary policy expectations. These characteristics indicate that EU bonds do not function as a safe asset, yet explanations from the literature, such as perceived credit risk, are inconsistent with the empirical evidence.

We show that EU bonds pay a large premium not because of their economic fundamentals, but because of their legal status. They are excluded from sovereign bond indices because they are "supranationals": securities backed by tax revenues but not legally issued by a government. Consequently, many institutional investors cannot participate in this market because their investment universes are defined by index inclusion. This exclusion matters because it shrinks the investor base, and a smaller base means prices fall more during crises, which makes the bonds unattractive to investors who might need to liquidate assets.

We begin by ruling out other explanations and use credit default swaps to show that the spread is up to 10 times larger than default risk alone could justify. Crucially, this finding extends to all supranationals, regardless of their activity or credit backing. Even bonds issued by KfW, a policy bank fully controlled and solely guaranteed by Germany, trade at the same spread both in levels and changes. The spread cannot be accounted for by issuer size, secondary market liquidity, or preferential regulatory treatment for government bonds.

In line with a classical approach to asset pricing, we document that the unconditional spread on EU bonds reflects their inferior stochastic properties, with prices falling more during periods of market stress. The higher sensitivity to adverse shocks does not reflect expectations of worsening fundamentals, as is the case for risky governments like Spain and Italy, since it is common to all supranationals. Instead, a higher probability of a crisis has a larger impact on EU bonds because they are expected to fall by more in price during a period of severe market disruption due to their smaller investor base.

To explain why supranational bonds have worse stochastic properties, we construct a novel measure that quantifies the size of the potential investor base for different issuers. We find that bonds issued by the EU and other supranationals have a benchmarked investor base only about 20% as large as that of comparable sovereign bonds, a dramatic difference that cannot be explained by characteristics such as credit quality, maturity, or issue size.

Our measure is constructed by collecting the weights assigned to thousands of individual bonds across a wide range of European fixed-income indices and combining these with data on the total assets under management (AUM) that track each index from mutual funds and ETFs. For each bond, we calculate the fraction of its outstanding amount that would be held by benchmarked investors if they replicated their indices exactly. This measure accounts for both active and passive investors, following a large literature showing that even active funds tend to minimize deviations from their benchmarks. Using the terminology in the index-inclusion literature, we refer to this measure as inelastic demand, and show that securities with smaller investor bases face significantly higher borrowing costs.

In Section 3, we confirm the link between low inelastic demand and worse conditional properties that drive relative pricing by comparing the actual investor base of supranational and sovereign bonds. In particular, we show that it is investors with a potential need for cash that avoid buying EU bonds even if they are in their investment universe. We present evidence of investor sorting across bonds that are equally safe but have different stochastic properties both within and across classes of financial intermediaries. Within mutual funds and ETFs, we measure the flightiness of the investor base during Covid for different funds, and show that it is only those that expect to suffer large outflows during a crisis that pay a large premium to hold sovereigns relative to equally safe supranationals.

We also use confidential holdings data to establish that insurance companies and commercial banks almost entirely avoid government debt and are instead enthusiastic buyers of EU bonds, which offer AAA safety at a sizeable discount. They are the natural buyers for this type of debt since the long-dated or stable nature of their liabilities means they do not need to liquidate assets and realize losses during crisis episodes. By contrast, mutual funds and foreign investors pay a large premium to hold government debt since they have a higher willingness to pay for safe assets that do not depreciate in bad times. Mutual funds, with their short-dated liabilities, experience large outflows during periods of market disruption; as a result, they need to hold assets they can liquidate at a high price. Foreign holdings are dominated by central banks, which use European bonds as hard-currency reserves to draw on in times of need.

Banks and insurance companies thus naturally take advantage of this pricing differential, but cannot eliminate it. Foreign investors and mutual funds, who together hold nearly 80% of all AAA-rated European bonds, are simply too large relative to domestic intermediaries. The spread persists because the marginal investors are those with the greatest liquidity needs. In equilibrium, slow-moving institutions such as banks and insurers act as stabilizing arbitrageurs, while flight-prone mutual funds and foreign investors pay a stiff price to hold assets that retain value during episodes of market stress.

Having established the cross-sectional mechanism, we next examine why the spread varies so much over time. In Section 4, we develop a model showing that sovereign bonds enjoy superior properties because of their larger inelastic demand. The model provides a unified explanation for both the cross-sectional and time-series evidence, delivering two key insights. First, on the cross-sectional side, given a fixed total amount of benchmarked demand, inclusion of EU bonds in sovereign indices would come at the expense of national governments, raising their borrowing costs. The magnitude of this redistribution depends on model parameters but could be economically significant. Second, on the time-series side, the model incorporates expectations of future central bank support, what we call "conditional QE". This captures market expectations that the ECB will intervene with asset purchases during crises, even when no program is currently active. Because EU bonds' expected liquidity during crises depends more heavily on such interventions, changes in conditional QE have asymmetric effects across issuers: reductions disproportionately raise EU spreads.

The model yields three testable predictions. First, reductions in conditional QE widen spreads and increase sensitivity to bad news for low-inelastic-demand assets. Second, this effect is nonlinear: as the ECB signals reduced willingness to intervene, the impact on spreads accelerates. Third, investors with liquidity needs should respond by tilting their portfolios away from EU bonds, which have deteriorating stochastic properties. By contrast, actual asset purchases (unconditional QE) and conventional monetary policy have muted effects on spreads because they do not alter the relative stochastic properties across bonds. We test all three predictions and find strong empirical support.

In Section 5 we document substantial time-series variation in the EU bond spread at business cycle frequency. This pattern cannot be explained by slow-moving changes in inelastic demand, contemporaneous ECB asset purchases, or shifts in interest rate expectations. Instead, an option-implied measure of conditional QE tracks the spread remarkably well, demonstrating that this mechanism can increase the premium paid by supranational issuers by a factor of 4 (from 20 to 80 basis points). Strikingly, during monetary tightening, the sensitivity of EU bonds to market stress increases as much as sixfold, becoming even larger than for Italy or Spain. The nonlinearity of the mechanism provides a rationale for the sudden spike in spreads in 2022, which occurred only months after the beginning of the reversal in the policy stance. Consistent with this mechanism, we show that during this episode investors with liquidity needs shifted their portfolios further away from EU bonds and toward government bonds.

We thus provide an explanation for the failure of EU bonds as safe assets that disproves claims that financial markets require an "EU premium" arising from the political fragmentation of its institutions. We also rationalize the failure of policies aimed at reducing the spread paid by EU bonds because they did not address the issue of inelastic demand. Instead, we show that the legal status of the issuing entities is ill-suited for the market coordination on proper sovereign issuers and that monetary tightening widens the gap.

Finally, in Section 6 we estimate a demand-based asset pricing framework to understand which policies have the potential to reduce the spread paid by EU bonds. We show that incremental increases in outstanding quantities, potentially replacing part of each country's national debt, yield only modest gains in terms of reduced interest cost for EU bonds. Instead, the recognition of the European Commission as a fully sovereign entity, holding constant default risk and market size, would substantially reduce its borrowing costs. This ability to issue safe assets would come at the cost of only slightly higher yields for national governments, thanks to large additional demand by foreign investors in need of a store of value.

Our findings have substantial implications for the understanding of the ultimate source of the specialness of government debt and for the international role of the euro. We describe a setting where a large stock of debt issued by a safe institution cannot compete with government debt, even with full regulatory support. Instead, the recognition of an asset as a store of value accessible to a large investor base is the key source of convenience yields. Because reserve currency status requires assets that can attract broad demand, our findings suggest that the euro has limited prospects for challenging the dominance of the dollar.

Related literature. This paper first relates to the literature on European fiscal integration, where countries of differing credit quality consider joint debt issuance. Among the most influential contributions, Brunnermeier et al. (2017) analyze the institutional design of European Safe Bonds (ESBies), proposing a tranching mechanism to create AAA-rated securities from a diversified portfolio of sovereign debt. Similar proposals (e.g. Favero and Missale (2012), Beetsma and Mavromatis (2014)) have explored alternative structures for common issuance. While these designs have received considerable policy attention, they were never implemented, and our findings suggest that they would have failed to create a safe asset because financial markets would not have treated such instruments as sovereign debt.

The paper also contributes to the literature on the determinants of safe-asset status.

Following Brunnermeier et al. (2024), a truly safe asset must be not only free of default risk but also highly liquid during periods of stress, thereby earning a convenience yield. Geromichalos et al. (2023) show that the link between safety and liquidity is strong but not universal and this paper provides a salient example: despite their AAA rating, EU bonds are not treated as liquid stores of value. We thus speak to the ultimate source of the convenience yield on government debt as measured by Krishnamurthy and Vissing-Jorgensen (2012). In particular, we show that institutional design can impede market coordination on a given issuer as a provider of safe assets, consistent with Beber et al. (2009), who find that investors in the Euro area value liquidity properties associated with market size more than default risk. The closest theoretical foundation comes from Coppola et al. (2024), who model how issuers self-select into markets with larger investor bases, generating endogenous liquidity.

A third strand concerns the index inclusion effect, originally identified by Harris and Gurel (1986) and Shleifer (1986), who show that the inclusion of a stock in an index induces abnormal returns because of the inelastic demand of benchmarked investors. Our work differs from this literature in two key respects. First, we focus on fixed-income markets, where the importance of the index inclusion effect has only recently been discussed (see e.g. Calomiris et al. (2022), Dathan and Davydenko (2020) for corporates and Pandolfi and Williams (2019) for sovereigns). Second, whereas most studies employ an event-study approach for temporary price impacts, we identify a persistent consequence of index exclusion that is never arbitraged away. We build on Pavlova and Sikorskaya (2023) by computing a measure of benchmarking intensity and examining its implications for asset pricing and the investor composition.

Finally, the paper connects to the literature on conditional policy promises by central banks. Haddad et al. (2025b,a) show that expectations about support during crises can account for a substantial portion of price movements around policy announcements, reducing long-term yields by as much as 100 basis points. Hubert et al. (2024) demonstrate that the effect of ECB asset purchases depends on the conditional path of interventions, highlighting the role of signaling. We extend this literature by showing that changes in expectations about ECB support interact with market segmentation to drive spreads unrelated to fundamentals.

The rest of the paper is structured as follows. Section 2 shows that EU bonds pay a spread due to their exclusion from indices. Section 3 describes their investor base. Section 4 describes a model with dynamics consistent with the empirical facts. Section 5 shows how conditional QE can explain the time-series evolution of the spread. Section 6 estimates a demand-based asset pricing framework for policy counterfactuals. Section 7 concludes.

2 EU bonds failed because they are not sovereign debt

Common EU debt has not lived up to expectations of providing a new safe asset. EU bonds consistently trade at a large premium relative to sovereign bonds, a difference that cannot be explained by default risk, market size, or regulatory treatment. They also lack the key property of safe assets—high prices in bad times—and therefore must offer higher yields than equally safe sovereign issuers. We argue that investors demand this premium because EU bonds are not sovereign debt: the EU is not a government, and its securities are excluded from the sovereign bond indices that underpin inelastic demand in fixed-income markets.

2.1 Not issuing as a formal government has a large cost

We show that the European Union and other supranational institutions pay a large premium relative to equally safe and large governments due to their legal status, which does not qualify them as formal sovereigns. In particular, we show that the spread paid by EU bonds is exactly the same as that of a very heterogeneous group of issuers and that factors such as default risk and market size do not seem to have any effect on their cost of borrowing.

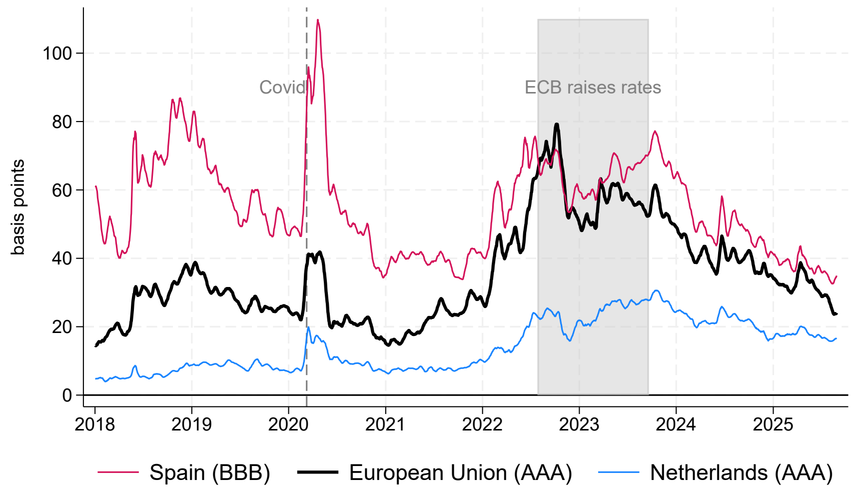
We document the large spread that AAA-rated EU bonds pay relative to AAA-rated governments as an empirical puzzle. Figure 2.1 shows the 5-year yield spread with AAA-rated German government bonds for selected issuers to show that the EU pays a very large premium relative to Germany (in the range of 20 to 80 basis points) and also relative to another smaller AAA-rated sovereign issuer such as the Netherlands. The EU spread at times exceeded the spread paid by Spain, a country with a significantly lower rating and that was part of a bailout program in the early 2010s.

We rule out that the spread is explained by credit risk considerations by employing a market-based measure of default risk: credit default swaps (CDS). These are financial contracts in which the seller insures the buyer against the default of a specific issuer over a period of time. We compute the so-called bond basis for an issuer i as the difference between the 5-year spread (shown in Figure 2.1) and the 5-year CDS premium differential, or

$$bb_t^i = \left(y_t^i - y_t^{\text{Germany}}\right) - \left(CDS_t^i - CDS_t^{\text{Germany}}\right), \tag{1}$$

where y_t^i is the yield for issuer i at time t and CDS_t^i is the corresponding CDS premium. Figure B.1 in the Appendix shows that the bond basis is positive and large - up to 70 basis points - for EU bonds, meaning that the required compensation for credit risk is much smaller

Figure 2.1: 5-year yield spread with German government bonds



The figure shows the difference between the 5-year point of the yield curve for a given issuer and the 5-year point of the yield curve for Germany, computed for Spain (in red), the European Union (in black), and the Netherlands (in blue). The yield for the European Union is computed as the average yield for the 4 EU institutions listed in Table 2.1. The vertical line marks the start of turmoil in financial markets due to the Covid epidemic (9 March 2020), while the shaded gray area is the period during which the ECB raised interest rates (from 27 July 2022 to 20 September 2023). Data comes from Bloomberg.

than the observed spread over German bonds.[1]

We then use a heterogeneous group of supranational institutions to further show that the spread paid by EU bonds is not due to commonly cited factors such as market size or regulatory treatment. The context is the sovereign debt market in euros, where all issuers are comparably large but belong to two groups according to their legal status and hence the size of potential investors: they are either national governments or supranational institutions. For both groups, we focus on the issuance in euros and ignore the smaller amounts issued in dollars or other currencies.

For national governments, we consider the central administrations of the 5 largest economies of the euro area since this grouping exhibits heterogeneity in both market size and credit risk. In particular, Table 2.1 reports the credit rating and outstanding debt in euros at the end of 2024, and both dimensions of heterogeneity are apparent. First, the credit rating ranges from the very safest (Germany and the Netherlands) to a merely safe BBB (Italy). Secondly, the size of markets varies to a large extent, with the outstanding debt for France being about double the Spanish debt, which in turn is about 3 times as large as the Dutch debt.

[1]The CDS premium on AAA-rated issuers of medium size is the price of an illiquid contract that is traded by a small subset of financial intermediaries and it likely includes some amount of counterparty risk and market power. As a result, IHS Markit only reports prices for the EIB (with several days without data), KfW (starting in 2021), and the European Commission (starting in 2025).

For supranationals, we consider 5 entities with very different roles and the legal status as the only common characteristic. Four are institutions linked to the European Union and the fifth is a German policy bank and they are all AAA-rated entities with established debt markets. Table 2.1 lists their names and outstanding debt but we show below that this heterogeneity is irrelevant for market pricing and that they all pay the same interest rates. The only significant difference with national governments is that the securities issued by these institutions are not formally classified as sovereign debt.

Table 2.1: Selected national governments and supranational institutions issuing debt in euros

The table shows characteristics of the central governments for the five largest countries in the Euro area by GDP and the five largest supranational issuers in euros, whose role and legal status are described in the body of the text. For each issuer, the table reports the corresponding default rating (median across rating agencies) and the total amount of tradable debt in euros outstanding as of December 31, 2024. We define the category of "EU bonds" as the combined issuance of the 4 institutions linked to the European Union.

Issuer (national governments)	**Rating**	**Debt (EUR Bn)**
Germany	AAA	2,300
Netherlands	AAA	500
France	AA	2,900
Spain	A	1,500
Italy	BBB	2,700
Issuer (supranational institutions)	**Rating**	**Debt (EUR Bn)**
Kreditanstalt für Wiederaufbau (KfW)	AAA	400
European Commission (EC)	AAA	600
European Investment Bank (EIB)	AAA	300
European Financial Stability Facility (EFSF)	AAA	200
European Stability Mechanism (ESM)	AAA	100
Total "EU bonds" (EC, EIB, EFSF, and ESM)	AAA	1,200

The 4 institutions linked to the European Union are tasked with very different roles but have always been AAA-rated[2] thanks to the understanding that their bonds are a joint and several liability of the member countries.[3] The European Investment Bank (EIB) is a multilateral development bank established in 1959 and with operations in a wide range of countries. The European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM) provided concessionary loans to governments during the Euro crisis of the early 2010s. The European Commission (EC) is the political body at the head of the Union

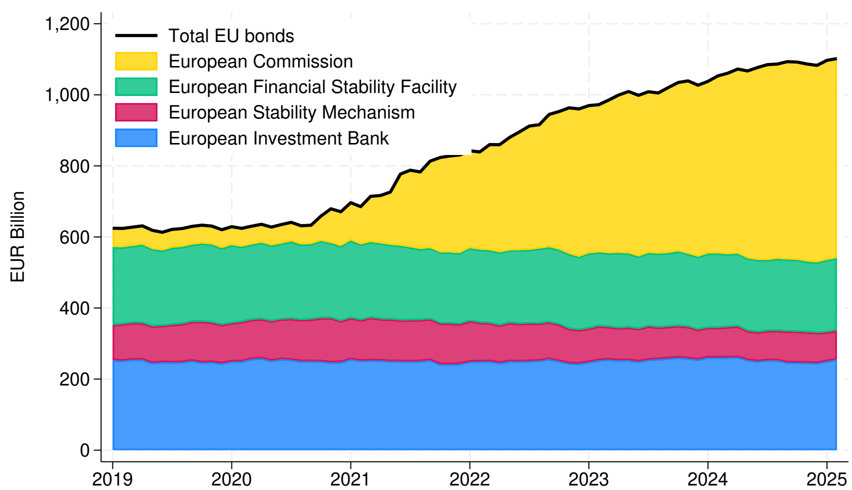
[2]In some periods, issuers other than the EIB have had an AA rating assigned by some of the agencies.

[3]The legal status of these liabilities is the result of political negotiations at different points in time, giving rise to a variety of *ad-hoc* arrangements of unclear classification, see Estrella Blaya (2022). However, the evidence presented in this Section shows that the exact legal status of the securities is not a pricing factor.

and whose funding comes from a multiannual budget financed by the member countries; Figure 2.2 shows how the EC rapidly increased its share of debt after a big recovery package was agreed during Covid and now accounts for the bulk of the outstanding amounts.

The last supranational borrower is a German policy bank whose credit standing is fully backed by the German government and whose securities can thus be regarded as having the exact same credit risk as those of the national government. The full name is Kreditanstalt für Wiederaufbau (KfW) and while being formally a private entity, the institution operates within a political mandate and the federal government has an explicit and binding legal obligation to guarantee all its liabilities. A long literature in finance has thus treated securities issued by KfW as having the same credit risk as German government bonds, and interpreted the higher yield of its securities as a measure of "illiquidity".[4]

Figure 2.2: Outstanding EU bonds denominated in euros by issuing institution



The figure shows total outstanding tradable debt in euros issued by the 4 supranational institutions of the European Union, whose legal status is described in the body of the text. In the rest of the paper we refer to the total amount of bonds issued by the four institutions as "EU bonds". Data comes from the ECB's CSDB and is shown at a monthly frequency.

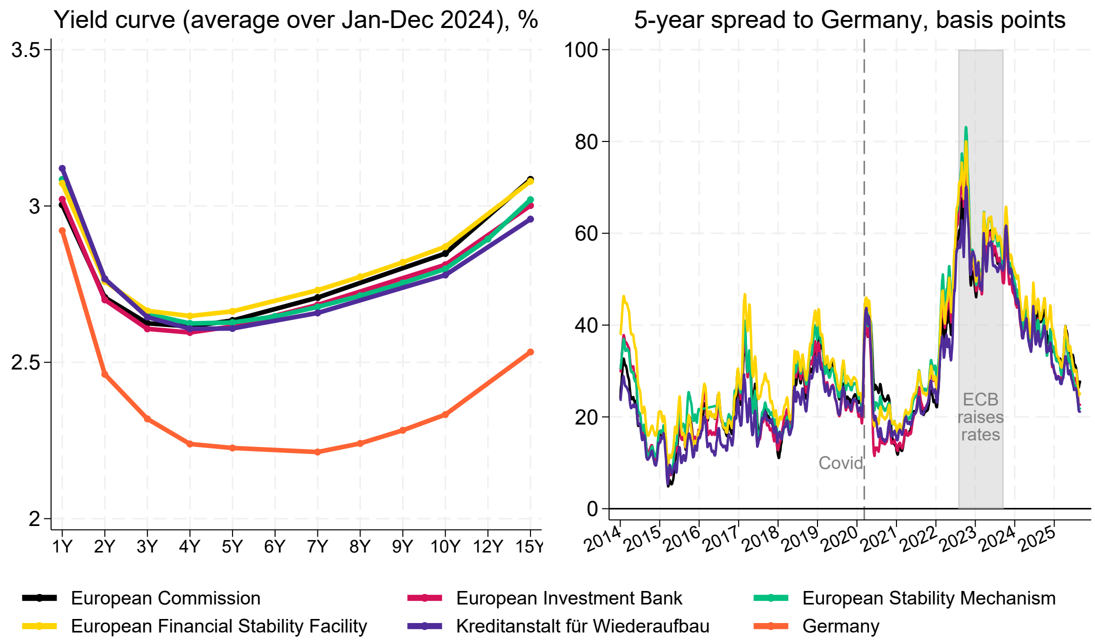
We now document that the different legal status of supranational institutions translates into significantly higher borrowing costs for reasons unrelated to default risk. Figure 2.3 plots the yield to maturity of the 5 supranational institutions together with Germany, where all issuers are large, AAA-rated, and have preferential treatment in regulatory terms. In particular, the left panel shows how all supranationals pay a very similar interest rate for all the maturities shown[5], regardless of the nature of their activity or their ultimate financial backing. Most importantly, all these institutions must pay a very large premium relative to

[4] See, among others, Du and Schreger (2016), Du et al. (2018), Schwarz (2019), Du et al. (2023).

[5] Figure B.2 shows that rates seem to diverge for very long maturities like 20 and 30 years, where our

bonds issued by the German central government. The right panel shows that this phenomenon is not specific to the period in question, with the 5-year yields of the institutions moving in tandem for the past decade and maintaining a large gap to the rate paid by Germany.

Figure 2.3: Yield to maturity in secondary market for selected AAA-rated issuers



The figure shows yield to maturity data in the secondary market for selected AAA-rated issuers in Europe. The left panel shows the average yield curve for each issuer over the 2024 calendar year for maturities from 1 to 15 years. The right panel shows the evolution of the 5-year spread to Germany for each issuer from 2015 to the end of May 2025, computed as the 17-day centered moving average. Data comes from yield curves as computed by Bloomberg.

The spread of supranationals relative to Germany cannot be explained by different default risk because KfW has long been considered as safe as Germany in the literature and yet its borrowing costs are exactly the same as all EU institutions. This also rules out related explanations such as redenomination risk (since KfW bonds would be redenominated in the same currency as German bonds) or the complexity of enforcing the claim on the many different governments backing EU bonds (only the German government guarantees KfW).

We can also rule out other explanations that have been shown to drive relative pricing in other settings such as market size or liquidity. As regards the former, the Netherlands is an issuer whose market size is comparable to that of the EU institutions and yet pays a much lower premium (see Figure B.2) since it is a national government issuing sovereign debt. For liquidity, Figure B.3 in the Appendix shows that bid-ask spreads of EU bonds are comparable

mechanism might apply to a smaller extent and other pricing factors might be more important. Since the vast majority of debt is within the 1-15 maturity we leave this issue aside.

to those of the Netherlands and at least one order of magnitude smaller than interest rate differentials; if anything, supranationals pay the same interest rates on securities with very different bid-ask spreads. The rate paid by EU bonds is also not an average of the yield of member countries computed using some weighting scheme such as GDP or the share of contributions to the EU budget: Figure B.4 shows that such averages fail to match both the cross-section and the time series of the yield paid by EU bonds.

A final set of explanations related to the regulatory treatment of different issuers can also be rejected, as supranational bonds receive the same regulatory treatment as sovereign bonds.[6] For example, commercial banks and insurers use a 0% weight for credit risk purposes for both categories and the ECB conducts open market operations by allocating a share of purchases towards EU bonds that is broadly equivalent to their share of the outstanding.

The next Section shows that the unconditional spread paid by supranationals is due to their higher sensitivity to bad news and in this sense their lower price is consistent with their stochastic properties. Since we established that all institutions related to the EU are treated as identical by market participants, in the following we consider all their bonds jointly and refer to the combined outstanding as debt of the "European Union". Daily yields are a simple average of the very similar rates paid by the different institutions, and all the results shown for the aggregate also apply to the issuers when considered individually as well as for KfW.

2.2 EU bonds spread is due to higher sensitivity to bad news

The price of EU bonds reacts adversely to bad news compared to equally safe bonds issued by national governments and this explains the spread. Figure B.6 shows examples of EU bonds depreciating relative to German bonds over periods of heightened uncertainty like the start of Covid or political upheaval in France. To show this formally, we define the realized excess holding-period return for an n-year bond issued by i relative to Germany as

$$rx^i_{n,t} = ns^i_{n,t-\Delta t} - (n - \Delta t)s^i_{n-\Delta t,t}, \tag{2}$$

where $s^i_{n,t-\Delta t}$ is the spread of a n-year bond issued by i relative to Germany at time $t - \Delta t$. Since Germany pays the lowest interest rate among European governments (see e.g. Figure 2.1), $rx^i_{n,t}$ is on average positive for any other issuer i, but it turns negative when bonds issued by Germany appreciate relative to bonds issued by i.

We compute a measure of the covariance between risk-off movements and the widening

[6]Section 6.2 discusses attempts to reduce the spread by improving the regulatory status of EU bonds.

Table 2.2: Estimated sensitivity to VIX for major issuers in the Eurozone

The table shows estimation results for Equation 3, where we regress the realized excess return relative to Germany for each issuer on the contemporaneous log change in VIX. We use monthly data for the period 2019m1-2025m5 for a total of 80 observations for each issuer. We use Newey-West standard errors with 24 lags and 90% confidence intervals. Yield data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX. Significance stars are as follows: * p<.05, ** p<.01, *** p<.001.

	Netherlands	France	EU	Spain	Italy
$\Delta \ln VIX_t$	-0.15***	-0.32***	-0.41***	-0.69***	-0.92***
	[-.22,-.08]	[-.47,-.17]	[-.59,-.23]	[-.79,-.59]	[-1.50,-.34]
Constant	0.01	0.01	0.04	0.08***	0.21**
	[-.01,.03]	[-.01,.04]	[-.00,.09]	[.04,.13]	[.06,.35]

in spreads in line with the literature (e.g. Du and Schreger (2016)) by running a contemporaneous regression of the excess return on the percent change in VIX.[7] Formally, we obtain estimates of parameters for each issuer i in

$$rx^i_{5,t} = \alpha_i + \beta_i \cdot \Delta \ln VIX_t + \varepsilon_{t,i}. \tag{3}$$

Table 2.2 shows that the spread of EU bonds to German bonds reacts to bad news by widening more than for comparably safe governments. All estimated beta parameters are negative, meaning that all spreads widen during risk-off movements, but the spread of EU bonds widens by more than both the Netherlands and France.[8] The estimated coefficient for the EU is so large that it is not statistically different from Spain and Italy.

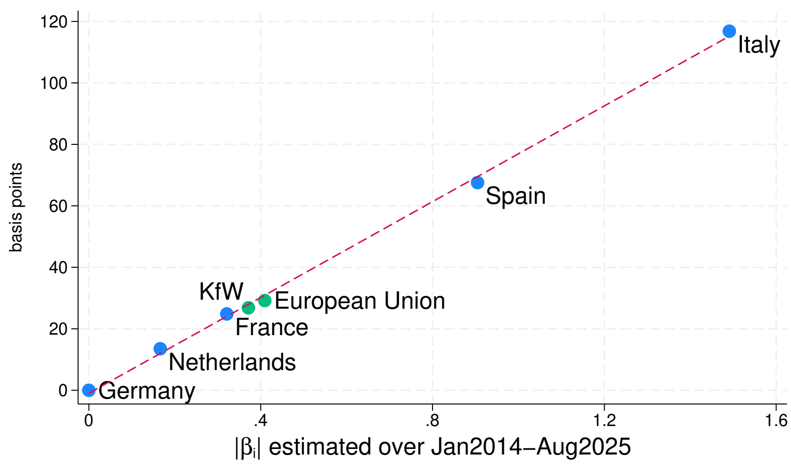
The estimated sensitivity to adverse shocks explains the cross-section of unconditional yields over the past decade very well so the spread paid by EU bonds reflects their high conditional volatility. This is shown in Figure 2.4, where there is a very strong correlation between the estimated β and the unconditional spread over the sample. Section 5.1 shows that, contrary to expectations, the volatility of EU bonds has not improved as outstanding amounts have increased.

The higher sensitivity to bad news of EU bonds cannot be due to credit risk, as is the case for Spain and Italy, because German-guaranteed KfW also has the same stochastic properties. Figure B.10 shows that the estimated β_i for KfW and the European Union are not statistically different from each other, while being larger than equally safe Germany and

[7] Here VIX is the implied volatility computed from options on the EURO STOXX 50.

[8] Figure B.9 shows estimated parameters using the swap rate to compute excess returns and Germany is the only issuer with a positive β, consistent with market coordination on German bonds as safe assets.

Figure 2.4: Average 5-year spread to Germany over Jan2014-Aug2025



The figure shows the average 5-year spread to Germany over Jan2014-Aug2025 (on the vertical axis) and the volatility to VIX estimated over the same period (on the horizontal axis), computed as in Equation 3 and reported in absolute value. Yield data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX.

the Netherlands.

Having shown that the spread of supranational bonds is due to their worse conditional properties, the Section documents how this is due to their exclusion from sovereign bond indices.

2.3 Supranational bonds are arbitrarily excluded from indices

We show that EU bonds are excluded from European government bond indices due to the legal classification of EU institutions as not formally sovereign and that this translates into a smaller investor base compared to equally safe governments. This smaller investor base is associated with higher borrowing costs and institutional investors explicitly identify this as the main hurdle preventing EU bonds from commanding a higher price.

Large financial institutions that compile fixed-income indices explicitly exclude EU bonds from their sovereign indices and investors list this exclusion as the main reason for the failure of EU bonds as safe assets. For example, the prospectus of one of the largest states that *"The J.P. Morgan EMU Government Bond Investment Grade Index aims to track the performance of eligible fixed-rate, euro-denominated domestic government debt issued by Eurozone countries."* Since supranational institutions are not formally countries, they are automatically excluded from such indices, regardless of their safety or liquidity.

In a recent survey of institutional investors, respondents noted that *"Inclusion of EU-Bonds in sovereign indices is the single-most important remaining step in order for EU-Bonds* *to trade and price similarly to European government bonds."*[9] The European Commission has tried to have its bonds recognized as sovereign securities but all major index providers declined to change its status as a supranational even after formal consideration.[10] This highlights the equilibrium nature of the supranational status, since it is not in the interest of an individual provider to include bonds with worse conditional volatility properties until all other providers do the same.[11]

Since each index provider offers tens of different benchmarks for European bond markets, the institutional investors that benchmark their returns against such indices could in principle use other, broader indices that do include EU bonds but we show in the rest of this Section that this is not the case. In particular, we develop a new measure to show that while supranational bonds are included in other euro-denominated indices, the size of investors ultimately tracking their bonds is much lower than for central governments.

We develop a measure of inelastic demand due to the inclusion in fixed-income indices and show that bonds issued by supranational institutions are characterized by a smaller investor base than sovereign bonds. Intermediaries such as mutual funds, money market mutual funds, and exchange-traded funds (ETFs) declare an index and benchmark their return against that of the index. Passive funds aim at tracking closely the composition of an index, but a large literature has shown that even active funds tend to follow the investment universe defined by their respective benchmark (see e.g. Raddatz et al. (2017)) so we use data for both categories.

The measure is conceptually similar to others used in the literature (e.g. Pavlova and Sikorskaya (2023)) but we are the first in the literature to employ data on the actual composition of a large number of fixed-income indices. To compute the measure we assume that every fund invests in each bond exactly in proportion to the weight assigned to it by the respective index and then we compute what fraction of the outstanding amounts would be held by this class of investors.

The notation is as follows: every fund f has size $\mu_{f,t}$ and it declares a "benchmark" (or index) x; for every index, bond b has a specific weight $\omega^x_{b,t}$ at each date t and $\Sigma_b \omega^x_{b,t} = 1\ \forall x, t$. Therefore, each index x is tracked by a total amount equal to the sum of assets under management (AUM) of these funds, $M^x = \Sigma_{\text{index}(f)=x} \mu_{f,t}$. If all funds invest according to the

[9] "EU Inaugural Investor Survey: Overview of results", European Commission, 29 September 2023.

[10] For example, after rejecting the inclusion of EC bonds in its sovereign indices, ICE stated that (our emphasis) "There were many views for and against this proposal, but nothing close to a *consensus*".

[11] The second reason is that the inclusion of a large issuer like the EC would have to come at the expense of existing sovereign issuers, which would experience reduced inelastic demand for their securities. Section 4.3 illustrates this mechanism in a theoretical model and Section 6.4 provides an estimate of the increase in the funding cost for different countries if the EC was recognized as a sovereign issuer.

weights of their respective index, then funds tracking index x buy a total amount of bond b equal to

$$\Omega^x_{b,t} = M^x_t \cdot \omega^x_{b,t}. \tag{4}$$

For each bond b, we can then compute how much is bought by the funds tracking all the indices,

$$\Phi_{b,t} = \Sigma_x \Omega^x_{b,t}. \tag{5}$$

We normalize this by the total outstanding amount for each bond, $T_{b,t}$, to obtain

$$\phi_{b,t} = \Phi_{b,t}/T_{b,t}. \tag{6}$$

Finally, we compute the size-weighted mean inelastic demand for issuer i as

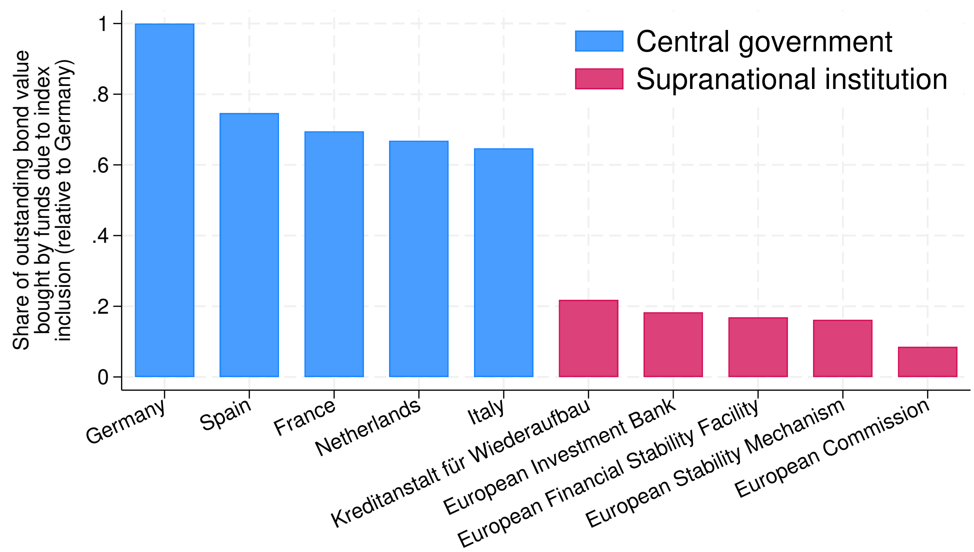
$$\phi^i_t = \sum_b \frac{\phi_{b,t} T_{b,t}}{\sum_b T_{b,t}}. \tag{7}$$

We use data from Morningstar Direct to identify the universe of active funds and obtain a time series of their total assets that we match to the declared benchmark. We identify all mutual funds, MMMFs, and ETFs located in major jurisdictions and define our total potential investor universe as funds denominated in euros or classified as investing in European fixed income. The total amount of AUM is above €10 Tn as of May 2025 and only 13% is composed of explicitly passive funds.

For the composition of fixed-income indices in euros we instead rely on Bloomberg and collect daily data on all available benchmarks, a significant improvement over the existing literature that tends to focus on the composition of a single index. Figure B.5 in the Appendix shows the largest indices by the sum of tracking AUM and we are able to obtain data for most of the indices provided by Bloomberg and ICE, the two main providers, for a total of about 50% of AUM in the European fixed income asset class (about €500 Bn).

Computing the measure described in the previous section, we find that bonds issued by supranational institutions can count on a much smaller inelastic demand compared to central governments. Figure 2.5 shows how all governments exhibit similar levels of ϕ^j_t regardless of their rating and the size of their debt markets, while supranational institutions have inelastic demand that is around 80% lower. In order to discard the hypothesis that these lower values are driven by a different composition of bond characteristics in the outstanding securities of the two groups we regress the bond-level inelastic demand on a supranational issuer dummy

Figure 2.5: Mean inelastic demand ϕ_t^i by bond issuer



The figure shows the mean inelastic demand, $\phi_{b,t}$, for the issuers listed in Table 2.1 expressed as a percentage of the corresponding value for Germany. The measure is computed from daily bond-level data averaged over the period 2019-2024 and weighted by bond outstanding amount. For each European fixed-income index we obtain data about bond inclusion and weights from Bloomberg, we match fund size and declared benchmark from Morningstar Direct, and use bond characteristics from the ECB CSDB.

and time-varying bond characteristics,

$$\phi_{b,t} = f(\sigma_b + \alpha_t + \boldsymbol{z'_{b,t}\zeta}) + \varepsilon_{b,t}, \tag{8}$$

where f is the logit function in a generalized linear model to account for the fact that $\phi_{b,t}$ is a small number between 0 and 1.

Table 2.3 shows that supranationals are excluded from fixed-income indices for reasons other than the characteristics of the bonds. In particular, the exponentiated coefficient for the dummy always being smaller than 1 indicates that supranational bonds are included to a lower extent than bonds issued by central governments. Without controlling for any bond characteristics (first column), the average bond issued by a supranational is included in fixed-income indices only 25% as much as a bond by a sovereign government. Progressively adding controls for bond characteristics does not change the conclusion, with the last column showing that a bond issued by a supranational is included only 17% as much as a sovereign bond having the same coupon type, outstanding amount, duration, and rating.

We also verify that a higher measure of index inclusion is associated with lower borrowing costs, consistent with the views expressed by investors. To do so, we regress the yield to

Table 2.3: Regression of inelastic demand $\phi_{b,t}$ on bond characteristics

The table shows estimation results from Equation 8, where we regress inelastic demand, $\phi_{b,t}$, on a dummy for supranational issuer, σ_b, and bond characteristics, $\boldsymbol{z_{b,t}}$. Since $\phi_{b,t}$ is a number between 0 and 1, we use a generalized linear model with logit function and report exponentiated point estimates. We use monthly data between 2019m1 and 2024m12 with $\phi_{b,t}$ computed as described in Section 2.3 and bond characteristics from the ECB's CSDB. Bond characteristics are controlled in a nonparametric way as follows: issuer rating is the median rating across Moody's, Standard & Poor's, Fitch, Scope and DBRS (a dummy for each level); coupon type is a dummy for fixed interest rate and a dummy for floating (so the base is zero-coupon bonds); bond size is a dummy for each decile of the amount outstanding distribution; bond duration is seven dummies for conventional cutoffs. Standard errors are clustered at the bond-month level and significance stars are as follows: * p<.05, ** p<.01, *** p<.001.

	(1)	(2)	(3)	(4)	(5)
Supranational issuer	0.25***	0.21***	0.20***	0.22***	0.17***
	(-25)	(-21)	(-18)	(-17)	(-20)
Issuer Rating	No	Yes	Yes	Yes	Yes
Coupon Type	No	No	Yes	Yes	Yes
Bond Size	No	No	No	Yes	Yes
Bond Duration	No	No	No	No	Yes
N	161,521	161,232	161,232	161,232	161,232

maturity of a bond b issued by i, $y^i_{b,t}$, on ϕ^i_t, a time fixed effect, and bond characteristics, or

$$y^i_{b,t} = \gamma\phi^i_t + \alpha_t + \boldsymbol{z'_{b,t}\zeta} + \varepsilon^i_{b,t}. \tag{9}$$

Table B.2 in the Appendix shows that a higher inelastic demand is indeed associated with lower yields even when controlling for all bond characteristics. The estimated coefficient for the measure of inelastic demand is large and statistically significant in all specifications, even with standard errors clustered at the bond-month level.

We conclude that the large spread paid by EU bonds is fully consistent with their worse conditional properties, which are due to their exclusion from sovereign indices. The next Section explores the relation between these stochastic properties and the investor base in supranational as opposed to sovereign bonds.

3 Investors with liquidity needs avoid EU bonds

We show that investor classes that value the low conditional volatility properties of safe assets avoid EU bonds and instead tilt their portfolios towards expensive sovereign bonds. We show that mutual funds hold AAA-rated sovereigns as opposed to EU bonds only if they anticipate suffering large outflows from retail investors during a crisis. Across investor classes, mutual funds and foreign investors with conditional liquidity needs tilt their allocation towards AAA-rated sovereigns while banks and insurance corporations are enthusiastic buyers of EU bonds.

3.1 Only mutual funds with flighty investors avoid EU bonds

Using holdings data from mutual funds we show that the funds that avoid holding EU bonds are those that anticipate experiencing larger outflows during crises. We measure this heterogeneity in the conditional need for liquidity using outflows during the Covid pandemic.

The market selloff during March 2020 was a liquidity crisis that forced intermediaries to sell assets in order to meet redemptions from investors. A large literature has documented how investor outflows generated a "dash for cash" unrelated to the safety of securities but purely driven by the need for liquidity and constrained intermediaries (see e.g. He et al. (2022)). Mutual funds played a major role in the market rout due to the nature of their liabilities that allowed large withdrawals from investors within a few days (Ma et al. (2022)). We thus focus on the universe of mutual funds and ETFs denominated in euros or with European fixed Income as investment class as reported by Morningstar. We obtain complete holdings data for 6,240 individual funds with a combined AUM of €3.5 Tn in June 2023, of which about 90% is accounted for by mutual funds.

We obtain a measure of the "flightiness" of the investor base for each fund by computing the ratio between net flows into the fund for the worst week of market distress during Covid and its AUM at the beginning of the month. We show in Figure B.13 that March 2020 is a large outlier with €71 billion of combined net outflows from funds, over 3 standard deviations below the mean of €10 billion of net inflows, with the week of March 16-20 registering net outflows of about €20 billion daily. Figure B.14 shows flows as a fraction of assets and not all funds experienced outflows to the same extent, with a tenth of funds losing at least 6% of AUMs and a tenth registering inflows of at least 1%. We can thus use this heterogeneity to sort funds by their conditional need for liquidity.

Since the intensity of outflows depended on the characteristics of the investor base in each fund and those are slow-moving factors, we assume that outflows share during a crisis is a constant property of each fund and define the time-invariant property of fund j, χ_j, as the fraction of outflows experienced by j during March 16-20. We implicitly assume that this scales proportionally with the overall level of liquidity needs and that fund managers know their value of χ_j after its realization in March 2020.

Table 3.1: Regression of portfolio weight $\omega_{b,j}$ on bond and fund characteristics

The table shows the estimation results of Equation 10, where we regress the portfolio share of fund j in bond b among AAA-rated bonds in euros on a dummy for EU bonds and bond characteristics. Data for June 2023 with 1,418 funds with at least one holding of AAA-rated bonds in euros. χ_j is the fraction of outflows experienced by fund j during March 16-20 (as a percentage of AUM at the end of February 2020). Holding and fund flows data come from Morningstar while bond characteristics come from the ECB's CSDB.

	(1)	(2)	(3)	(4)
EU_b	-3.35***	-1.65***	-0.12	-0.06
	(-16.12)	(-5.47)	(-0.41)	(-0.19)
$\text{EU}_b \times \chi_j$	-17.25***	-18.59***	-21.06***	-17.37***
	(-3.84)	(-4.20)	(-4.82)	(-4.05)
Bond Size	No	Yes	Yes	Yes
Coupon Type	No	No	Yes	Yes
Bond Duration	No	No	No	Yes
N	15,386	15,386	15,386	15,386

We show that funds with larger liquidity needs tilt their holdings of highly rated bonds in euros toward expensive sovereign bonds rather than EU bonds. We compute $\omega_{b,j}$ as the value of holdings of bond b for fund j as a share of all holdings of AAA-rated bonds in euros (either EU bonds or German and Dutch bonds). We regress $\omega_{b,j}$ on a dummy for EU bonds, EU_b, our measure of investor flightiness, χ_j, their interaction, and bond-level characteristics. Formally:

$$\omega_{b,j} = \gamma \cdot EU_b + \psi \cdot \chi_j + \beta \cdot EU_b \cdot \chi_j + \boldsymbol{z_b'\zeta} + \varepsilon_{b,j}. \tag{10}$$

Table 3.1 shows that progressively adding bond controls removes the unconditional bias against EU bonds while preserving the effect of the heterogeneous conditional need for liquidity. The interaction coefficient is negative, meaning that funds that suffer larger outflows avoid holding EU bonds relative to other AAA-rated bonds. An increase in χ_j of one standard deviation reduces holdings of EU bonds by about 1.5 percentage points in a sample where the average holding is 10% of the portfolio in AAA-rated bonds.

Table B.3 shows that a similar pattern, if less pronounced, exists for holdings at the end of 2019, suggesting that fund managers had some prior knowledge about the flightiness of their investor base. This also addresses concerns about reverse causality, since it implies that funds holding a larger share of EU bonds suffered smaller outflows.

Next, we show that this same pattern of investor sorting is detectable in the holdings of different classes of financial intermediaries. In particular, the investors with a potential need for liquidity avoid EU bonds and buy governments.

3.2 Investors with liquidity needs buy sovereigns, not EU bonds

We show that investors with liquidity needs hold disproportionately highly-rated sovereigns even if they are expensive. Mutual funds and foreign investors avoid EU bonds, while banks and insurance corporations do the opposite and earn the premium.

We employ the confidential Securities Holdings Statistics by Sector (SHSS) as collected by the Eurosystem. This dataset has already been used in the academic literature but it remains a vastly underutilized resource.[12] SHSS reaches the full span of all securities issued by entities based in the euro area or denominated in euros, including fixed income, equities and all other financial instruments. The holdings are reported at the single ISIN level and the frequency of observations is quarterly, with the first available data point for 2013Q4.

Data is obtained via depository institutions and holdings of individual investors are aggregated at the country and sector level (e.g., French banks, German insurers). We further aggregate holdings of domestic institutions (located inside of the Euro area) into four broad categories of investors: mutual funds (including ETFs and hedge funds), commercial banks, insurance corporations, and households (including government institutions and social security funds)[13]. We remove the amounts held by the Eurosystem and compute the holdings of foreign investors as the difference between the total outstanding amounts and holdings by domestic investors.

In order to establish clear empirical facts, we define a measure of portfolio "tilt" for investor j and issuer i in quarter t as

$$TILT_{i,j,t} = \frac{\omega_{j,i,t}}{m_{i,t}} - 1 \in [-1; \infty). \tag{11}$$

where $\omega_{j,i,t}$ is the share of country j's portfolio invested in securities of issuer i, and $m_{i,t}$ is the market weight of securities issued by i. Positive values mean that investor j is overweight issuer i relative to the market portfolio, while negative values imply the opposite. We compare the tilt towards EU bonds and the tilt towards AAA-rated sovereign bonds (issued by Germany or the Netherlands) because the two groups have the same default risk but different

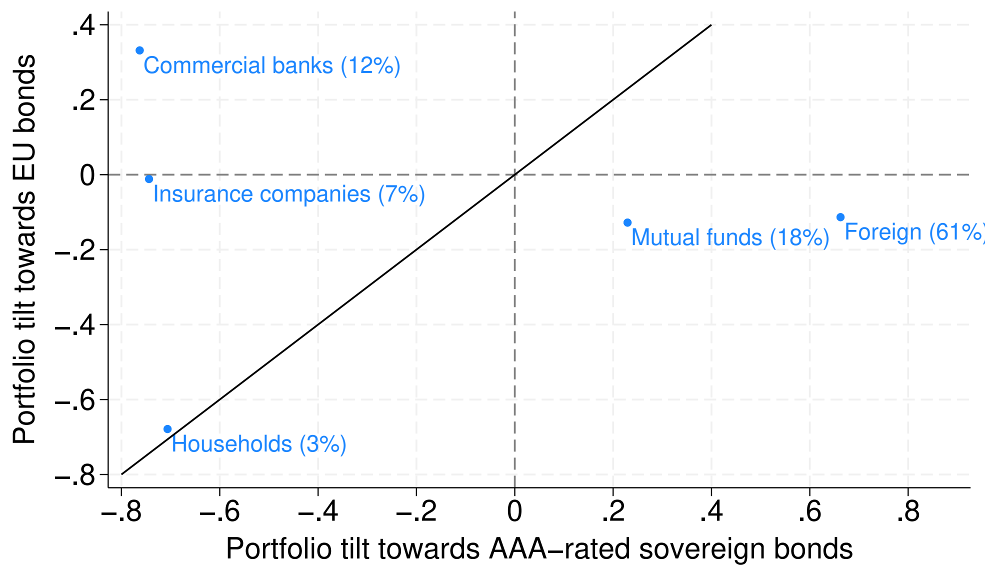
[12] See Boermans et al. (2022) for a detailed description of the data and a literature review.

[13] We drop holdings by the German central government of its own debt as they reflect the activities of the debt management office (Finanzagentur) that operates a large repo facility such that issued securities appear on its balance sheet while being effectively used to borrow from investors.

stochastic properties.

Figure 3.2 shows that different classes of investors differ widely in their holding patterns of EU bonds and equally safe sovereigns. Commercial banks and insurance companies hold very little of the expensive bonds issued by Germany and the Netherlands (only about 20% as their market share), while they are comparatively large buyers of the cheap EU bonds. Vice versa, mutual funds and especially foreign investors are significantly overweight sovereign bonds while avoiding EU bonds, and since they account for almost four-fifths of the total market, their buying behavior drives a gap between sovereign and supranational bonds.

Figure 3.1: Portfolio tilt for different investor sectors in 2025Q2



The figure shows the portfolio tilt, computed as described in Equation 11, towards AAA-rated sovereign bonds and towards EU bonds for different investor sectors. In parentheses is shown the total share of holdings of AAA-rated sovereign or supranational bonds for each investor class (excluding the ECB). Data comes from the ECB's Securities Holdings Statistics by Sector.

This investor sorting reflects the interplay between the stochastic properties of bonds and the differential aversion to volatility. In particular, insurance companies have very long-dated liabilities and thus have relatively less need to hold securities that remain liquid during times of stress; the same is true for commercial banks, which, while having a portion of their liabilities with potentially very low maturity, tend to experience inflows during crises.[14] Vice versa, mutual funds tend to suffer outflows in periods of market turbulence[15] and thus have

[14]In a market crisis households typically liquidate their holdings of securities and hold larger precautionary balances in checking accounts and hence the liquidity at the disposal of depository institutions actually increases. During the first months of Covid, for example, American and European banks saw their deposit base increase at a fast pace (e.g. Castro et al. (2022)).

[15]For recent documentation of this pattern, see e.g. Ma et al. (2022).

a higher willingness to pay for securities with lower price risk. Finally, foreign investors are dominated by reserve managers[16] that hold assets in euros to use specifically during crises and hence are the class that is most willing to pay a premium to hold liquid sovereigns rather than EU bonds that will lose some of their value when it matters most.

Within the sectors of commercial banks and insurance companies, it is institutions based in countries where the local sovereign bond is more expensive that are the largest holders of EU bonds. Figure B.11 shows that investors based in Germany and the Netherlands hold very little of their own sovereign bonds and are instead significantly overweight EU bonds, while investors from Italy and Spain do the opposite. It thus seems that the spread between EU bonds and highly-rated sovereigns is large enough to flip the direction of the home bias.

The next section shows that this pattern holds even at the bond level and that investors sort across sovereign issuers according to their need for liquid securities.

3.3 Investor sorting reflects the stochastic properties of bonds

We show that the investor base in government bonds reflects their conditional properties, with highly-rated bonds mostly held by investors with liquidity needs. The investor base of EU bonds is more similar to that of a lower-rated government, whose bonds tend to depreciate during a crisis.

We consider two aggregate classes of investors: financial intermediaries with short-dated liabilities (called Flighty) and with long-dated liabilities (called Stable). We identify the two groups according to the holding patterns in Figure 3.2: Stable are insurance corporations, commercial banks, and households while Flighty are mutual funds and foreign investors.

We show that there is a sorting of investors with potential liquidity needs (Flighty) into markets with more potential buyers during a crisis. Such sorting is apparent in Figure B.12, where the market share of Stable (ρ^i in the model) unambiguously correlates with the average interest rates shown in Figure 2.4. The issuer with the lowest interest rate, Germany, is characterized by the largest market share of Flighty investors, with the Netherlands and France earning comparably lower convenience yields and having a marginally smaller market share held by Flighty. The investor base in bonds issued by the European Union is instead markedly skewed toward investors that are less averse to volatility and is thus more similar along this dimension to that of Spain and Italy.

We check that this aggregate pattern survives controlling for bond characteristics that

[16] In 2025Q1 foreigners held €2.1 trillion of bonds issued by EU institutions, Germany, or the Netherlands, while total reserves denominated in euros by foreign central banks were €2.3 trillion (from the IMF COFER).

Table 3.2: Issuer fixed effect in a regression of $1 - \rho_{b,t}$ on bond characteristics

The table shows the estimated issuer fixed effect from Equation 12, where we regressed the market share held by Flighty, $1-\rho_{b,t}$, on an issuer fixed effect, μ_b, and bond characteristics, $\boldsymbol{z_{b,t}}$. Since $\rho_{b,t}$ is a number between 0 and 1, we use a generalized linear model with logit function and report exponentiated point estimates. Issuer fixed effects are computed relative to bonds issued by Germany and bond characteristics are the same as in Table 2.3. Holdings data comes from the ECB's Securities Holdings Statistics by Sector and bond characteristics from the ECB's CSDB.

	Netherlands	France	European Union	Spain	Italy
Issuer FE	0.71***	0.67**	0.19***	0.41***	0.23***
	(-3.56)	(-3.17)	(-12.53)	(-5.05)	(-7.26)

might bias our conclusion. For example, if the European Union disproportionately issues the long-term bonds that are favored by Stable investors, we would observe this sorting pattern irrespective of the presence of our mechanism through investment mandates. We thus use bond-level data and regress the share of outstanding amounts of bond b held by Flighty investors at time t, defined as $1 - \rho_{b,t}$, on an issuer fixed effect μ_b and the rich set of time-varying bond characteristics already used in Table 2.3. Since $\rho_{b,t}$ is between 0 and 1, we use a generalized linear model with logit as the link function and set Germany as the base level for the fixed effect. Formally, we estimate the following

$$1 - \rho_{b,t} = f(\mu_b + \boldsymbol{z'_{b,t}\zeta}) + \varepsilon_{b,t}. \tag{12}$$

Table 3.2 shows that, even after controlling for bond characteristics, the investor base for EU bonds is much more skewed toward Stable investors than comparably safe issuers and in this respect it is more similar to that of a risky country like Italy.

We thus conclude that there are strong patterns of investor sorting according to the conditional volatility properties of equally safe bonds and the next section develops a simple theoretical model that is able to match qualitatively this evidence.

4 A model of inelastic demand and conditional QE

We develop a simple framework in which bonds with the same fundamentals can trade at different prices due to investor segmentation driven by inelastic demand. Investors with liquidity needs pay a premium to hold bonds with higher inelastic demand because they are more liquid during crises. We show how expectations of asset purchases by the central bank can compress spreads even if they are ex-ante symmetric across issuers.

4.1 Segmented demand in a market with search frictions

We consider segmented demand with marginal investors that have short-dated liabilities and hence value liquid bonds, called Flighty, a class of intermediaries that invest inelastically according to the weights of some index, called Indexers, and residual demand coming from other investors, termed here Stable.

Time is discrete and similar to Diamond and Dybvig (1983): an investment decision is made under uncertainty at $t = 0$, some agents are forced to fire-sale in $t = 1$, and payoffs materialize in the last period $t = 2$. Investors allocate capital across n issuers of identical risk-free securities that pay €1 in $t = 2$.[17]

Stable investors are characterized by long-dated liabilities and their empirical counterpart of Section 3.3 is insurance companies and commercial banks. We consider the investment behavior of all these intermediaries as an aggregate[18] where demand at $t = 0$ for bonds issued by i with price P_0^i is given by

$$D^i = A - BP_0^i, \tag{13}$$

where $A > 0$ is an inelastic component and $B > 0$ is the price elasticity. Indexers are a generic class of investors that allocate their assets under management following the exact weight distribution of their chosen benchmark index and hence buy an amount Γ^i of bonds issued by i. Flighty investors are atomistic and symmetric with a total mass of 1 and in $t = 1$ a fraction π is hit with redemptions from their retail investors and forced to sell all its holdings. This assumption is meant to capture the observed patterns of disinvestment during periods of intense market distress from mutual funds and foreign investors (the empirical counterpart of Flighty investors in Section 3.3). The parameter π is the exogenous probability of severe market disruption, like what happened in March 2020 with the first impact of Covid.

Each Flighty investor maximizes their gains by allocating €1 across the n issuers and holding the bonds to maturity with probability $1 - \pi$ or selling all assets at the $t = 1$ price with probability π. For simplicity, there is no time discounting and Flighty investors are risk-neutral so they allocate a share ω^i to each issuer i such that their problem is

$$\max_{\{\omega^i\}_{i=0}^n} \sum_{i=0}^{n} \frac{\omega^i}{P_0^i} \left(\pi \mathbb{E}\left[P_1^i\right] + (1-\pi) - P_0^i\right) \quad \text{s.t.} \quad \sum_{i=0}^{n} \omega^i = 1. \tag{14}$$

[17] Heterogeneous default risk could easily be added without changing any of the properties of the model.

[18] Given the additive form of demand, this could be decomposed as the sum of demand by different investors:

$$D^i = \sum_j \left(a_j^i - b_j^i P^i\right) = \sum_j a_j^i - P^i \sum_j \left(b_j^i\right).$$

Market clearing at $t = 0$ for an $S > 0$ number of bonds issued by i is thus given by

$$P_0^i S = \Gamma^i + \omega^i + A - BP_0^i. \tag{15}$$

Flighty investors have access to an outside asset with exogenous gross return R that is available in unlimited supply, akin to the deposit facility at the ECB where the interest rate is a policy choice.[19] We assume that the total size of Flighty investors is sufficient to impose full arbitrage such that the expected return on every asset must be the same:

$$\frac{\pi \mathbb{E}\left[P_1^i\right] + (1-\pi)}{P_0^i} = \frac{\pi \mathbb{E}\left[P_1^j\right] + (1-\pi)}{P_0^j} = R \quad \forall i, j. \tag{16}$$

We can immediately observe that if the bonds issued by i are expected to be more liquid in $t = 1$ than those of j (meaning that $\mathbb{E}\left[P_1^i\right] \geq \mathbb{E}\left[P_1^j\right]$), their price will be higher in $t = 0$ as well. This happens due to the willingness of Flighty investors to pay a premium to hold securities that are expected to be more liquid during a crisis.

We assume that during the crisis there is an unraveling of normal market functioning such that not all markets clear. We follow the classic approach of Duffie et al. (2005) by assuming that the number of matches between buyers (with mass m_B^i) and sellers (m_B^i) is an increasing function of their size:

$$m^i = \lambda \left(m_S^i\right)^\theta \left(m_B^i\right)^\theta, \quad \frac{1}{2} < \theta \leq 1. \tag{17}$$

This formulation is also found in Coppola et al. (2024) in the context of an endogenous currency choice and parameters have a similar interpretation: $\lambda > 0$ is a scale parameter for the overall degree of liquidity of the market while θ governs the increasing returns of the matching function and gives rise to the thick-market externality. In the following, we derive analytical results for the case $\theta = 1$ and show a calibration exercise for $\theta \in (0.5, 1)$.

A fraction π of Flighty liquidates their holdings and since they are symmetric and atomistic, the mass of potential sellers is just $\pi\omega^i/P_0^i$, while the mass of potential buyers is the inelastic demand of Indexers, Γ^i. We assume that investors who do not find a match collect

[19] Removing the outside asset would result in a model with the same qualitative dynamics but more involved analytical formulas and a risk-free interest rate that is endogenous rather than a policy choice of the ECB.

a payoff of 0 so the expected price for sellers is just the probability of finding a buyer:[20]

$$\mathbb{E}\left[P_1^i\right] = \frac{m^i}{m_S^i} = \lambda \left(\pi \frac{\omega^i}{P_0^i}\right)^{\theta-1} \left(\Gamma^i\right)^{\theta}. \tag{18}$$

In order to align model quantities with the empirical measures of Section 2, we define the interest rate spread of issuer i relative to j as

$$\zeta_{i,j} = \left[-\ln\left(P_0^i\right)\right] - \left[-\ln\left(P_0^j\right)\right], \tag{19}$$

and the sensitivity to risk, or conditional volatility, of issuer i relative to j as

$$\beta_{i,j} = \frac{\partial \zeta_{i,j}}{\partial \pi}. \tag{20}$$

This derivative is the model equivalent of the empirical β computed in 2.2 (with opposite sign), where we regressed the (opposite of the) change in spread to Germany on a change in a measure of future expected volatility, whose natural counterpart in the model is the probability of a crisis π. To align more closely to the holdings data in Section 3.3, we also define ρ_i as the share of outstanding bonds issued by i held by Stable investors:

$$\rho_i = \frac{A - BP_0^i}{P_0^i S}. \tag{21}$$

4.2 Inelastic demand increases liquidity in crises and hence prices

We show that investors with higher inelastic demand are able to issue bonds at higher prices because the higher expected liquidity during crises is valued by Flighty investors. We start by characterizing equilibrium prices, spreads and volatility with the following Proposition.

Proposition 1. *Assume that there are n issuers of bonds that are symmetric in all respects except for inelastic demand Γ^i. Then the initial price of bonds issued by i, P_0^i, and the spread of issuer i relative to issuer j, $\zeta_{i,j}$, are a function of model parameters θ, π, λ, R, S, B, A and Γ^i. If $\theta = 1$, the analytical expressions are*

$$P_0^i = \frac{(1-\pi) + \pi\lambda\Gamma^i}{R} \quad \text{and} \quad \zeta_{i,j} = \ln\left(\frac{\pi\lambda\Gamma^j + (1-\pi)}{\pi\lambda\Gamma^i + (1-\pi)}\right). \tag{22}$$

[20] For every match there is a surplus of 1 and we could model it as being split between seller and buyer with proportions η and $1-\eta$ but since this does not play any role in the mechanics of the model we set $\eta = 1$.

In addition, the volatility of bonds issued by i relative to j is

$$\beta_{i,j} = \frac{\lambda(\Gamma^j - \Gamma^i)}{(1-\pi+\pi\lambda\Gamma^i)(1-\pi+\pi\lambda\Gamma^j)}. \tag{23}$$

Proof. See Appendix Section A.1. □

Corollary 1. *The initial price for issuer i, P_0^i, is increasing in inelastic demand for i, Γ^i. Therefore, the spread of issuer i to any other issuer, $\zeta_{i,j}$ $\forall j \neq i$, is decreasing in Γ^i.*

This establishes that issuers with higher inelastic demand issue bonds at higher prices because Γ^i increases the expected liquidity at $t = 1$ and hence Flighty investors are willing to pay a premium.[21] This conclusion is not trivial because holding other variables constant, liquidity is a decreasing function of the share held by Flighty investors (see Equation 18) but this corollary shows that the equilibrium effect is an increase in liquidity and price at $t = 0$. A direct consequence of this diverging effect of Γ^i on price is that the spread of i to other issuers is unambiguously reduced. The next result shows that issuers with higher Γ^i also exhibit lower volatility to bad news than issuers with lower Γ^i, consistent with the evidence shown in Section 2.2.

Corollary 2. *The volatility of issuer i to any other issuer, $\beta_{i,j}$ $\forall j \neq i$, is decreasing in Γ^i.*

Having characterized the price effect of differences in Γ^i, we now obtain model predictions for the composition of the investor base across issuers. In particular, the next Proposition establishes that investors sort across issuers according to their need for liquidity.

Proposition 2. *Assume that there are n issuers of bonds that are symmetric in all respects except for inelastic demand Γ^i. Then the market share of Flighty investors and indexers for issuer i, ρ^i, is a function of model parameters θ, π, λ, R, S, B, A and Γ^i. If $\theta = 1$, the analytical expression is*

$$\rho^i = \frac{RA}{S(1-\pi+\pi\lambda\Gamma^i)} - \frac{B}{S}. \tag{24}$$

The market share of Stable investors for issuer i relative to issuer j depends on the relative parameters of inelastic demand, Γ^i and Γ^j, in addition to common parameters. If $\theta = 1$, the analytical expression is

$$\rho^i - \rho^j = \frac{RA\pi\lambda}{A(1-\pi+\pi\lambda\Gamma^i)(1-\pi+\pi\lambda\Gamma^j)}(\Gamma^j - \Gamma^i) \tag{25}$$

[21] Figure B.22 shows the effect of a variation in Γ^2 for a calibration with $\theta < 1$ and 3 issuers.

Proof. See Appendix Section A.1. □

Corollary 3. *The market share of Stable investors, ρ^i, and the market share relative to another issuer, $\rho^i - \rho^j$, are decreasing in inelastic demand for issuer i, Γ^i.*

This result gives the testable implication that if spreads are driven by differences in Γ^i, then the market share of Flighty investors should be higher for issuers with lower yields. This is due to the fact that inelastic demand increases liquidity and hence the value for Flighty investors, but Stable investors do not value this property and the resulting increase in price makes them substitute away from bonds issued by i.

The simple patterns in holdings data described in Section 3.3 are consistent with the idea that spreads are driven by differences in inelastic demand. In particular, Figure B.12 shows that the investor base for EU bonds is more skewed towards Stable investors than comparably safe national governments, in line with the predictions of Corollary 3 for issuers with high spread (due to low Γ^i).

4.3 Increases in Γ^i for an issuer come at the expense of others

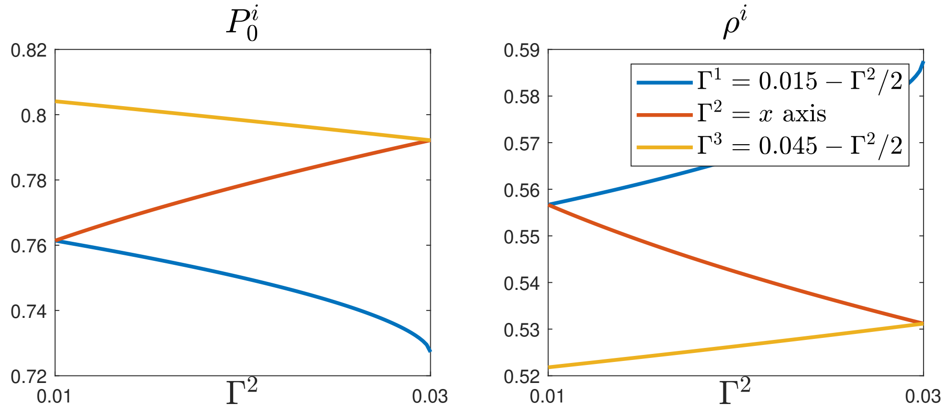
We now consider a counterfactual scenario in which there is a reallocation of inelastic demand towards an issuer that lowers its cost of issuing debt but increases it for all other issuers. This is the model equivalent of an inclusion of EU bonds in European sovereign bond indices, which would necessarily imply a reduction in inelastic demand for all other issuers that are currently included. In particular, we assume that the total amount of inelastic demand, $\Omega = \sum_{j=1}^{n} \Gamma^j$, is fixed but its allocation across different issuers can change.

Figure 4.1 shows that an increase in inelastic demand for issuer $i = 2$, Γ^2, increases the price of its bonds while decreasing the price of all other bonds. This happens because there is a change in the relative expected liquidity such that the position of all issuers worsens relative to $i = 2$. This is accompanied by a reallocation of the portfolios of investors who care about liquidity toward the bonds issued by $i = 2$ even as they become more expensive.

Our model thus provides a rationale for the refusal of fixed-income indices providers to include EU bonds, as such a move would have potentially large effects on the cost of funding of national governments. Section 6 estimates a demand system for European sovereign bonds to quantify potential gains for EU bonds from index inclusion to be weighed against the increase in yields for all other issuers.

We have provided a model that links demand segmentation to asset prices and is thus able to explain the cross-section of interest rates. However, the index inclusions that drive

Figure 4.1: Model equilibrium for changes in the size of inelastic demand for issuer $i = 2$



The figure shows the model equilibrium for a setting with 3 issuers that are symmetric in all respects except for the inelastic demand parameter Γ^i. Common parameter values are as follows: $\theta = 0.6, \pi = 0.1, \lambda = 1, S = 1, B = 0.1, A = 0.5$. The figure shows how the model equilibrium changes as inelastic demand for the second issuer, Γ^2, increases while Γ^1 and Γ^3 decrease since their sum remains fixed at 0.105.

inelastic demand are slow-moving factors that cannot explain the large cyclical variations in spread observed in Figure 2.1. Therefore, the next Section shows how to incorporate expectations about asset purchases in the model in order to explain the time series evidence.

4.4 Expectations about conditional QE drive spreads, volatility

We show how expectations about asset purchases during crises (which we call conditional QE) drive time-series variation in spreads, relative volatility, and the composition of the investor base.[22] To do so, we introduce parameter κ that enters Equation 17 as a measure of the potential purchases of bonds at time $t = 1$, such that liquidity for bonds issued by i becomes

$$\mathbb{E}\left[P_1^i\right] = \frac{m^i}{m_S^i} = \lambda \left(\pi \frac{\omega^i}{P_0^i}\right)^{\theta-1} \left(\Gamma^i + \kappa\right)^{\theta}. \tag{26}$$

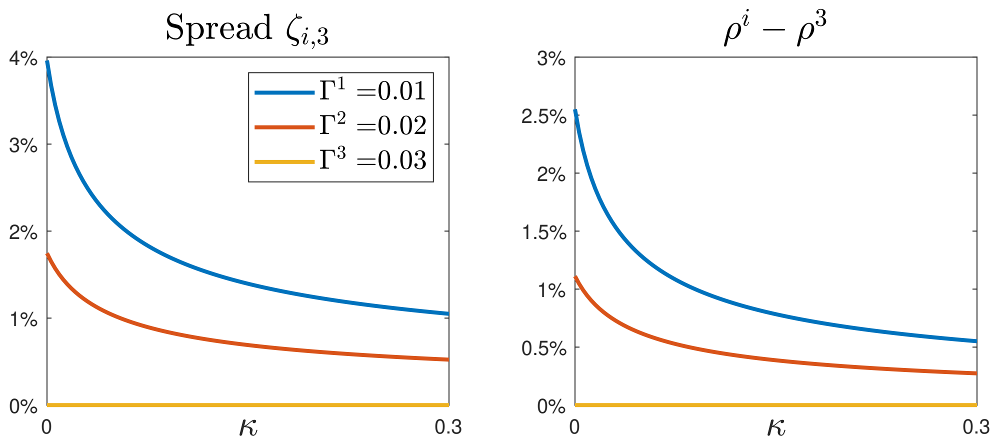
We assume that asset purchases are symmetric across issuers because the ECB is legally required to conduct purchases according to a predefined capital key that is proportional to each country's size within the Euro area.[23] Asset purchases can only deviate from the capital

[22] Section A.2 in the Appendix describes the effects of a symmetric change in unconditional purchases, equivalent to variations in A, or conventional monetary policy, meaning changes in R. The predictions are inconsistent with the empirical evidence described in Section 5 so we focus here on conditional QE.

[23] The capital key is an average of the share of GDP and population within the Euro area at the time of the last update, see the latest values for each country in Table B.1. There is no legally-mandated capital key for EU bonds so the ECB set the 10% figure; this means that 10% of total asset purchases are allocated towards EU bonds and the remaining 90% is split among national issuers according to the capital key.

key "temporarily" and the ECB perceives a clear political cost in doing so. This institutional feature is unique to the Euro area and is the reason why the sovereign bond market in euros is a unique setting to study the impact of inelastic demand on interest rates.[24] The assumption in 26 allows for any issuer-specific level of support by the ECB to be absorbed into Γ^i, leaving only time variation that is common to all issuers in κ. In other words, the model is consistent with a preference of the ECB for a specific issuer (say, EU institutions) as long as this implicit commitment relative to the other issuers is fixed over time.

Figure 4.2: Model equilibrium for changes in the common part of asset purchases κ



The figure shows the model equilibrium for a setting with 3 issuers that are symmetric in all respects except for the inelastic demand parameter Γ^i. Common parameter values are as follows: $\theta = 0.6, \pi = 0.1, \lambda = 1, S = 1, B = 0.1, A = 0.5$. The figure shows how the model equilibrium changes as conditional QE, κ, increases from 0 to 0.3.

We now study how changes in expectations about asset purchases during crises impact relative prices, volatilities and the investor composition. We derive analytical results for $\theta = 1$ while Figure 4.2 shows a calibration exercise.

Proposition 3. *Assume that there are n issuers of bonds that are symmetric in all respects except for inelastic demand Γ^i. The spread of issuer i relative to issuer j, $\zeta_{i,j}$, its relative volatility, $\beta_{i,j}$, and the relative market share, $\rho^i - \rho^j$, are decreasing in the conditional QE, κ, if and only if inelastic demand for j is larger than for i.*

Proof. See Appendix Section A.1. □

This result implies that a decrease in expected purchases in times of crisis induces a reallocation of Flighty investors from issuers with relatively low Γ^i to issuers with relatively

[24] In other bond markets, the central bank has an implicit mandate to preserve the liquidity of bonds issued by the national government. Therefore, the central government earns a convenience yield relative to other issuers thanks to the expectation of special treatment in times of crisis by its central bank.

high values. This happens because a decrease in κ deteriorates expected liquidity for all issuers but more so for those with lower Γ^i and hence Flighty investors want to substitute away from them. The next result shows that the model is also able to reproduce the widening of spreads documented in Figure 2.1.

Corollary 4. *Let's assume i^* is an issuer with $\Gamma^{i^*} \geq \Gamma^i \; \forall i$ and hence $P_0^{i^*} \geq P_0^i \; \forall i$. Spreads relative to i^*, ζ_{i,i^*}, and volatility relative to i^*, β_{i,i^*}, are decreasing in κ for all other issuers.*

This corollary implies that a decrease in expected purchases in times of crisis increases spreads and relative volatility because it has a larger impact on the prices of issuers with lower Γ^i. This happens because while κ varies by the same amount for all issuers, high values of Γ^i translate into lower proportional decreases in expected liquidity. The left panel in Figure 4.2 illustrates this effect by showing a widening of all spreads relative to the issuer with the largest Γ^i.

Corollary 5. *Let's assume i^* is an issuer with $\Gamma^{i^*} \geq \Gamma^i \; \forall i$ and hence $P_0^{i^*} \geq P_0^i \; \forall i$. The derivative with respect to κ of the spread, ζ_{i,i^*}, and volatility, β_{i,i^*}, are increasing in κ.*

This result shows that the effect of variations in conditional QE is larger when κ is lower, which means that reductions in expectations about price support by the ECB can cause large sudden increases in spreads and volatility. This comes as a cautionary tale for policymakers in the process of winding down measures of market support, as the effect on prices may be muted in the first stages but will increase significantly as the level of support is reduced.

We described a model with clear predictions for how expectations about state-contingent purchases should affect prices, volatilities, and the investor composition. Section 5 shows that the empirical evidence is consistent with a major role for conditional QE in driving the time series variation of the spread paid by EU bonds. Section 6 extends the theoretical insights from the model in order to evaluate policy counterfactuals by estimating a rich demand system with different elasticities for each investor class.

5 QE expectations change the properties of EU bonds

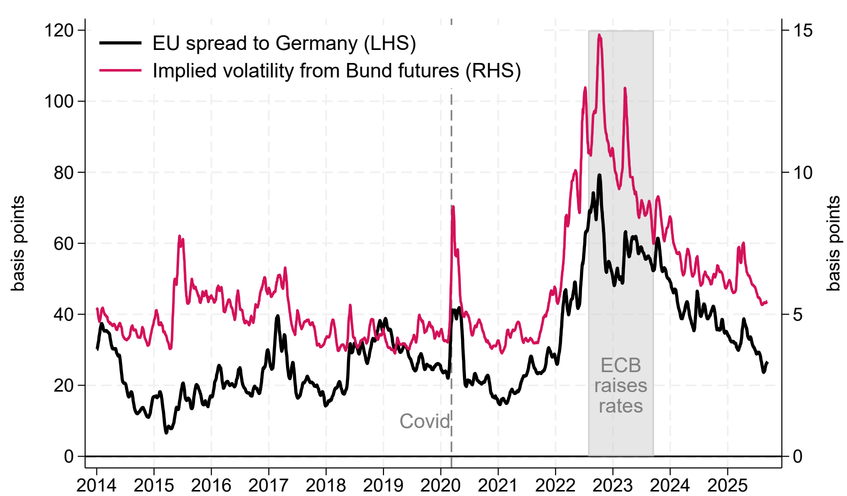
We show that the premium required by investors to hold EU bonds relative to equally safe government bonds is a function of expectations of state-contingent purchases. We document that the large increase in the outstanding amount of EU bonds has been accompanied by a worsening in their volatility properties. We attribute this deterioration to a shift in the stance of the ECB towards tighter policy by showing that EU bonds become more volatile than even the riskiest of governments during periods of tightening. Finally, we show that investors with liquidity needs reacted by reducing their holdings of EU bonds even further.

5.1 EU bonds become risky assets without the ECB's support

We document that expectations about the ECB's willingness to buy assets during crises drive spreads and relative volatility, consistent with the theoretical results shown in Section 4.4. We stress the difference between state-contingent policy (conditional QE) and unconditional asset purchases that are announced in advance and implemented over a period of time.

We use a market-based measure of conditional QE consistent with the literature to show that it closely mirrors the evolution of the spread of EU bonds to Germany. In particular, we focus on the implied volatility of bond prices computed from options on futures on German Bunds, similar to what Haddad et al. (2025a) do for the US. This can be interpreted as a measure of the ECB's willingness to tolerate large price movements without asset purchases. Figure 5.1 shows the very strong correlation between the two series, consistent with our mechanism of higher expected volatility due to the ECB's disengagement translating into investors demanding a higher premium for securities with worse conditional properties.

Figure 5.1: 5-year spread with Germany and implied volatility from Bund futures



The figure shows the 5-year yield spread of EU bonds with Germany (in black) and the implied volatility of Bund prices computed from options on futures on German Bunds (in red). Yield and implied volatility data come from Bloomberg.

The large spread increase in 2022 coincided with a sharp adjustment in market expectations about the willingness of the ECB to hold assets on its balance sheet in future periods. Figure B.17 uses a survey of professional forecasters to show how between December 2021 and

March 2022 expectations about the size of the balance sheet of the ECB in future quarters were dramatically curtailed, with the start of QT forecast to start 2 years earlier and from a lower peak than previously thought. This sharp turn in the monetary policy stance was due to the unexpected and protracted increase in inflation that rose significantly above the 2% target, in part due to the war in Ukraine that started in February 2022.

What matters for stochastic properties and hence the spread is not current purchases but expectations about how the central bank will react in a future crisis. This can be seen in Figure B.18, where we report the EU spread together with net QE purchases to show that contemporaneous purchases cannot account for the time series variation in the spread. While the correlation appears to be negative in the earlier part of the sample, this turns sharply positive in mid-2022, with large net selling by the ECB coinciding with a large reduction in the spread. In addition, the spread remained subdued when the ECB initially stopped QE in 2019 while it spiked in 2022 when it was still conducting purchases.

The spread can also not be accounted for by the absolute level of interest rates because it reflects the relative stochastic properties of different assets. This is shown in Figure B.19, where the spread declined almost monotonically as the ECB raised its policy rate by 450 basis points first and then decreased it by 200. Finally, Figures 2.1 and B.4 show that the effect of monetary tightening was much more pronounced on EU bonds than on lower-rated governments, consistent with the key role of inelastic demand discussed in Section 4.4.

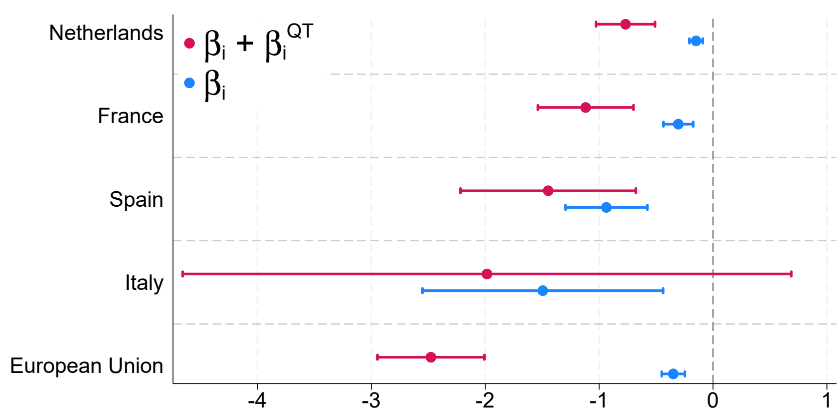
The substantial increase in the spread reflected worsening stochastic properties of EU bonds during 2022, even as their outstanding grew quickly (see Figure 2.2). We obtain a time-varying measure of conditional volatility by regressing excess returns on changes in VIX (Equation 3) over a rolling window of 24 months and show the results in Figure B.15. Starting in early 2022, the estimated β for EU bonds dropped significantly below the -0.4 value estimated over the entire sample and is now close to the estimated value for Spain.

We show that expectations of a tight monetary policy increase volatility for all issuers but particularly so for EU bonds while actual purchases by the ECB have no effect. To prove this, we expand Equation 3 by interacting the increase in expected volatility with a dummy for a period of monetary tightening, defined as the months in which the spread between the 1-year Euribor interbank rate exceeds the ECB's deposit facility rate by at least 100 basis points. In our sample this corresponds to the period between June 2022 and February 2023 but we consider alternative thresholds for the spread that yield longer periods and the results are similar.[25] Formally, we estimate:

$$rx^i_{5,t} = \alpha_i + \beta_i \cdot \Delta \ln VIX_t + \beta_i^{\text{QT}} \cdot \Delta \ln VIX_t \cdot \text{QT}(t) + \varepsilon_{t,i}. \tag{27}$$

Figure 5.1 shows that periods of QT are associated with increased exposure to volatility for all issuers except Italy and Spain, for which β is large in absolute value regardless of the ECB's stance. However, the increase is particularly pronounced for EU bonds that become the asset that is most exposed to volatility among the major issuers in euros, with the confidence interval suggesting that a doubling of the VIX would translate into an annualized negative excess return relative to German bonds of between 2% and 3%.

Figure 5.2: Estimation of β_i over the sample and during QT periods



The figure shows estimated beta parameters from Equation 27, where we regress the realized excess return relative to Germany for each issuer on the contemporaneous log change in VIX and the interaction between the contemporaneous log change in VIX and an indicator function for QT period. We define a QT period as a month in which the spread between the 1-year Euribor interbank rate exceeds the ECB's deposit facility rate by at least 100 basis points. We use Newey-West standard errors with 24 lags. Yield data come from Bloomberg, Euribor data from Refinitiv, and the deposit facility rate from the ECB.

We also prove that this wedge is driven by expectations about conditional policy and not by current purchases by using an alternative definition of QT as the months in which the ECB is not currently purchasing government bonds within either of its two programs (PSPP and PEPP). In our sample this corresponds to the period before March 2015 and the period after December 2024 but we also consider a broader definition that includes months in which the ECB was not expanding its holdings but still reinvesting its portfolio (Jan-Oct 2019 and after June 2022) to obtain similar results. Figure B.21 shows that the effect of volatility on relative asset prices is not statistically different in periods when the ECB is actively conducting QE relative to periods in which it is disinvesting its portfolio.

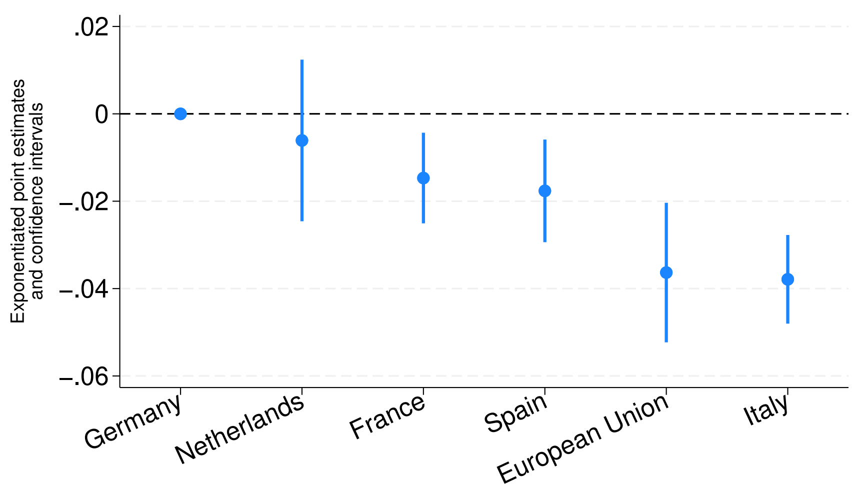
[25] See e.g. 50 basis points in Figure B.20.

We conclude that among the major issuers in euros, the price of EU bonds is uniquely sensitive to expectations about the ECB's policy. The extension of the model described in Section 4.4 shows how variations in the expected support by the ECB can translate in changes in spreads and volatility even if asset purchases are designed to be neutral across issuers. Furthermore, Corollary 5 shows that this effect is nonlinear, which explains why the estimated volatility of EU bonds increased so dramatically.

5.2 Expectations of QT further skewed investor sorting

We show that changes in expectations about conditional QE are accompanied by a rebalancing of portfolios between issuers with different inelastic demand, consistent with the predictions of the Section 4.4. In particular, the sharp rise in spreads after February 2022 happened together with a reallocation of Flighty investors' portfolios away from issuers with low inelastic demand relative to Stable investors. Flighty investors adjust their portfolios because with lower expected support from the ECB, markets with low inelastic demand are now expected to have comparatively worse liquidity in a crisis. This is consistent with Proposition 3, which predicts that a reduction in conditional support is followed by a reallocation of Flighty investors away from issuers with the highest initial spreads.

Figure 5.3: Fixed effect for change in investor composition between 2021Q4 and 2022Q2



The figure shows the estimated issuer fixed effect, μ_i, for Equation 28 estimated on the percentage change in $1 - \rho_{b,t}$ (the share of outstanding held by investors other than Stable) between 2021Q4 and 2022Q2. Holdings data come from the ECB Securities Holdings Statistics by Sector and bond characteristics from the ECB CSDB.

We consider the measure of investor base from Section 3.3 and define $\Delta_t(1 - \rho_b)$ as the percentage change in the share of bond b held by investors other than Stable during the period 2021Q4-2022Q2, the time range that Figure 5.1 shows being characterized by the sharpest rise in the spread paid by EU bonds relative to sovereigns. We use data on the face value of holdings (as opposed to market values) to capture portfolio decisions that are not mechanically driven by valuation effects on different initial portfolios. We control for bond characteristics and regress $\Delta_t(1-\rho_b)$ on an issuer fixed effect μ_b with Germany as the base level. Formally, we estimate the following:

$$\Delta_t(1-\rho_b) = \mu_b + \boldsymbol{z_b'}\boldsymbol{\zeta} + \varepsilon_b. \tag{28}$$

Figure 5.3 shows that, even conditional on bond characteristics, Dutch bonds were sold (or bought) by Flighty investors to the same extent that German bonds were, with France and Spain instead experiencing a reallocation of their investor base towards Stable investors. The pattern is even stronger for bonds by the European Union, which experienced a reallocation away from Flighty investors by the same magnitude that Italy did. We thus conclude that our evidence on both cross-sectional holdings and their variation over time is consistent with our proposed mechanism to explain relative interest rates.

Given the importance of different policies in the determination of the status of EU bonds, the next Section proposes a simple framework to evaluate the effectiveness of different proposed interventions.

6 The road towards a safe asset: possible scenarios

In this section, we consider alternative scenarios in which EU bonds assume the properties of safe assets and show what would happen to their price and investor base. To do so, we estimate a demand system for European sovereign bonds and compute counterfactual scenarios about investors' preferences for EU bonds and increases in the amount of common debt. We thus inform the policy debate about the desirability of this instrument, its optimal size, and the potential benefits for European taxpayers.

6.1 Estimation of a demand system for European sovereign bonds

We start by estimating a demand system for bonds issued by sovereign countries and large supranational institutions in Europe in a setup similar to Koijen and Yogo (2019). This is the empirical counterpart to Section 4, where we described a model in which different investor classes have a differential need for safe assets. Here we use observed prices and portfolios to infer investor preferences over a set of securities characteristics. We then compute the counterfactual prices and portfolio allocations that would clear markets if asset characteristics or investor idiosyncratic preferences were to change.

We obtain holdings data from the SHSS database already described in Section 3.2 and use them for an estimation exercise that expands on Koijen et al. (2021). We define investor classes at the country-sector level (for a total of 46 portfolios) and consider their holdings of bonds issued by the 6 largest European national governments[26] or the four supranational institutions listed in Table 2.1.[27] We use holdings at the issuer level to avoid taking a stance on the substitutability of specific bonds and use the 5-year point of the yield curve as the inverse of the bond price. We use quarterly data for the period 2019Q4:2025Q1 and exclude holdings by the Eurosystem from outstanding amounts as such securities are removed from the effective supply. In total, we observe holdings of European sovereign bonds of almost €10 Tn for investors with combined portfolios worth over €53 Tn.[28]

We thus observe the portfolios of m classes of investors across N issuers of securities for a total of T quarters and define the market value of holdings of investor j for issuer i at time t as $B^i_{j,t}$ and the value of the holdings in outside assets as $B^0_{j,t}$. In order to aggregate the holdings of bonds with different maturities and coupon rates, we define the market value as the product between the face value of holdings, $FV^i_{j,t}$, and the price of a zero-coupon bond with 5-year maturity and yield corresponding to the 5-year point of the issuer yield curve, $P(y^i_t)$. With this, we can express portfolio shares as

$$w^i_{j,t} = \frac{B^i_{j,t}}{B^0_{j,t} + \sum_{n=1}^{N} B^n_{j,t}} = \frac{\delta^i_{j,t}}{1 + \sum_{n=1}^{N} \delta^n_{j,t}}, \tag{29}$$

where we defined the portfolio share relative to the outside asset as $\delta^i_{j,t} = w^i_{j,t}/w^0_{j,t}$.

The contribution of Koijen and Yogo (2019) is to show that under assumptions that are standard in asset pricing, the optimal portfolio gives a demand function that depends on the observed characteristics of each asset. The necessary assumptions are weak and common in the literature: investors have preferences such that the optimal portfolio is a mean-variance portfolio, returns have a factor structure and expected returns and factor loadings depend

[26]These are France, Italy, Germany, Spain, Belgium, and the Netherlands.

[27]Supranational institutions are 4 instead of the original 5 because we consider the European Financial Stability Facility together with the European Stability Mechanism as they have the same management and board and an identical investor base.

[28]Note that for domestic investors we observe the complete portfolio of securities including fixed-income, equity, and mutual funds even if invested abroad, while for foreign investors we only observe holdings that fall within the reporting scope of SHSS, i.e. assets held in Europe or denominated in euros.

only on an asset's own prices and characteristics. As a result, we can write relative portfolio weights as a function of the yield to maturity, y_t^i, and other characteristics of the asset, $\boldsymbol{\zeta_t^i}$,

$$\delta_{j,t}^i = \exp\left(\alpha_{j,t} + \beta_j y_t^i + \boldsymbol{z_j'\zeta_t^i}\right) \cdot \varepsilon_{j,t}^i, \tag{30}$$

where $\varepsilon_{j,t}^i$ is commonly referred to as latent demand, which captures the time-varying demand of investor j for additional characteristics of issuer i. By normalizing the mean of $\varepsilon_{j,t}^i$ to 1, we can interpret $\alpha_{j,t}$ as the parameter for the attractiveness of European sovereign bonds relative to the outside asset for investor j in quarter t. In practice, parameter estimation requires dealing with the endogeneity concerns of correlated demand shocks that have aggregate price impact. With a valid instrument for the yield, we can use the standard moment condition to retrieve parameter values for each investor:

$$\mathbb{E}[\varepsilon_{j,t}^i | \hat{y}_t^i, \boldsymbol{\zeta_t^i}] = 1. \tag{31}$$

We instrument the yield using a source of exogenous variation that is novel in this context and refers to the index inclusion of different issuers. In particular, we use the measure of index inclusion computed in Section 2.3 at the issuer level, ϕ_t^j, to measure the extent of inelastic demand for bonds issued by different entities. The vector of additional characteristics $\boldsymbol{\zeta_t^i}$ includes a dummy for home bias, the 5-year default probability (computed from ratings), the outstanding amount (at face value), and its square root. As a result, ϕ_t^j captures the index inclusion practices of different issuers for reasons other than perceived default or market size and is thus particularly relevant for the context of supranational issuers, whose bonds are excluded from indices for reasons that are not related to the fundamentals of the securities themselves (see Table 2.3).

Index inclusion is a very strong instrument for all investors and the relevant statistics are above conventional thresholds. We run the first-stage regression for each investor with time fixed effects and cluster standard errors at the time-issuer level, with parameter estimates shown in B.4. Table 6.1 shows how the absolute t-statistic for the excluded instrument (index inclusion) is above the threshold of 4.05 from Stock and Yogo (2002) for all investors.

Using this instrument, we rely on the moment condition in 31 to estimate model parameters for each investor. The flexibility of GMM estimation allows us to impose restrictions on the sign of some coefficients and we impose a positivity constraint for the yield (meaning a downward demand schedule). Table B.5 shows the large amount of dispersion of estimated parameters across investors while Figure B.24 plots the average estimate by investor sector.

Table 6.1: Statistics for excluded instrument (index inclusion) from first-stage regressions

The table shows statistics for the first stage of Equation 30, where for each investor j we regress the 5-year yield of issuer i on a time fixed effect and a set of issuer characteristics: a dummy for home bias, the 5-year default probability (computed as the median across rating agencies) and the log of outstanding amounts. We cluster standard errors at the issuer-quarter level and report the distribution of t-statistics, F-statistics, and partial R2 across regressions for each investor.

	min	p25	p50	p75	max
t statistic	-8.24	-6.57	-6.57	-6.05	-5.02
F statistic	25.24	36.58	43.14	43.14	67.91
Partial R2	0.11	0.15	0.17	0.17	0.24

For all regressors we observe a ranking across sectors that is consistent with the literature, for example with households displaying the strongest home bias and foreign investors the most negative loading on default probability.

In order to compute counterfactual scenarios, we notice that market clearing together with the estimated loadings on characteristics implicitly pin down prices and portfolio allocations as a function of asset characteristics. To see this, consider that each investor has a total portfolio worth $A_{j,t}$ and that each issuer has a total face value outstanding of $S_t^i = \sum_j FV_{j,t}^i$. For each issuer, the bond market clears at observed prices and portfolio allocations:

$$S_t^i P(y_t^i) = \sum_{j=1}^{m} B_{j,t}^i = \sum_{j=1}^{m} A_{j,t}\omega_{j,t}^i \quad \forall\ i, t. \tag{32}$$

Taking the size of investors and asset supply as exogenous, the estimated parameters of Equation 30 provide an expression for portfolio weights as a function of yields and asset characteristics:

$$\omega_{j,t}^i = f\left(y_t^i, \boldsymbol{\zeta}_t^i \middle| \alpha_{j,t}, \beta_j, \boldsymbol{\gamma_j}, \varepsilon_{j,t}^i\right). \tag{33}$$

By combining 32 and 33 we obtain a system in $m \times N$ equations for each period such that for each collection of counterfactual characteristics $\{\tilde{\boldsymbol{\zeta}}_{\boldsymbol{t}}^{\boldsymbol{i}}\}_{i=1}^N$ there is a vector of counterfactual prices, $\tilde{\boldsymbol{P}}_t$, that solves the system. Koijen and Yogo (2019) show that such a solution is unique as long as demand curves are downward sloping, a condition that we imposed in the GMM estimation as shown in Table B.5.

The next Sections compute price and quantities corresponding to different distributions of outstanding amounts across issuers, $\{S_t^i\}_{i=1}^N$, or different investor preferences for other characteristics through changes in latent demand, $\{\{\varepsilon_{j,t}^i\}_{i=1}^N\}_{j=1}^m$, for the latest available period. Similar exercises have been carried out in the literature in a different context (see e.g. Koijen and Yogo (2020) and Bretscher et al. (2022)).

Some limitations of this approach are inevitable and hence we limit ourselves to scenarios where the total face value of outstanding assets is unchanged. We do this because our counterfactual exercises only clear the markets for which we observe the full investor composition, i.e. European sovereign debt, and do not consider the pricing of any outside asset. Furthermore, the model allows unlimited substitution between the outside asset and European sovereign bonds and hence does not explicitly capture rigidities in allocations to specific asset classes. Finally, since for foreign investors we do not observe holdings outside the European market, we are unable to observe scenarios with radical changes, such as a shift of international reserves from the dollar to the euro as a result of improvements in the properties of EU bonds. Before showing counterfactuals, we briefly discuss policies that have already been tried but failed to bring about a change in the status of EU bonds.

6.2 The failure of policies to change the status of EU bonds

After the realization that common debt was more expensive than originally thought[29], policymakers in the European Union announced a range of policies to close the gap between the rates paid by their institutions and those of national governments.

We consider 4 policies implemented by the European Commission (EC) and the ECB with the aim of increasing the liquidity of debt issued by the EC; other EU institutions and KfW were unaffected by these changes. First, the EC announced in December 2022 that it would start issuing single-branded "EU-Bonds" for all its spending programs rather than bonds tied to a specific spending program as it had done in the past. Second, the ECB announced that in its collateral framework it would apply to the EC the same haircut that it uses for national governments starting from June 2023, while previously the EC was assigned a worse category together with the other EU institutions. Third, in October 2024 the EC started operating a repo facility for its debt to increase the market liquidity, in line with the established practice of large sovereign issuers like Germany. Fourth, the EC partnered with the largest European derivatives exchange to start a market for futures on its securities that became operational in September 2025.

These policies did not close the spread between interest rates paid by the EC and national governments and this is apparent in Figures B.7 and B.8, where no differential pattern in interest rates within EU institutions is discernible in any of the periods mentioned above. While sensible in their own merit, these measures did not address the fact that debt issued

[29]For example, the large spread to Germany was described in Bonfanti and Garicano (2022).

by the EC remains outside the investment universe of a large class of investors. In particular, Kaldorf and Poinelli (2023) show that the haircut change by the ECB resulted in a reduction in EC repo rates relative to Germany, and yet the gap in secondary market yields remains substantial. More importantly, market yields for the EC have remained close to those of the other supranationals, suggesting that all these reforms failed to change the market view of the Commission as just another supranational. The next subsections will thus evaluate other potential roads to change the nature of EC bonds, either via an increase in outstanding amounts or via policies that change investors' idiosyncratic demand.

6.3 If common debt partly replaced national bonds

We compute model equilibria in which the distribution of outstanding amounts across issuers is different from the one observed. We think of a counterfactual supply, $\tilde{S}_t^i$, and hence asset characteristics, $\tilde{\boldsymbol{\zeta}}_t^i$, and compute the prices that would clear markets in 32. A larger supply of securities of a given issuer has to be matched by an increase in aggregate demand that comes from the changed characteristics themselves (the outstanding amount is included in $\boldsymbol{\zeta}_t^i$) or from an increase in the yield. Depending on the amount of the increase and the estimated elasticities, a supply increase can either lower or raise the interest rate for a given issuer.

In particular, we think of two scenarios in which there is an increase in the amount of EU bonds while holding constant the total face value of outstanding bonds. The first scenario considers an institutional arrangement such that all the large issuers related to the EU[30] establish a single Debt Management Office (DMO) that issues debt on behalf of the individual entities through the European Commission in order to create a single asset market. The second scenario analyzes the case of a debt mutualization exercise in which €500 Bn of national debt is replaced by bonds of the Commission, with different countries benefiting in proportion to their ECB capital key (shown in Table B.1). This exercise abstracts from the effects of this mutualization on default rates and we assume that each country pays a fraction of the interest bill on common debt that is equal to the ECB capital key.

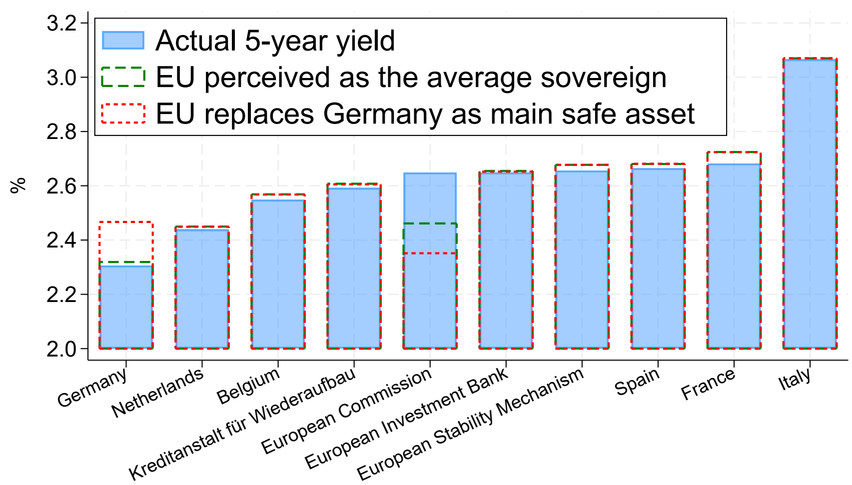
We show in Figure B.25 that in both scenarios the interest rate paid by EU bonds (European Commission in the figure) decreases by less than 10 basis points, while all other issuers are virtually unaffected other than a marginal reduction for the largest issuers. These exercises explain why proposals of debt mutualization have faced such stiff resistance, given the limited aggregate gains and the large implicit fiscal transfers that they would entail. Implicit redistribution would happen even if the total debt level is held constant and riskier countries

[30]These are the 4 EU institutions listed in Table 2.1.

never defaulted. In particular, countries such as Germany and the Netherlands could end up paying a higher average interest rate, even if all rates were to decrease, while countries like Italy and France would benefit from paying lower rates on their individual debt, as well as access to cheaper common debt.

We conclude that reasonably large increases in outstanding quantities are, by themselves, unlikely to bring about a significant change in the nature of EU bonds, while also being politically costly to achieve. We thus caution against the idea that a gradual increase in common debt will transform EU bonds into a safe asset able to rival national debt. The next section shows instead that a change in the idiosyncratic preferences of investors offers more hope even without additional issuance of common debt.

Figure 6.1: 5-year yield and counterfactuals under different scenarios, by issuer



The figure shows the 5-year yield to maturity for different issuers at the end of 2025Q1 (in light blue) and counterfactual values obtained from the computation of the price vector that would clear the system in 32 given the estimated elasticities for each investor. In the first counterfactual scenario (dashed green line) we set the latent demand for EC bonds for each investor equal to the average latent demand for bonds issued by Germany, the Netherlands, or Belgium (see Equation 34) and then rescale all latent demand values such that the mean and standard deviation are unchanged. In the second counterfactual scenario (dotted red line) we set the latent demand for EC bonds for each investor equal to the latent demand for Germany, which in turn is replaced by the average latent demand for bonds issued the Netherlands, or Belgium (see Equation 35) and then rescale all latent demand values such that the mean and standard deviation are unchanged.

6.4 If the EU was recognized as a proper sovereign issuer

We compute counterfactual scenarios in which we hold fixed the characteristics of the issuers but change the demand of investors for features other than those in the specification. In practical terms, we focus on the last available quarter and compute the model equilibrium for variations in the term for latent demand, $\varepsilon^i_{j,t}$. In general, an increase in latent demand for issuer i will lead to a decrease in its yield even holding constant observable asset characteristics like default probability and outstanding amounts.

We consider two scenarios in which we change the vector of latent demand for EC bonds in order to match the unobservable characteristics of sovereign issuers. In the first alternative, for each investor j we set the latent demand for EC bonds equal to the average latent demand for the 6 sovereign issuers, or

$$\tilde{\varepsilon}_j^{\text{EC}} = \sum_i \varepsilon_j^i / 6 \quad \forall\, j. \tag{34}$$

In the second scenario, the European Commission replaces Germany as the supplier of the securities that are broadly recognized as the main safe asset in euros, while Germany becomes like the average government. Formally, we set

$$\tilde{\varepsilon}_j^{\text{EC}} = \varepsilon_j^{\text{Germany}}, \quad \tilde{\varepsilon}_j^{\text{Germany}} = \sum_i \varepsilon_j^i / 6 \quad \forall\, j. \tag{35}$$

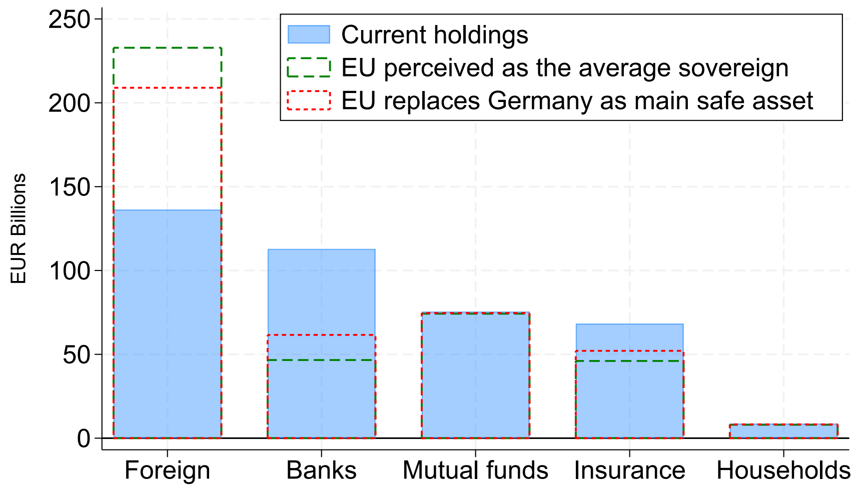
In both cases, we change all values of latent demand such that the mean and standard deviation at the investor level are unaffected. This ensures that increases in demand for EC bonds come at the expense of other issuers, rather than coming from funds previously allocated to the unspecified outside asset.

Figure 6.1 shows that in both scenarios the yield on EC bonds would decrease significantly, by about 20 basis points if it were perceived as a fully sovereign issuer and by more than 30 basis points if it replaced Germany as the prime safe asset provider. This shows that the characteristics of common debt in terms of size and rating are such that it could potentially become a safe asset if it were perceived as having the same intrinsic properties of sovereign debt. Contrary to a widely held belief, the lack of a captive investor base (expressed here by the absence of investors for which the home-bias dummy assumes a value of 1) does not prevent EC bonds from earning a large convenience yield.

If recognized as a sovereign issuer, the EC could issue more than €2,500 billion of new debt and end up paying an interest rate no higher than it currently does. This is shown in Figure B.26, where we compute the counterfactual yield of EC bonds corresponding to different values of latent demand and outstanding amounts (where increases in EC bonds are accompanied by decreases in national debt in proportion to the ECB's capital key).

In these scenarios, where we explicitly ruled out paradigm shifts like a move away from the dollar by international investors, improvements in the interest rate paid by common debt would necessarily come at the expense of other issuers. This is particularly true for Germany, which currently earns a convenience yield in the order of 10 basis points and whose role as

Figure 6.2: Holdings of EC bonds and counterfactuals, by investor sector



The figure shows holdings of bonds issued by the European Commission in 2025Q1 by different classes of investors (in light blue) and counterfactual holdings under the alternative scenarios described in Figure 6.1. Data comes from the ECB's Securities Holdings Statistics by Sector.

the prime provider of safe assets would be diminished by an increase in the attractiveness of EC bonds. All other countries would instead benefit from such a change, as the convenience yield rents would be shared among all countries through the budget of the Commission.

Figure 6.2 shows that if EC bonds were to become more similar to a true safe asset, their investor base would change dramatically. In particular, foreign investors would almost double their holdings of EC bonds and end up holding almost half of the entire supply. Commercial banks and insurance companies would drastically scale back their holdings due to the significantly reduced yield on EC bonds, and as a result, they would hold little of them, just as they currently do for Germany (see Figure B.11).

We conclude that incremental increases in supply are unlikely to bring common EU debt closer to a safe asset, since a change in investor preferences is required to reduce its yield by a significant amount. Foreign investors, in particular, would have to drastically increase their holdings of an asset that is currently walled off due to investment mandates or perceived as too volatile to compete with sovereign issuers. We also highlighted political considerations, as gains for common EU debt would likely come at the expense of Germany, which is currently able to earn a large convenience yield on its sovereign debt.

7 Conclusion

We show that bonds jointly issued by the European Union, despite their AAA rating and joint-and-several guarantees, do not function as a safe asset. The key factor is the issuer's legal status, which limits the investor base through exclusion from fixed-income indices. Because EU bonds are not legally classified as sovereign debt, investment mandates prevent or discourage many institutional investors from holding them, shrinking the investor base and causing larger price declines during crises. Because investors value securities that retain value during crises, they demand a premium for holding EU bonds.

Our first contribution is to demonstrate that the special properties of government debt cannot be replicated through preferential regulatory treatment alone, as they emerge from market coordination around sovereign legal status. A large stock of low-risk debt can serve as a superior store of value only if it is accessible to the broadest possible investor base, as sovereign bonds are. Safety alone is insufficient for investors who may face crisis-induced fire sales, when the ability to find a buyer is most valuable.

Second, we reveal a novel monetary policy channel operating through state-contingent asset purchases. Expectations about the ECB's crisis response drive spread dynamics because bonds with smaller investor bases depend more on central bank interventions during crises. This effect is unrelated to fundamentals or conventional risk premia and is quantitatively large: spreads can quadruple within a year due to shifts in expected ECB support alone. Moreover, the effect is nonlinear in the policy stance, explaining why moderate monetary tightening can trigger disproportionate spread widening. This mechanism applies broadly to any low-risk asset lacking a broad investor base, including highly rated corporate bonds.

Together, these findings reshape our understanding of safe asset creation and carry important implications for the future of Europe and the international role of the euro. By constructing a novel measure of the investor base, we demonstrate that the spread relative to national governments will not close through incremental liquidity gains alone. Even substantial increases in issuance are unlikely to make EU bonds function as a true safe asset, implying that the euro will struggle to challenge the dollar's dominance as a global reserve currency. Lasting progress will require reforming the legal foundations to align EU debt with the market's coordination on sovereign debt.

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Appendix A Additional model results

A.1 Model proofs

In order to study the effect of segmented demand in isolation from other factors, in the following we assume that the n issuers are symmetric in all respects except for the inelastic demand (Γ^i). All other parameters are set equal to the same value: $B^i = B$, $S^i = S$, $A^i = A$, $\lambda^i = \lambda \ \forall i$.

Proof of Proposition 1. We start by obtaining an expression for the initial price P_0^i by rewriting market clearing for bonds issued by i in Equation 15:

$$P_0^i S = \omega^i + \Gamma^i + A - BP_0^i \iff P_0^i = \frac{\omega^i + \Gamma^i + A}{S + B}. \tag{36}$$

Then we note that if $\theta = 1$ the probability of finding a buyer in 18 is only a function of model parameters and by combining it with 18 we obtain

$$\mathbb{E}[P_1^i] = \lambda \Gamma^i. \tag{37}$$

By plugging this into the FOC in 16 and substituting the expression for P_0^i from 36 we have

$$(\pi\lambda\Gamma^i + 1 - \pi)\frac{S + B}{\omega^i + \Gamma^i + A} = R. \tag{38}$$

With some rearranging, we obtain an expression for ω^i that is only a function of exogenous parameters:

$$\omega^i = \frac{(S+B)(1-\pi)}{R} + \left(\frac{(S+B)\pi^2\lambda}{R} - 1\right)\Gamma^i - A \tag{39}$$

$$= \frac{(S+B)(1-\pi+\pi^2\lambda\Gamma^i) - R(\Gamma^i + A)}{R}. \tag{40}$$

The expression for P_0^i in 22 follows directly by combining 36 with 39:

$$P_0^i = \frac{\Gamma^i + A^i + \omega^i}{S^i + B^i} = \frac{1-\pi}{R} + \frac{\pi\lambda}{R}\Gamma^i = \frac{(1-\pi) + \pi\lambda\Gamma^i}{R}. \tag{41}$$

The spread of issuer i relative to j is thus computed as follows

$$\zeta_{i,j} = \left[-\ln\left(P_0^i\right)\right] - \left[-\ln\left(P_0^z\right)\right] = \ln\left(\frac{P_0^j}{P_0^i}\right) = \ln\left(\frac{1-\pi+\pi\lambda\Gamma^j}{1-\pi+\pi\lambda\Gamma^i}\right). \tag{42}$$

Finally, by computing the derivative with respect to π we obtain the relative volatility

$$\begin{aligned}
\beta_{i,j} &= \frac{\partial \zeta_{i,j}}{\partial \pi} && (43)\\
&= \frac{\lambda\Gamma^j - 1}{1-\pi+\pi\lambda\Gamma^j} - \frac{\lambda\Gamma^i - 1}{1-\pi+\pi\lambda\Gamma^i} && (44)\\
&= \frac{\lambda(\Gamma^j - \Gamma^i)}{(1-\pi+\pi\lambda\Gamma^i)(1-\pi+\pi\lambda\Gamma^j)}. && (45)
\end{aligned}$$

□

Proof of Corollary 1. By deriving 41 and 42 with respect to Γ^i we immediately obtain

$$\frac{\partial P_0^i}{\partial \Gamma^i} = \frac{\pi\lambda}{R} > 0 \quad \text{and} \quad \frac{\partial \zeta_{i,j}}{\partial \Gamma^i} = -\frac{\pi\lambda}{1-\pi+\pi\lambda\Gamma^i} < 0. \tag{46}$$

□

Proof of Corollary 2. By deriving 45 with respect to Γ^i we obtain

$$\begin{aligned}
\frac{\partial \beta_{i,j}}{\partial \Gamma^i} &= \frac{-\lambda(1-\pi+\pi\lambda\Gamma^i)(1-\pi+\pi\lambda\Gamma^j) - \pi\lambda^2(\Gamma^j-\Gamma^i)(1-\pi+\pi\lambda\Gamma^j)}{(1-\pi+\pi\lambda\Gamma^i)^2(1-\pi+\pi\lambda\Gamma^j)^2} && (47)\\
&= \frac{-\lambda(1-\pi+\pi\lambda\Gamma^i) - \pi\lambda^2(\Gamma^j-\Gamma^i)}{(1-\pi+\pi\lambda\Gamma^i)^2(1-\pi+\pi\lambda\Gamma^j)} && (48)\\
&= -\frac{\lambda(1-\pi+\pi\lambda\Gamma^j)}{(1-\pi+\pi\lambda\Gamma^i)^2(1-\pi+\pi\lambda\Gamma^j)} && (49)\\
&= -\frac{\lambda}{(1-\pi+\pi\lambda\Gamma^i)^2} < 0. && (50)
\end{aligned}$$

□

Proof of Proposition 2. We obtain the market share of Stable, ρ^i, using its definition in 21 and substituting the expression for P_0^i from 41

$$\rho^i = \frac{A - BP_0^i}{SP_0^i} = \frac{A}{SP_0^i} - \frac{B}{S} = \frac{AR}{S((1-\pi)+\pi\lambda\Gamma^i)} - \frac{B}{S}. \tag{51}$$

The difference between the market share for two issuers i and j is then

$$\rho^i - \rho^j = \frac{RA^i}{S(1-\pi+\pi^2\lambda\Gamma^i)} - \frac{RA^j}{S(1-\pi+\pi^2\lambda\Gamma^j)} \tag{52}$$

$$= \frac{R}{S}\frac{A^j(1-\pi+\pi^2\lambda\Gamma^j) - A^i(1-\pi+\pi^2\lambda\Gamma^j)}{(1-\pi+\pi^2\lambda\Gamma^i)(1-\pi+\pi^2\lambda\Gamma^i)} \tag{53}$$

$$= \frac{RA}{S}\frac{\pi^2\lambda(\Gamma^j-\Gamma^i)}{(1-\pi+\pi^2\lambda\Gamma^i)(1-\pi+\pi^2\lambda\Gamma^j)} \tag{54}$$

$$= \frac{RA\pi\lambda}{S(1-\pi+\pi\lambda\Gamma^i)(1-\pi+\pi\lambda\Gamma^j)}(\Gamma^j-\Gamma^i). \tag{55}$$

□

Proof of Corollary 3. By deriving 51 with respect to Γ^i we obtain the first statement

$$\frac{\partial\rho^i}{\partial\Gamma^i} = -\frac{RA\pi\lambda}{S(1-\pi+\pi\lambda\Gamma^i)^2} < 0. \tag{56}$$

For the second statement we instead derive 55 to obtain

$$\frac{\partial(\rho^i-\rho^j)}{\partial\Gamma^i} = -\frac{RA\pi\lambda}{S(1-\pi+\pi\lambda\Gamma^i)^2} < 0. \tag{57}$$

□

Proof of Proposition 3. We start by rewriting 42 expanding Γ^i and Γ^j as $\Gamma^i+\kappa$ and $\Gamma^j+\kappa$

$$\zeta_{i,j} = \ln\left(\frac{1-\pi+\pi\lambda(\Gamma^j+\kappa)}{1-\pi+\pi\lambda(\Gamma^i+\kappa)}\right). \tag{58}$$

Deriving this with respect to κ we obtain an expression whose sign depends on $\Gamma^i - \Gamma^j$

$$\frac{\partial\zeta_{i,j}}{\partial\kappa} = \frac{\pi\lambda}{1-\pi+\pi\lambda(\Gamma^j+\kappa)} - \frac{\pi\lambda}{1-\pi+\pi\lambda(\Gamma^i+\kappa)} \tag{59}$$

$$= \frac{\pi\lambda}{[1-\pi+\pi\lambda(\Gamma^j+\kappa)][1-\pi+\pi\lambda(\Gamma^i+\kappa)]}(\Gamma^i-\Gamma^j). \tag{60}$$

With a similar rewriting of 45 we obtain

$$\frac{\partial\beta_{i,j}}{\partial\kappa} = \lambda(\Gamma^j-\Gamma^i)\frac{\pi\lambda(1-\pi+\pi\lambda(\Gamma^j+\kappa)) - \pi\lambda(1-\pi+\pi\lambda(\Gamma^i+\kappa))}{(1-\pi+\pi\lambda(\Gamma^i+\kappa))^2(1-\pi+\pi\lambda(\Gamma^j+\kappa))^2} \tag{61}$$

$$= -\frac{\lambda^3\pi^2(\Gamma^j-\Gamma^i)^2}{(1-\pi+\pi\lambda(\Gamma^i+\kappa))^2(1-\pi+\pi\lambda(\Gamma^j+\kappa))^2} < 0 \tag{62}$$

The same procedure for 55 yields

$$\rho^i - \rho^j = \frac{RA\pi\lambda}{S(1-\pi+\pi\lambda(\Gamma^i+\kappa))(1-\pi+\pi\lambda(\Gamma^j+\kappa))}(\Gamma^j - \Gamma^i). \tag{63}$$

Deriving this with respect to κ we obtain an expression whose sign depends on $\Gamma^i - \Gamma^j$

$$\frac{\partial(\rho^j - \rho^i)}{\partial\kappa} = -\frac{RA\pi\lambda(\Gamma^i-\Gamma^j)}{S}\frac{\pi\lambda[1-\pi+\pi\lambda(\Gamma^j+\kappa)]+\pi\lambda[1-\pi+\pi\lambda(\Gamma^i+\kappa)]}{[1-\pi+\pi\lambda(\Gamma^i+\kappa)]^2[1-\pi+\pi\lambda(\Gamma^j+\kappa)]^2} \tag{64}$$

$$= \frac{RA\pi^2\lambda^2[2(1-\pi)+\pi\lambda(\Gamma^i+\Gamma^j+2\kappa)]}{S[1-\pi+\pi\lambda(\Gamma^i+\kappa)]^2[1-\pi+\pi\lambda(\Gamma^j+\kappa)]^2}(\Gamma^j-\Gamma^i). \tag{65}$$

□

Proof of Corollary 4. Since the sign of 60 depends on $\Gamma^i - \Gamma^j$, it's immediate to see that

$$\Gamma^{i^*} \geq \Gamma^i \ \forall i \implies \frac{\partial\zeta_{i,i^*}}{\partial\kappa} \leq 0 \ \forall i. \tag{66}$$

□

Proof of Corollary 5. By deriving 60 with respect to κ (following the same step as in 65) we obtain

$$\frac{\partial^2\zeta_{i,j}}{\partial\kappa^2} = -\frac{RA\pi^2\lambda^2[2(1-\pi)+\pi\lambda(\Gamma^i+\Gamma^j+2\kappa)]}{S[1-\pi+\pi\lambda(\Gamma^i+\kappa)]^2[1-\pi+\pi\lambda(\Gamma^j+\kappa)]^2}(\Gamma^i-\Gamma^j). \tag{67}$$

Since the sign of this depends on $\Gamma^j - \Gamma^i$, it's immediate to see that

$$\Gamma^{i^*} \geq \Gamma^i \ \forall i \implies \frac{\partial^2\zeta_{i,i^*}}{\partial\kappa^2} \geq 0 \ \forall i. \tag{68}$$

□

A.2 Variations in unconditional QE have wrong predictions

We show that a symmetric change in unconditional purchases by the ECB generates changes in model quantities that are inconsistent with the empirical evidence in Section 5. To do this, we introduce parameter ξ as the purchases that the ECB conducts at $t = 0$ in common across all issuers. This demand enters directly into the market clearing equation in 15 and is equivalent to common variations in the inelastic demand A. Figure B.23 shows the effect of variations in unconditional QE for our baseline numerical calibration and the next proposition shows that variations in ξ generate counterfactual changes in spreads and market shares.

Proposition 4. *A change in unconditional QE, ξ, has no effect on spreads and relative volatility while it increases the degree of investor sorting according to the need for liquidity.*

Proof. The expressions for $\zeta_{i,j}$ in 42 and $\beta_{i,j}$ in 45 do not depend on A since Flighty investors are the marginal investors and A has no effect on market liquidity in $t = 1$. While from 55 we obtain

$$\frac{\partial(\rho^i - \rho^j)}{\partial \xi} = \frac{R}{S} \frac{\pi\lambda(\Gamma^j - \Gamma^i)}{(1 - \pi + \pi\lambda\Gamma^i)(1 - \pi + \pi\lambda\Gamma^j)}. \tag{69}$$

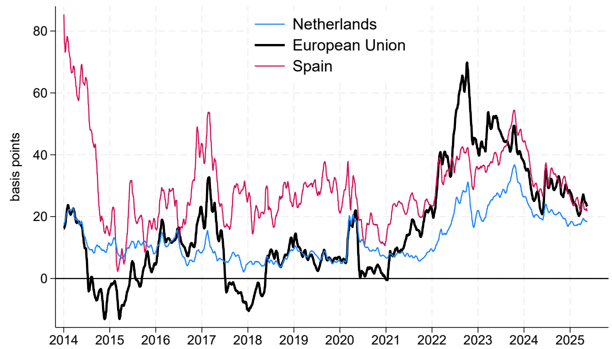
□

This means that announcements by the ECB that it will stop conducting unconditional purchases (a reduction in ξ) should be accompanied by a partial reversal of the investor sorting, while Figure 5.3 shows that the opposite happened in 2022.

We also show that conventional monetary policy cannot account for the sharp increase in relative volatility shown in Figure B.18. To do this, it's sufficient to note that the expressions for spreads and relative volatility in 22 and 23 do not depend on parameter R. This is because changes in the required rate of return do not affect relative asset prices.

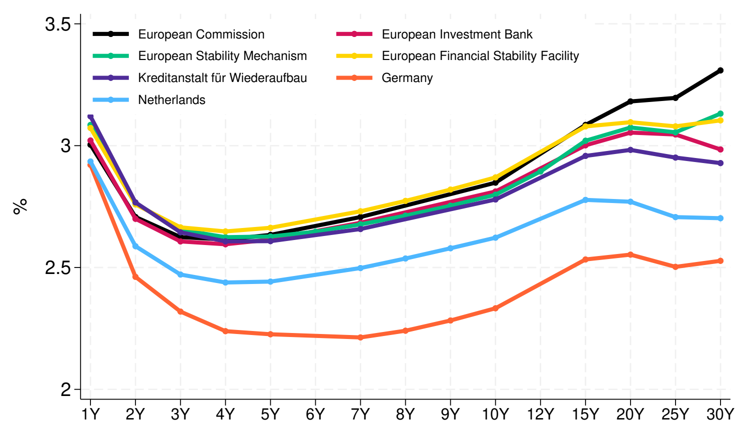
Appendix B Additional figures

Figure B.1: 5-year yield spread with German government bonds net of CDS premia



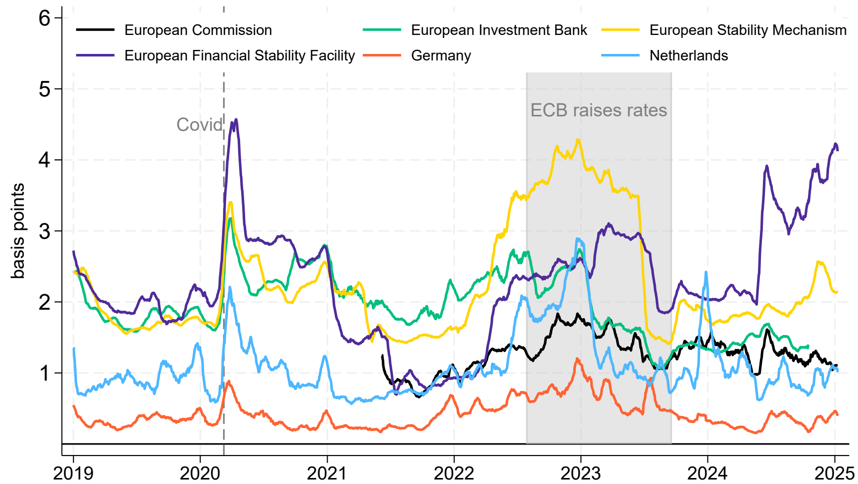
The figure shows the bond basis for the Netherlands (in blue), the European Union (black), and Spain (red). We compute the bond basis as $bb_t^i = (y_t^i - y_t^{\text{Germany}}) - (CDS_t^i - CDS_t^{\text{Germany}})$, where y_t^i is the 5-year yield for issuer i at time t and CDS_t^i is the corresponding 5-year CDS premium. The yield for EU bonds is computed as the arithmetic average of the yield for the European Commission, the European Investment Bank, the European Stability Mechanism, and the European Financial Stability Facility. We use the CDS contract for European Investment Bank for the European Union. Yield data comes from Bloomberg and CDS premia come from IHS Markit.

Figure B.2: Yield curve (average over Jan-Dec 2024)



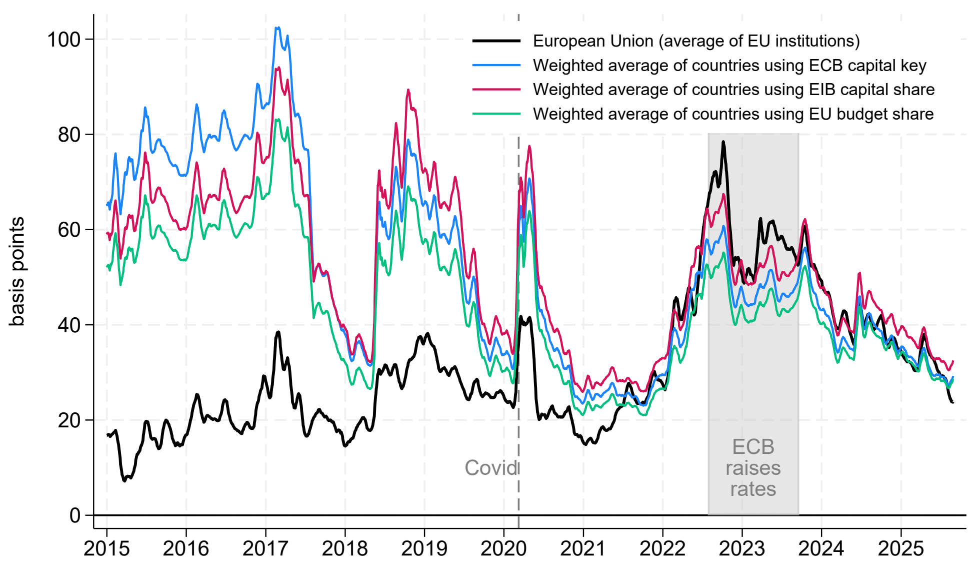
The figure shows the average yield curve for each issuer over the 2024 calendar year for maturities from 1 to 30 years. Data comes from yield curves as computed by Bloomberg.

Figure B.3: Bid-ask spread for 5-year benchmark



The figure shows the bid-ask spread for the 5-year benchmark bond for selected issuers. Data comes from Bloomberg.

Figure B.4: 5-year yield spread with German government bonds



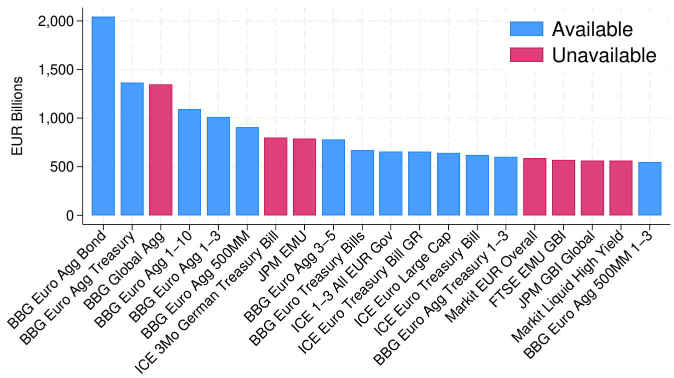
The figure shows the 5-year spread to Germany for EU bonds (in black) and for an average of Euro area member countries using three different weighting schemes. The yield for EU bonds is computed as the arithmetic average of the yield for the European Commission, the European Investment Bank, the European Stability Mechanism and the European Financial Stability Facility. The red line is the average of countries' yields using the ECB capital key, the green line is the average using the capital share in the European Investment Bank and the yellow line is the average using the country share of the EU budget. Yield data comes from Bloomberg, capital key data from ECB, capital share from the EIB, and the EU budget from the European Commission. Country shares for all weighting schemes are shown in Table B.1. For all three averages we only include countries that are members of the Euro area.

Table B.1: Country shares in different EU institutions

The table shows the shares corresponding to each country in three institutions related to the European Union. The capital key in the European Central Bank reflects an equal weighting of GDP and population at the time of the last update and data comes from the ECB. The capital share in the European Investment Bank and the share of contributions to the budget of the European Union are the result of complex political negotiations but are broadly representative of the share of GDP, with data coming from the EIB and the European Commission, respectively.

Country	**ECB capital key**	**EIB capital share**	**EU budget share**
Austria	2.9%	2.6%	2.4%
Belgium	3.6%	5.2%	3.5%
Bulgaria	0.0%	0.2%	0.6%
Cyprus	0.2%	0.1%	0.2%
Czech Republic	0.0%	0.9%	1.9%
Germany	26.1%	18.8%	23.4%
Denmark	0.0%	2.6%	2.1%
Spain	11.8%	11.3%	8.7%
Estonia	0.3%	0.1%	0.2%
Finland	1.8%	1.5%	1.7%
France	20.3%	18.8%	18.7%
Greece	2.5%	1.4%	1.3%
Croatia	0.8%	0.4%	0.5%
Hungary	0.0%	0.8%	1.4%
Ireland	1.7%	0.7%	2.5%
Italy	16.9%	18.8%	12.8%
Lithuania	0.6%	0.2%	0.5%
Luxembourg	0.3%	0.1%	0.5%
Latvia	0.4%	0.1%	0.3%
Malta	0.1%	0.0%	0.1%
Netherlands	5.8%	5.2%	4.6%
Poland	0.0%	4.6%	4.5%
Portugal	2.3%	0.9%	1.7%
Romania	0.0%	0.7%	2.0%
Slovakia	1.1%	0.3%	0.7%
Slovenia	0.5%	0.3%	0.4%
Sweden	0.0%	3.5%	2.6%

Figure B.5: Sum of tracking AUMs (sum over 2019m1-2025m2) by index and data availability



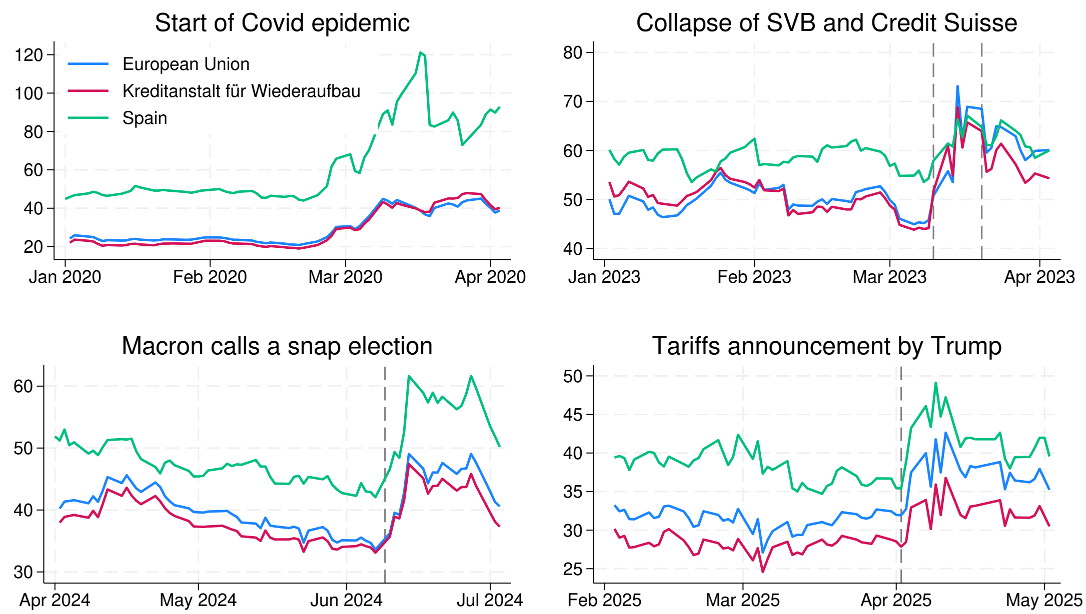
The figure shows the sum of assets under management over the period 2019m1-2025m2 tracking each index. In blue are the indices for which we have composition data and in red are those for which we do not. Data on the size of each fund and the respective index comes from Morningstar Direct and index composition comes from Bloomberg.

Table B.2: Regression of yield on inelastic demand and bond characteristics

The table shows estimation results from Equation 9, where we regress the yield to maturity of bond b issued by i, $y^i_{b,t}$, on ϕ^i_t, a time fixed effect, and bond characteristics, $\boldsymbol{z_{b,t}}$. We use monthly data between 2019m1 and 2024m12 with ϕ^i_t computed as described in Section 2.3 and bond characteristics from the ECB's CSDB. Bond characteristics are controlled in a nonparametric way as follows: issuer rating is the median rating across Moody's, Standard & Poor's, Fitch, Scope and DBRS (a dummy for each level); coupon type is a dummy for fixed interest rate and a dummy for floating (so the base is zero-coupon bonds); bond size is a dummy for each decile of the amount outstanding distribution; bond duration is seven dummies for conventional cutoffs. Standard errors are clustered at the bond-month level and significance stars are as follows: * p<.05, ** p<.01, *** p<.001.

	(1)	(2)	(3)	(4)	(5)
Inelastic demand	-10.70***	-10.70***	-11.51***	-4.317***	-5.619***
	(-8.18)	(-6.87)	(-6.53)	(-4.92)	(-5.57)
Time FE	Yes	Yes	Yes	Yes	Yes
Issuer Rating	No	Yes	Yes	Yes	Yes
Coupon Type	No	No	Yes	Yes	Yes
Bond Size	No	No	No	Yes	Yes
Bond Duration	No	No	No	No	Yes
N	150,210	150,210	150,210	150,210	150,210
r2	0.80	0.83	0.83	0.85	0.90

Figure B.6: 5-year yield spread with German government bonds, basis points



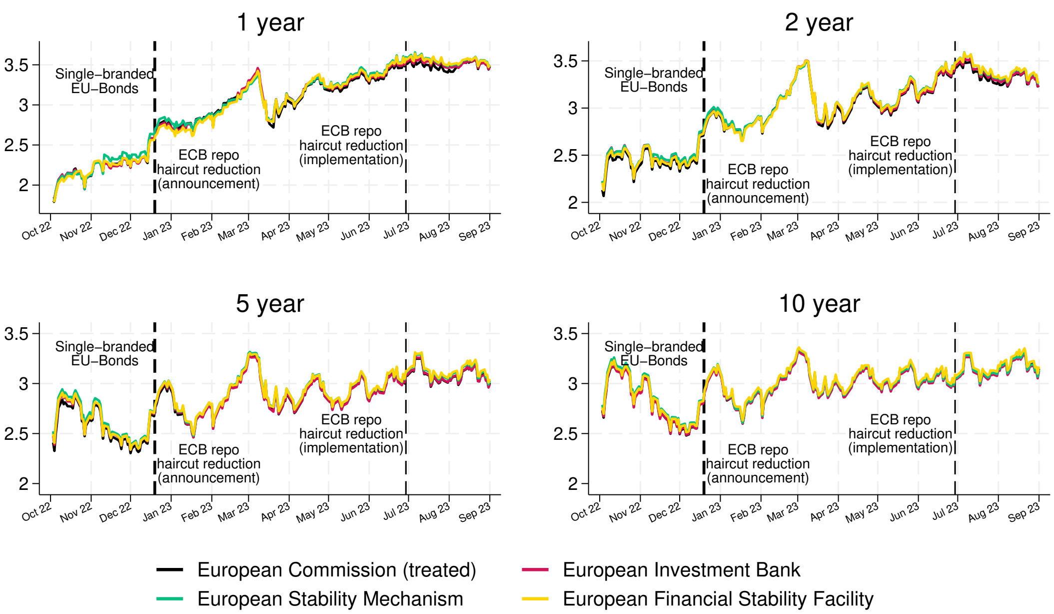
The figure shows the 5-year yield spread with German government bonds for the European Union (in blue), Kreditanstalt für Wiederaufbau (in red) and Spain (in green). Yields are shown are 4 periods of hightened volatility in financial markets: the start of the Covid epidemic (1 January - 1 April 2020), the collapse of SVB and Credit Suisse (1 January - 1 April 2023), Macron calling a snap election following disappointing results in elections for the European Parliament (1 April - 1 July 2024), and the announcement of tariffs by Trump (1 February - 1 May 2025). Yield data comes from Bloomberg.

Table B.3: Regression of portfolio weight $\omega_{b,j}$ on bond and fund characteristics

The table shows the estimation results of Equation 10, where we regress the portfolio share of fund j in bond b among AAA-rated bonds in euros on a dummy for EU bonds and bond characteristics. Data for December 2019 with 676 funds with at least one holding of AAA-rated bonds in euros. χ_j is the fraction of outflows experienced by fund j during March 16-20 (as a percentage of AUM at the end of February 2020). Holding and fund flows data come from Morningstar while bond characteristics come from the ECB's CSDB.

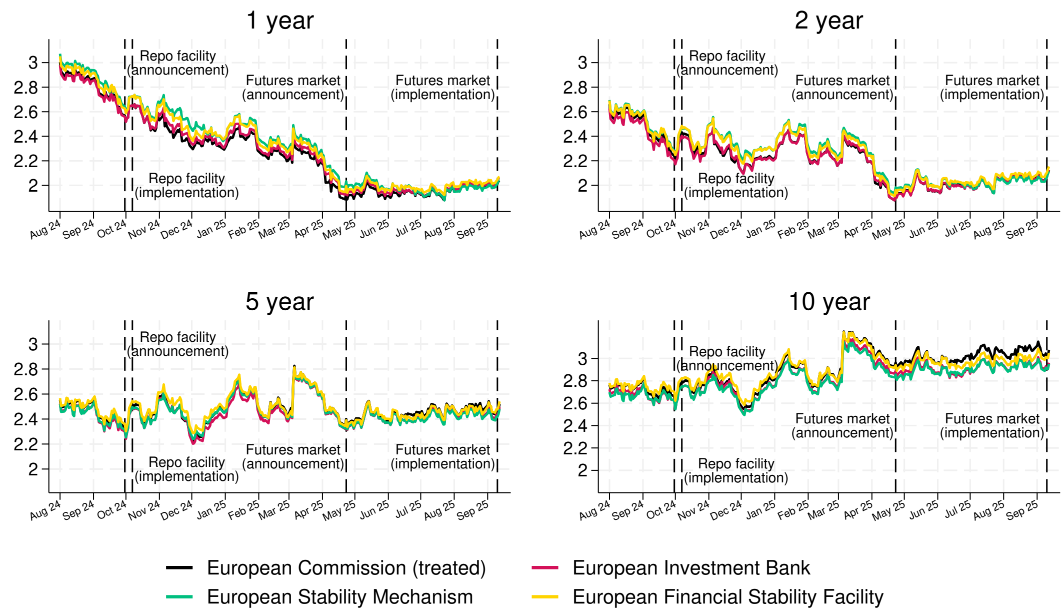
	(1)	(2)	(3)	(4)
EU_i	-4.33*	-13.77*	1.26	-9.38
	(-2.58)	(-2.58)	(0.27)	(-1.62)
$EU_i \times \chi_j$	-100.60	-96.39	-125.89	-120.86*
	(-1.07)	(-1.11)	(-1.45)	(-2.13)
Bond Size	No	Yes	Yes	Yes
Coupon Type	No	No	Yes	Yes
Bond Duration	No	No	No	Yes
N	5,843	5,843	5,843	5,843

Figure B.7: Yield to maturity for 1-, 2-, 5-, 10-year bonds, %



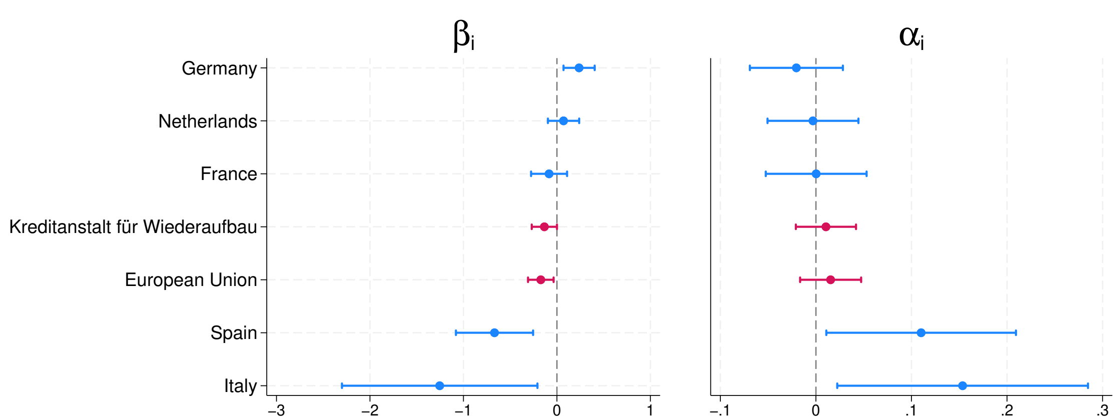
The figure shows the yield to maturity for 1-, 2-, 5-, and 10-year bonds for the 4 issuers linked to the European Union between October 1, 2022 and September 1, 2023. The vertical dashed lines show dates for the announcement of the single funding strategy (19 December 2022), the announcement of the haircut reduction (20 December 2022) and its implementation (29 June 2023).

Figure B.8: Yield to maturity for 1-, 2-, 5-, 10-year bonds, %



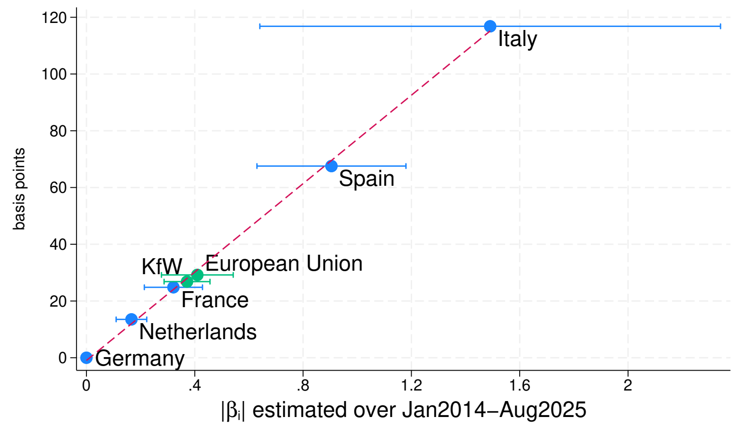
The figure shows the yield to maturity for 1-, 2-, 5-, and 10-year bonds for the 4 issuers linked to the European Union between August 1, 2024 and August 1, 2025. The vertical dashed lines show dates for the announcement of the EC repo facility (30 September 2024), its implementation (7 October 2024), the announcement of the establishment of a futures market by Eurex (23 April 2025), and its implementation (10 September 2025).

Figure B.9: Estimated parameters for major issuers in the Eurozone



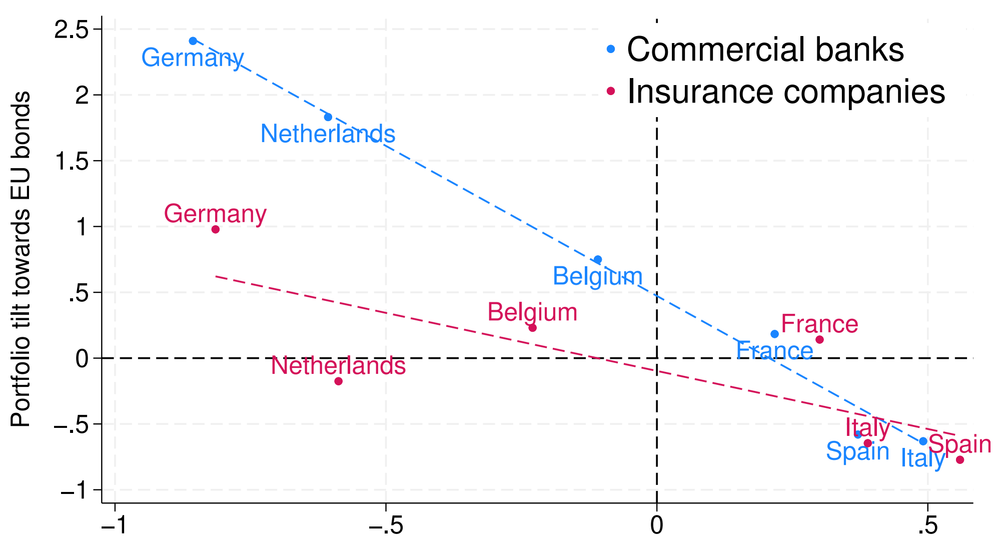
The figure shows estimation results for Equation 3 but the difference relative to Table 2.2 is that here we regress the realized excess return relative to the risk free rate as measured using the 5-year swap-implied rate on the contemporaneous log change in VIX. We use monthly data for the period 2014m1-2025m5 for a total of 137 observations for each issuer. We use Newey-West standard errors with 24 lags and 95% confidence intervals. Yield ans swap data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX.

Figure B.10: Average 5-year spread to Germany over Jan2014-Aug2025



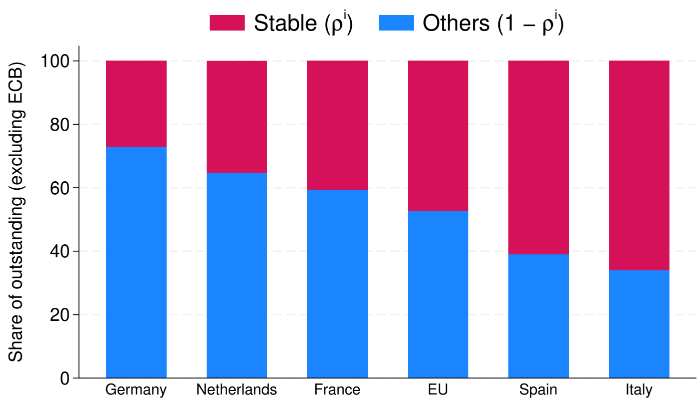
The figure shows the average 5-year spread to Germany over Jan2014-Aug2025 (on the vertical axis) and the volatility to VIX estimated over the same period (on the horizontal axis), computed as in Equation 3 and reported in absolute value. 90% confidence intervals using Newey-West standard errors with 24 lags. Yield data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX.

Figure B.11: Portfolio tilt for different investor sectors and countries in 2025Q1



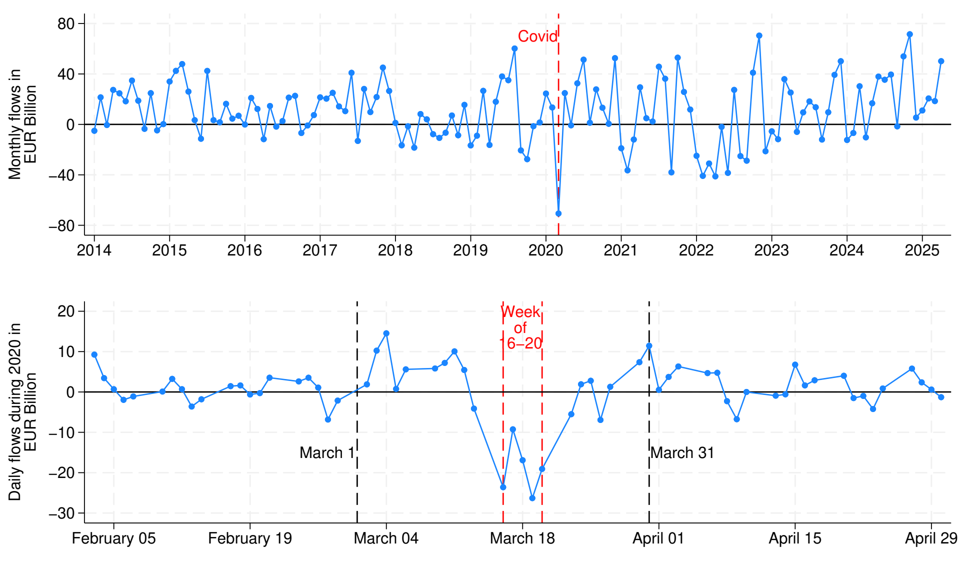
The figure shows the portfolio tilt (as defined in 11) for commercial banks (in blue) and insurance corporations (in red) located in different countries towards EU bonds (vertical axis) and bonds issued by their own national government (horizontal axis). We data for 2025Q1 and consider portfolio and market shares out of total holdings and outstanding amounts of European sovereign bonds denominated in euros. Data come from the ECB Securities Holdings Statistics by Sector.

Figure B.12: Investor composition for sovereign issuers in euro (excluding the ECB)



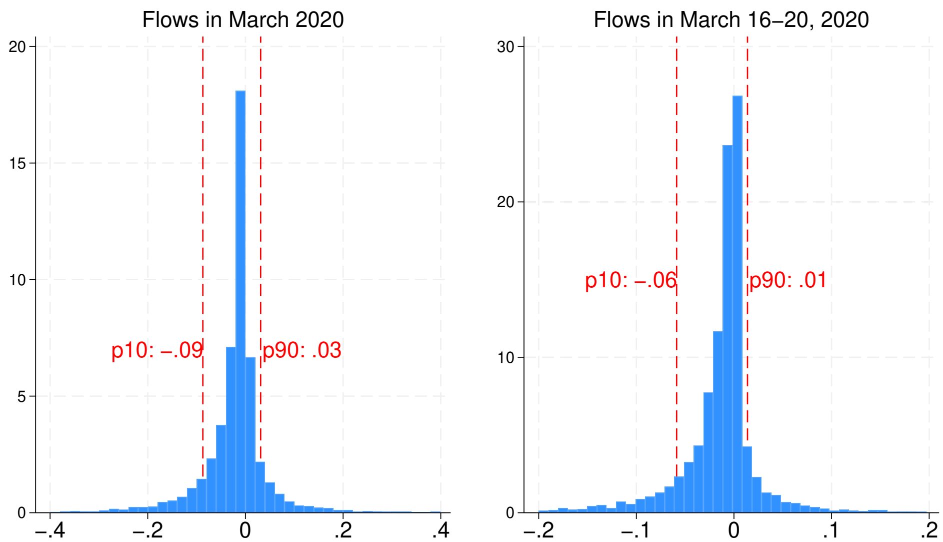
The figure shows the investor composition (excluding the ECB) for selected issuers, where we divide all investor sectors into 2 categories. Stable is commercial banks, insurance corporations, households, and government while refers to all other categories, mostly to mutual funds, MMMFs, ETFs and foreign investors. We use data for 2025Q1 and consider outstanding amounts of European sovereign bonds denominated in euros. Data come from the ECB Securities Holdings Statistics by Sector.

Figure B.13: Monthly and daily total net flows into selected universe of funds



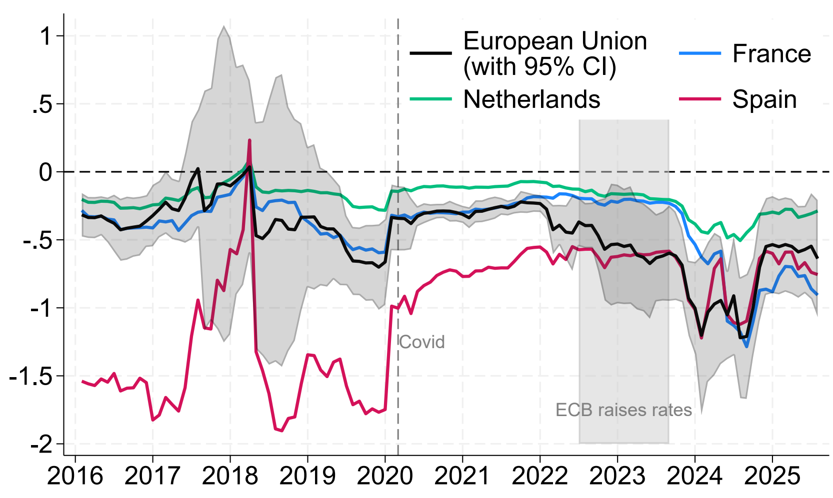
The figure shows total net flows into the selected universe of funds at the monthly frequency (top panel) and daily frequency (bottom panel). We include all available funds denominated in euros or with European Fixed Income as investment category. Data comes from Morningstar Direct.

Figure B.14: Distribution of net outflows as a share of AUM in February 2020



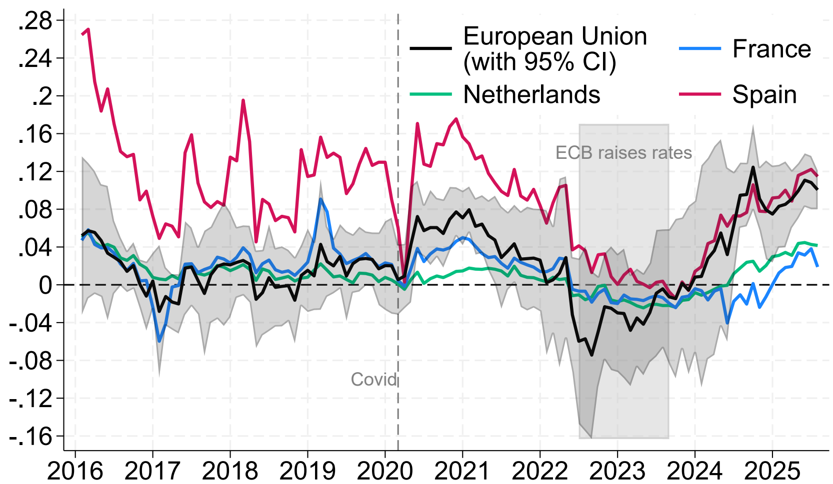
The figure shows the distribution of fund outflows during March 2020 (left panel) and during the week of March 16-20 (right panel). We include all available funds denominated in euros or with European Fixed Income as investment category. Data comes from Morningstar Direct.

Figure B.15: Rolling estimation of β_i over preceding 24 months



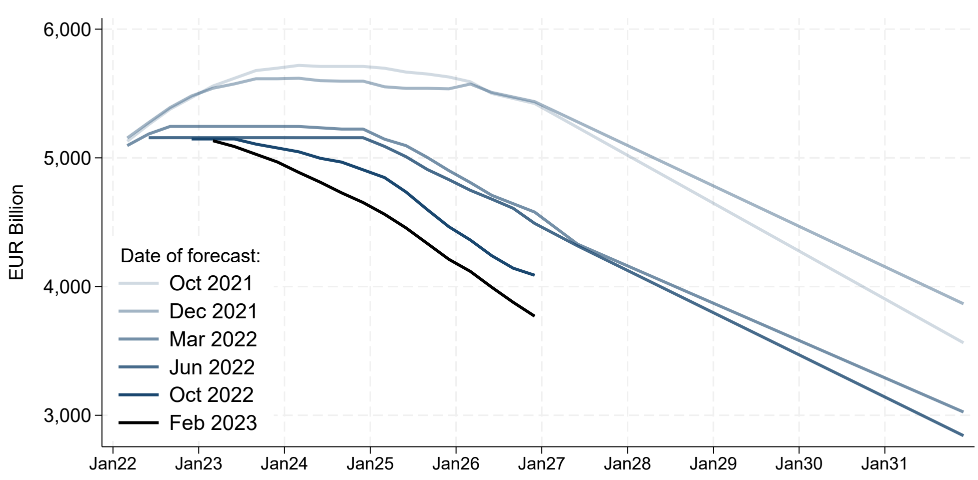
The figure shows the beta parameter for Equation 3 estimated over a rolling window of the preceding 24 months for the four issuers. The shaded area is the 95% confidence interval for the estimated beta parameter for the European Union, computed using Newey-West standard errors with 23 lags. Yield data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX. Figure B.16 shows the corresponding alpha parameters for the four issuers.

Figure B.16: Rolling estimation of α_i over preceding 24 months



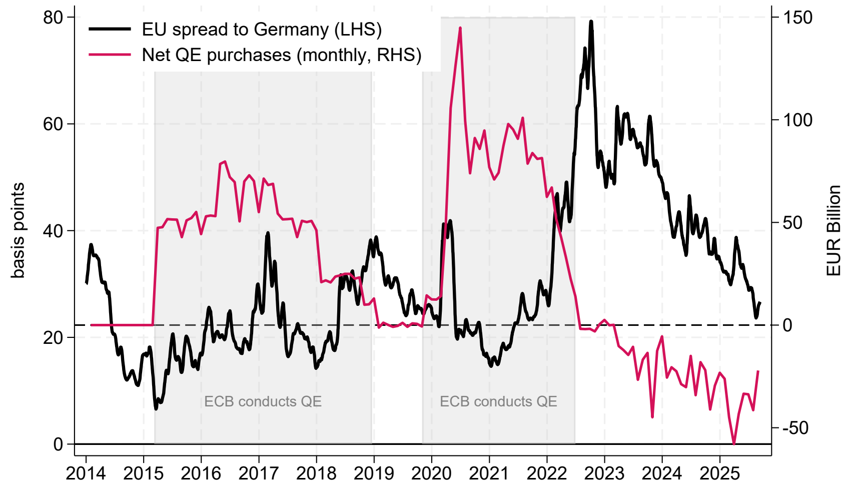
The figure shows the alpha parameter for Equation 3 estimated over a rolling window of the preceding 24 months for the four issuers. The shaded area is the 95% confidence interval for the estimated beta parameter for the European Union, computed using Newey-West standard errors with 23 lags. Yield data comes from Bloomberg and EURO STOXX 50 Volatility (VSTOXX) data from STOXX. Figure B.15 shows the corresponding beta parameters for the four issuers.

Figure B.17: ECB QE balance sheet projection by analysts, by date of survey



The figure shows the projection of the total holdings of securities for QE purposes by the ECB for different dates by date of the forecast. We use the median value across the pool of survey respondents. Data comes from the ECB Survey of Monetary Analysts (SMA).

Figure B.18: 5-year spread with Germany and net QE purchases by the ECB

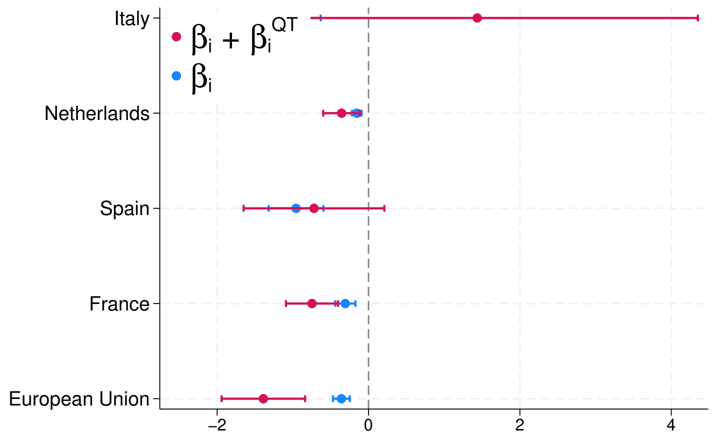


The figure shows the 5-year yield spread of EU bonds with Germany (in black) and net QE purchases by the ECB (in red). QE purchases are the sum of PSPP and PEPP programs as reported at the end of each month. Yield data comes from Bloomberg and QE purchases from public ECB data.

Figure B.19: 5-year spread with Germany and ECB deposit facility rate

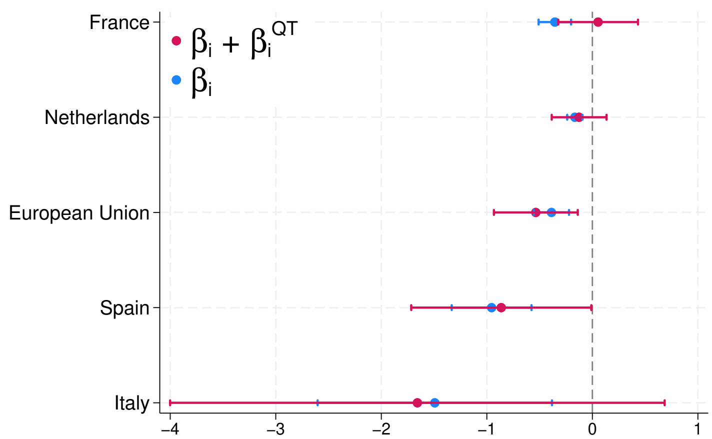
The figure shows the 5-year yield spread of EU bonds with Germany (in black) and the deposit facility rate by the ECB (in red). Yield data comes from Bloomberg and the deposit facility rate from the ECB.

Figure B.20: Estimation of β_i over the sample and during QT periods



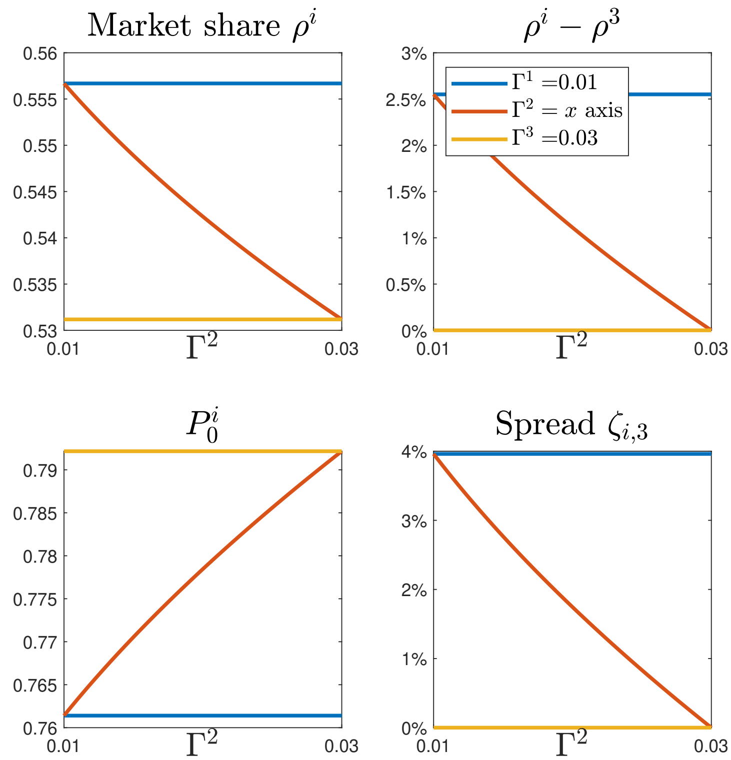
The figure shows estimated beta parameters from Equation 27, where we regress the realized excess return relative to Germany for each issuer on the contemporaneous log change in VIX and the interaction between the contemporaneous log change in VIX and an indicator function for QT period. We define a QT period as a month in which the spread between the 1-year Euribor interbank rate exceeds the ECB's deposit facility rate by at least 50 basis points. We use Newey-West standard errors with 24 lags. Yield data come from Bloomberg, Euribor data from Refinitiv, and the deposit facility rate from the ECB.

Figure B.21: Estimated parameters for major issuers in the Eurozone



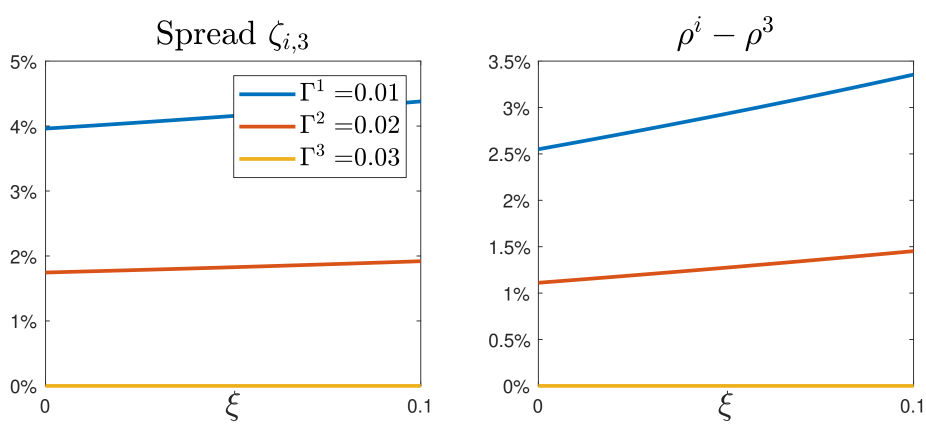
The figure shows estimated beta parameters from Equation 27, where we regress the realized excess return relative to Germany for each issuer on the contemporaneous log change in VIX and the interaction between the contemporaneous log change in VIX and an indicator function for QT period. Unlike in Figure 5.1, here we define a QT period as a month in which the ECB is not conducting large-scale asset purchases. We use Newey-West standard errors with 24 lags. Yield data come from Bloomberg and asset purchase data from the ECB.

Figure B.22: Model equilibrium for changes in the size of inelastic demand for issuer i = 2



The figure shows the model equilibrium for a setting with 3 issuers that are symmetric in all respects except for the inelastic demand parameter Γ^i. Common parameter values are as follows: $\theta = 0.6, \phi = 0.1, \lambda = 1, S = 1, B = 0.1, A = 0.5$. The figure shows how the model equilibrium changes as inelastic demand for the second issuer, Γ^2, increases while Γ^1 and Γ^3 remain fixed.

Figure B.23: Model equilibrium for changes in unconditional QE ξ_t



The figure shows the model equilibrium for a setting with 3 issuers that are symmetric in all respects except for the inelastic demand parameter Γ^i. Common parameter values are as follows: $\theta = 0.6, \phi = 0.1, \lambda = 1, S = 1, B = 0.1, A = 0.5$. The figure shows how the model equilibrium changes as unconditional QE, ξ, increases from 0 to 0.3.

Table B.4: First-stage regression of yield y_t^i on index inclusion and included regressors

The table shows the results of the first-stage regression of the GMM condition 31, where we run a linear regression of y_t^i on the index inclusion measure and included regressors. We report interquartile statistics for all regressors including the time fixed effects and the constant. Statistics for the excluded regressors are shown in Table 6.1.

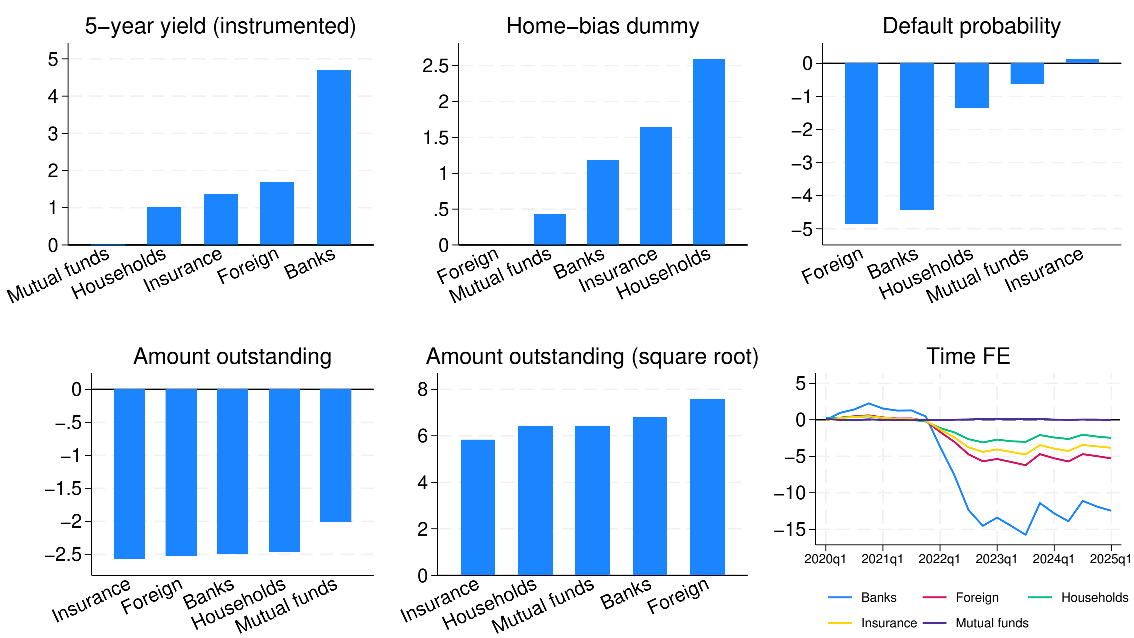
	min	p25	p50	p75	max
Index inclusion	-15.74	-14.76	-14.38	-14.32	-12.74
Home-bias dummy	-0.29	-0.04	0.00	0.05	0.30
Default probability	1.44	1.51	1.51	1.51	1.97
Amount outstanding	-0.30	0.04	0.04	0.06	0.14
Amount outstanding (sqrt)	-0.34	-0.19	-0.15	-0.12	0.23
2020Q1	0.04	0.04	0.04	0.04	0.04
2020Q2	-0.18	-0.18	-0.18	-0.18	-0.17
2020Q3	-0.29	-0.29	-0.29	-0.29	-0.28
2020Q4	-0.39	-0.39	-0.39	-0.39	-0.39
2021Q1	-0.25	-0.25	-0.25	-0.25	-0.25
2021Q2	-0.18	-0.18	-0.18	-0.18	-0.17
2021Q3	-0.18	-0.18	-0.18	-0.18	-0.18
2021Q4	-0.01	-0.01	-0.01	-0.01	-0.01
2022Q1	0.89	0.89	0.89	0.89	0.89
2022Q2	1.73	1.73	1.73	1.74	1.74
2022Q3	2.73	2.73	2.73	2.73	2.74
2022Q4	3.21	3.21	3.22	3.22	3.22
2023Q1	2.99	2.99	2.99	2.99	3.00
2023Q2	3.24	3.24	3.24	3.24	3.26
2023Q3	3.49	3.49	3.49	3.49	3.50
2023Q4	2.57	2.57	2.57	2.57	2.59
2024Q1	2.87	2.87	2.87	2.87	2.89
2024Q2	3.11	3.11	3.11	3.11	3.13
2024Q3	2.53	2.54	2.54	2.54	2.56
2024Q4	2.70	2.70	2.70	2.70	2.72
2025Q1	2.86	2.86	2.86	2.86	2.89
Constant	-0.23	-0.12	-0.11	-0.10	-0.05

Table B.5: First-stage regression of yield y_t^i on index inclusion and included regressors

The table shows the results of the GMM estimation from condition 31. We report interquartile statistics for all regressors.

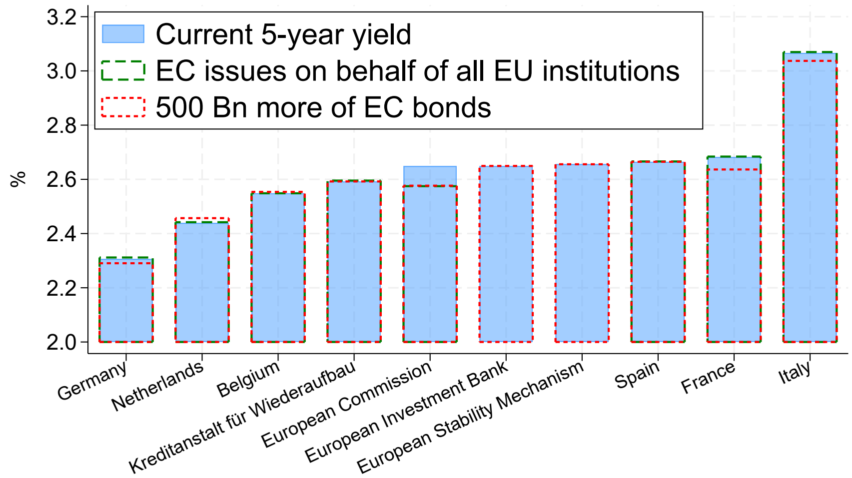
	min	p25	p50	p75	max
5-year yield (instrumented)	0.00	0.00	0.00	2.69	10.53
Home-bias dummy	-2.66	0.00	0.00	2.09	5.61
Default probability	-9.44	-3.85	-1.19	1.02	10.01
Amount outstanding	-9.38	-3.55	-2.30	-1.36	0.22
Amount outstanding (square root)	1.45	4.52	6.61	8.95	21.56

Figure B.24: Distribution of estimated parameters from GMM across investors



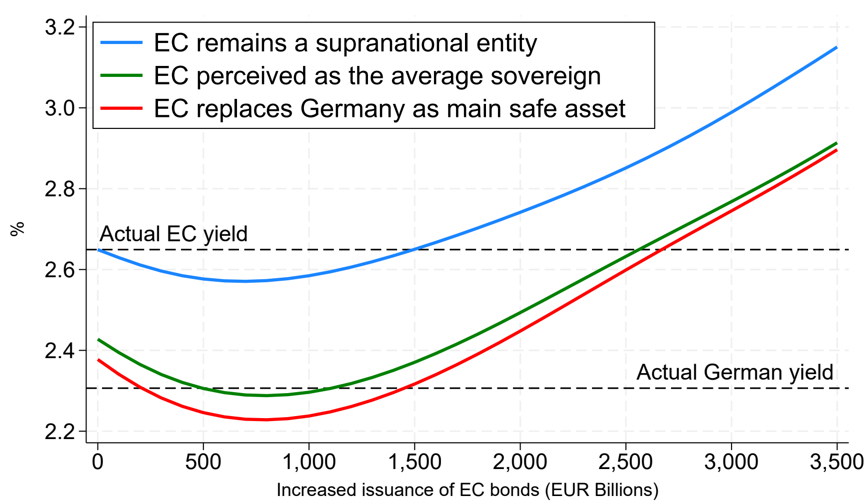
The figure shows the distribution of the GMM estimation from condition 31. For each regressor, we report the mean (weighted by asset size) coefficient for different investor sectors.

Figure B.25: 5-year yield and counterfactuals under different scenarios, by issuer



The figure shows the 5-year yield to maturity for different issuers at the end of 2025Q1 (in light blue) and counterfactual values obtained from the computation of the price vector that would clear the system in 32 given the estimated elasticities for each investor. In the first counterfactual scenario (dashed red line) we set the amount outstanding for the European Investment Bank and the European Stability Mechanism to zero and increase the amount for the European Commission by the corresponding number. In the second counterfactual scenario we increase the amount outstanding of the European Commission by €500 Bn and decrease the amount of national governments by the same total amount, with each country benefiting in proportion to the ECB's capital key shown in Table B.1.

Figure B.26: 5-year yield for EC bonds in counterfactuals of increased issuance, by scenario



The figure shows the 5-year yield to maturity for EC bonds at the end of 2025Q1 for counterfactuals of increased issuance under different assumptions about the parameters of latent demand. For each scenario we increase the amount outstanding of the European Commission and decrease the amount of national governments by the same total amount, with each country benefiting in proportion to the ECB's capital key shown in Table B.1. The blue line uses the latent demand parameters as estimated from 31, while the green and red line replace the latent demand parameters for the EC as described in 34 and 35.