Supranational Debt as Safe Asset: The Role of Repo*

Matthias Kaldorf[†] Andrea Poinelli[‡]

November 13, 2023

Abstract

This paper demonstrates that repo markets play a crucial role in the manufacturing of safe assets. We overcome endogeneity concerns regarding repo market activity and the safety and liquidity attributes of government bonds by exploiting a liquidity upgrade of Eurobonds in the Eurosystem collateral framework. Using transaction level data from the German repo market, we document that repo rates for Eurobonds decline by around 50 basis points relative to Bund repo rates. This effect is robust to using agency bonds as control group, which did not receive an upgrade, while Eurobond repo volumes increase significantly as well. The effect is most pronounced for short-term bonds and there is a considerable pass-through to secondary market rates and bid-ask spreads. Exploiting the granularity of our dataset, we identify bond demand factors by cash lenders as the main driver of these effects, suggesting a strong market segmentation between safe and quasi-safe assets. Our results suggests that a well-functioning repo market is one important prerequisite for the safety and liquidity status of supranational government bonds.

Keywords: Repo Markets, Collateral Framework, Safe Assets, Supranational Debt, Market Microstructure

JEL Classification: E58, E63, F33, H63

---

*The views expressed here are our own and do not necessarily reflect those of the Deutsche Bundesbank, the European Central Bank, or the Eurosystem.

[†]Deutsche Bundesbank, Research Centre. Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main, Germany. Email: matthias.kaldorf@bundesbank.de

[‡]Deutsche Bundesbank, Research Centre. Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main, Germany. Email: andrea.poinelli@bundesbank.de

1 Introduction

The absence of a euro area safe asset is an important concern for monetary and fiscal policies in the currency union. During the European debt crisis of 2011, German government bonds emerged as the closest substitute to an euro area safe haven asset. They arguably have the strongest fundamentals relative to other member states and are also issued in sufficiently large quantities to qualify as safe haven asset.[1] In the context of a currency union with incomplete fiscal integration, the safe asset status of the Bund is an issue since the amount of outstanding Bunds is rather small compared to the size of the euro area financial sector. Furthermore, there might be undesirable consequences for regional imbalances and country-specific fiscal policy if government bonds of some member states trade at exceptionally low yields, as argued in Jiang et al. (2021). Following the Covid19 pandemic, the European Commission issued marketable debt in large quantities, which might provide investors with an alternative (euro-denominated) safe haven asset to the Bund.[2] However, in the first two years following their initial issuance, EU bonds have traded at yields considerably above the Bund, both on the secondary market and on the repo market, despite being rated AAA. This raises the question what determines the safe asset status of supranational government bonds.[3]

While theory suggests that, in addition to excellent fundamentals, a large outstanding amount is necessary for government bonds of a specific issuer to qualify as safe asset (He et al., 2019). It is, however, empirically challenging to test whether the outstanding amount of government bonds is large enough for investors to coordinate on them as safe and liquid assets. Instead, we take a more direct approach that is based on the *microstructure* of the supranational and government bond repo market. On this market, arbitrageurs, such as hedge funds, can borrow bonds for short-selling purposes, while hold-to-maturity investors, such as pension funds, can earn fees by lending out bonds. This stable supply and demand for bonds enhances the possibilities of safety or liquidity seeking investors to trade in times of stress.[4] Safety and liquidity attributes increase if an asset class is actively traded on the repo market. Put differently, an active repo market is, therefore, indicative for the safety and liquidity of an asset class. Conversely, only safe and liquid assets are accepted as collateral by repo market participants. Naturally, this endogeneity poses a challenge to the identification of causal effects in the context of safe asset creation.

To overcome this identification challenge, we exploit a change to the Eurosystem collateral framework announced in December-20, 2022 and implemented in June-29, 2023. With this policy change, the Eurosystem promoted Eurobonds from liquidity category II to liquidity category

[1] Both factors, relative fundamentals and the free float of government bonds are crucial determinants of their safe asset status, see He et al. (2019) and the references therein.

[2] While the European Stability Mechanism issued supranational debt already prior to the pandemic, the amount outstanding was very small. In response to the pandemic, the European Commission issues bonds within the so called "Next Generation EU" (NextGenEU) programme and to fund "The European instrument for temporary Support to mitigate Unemployment Risks in an Emergency" (SURE).

[3] See Bletzinger et al. (2022) for a discussion of the Eurobond market in 2020 and 2021. A summary of recent developments is provided by the Financial Times, available here.

[4] Eisenbach and Phelan (2023) propose a model that explicitly distinguishes between liquidity and safety seeking investors.

I.[5] This upgrade places Eurobonds in the same liquidity category as central government bonds, while they were treated like (supranational) agency and local government debt prior to the upgrade. Since Eurobonds are rated AAA, they can be pledged at Eurosystem facilities under the same conditions as German government bonds after the upgrade.

Using transaction level data from the euro area repo market, we first show that repo rates decline significantly and substantially after the liquidity upgrade, relative to a untreated Bunds by -50bps. This effect is economically meaningful, compared to a full sample average repo rate of 125bps. At the same time, the Eurobond repo transaction size increases by EUR 2 millions after the liquidity upgrade, which is a substantial increase relative to a full sample average of EUR 18 millions. These results are robust to using stringent fixed effects at the bond level as well as the bank × counterparty relationship level.

We then decompose the large aggregate effect into maturity-specific effects and find that they are particularly pronounced at the short end: repo rates decline by -70bps for Eurobond with a remaining maturity up to five years, which make up around 30% of all Eurobonds outstanding. This result is consistent with repo market segmentation across maturities, typically referred to as preferred habitat, and a relative scarcity of short-term government bonds: the inverted yield curve in our sample period makes borrowing short-term comparatively expensive for the government and is expected to reduce the supply of short-term government bonds (Greenwood et al., 2015).

There is a considerable transmission of to secondary market yields and bid-ask spreads. Using bond level data, we find that the Eurobond-Bund spread declines by 21bps and that bid-ask spreads decline by around 2bps after the liquidity upgrade. Consistent with the repo market effects, bonds experience the strongest yield reduction at the short-end, where they decline by 39bps, relative to the Bund. This reduction is also relevant at the macro level, since it would reduce the interest expenses of the European Commission by around EUR 1.6 bn. Since the results are most pronounced at the short end, the liquidity upgrade also affects the term structure and we provide suggestive evidence on real implications for the maturity structure of Eurobonds. While there was no effect on the maturity structure of Bunds, the share of short-term Eurobonds increased within two weeks after the implementation.[6]

We then exploit the granularity of our dataset to inspect the driving forces behind these economically large effects. Specifically, we study the role of bond demand and supply effects on the repo market. The decrease in repo rates and the simultaneous increase in volumes point to dominating demand effects. To see this, note that the liquidity upgrade implies a haircut reduction on Eurobonds, which increases their convertibility into central bank funding. For example, a fixed coupon Eurobonds with a maturity between five and seven years experienced a haircut reduction from 3.5% to 2%. This increases banks' opportunity cost of borrowing against them on the private repo market relative to borrowing from the central bank, which would imply a *reduction* in their repo market supply. On the bond demand side, the liquidity upgrade might

[5] See this link for the full policy announcement.

[6] Maturity-specific government debt supply effects in response to unconventional monetary policy have been documented in Kaufmann et al. (2023).

increase the willingness of counterparties, such as hedge funds and other securities borrowers, to borrow Eurobonds on the repo market. Alternatively, banks might be able to trade with a larger investor clientele after the upgrade. We test the relevance of bond demand factors by augmenting the baseline specification with bank × date fixed effects, which controls for bond supply. The coefficient of interest increases relative to the baseline specification. In contrast, adding counterparty × date fixed effect drastically reduces the effect size, suggesting that bond demand factors are the key driver of the results. In support of this observation, the effect size is particularly large for bilateral trades, consistent with the notion of bargaining power on the repo market.

To justify the causal interpretation of our estimated effects, we need to address several concerns arising in empirical setups like ours. Our sample period starts on April-01, 2022, after the last major collateral policy change by the Eurosystem. There was arguably no change in fundamentals and liquidity conditions for Eurobonds or Bunds between April and December 2022, such that it is reasonable to treat the Eurosystem liquidity upgrade as exogenous with respect to the liquidity upgrade. This is supported by the absence of statistically significant pre-trends.

The choice of an appropriate control group is more challenging: incumbent bonds in liquidity category I might be negatively effected due to increased competition by Eurobonds, i.e. their repo rates and cash market yields might increase. However, the outstanding volume of Eurobonds is currently small compared to Bunds, such that this crowding-out effect should be relatively small. It might nevertheless bias the estimated treatment upwards. An alternative choice are AAA-rated agency bonds that remained in liquidity category II after July 2023. Bonds issued by the German development bank (*Kreditanstalt für Wiederaufbau*, KfW) are guaranteed by the German government and have been used in similar empirical setups, see for example Beber et al. (2009) and Monfort and Renne (2013). Compared to the effect of -50bps in the baseline specification, the effect size declines to -42bps. Both the maturity decomposition and the pass-through to the secondary market are robust to using KfW bonds as control group as well.

We provide a series of additional tests and robustness checks to support our key results. First, our main results are robust to using cash lending rates, which are based on transactions where banks extend funding to counterparties in exchange for collateral. Notably, the effects are about 25% smaller. Also, bond-specific demand factors are less important in these transactions, since the profits of such trades are arguably less bond-specific than for cash borrowing transactions. Second, we re-estimate our main empirical specifications under different sample selection criteria. We exclude green bonds issued in the NextGenEU programme, which might have been in high demand around the Eurosystem strategy review and subsequent policy announcements regarding a preferential collateral treatment of green bonds. We also exclude bonds targeted by the German debt management office in a reverse repo facility, which might change the repo market liquidity of our control group. We also restrict the beginning of the sample to July-01, 2023, the date at which the changes to the Eurosystem collateral framework announced on April-01, 2022 were implemented. None of these sample selection criteria changes our results by more than a few basis points. Lastly, our results are also robust to using the announcement date rather than the implementation date as treatment indicator. The effect size declines to -28bps, i.e. around half of the total effect can be attributed to the announcement.

Our results underscore the importance of repo markets in the manufacturing of safe assets. This suggests that the European Commission's plan to introduce a Eurobonds repo facility by 2024 can be expected to strengthen Eurobonds' safe asset status. It should however be noted that liquid repo and secondary markets are necessary, but not sufficient conditions for bonds to achieve safe asset status. The second key necessary condition are excellent fundamentals, which is arguably the case for Eurobonds, but not for many other euro area member states. Since the Eurosystem' collateral framework change only affected AAA-rated bonds, it is not clear whether our results, especially regarding the positive effects on repo market volumes, carry over to a liquidity upgrades of riskier bonds or whether such a policy might instead crowd out private repo market activity.[7]

Related Literature First, our paper draws on a large literature on the relationship between government bond repo and secondary markets and the role of central bank policies. Bindseil et al. (2009) use Eurosystem repo auction data to study the effects of central bank liquidity provision on the repo market. Repo markets have gained further attention since central banks implemented large scale asset purchase programmes (APPs). Using US data, D'Amico et al. (2018) study security-specific demand and supply effects on the repo market and find results consistent with a collateral scarcity channel of APPs. Schlepper et al. (2020) use high frequency data from Eurosystem purchases of German Bunds to study the secondary market effects of APPs. Corradin and Maddaloni (2020) and Arrata et al. (2020) link the APPs to safe asset scarcity on the repo market using data from the Eurosystem Public Sector Purchase Programme. In this context, Tischer (2021) identifies a positive effect of APP-induced safe asset scarcity on bank lending. **greppmair˙jank2022** Doerr et al. (2023) focus on money market funds and show that these large investors are an important driver of the dynamics in the secondary and repo market for US Treasury bonds.

Second, our paper is closely related to a series of papers studying the relationship between fiscal policy and the functioning of government bond markets. Using US data, Lou et al. (2013) demonstrate that US Treasury yields increase significantly around US Treasury auctions, which they link to dealer's balance sheet constraints. Droste et al. (2023) attribute similar effects to market segmentation. Dufour et al. (2020) report similar findings using Italian government bond data. D'Amico and Pancost (2021) identify repo specialness as an important driver of Treasury prices, using a dynamic term structure model. Phillot (2023) uses US Treasury futures rates to identify the effects of Treasury supply shocks. Taking a more macroeconometric approach, Jiang et al. (2021) study convenience yield on sovereign bonds in the cross-section of euro area government bonds and show that convenience yield contributes to euro area imbalances. Benigno and Nisticò (2017) discuss macroeconomic and monetary policy implications of safe asset scarcity

[7] For a discussion of collateral policy in the context of sovereign risk, we refer to Lengwiler and Orphanides (2023) for a discussion of multiple equilibria and Kaldorf and Roettger (n.d.) for the role of fiscal incentives, and to the references therein.

through the lenses of a structural model. We contribute to this literature by showing the key role of the repo market for fiscal policy and in the manufacturing of safe assets.

By using a change to the collateral framework as exogenous source of variation, our paper is also related to papers studying the real implications of central banks' collateral framework. Pelizzon et al. (2023) finds that the inclusion of corporate bonds in the Eurosystem's list of eligible assets lowers their yields, eligible corporations expand their market presence in corporate bonds and reduce bank debt. Van Bekkum et al. (2018), Mésonnier et al. (2021), Chen et al. (2022) and Harpedanne de Belleville (2023) use relaxations in minimum rating requirements to establish effects on corporate bond or loan rates. Using the introduction of the ECB single collateral framework list, which allowed euro area banks to pledge cross-border bank loans as collateral Hüttl and Kaldorf (2023) show that collateral policy has an effect on increased loan supply and pricing of affected banks, even without affecting minimum rating requirements. The estimated effect of the liquidity upgrade on secondary market yields is at the upper end, but still in the range of this literature. The effects of changes to central bank *haircuts* on the secondary and repo market are still largely unexplored, see Adler et al. (2023). We further contribute to this literature by providing evidence on (i) the pass-through of collateral framework changes through the repo market to the secondary market and (ii) implications for fiscal policy.

The paper is structured as follows. After describing the institutional background and data in Section 2, Section 3 lays out our empirical strategy. The baseline results are shown in Section 4, further results are discussed in Section 5. Section 6 discusses potential policy implications and concludes.

2 Institutional Background and Data

In this section, we provide an overview of the Eurosystem collateral framework in the context of government bonds and supranational debt and on the European Commission's debt issuance.

Eurosystem Collateral Framework The Eurosystem implements monetary policy by providing various types of loans to banks, spanning from very short-term loans, such as overnight and intra-day, to longer-term loans with maturities of up to four years. All central bank lending by the Eurosystem is against collateral, which in turn is subject to haircuts. Collateral haircuts depend on instrument and issuer characteristics, such as seniority, credit rating, remaining maturity and coupon structure, but are independent of the counterparty (see Bindseil et al. (2017) for a comprehensive discussion). While they are revised irregularly, one important revision of haircut schedules was a 20% haircut reduction in April 2020, following the Covid19 pandemic. The haircut adjustment was subsequently revised in two stages. On March-20, 2022, the Eurosystem announced to cut the haircut reduction across all assets from 20% to 10% after July-8, 2022.[8] This announcement was the last modification of the Eurosystem collateral framework affecting central government bonds and Eurobonds before the liquidity upgrade and, thereby, restricts our sample to start in April 2022. On December-20, 2022, the Eurosystem announced

[8] See the press release here for more details.

that the haircut schedules would resume to their pre-pandemic level in June 2023 and announced several additional modifications. It re-assigned debt instruments issued by the European Union from haircut category II to haircut category I, the same used for debt instruments issued by central government.[9]

We provide a comparison of the change in valuation haircuts applied to Eurobonds before and after the policy change in Table 1. Note that the general increase in the haircut level affects all asset classes uniformly and has been announced already in March 2022 and can, thus, reasonably assumed to be priced by market participants. The surprise component in the policy change announced in December 2022 is the re-assignment of Eurobonds form liquidity category II to category I. Here, the *relative* reduction is fairly stable across maturities, at 50% for the shortest bonds, at 33% for maturities between one and three years, and at 40% for bonds with a maturity of more than 30 years.

Table 1: Haircuts (in %) on AAA-rated bonds in liquidity categories I and II

Maturity	December 2022		July 2023	
(years)	Category I	Category II	Category I	Category II
$[0,1)$	0.5	0.9	0.5	1.0
$[1,3)$	0.9	1.4	1.0	1.5
$[3,5)$	1.4	2.3	1.5	2.5
$[5,7)$	1.8	3.2	2.0	3.5
$[7,10)$	2.7	4.1	3.0	4.5
$[10,15)$	4.5	7.2	4.0	6.5
$[15,30)$	4.5	7.2	5.0	8.0
30+	4.5	7.2	6.0	10.0

Eurobonds The Covid-19 pandemic has induced the European Commission to increase bond market-based borrowing with the aim of supporting the European Union's effort to accelerate the recovery from the pandemic and the associated recession. Notably, this is in sharp contrast to earlier proposals aiming at manufacturing euro area safe assets by tranching sovereign bond portfolios (see for example Brunnermeier et al. (2016)). Bond issuances under the new "Support to Mitigate Unemployment Risk in an Emergency" (SURE) and "Next Generation EU" (NextGenEU) programmes have far exceeded historical issuances under the European Financial Stability Mechanism (EFSM) and Macro-financial Assistance programmes (MFA and MFA+). Furthermore, the European Commission has announced to switch towards a "unified funding strategy" that aims at reducing fragmentation between different EU programmes. Therefore, throughout the paper, we refer to bonds issued under any European Commission programme as Eurobonds.[10]

[9] See the press release here for more details.

[10] SURE social bonds were issued to reduce financing costs of the Union's members temporary unemployment schemes. NextGenEU bonds are issued to finance the economic recovery of member states with an emphasis on the green and digital transitions. NextGenEU bonds are linked to grants and loans disbursed via the Recovery and Resilience Facility. For details on the unified funding strategy, we refer to this press release.

Under the NextGenEU programme, the European Commission increased its issuance volumes from about EUR 0.4 bn in 2019 to almost EUR 120 bn in 2023, boosting its status from a small-scale supranational issuer to a sovereign-sized issuer. With more than EUR 400 bn of outstanding debt projected for 2023, the Eurobonds already exceeded the nominal debt of sovereigns such as Austria and the Netherlands and will soon approach Belgium. By the end of 2026, the European Commission will double this amount, reaching a total outstanding debt of about EUR 800 bn, placing itself among the key players in the euro-denominated debt worldwide. With NextGenEU, the European Commission has committed to raise 30% (e.g. EUR 250 bn) of funds via green bonds, a target that will make it the largest issuer of green bonds worldwide.

Eurobonds have received an AAA rating from all relevant credit rating agencies.[11] The AAA-rating of Eurobonds is a reflection of several layers of protections and guarantees for investors. Coupon and redemption payments are serviced by the member states's contributions to the European Commission, based on their Gross National Income (GNI). The annual contributions the EU can call from member states has been raised from 1.4% to 2.0% of Gross National Income specifically to finance repayment of NextGenEU bonds, while SURE, EFSM and MFA bonds re-payments are covered from the initial 1.4%. Additional member state safeguards are in place for specific programmes, such as SURE (e.g. an additional EUR 25 bn). Finally, the European Union can resort to active resource management, reallocating funds of its budget to honor its obligations. As a result of these guarantees, the European Union currently enjoys a better credit rating than 22 out of 27 members states.

Repo Market Our main data source is the repo segment of the money market statistical reporting (MMSR), a regulatory dataset introduced in July 2016 that contains all repo transactions with a maturity below one year, reported by banks to the Eurosystem. On the repo market, financial institutions trade securities against cash. A *borrowing* transaction refers to instances where banks obtain cash from counterparties, for example hedge funds, in exchange for a specific security. Consequently, banks obtain the security and become creditors vis-a-vis counterparties, such as pension funds in a *lending* transaction. Since the financial crisis, the euro repo market is typically characterized as a securities-driven market, rather than a cash-driven market, which reflects a scarcity of certain asset classes, specifically safe bonds. We refer to Mancini et al. (2015) and Brand et al. (2019) for an overview.

We use the German subset of the MMSR, which comprises 115 banks domiciled in Germany which are obliged to report all repo market transactions to the Deutsche Bundesbank. For every transaction, we observe tenor and repo rate, reporting agent (i.e. the bank), counterparty, transaction volume, and the bond used a collateral. We restrict our focus to overnight transactions, with overnight, tomorrow-next and spot-next tenor contracts, which account for the vast majority of repo segment's transactions.[12] We align transactions on the *settlement date*

[11] These rating agencies are Fitch, Moody's, Scope and DBRS. More details are provided by the European Commission here.

[12] In a spot-next tenor, the first leg of the contract is settled at $T+2$ and the second leg (e.g. maturity) at $T+3$. In a tomorrow-next transaction, repos are settled one day after the trade, at $T+1$ and the bond is repurchased at $T+2$. In overnight transactions, the agreement and settlement occur on the the trade date and the second leg

to address potential biases due to a mismatch in the repo tenors. Finally, we apply a simple trimming filter for the top 1% deal rates to clear our sample from high-volumes transactions.

We are exclusively interested in the repo transactions with Bunds, Eurobonds, and KfW-bonds as collateral. We obtain a list all bonds issued by these institutions since 1980 from *LSEG Refinitv*, accessed via *Eikon*. We focus on Euro-denominated bonds, since bonds in foreign currency are not eligible in the Eurosystem collateral framework. As customary in the literature, we focus on fixed coupon bonds, which account for the majority of outstanding public debt. We additionally retrieve secondary market bond yields from *LSEG Refinitv* and general information on the bonds such as maturity and issuance date and nominal value outstanding from the *Centralised Securities Database (CSDB)*.

3 Empirical Strategy

Using transaction level data from the German repo market and daily secondary market yield data, we adopt a canonical difference-in-difference strategy to identify the causal effect of the liquidity category upgrade. Finding an adequate control group for Eurobonds is a key empirical challenge. Based on the upgrade of Eurobonds from liquidity category II to category I, all bonds that remained in category I or II after the policy change are candidates for the control group. While the haircuts did not change for bonds remaining in their respective category, they nevertheless might experience indirect effects from the policy change. Specifically, liquidity category I incumbents might face more competition from Eurobonds on the safe asset market, which might induce an upward bias in the coefficient. Since the outstanding amount of Eurobonds is relatively modest, compared to the amount of outstanding Bunds, we argue that such a bias would be small. We nevertheless use liquidity category II remainders as an alternative control group. By a similar argument, bonds issued by category II remainders might in larger demand after the shock, especially if there is strong market segmentation. Using this alternative control group might, thus, provide a more conservatively estimated effect size.[13]

Within each control group, we further refine the included bonds. First, since haircuts are conditional on ratings *within liquidity categories*, all issuers not rated AAA can effectively be discarded in both control groups. Even though all bonds rated A- or higher receive the same haircut, a rigorous exclusion of bonds rated AA+ or lower provides the most adequate control group, since the likelihood of rating downgrades in the future is arguably smallest for AAA-rated bonds. All other euro area bonds rated AAA (Austria, Finland, Luxembourg, Netherlands) can be excluded from the control group based on size concerns.[14]

Regarding the alternative control group of liquidity category II remainders, we do not include local and regional government bonds due to lack of market depth and repo market activity. A second important asset class within liquidity category II are covered bonds. While these are

is settled at $T + 1$

[13] An alternative interpretation of such a strategy is pursued in Harpedanne de Belleville (2023): under a monotonicity assumption of the bias in the vicinity of the treatment, using both control groups separately provides bounds on the effect size.

[14] The role of size for the determination of the safe asset status is discussed in He et al. (2019).

arguably very safe, they are usually not issued by public entities, rendering them an ill-suited control group. Agency debt has traditionally been proposed as comparable to sovereign debt in terms of credit risk. In order to be conservative in our control group choice, we drop bonds issued by the *Agence Française de Développement* and the *Cassa Depositi e Prestiti*, the French and Italian development banks, respectively, since they are not rated AAA. The *European Investment Bank* and the *European Bank for Reconstruction and Development* are supranational agencies rated AAA, but their liabilities are not backed by a central government, such that we are left with bonds issued by the *Kreditanstalt für Wiederaufbau* (KfW), which are guaranteed by the German government and can, thus, reasonably assumed to have the same credit risk as the Bund and Eurobonds.

Aggregate Data We aggregate all repo market *borrowing rates* into a daily (volume-weighted) repo rate for Eurobonds (r_t^{EU}) and Bunds (r_t^{DE}) and run the following simple specification

$$r_t^{EU} - r_t^{DE} = \beta_0 + \beta_1 Post_t + \epsilon_t \tag{1}$$

In the baseline specification, $Post_t$ indicates the period after the liquidity upgrade's implementation (June-30, 2023). In Section 5.3, we study announcement effects by changing the $Post_t$ indicator to the period after December-20, 2022 and restricting the sample to the period before June-30, 2023. In either case, we use the period from April-01, 2022 until December-20, 2022 as pre-event window. Standard errors are robust to autocorrelation and heteroskedasticity. Since haircuts also depend on the remaining maturity and there is also comprehensive evidence for market segmentation across bond maturities, it is natural to investigate whether the effects are particularly pronounced at specific maturities. Therefore, we compute repo rates for three *maturity buckets*: short (<5 years), medium (5-10 years), and long (>10 years). We also run the same simple specification on secondary market yields, both using a full sample and a decomposition into maturity buckets. Consistent with our approach at the repo market, we first aggregate all outstanding bonds on each day and compute a Eurobond-Bund secondary market spread.

Transaction Level Data Since aggregating repo rates into daily averages omits potentially relevant drivers of repo rates, such as bond, bank and counterparty characteristics, we provide a more granular analysis that makes full use of our transaction-level dataset. Specifically, we estimate

$$r_{t,i,j,k} = \beta_0 + \beta_1 Post_t \times EU_k + maturity_k \times \tau_t + \epsilon_{t,i,j,k} \ , \tag{2}$$

where $r_{t,i,j,k}$ is the repo rate at day t paid by bank i to counterparty j when bond k is used as collateral. As before, $Post_t$ indicates the post-implementation window after June-30, 2023 for the baseline specification. We also test for announcement effects, where $Post_t$ indicates the post-announcement window after December-20, 2022. The treatment indicator EU_k equals one if bond k is an Eurobond. Our baseline specification uses date × maturity fixed effects to take the potentially time-varying term structure of interest rates into account. We assign bonds into three maturity buckets (short, medium, long), based on the bond's time to maturity at date t. Specifically, we define the same maturity buckets on which our decomposition of aggregate effects is based: $maturity_k \in \{< 5; 5-10; > 10\}$. Implicitly, we assume that three maturity buckets are sufficient to capture term-structure effects and that bonds are sufficiently substitutable within each bucket as far as the repo market is concerned.

In a more stringent specification, we use date and bond fixed effects instead of maturity × date fixed effects:

$$r_{t,i,j,k} = \beta_0 + \beta_1 Post_t \times EU_k + \kappa_k + \chi_i \times \gamma_j + \chi_i \times \tau_t + \epsilon_{t,i,j,k} \ , \qquad (3)$$

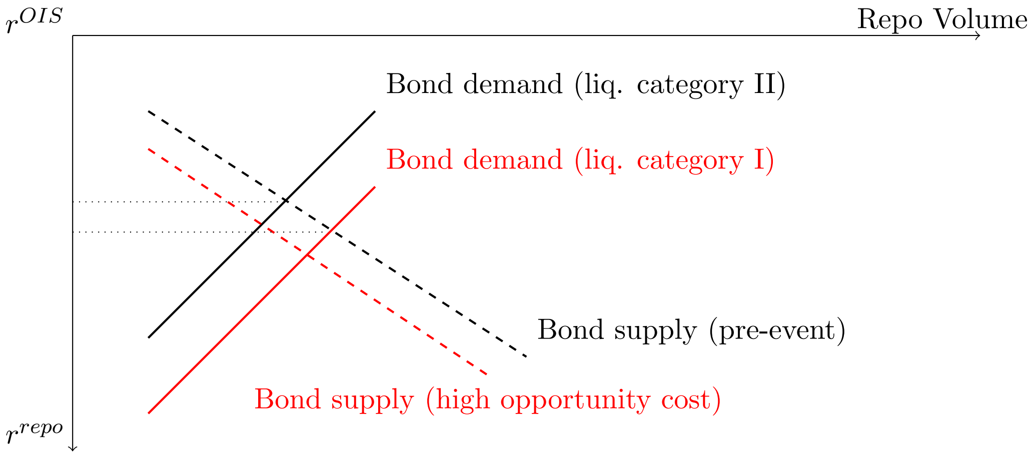
Here, date fixed effects capture time variation in the demand for safe assets. Using bond fixed effects is consistent with the market microstructure literature and, among other things, captures a particularly small issuance volume of a specific ISIN, such that this bond is more likely to be scarce on the repo market. Bond fixed effects also take into account that floating rate bonds receive different haircuts than fixed coupon bonds in the Eurosystem collateral framework. We also use bank × counterparty fixed effects to take relationship effects into account.

We can exploit the granularity of our dataset to shed light on demand and supply-specific drivers of the repo market effects. Theory does not give unambiguous guidance whether the re-assignment of Eurobonds is a bond demand or supply shock on the repo market. In Figure 1, we show a stylized representation of the repo market equilibrium. The black dashed line indicates banks' bond supply, which is closely related to the repo volume on the x-axis and increases if the repo rate is low, ceteris paribus. In a borrowing transaction, the repo rate reflects banks' refinancing conditions. Banks face higher opportunity cost if they supply Eurobonds to the private repo market after the policy change, since they can use them in Eurosystem facilities at favorable conditions (see also the model of collateral choice proposed in Cassola and Koulischer (2019)). This shifts the supply curve down and left, reflected in the dashed red line. If bond supply factors dominate, repo rates and volumes should decrease.

In addition to changing banks' opportunity cost, the re-assignment also changes the pool of potential counterparties. The solid black line reflects counterparties' bond demand curve prior to the policy change. If liquidity category I assets are scarce, the re-assignment might imply that banks easily find counterparties to borrow from in exchange for supplying Eurobonds. This is indicated by the solid red line, which is shifted down and right. Such a bond demand-shock induces repo rates to drop while, at the same time, implies that repo volumes increase.

We test this by using either bank × date fixed effects $\chi_i \times \tau_t$ which controls for bank-specific bond supply factors. For example, some banks might be strongly affected by the liquidity upgrade Similarly, we use counterparty × date fixed effects $\gamma_j \times \tau_t$ instead, which controls for counterparty-specific bond demand factors. In both cases, we use maturity × date fixed effects to absorb variation stemming from time variation in the term structure of interest rates.

Figure 1: Repo Market Equilibrium, Borrowing Rates



Bond Level For secondary market yield data, we estimate

$$y_{t,k} = \beta_0 + \beta_1 Post_t \times EU_k + maturity_k \times \tau_t + \epsilon_{t,k} \; , \tag{4}$$

at the bond level, which contains the same maturity × date fixed effects as our baseline specification for the repo market (2). Alternatively, we use bond and time fixed effects, which is in line with our second repo market specification (3). Different to the repo market however, there is no need for daily aggregation at the bond level, since we are naturally left with one observation per ISIN and date. This places some limitations of the possibility to absorb demand and supply specific variation. Furthermore, we re-estimate the same specifications using bid-ask spreads as the most common measure of secondary market liquidity as dependent variable.

4 Baseline Results

Our main results are presented in three steps. First, we establish that the liquidity upgrade had substantial effects on the repo and secondary market using aggregated data and document how they are distributed across bond maturities. In a second step, we show that these effects are also present when retaining the full granularity of our dataset, which allows us to control for bond-, bank-, and counterparty-specific factors. In a third step, we demonstrate that the repo market effects can be traced to secondary market yields *at the bond level.*

4.1 Daily Aggregates

The results of estimating (1) across all bonds are shown in Section 4.1. Panel A collects the repo market results. The first column suggests that the repo market spread between Eurobonds and German government bonds declined by 60bps after the liquidity category upgrade. Given a full sample average repo rate of 125bps and a full sample Bund yield of 250bps, the effects are economically relevant. Re-estimating Equation (1) for three different maturity buckets in column (2)-(4) reveals that the strongest effect can be found at the short end, i.e. for maturities below five years. At around 112bps, the effect at the short end is almost three times the size of the effect at the medium and long ends. This result is consistent with the term structure of "reserve convertibility premia" discussed in Nyborg and Woschitz (2023).

Table 2: Daily Aggregates: Eurobond-Bund Spread

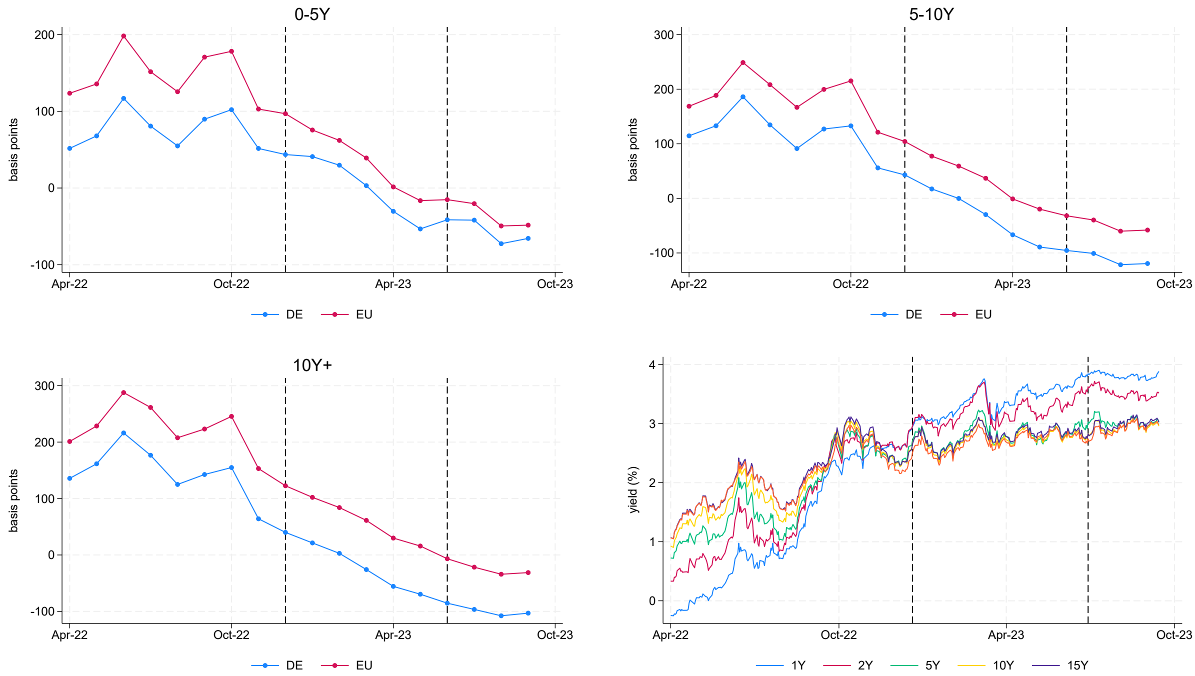
Panel A: Repo Market	(1) Full Sample	(2) $< 5y$	(3) $5 - 10y$	(4) $> 10y$
$Post_t$	-59.52***	-112.47***	-47.31***	-51.51***
	(-40.85)	(-32.77)	(-40.88)	(-25.41)
Constant	Yes	Yes	Yes	Yes
R-squared	0.823	0.886	0.757	0.751
Observations	244	244	244	244
Cluster SE	Date	Date	Date	Date

Panel B: Secondary Market	(1) Full Sample	(2) $< 5y$	(3) $5 - 10y$	(4) $> 10y$
$Post_t$	-43.66***	-47.88***	-5.96***	-5.40***
	(-44.43)	(-44.24)	(-7.64)	(-7.13)
Constant	Yes	Yes	Yes	Yes
R-squared	0.732	0.745	0.0708	0.0649
Observations	246	246	246	246
Cluster SE	Date	Date	Date	Date

The table shows coefficients of the regression of Eurobond-Bund spreads for repo rates and secondary market yields on the implementation dummy, see Equation (1). When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. Data source for secondary market: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Panel B reveals that there is a substantial pass-through to secondary market yields. Column (1) reveals 44bps decrease of the secondary market yield spread after implementation. The magnitude of the coefficient implies a substantial pass-through (72%) of the liquidity upgrade for the full sample. In line with the results for the repo market, the effects are concentrated at the short-end, see column (2)-(4) in Panel B of Section 4.1.

Figure 2: Yield Spreads by Remaining Maturity and Term Structure over Time



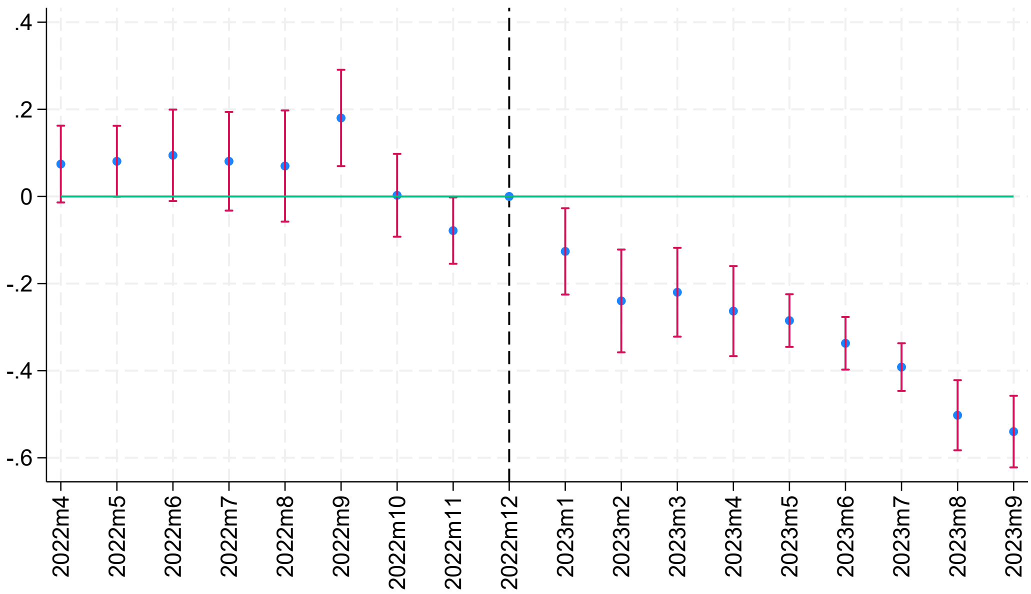
Notes: The upper left, upper right, and lower left panel show monthly average bond yield spreads of Eurobonds (red) and German government bonds (blue) for the short, medium and long maturity bucket. The spread is computed with respect to the ECB's deposit facility rate. In the lower right panel, we show the risk-free rate as measured by overnight index swaps for different maturities. The announcement and implementation dates are inidicated by vertical dashed lines. Data Source: LSEG.

In Figure 2, we visually inspect the effects of the liquidity upgrade on secondary market bond yields. Since our sample covers a period of rapidly increasing interest rates, we compute the spread relative to the deposit facility rate, which is the relevant policy rate as far as repo market participants are concerned. The downward trend across all maturities reflects the yield curve inversion displayed in the lower right panel. The upper left panel, which contains the average spread of bonds with a maturity of less than five years, indicates a substantial, economically relevant compression of the Eurobond-Bund spread, while the effect on medium and long maturity bonds is comparatively small.

4.2 Repo Market: Transaction Level

As a next step, we demonstrate that the effects of the liquidity upgrade on repo rates are also present at the transaction level. In Figure 3, we plot the time-varying effect of the liquidity upgrade, relative to December 2022, the last month prior to the announcement. We use the full sample and control for maturity-bucket × month fixed effects. Consistent with the baseline specification, we cluster standard errors at the maturity-bucket × month level. The coefficient on the treatment indicator is insignificant in most months prior to the liquidity category upgrade. A notable exception is September 2022, which contained the UK gilt crisis. It is reasonable to expect a decrease of Bund repo rates (the control group) during such a flight to safety event, such that the treatment indicator is significantly positive in that month.

Figure 3: Parallel Trend Assumption



Notes: This figure displays the results of estimating

$$\log(y_{ijt}) = \sum_{\tau \neq Dec2022} \beta_\tau \mathrm{EU}_k \times \mathbf{1}\{\tau = t\} + maturity_k \times \tau_t + \epsilon_{t,i,j,k} \ ,$$

where $\mathbf{1}\{\tau = t\}$ is a dummy variable that equals one in month t and 0 otherwise. We exclude December 2022 as the reference month. The red bars represent 95% confidence intervals, standard errors are clustered at the maturity-bucket × date level.

Column (1) of Table 3 displays the result of estimating Equation (2). The coefficient on the $Post_t \times EU_k$ interaction is in line with the aggregate results: the liquidity upgrade of Eurobonds decreased their borrowing costs relative to untreated Bunds by 50bps. Column (2) demonstrates that replacing the maturity bucket × date fixed effects with a more stringent combination of date and bond fixed effects even increases the coefficient size. As column (3) shows, relationship-specific effects seem to be less important: adding bank × counterparty fixed effects changes the coefficient on the $Post_t \times EU_k$ interaction by less than one basis point.

We exploit the granularity of our dataset to provide a decomposition into bond demand and bond supply effects in column (4) and (5) of Table 3. When absorbing counterparty-specific bond demand factors with counterparty × date fixed effects, the effect size declines to -17bps, which is still highly significant but much smaller than the baseline. With banks × date fixed effects, the coefficient in column (5) increases to -56bps, which even exceeds the baseline value. Since the coefficient size is much larger when absorbing bank-specific bond supply characteristics, we can attribute most of the effect to bond demand.

In Table 4, we provide a decomposition of the effect by maturity bucket. Columns (1)-(3) show that the effects are particularly large in the short maturity bucket, consistent with the aggregate

Table 3: Transaction Level: Baseline

	(1)	(2)	(3)	(4)	(5)
$Post_t \times EU_k$	-49.84***	-63.19***	-61.81***	-17.22***	-56.20***
	(-51.03)	(-4.71)	(-4.67)	(-17.35)	(-53.05)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	No	No
Bank x Counterparty FE	No	No	Yes	No	No
Date FE	No	Yes	Yes	No	No
Maturity x Date FE	Yes	No	No	Yes	Yes
Bank x Date FE	No	No	No	No	Yes
Counterparty x Date FE	No	No	No	Yes	No
R-squared	0.974	0.979	0.984	0.983	0.976
Observations	336,567	336,567	336,545	334,459	336,400
Cluster SE	Mat x Date	Bond	Bond	Mat x Date	Mat x Date

Notes: The table shows coefficients of the regression of borrowing repo rates on treatament indicator EU_k for the implementation window $Post_t$, using German government bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Transaction Level: Maturity and Segment Decomposition

	(1)	(2)	(3)	(4)	(5)	(6)
	$< 5y$	$5 - 10y$	$> 10y$	Bilateral	Bilateral	Bilateral
$Post_t \times EU_k$	-69.65***	-52.17***	-50.24***	-58.50***	-70.53***	-71.89***
	(-2.90)	(-2.81)	(-2.89)	(-51.42)	(-4.89)	(-4.90)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	Yes	Yes	Yes	No	Yes	Yes
Bank x Counterparty FE	No	No	No	No	No	Yes
Date FE	Yes	Yes	Yes	No	Yes	Yes
Maturity $\times$ Date FE	No	No	No	Yes	No	No
R-squared	0.981	0.979	0.971	0.952	0.960	0.970
Observations	197,664	156,554	138,092	147,829	147,829	147,807
Cluster SE	Bond	Bond	Bond	Mat$\times$Date	Bond	Bond

Notes: The table shows coefficients of the regression of borrowing repo rates on treatament indicator EU_k for the implementation window $Post_t$, using German government bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

results in Section 4.1. Relative to the Bund, the repo rate declines by 70bps for Eurobonds with a maturity of less than five years, compared to a 50bps decline in the full sample. Column (4)-(6) of Table 4 show that using only bilateral repos yields larger effects than the baseline results: using maturity × date fixed effects, the coefficient of interest increases from -50bps to -59bps. Similarly, the effect size is around 10bps larger when using bond and bank × counterparty fixed effects. This is consistent with bargaining power on the bond supply side (see also Eisenschmidt et al., 2022).

Table 5: Transaction Level: Volumes

	(1)	(2)	(3)
$Post_t \times EU_k$	2.08***	3.42**	0.81
	(3.95)	(2.41)	(0.72)
Constant	Yes	Yes	Yes
Bond FE	No	Yes	Yes
Bank x Counterparty FE	No	No	Yes
Date FE	No	Yes	Yes
Maturity x Date FE	Yes	No	No
R-squared	0.0448	0.0847	0.190
Observations	336,553	336,553	336,530
Cluster SE	Mat × Date	Bond	Bond

Notes: The table shows coefficients of the regression of repo transaction volumes on treatament indicator EU_k for the implementation window $Post_t$, using German government bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All results in EUR millions.

Table 5 presents the results of using repo volumes as dependent variable. We keep the same fixed effect structure as in the regressions of repo rates and find that the daily repo volume exhibits an increase by around EUR 2 millions, depending on the specification. These results are economically meaningful, given that the average trade volume is around EUR 20 millions over the full sample.

In unreported results, we exclude observations before July-8, 2022 from the pre-event window. On this date, the collateral framework's revisions - in particular an increase of 10% in the haircut across all assets - announced in April 2022, was implemented.[15] We also ensure that excluding green bonds issued within the NextGenEU programme does not change our results. The green bond market has experienced a remarkable boom during the last years, which might bias our results. Indeed, the Eurosystem has implemented or announced several modifications to its collateral framework as far as sustainability-linked and green bonds are concerned.[16] Similarly, we perform a robustness check by excluding 18 German government bonds which have been subject to special measures by the German debt management office (*Deutsche Fiananzagentur*) in October 2022. These measures include a reverse repo facility in order to enhance market

[15]See the discussion in Section 2 and the press release here for more details.
[16]See the press release here for more details.

functioning, which could affect demand for some bonds in our control group.[17] All regression results are available upon request.

4.3 Secondary Market: Bond Level

In this section, we document that the liquidity upgrade exhibits a substantial transmission from repo market rates to secondary market yields on Eurobonds and German government bonds. Consistent with the results based on daily aggregates (Panel B of Section 4.1), the strongest results can again be found at the short end (-36bps), while the full sample effect is -21bps.

Table 6: Bond Level: Yields

	(1)	(2)	(3) 0-5	(4) 5-10	(5) 10+
$Post_t \times EU_k$	-21.47***	-35.93***	-39.05***	-6.85**	-6.90***
	(-11.36)	(-4.30)	(-4.16)	(-2.20)	(-4.43)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	Yes	Yes
Date FE	No	Yes	Yes	Yes	Yes
Maturity x Date FE	Yes	No	No	No	No
R-squared	0.897	0.888	0.910	0.987	0.983
Observations	32,693	32,693	17,708	15,622	16,023
Cluster SE	Mat x Date	Bond	Bond	Bond	Bond

Notes: The table shows coefficients of the regression of bond yields on treatament indicator EU_k for the implementation window $Post_t$ using German government bonds as control group, see eq. (4). When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. Data source: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Re-estimating (4) with bid-ask spreads as dependent variable indicates that the liquidity upgrade in the Eurosystem collateral framework as also positive effects on secondary market liquidity. As Table 7 shows, they decline by 1 to 2bps, which is statistically significant and comparatively large, since government bonds usually trade at very low bid-ask spreads.

The reduction in secondary market yields is also relevant at a macroeconomic level. Based on the Eurobonds's total nominal amount outstanding of approximately EUR 320 bn in November 2022 and a monthly yield of 2.7%, the liquidity upgrade shock relieved financing costs of the European Union by approximately EUR 1.6 bn in interest payments ($320 \times 0.027 - 320 \times 0.022$) every year.

In Figure 4, we provide further suggestive evidence for real implications of the liquidity upgrade. Specifically, we provide a maturity decomposition of the nominal outstanding amount of Eurobonds and German government bonds. We use the same maturity buckets as in the baseline specification and further decompose the short end into bonds with a maturity smaller than two years and into bonds with 2-5 years to maturity. The maturity composition is remarkably stable for German government bonds and at most experiences a slight decline in the short segment

[17] See the press release here for more details.

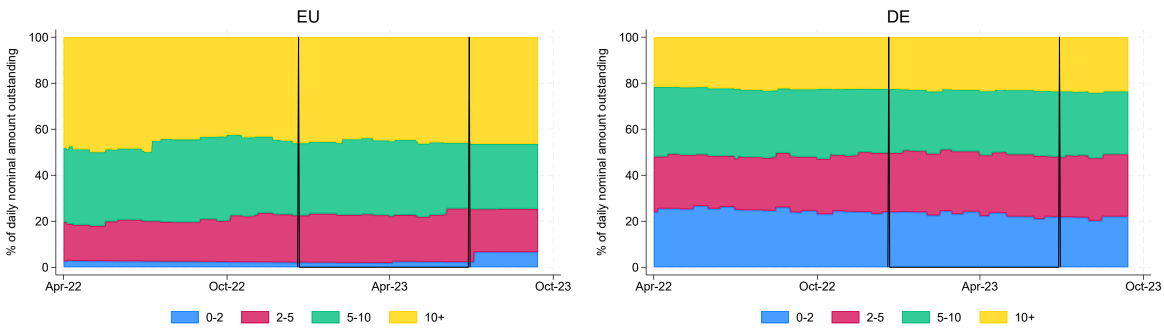
Table 7: Bond Level: Bid-Ask Spreads

	(1)	(2)
$Post_t \times EU_k$	-0.90*	-2.12**
	(-1.96)	(-2.03)
Constant	Yes	Yes
Bond FE	No	Yes
Date FE	No	Yes
Maturity x Date FE	Yes	No
R-squared	0.204	0.860
Observations	33,384	33,384
Cluster SE	Mat x Date	Bond

Notes: The table shows coefficients of the regression of bond bid-ask spread on treatament indicator EU_k for the implementation window $Post_t$ using German government bonds as control group, see eq. (4). When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from April-1, 2022 to September-14, 2023. Data source: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

(<2 years). This is again consistent with the inverted yield curve: financing costs are very high when using short-term bonds. In contrast, we see an increase in short-term Eurobond issuance - especially in the 0-2 years maturity bucket - within two weeks after the implementation.

Figure 4: Nominal Amount Outstanding by Remaining Maturity



5 Robustness and Further Results

In this section, we provide a series of robustness tests for our baseline results. First, we show that using a different control group, KfW-Bonds, implies similar effects of the liquidity upgrade, although of a smaller size. Furthermore, our results are slightly stronger when restricting the sample to bilateral repo rates, and are also present in lending rates. Lastly, we demonstrate that a large share of the effect on repo and secondary market yields could already be observed upon announcement.

5.1 KfW-Bonds as Control

In this section, we re-estimate our baseline specification table 3 using bonds issued by the *Kreditanstalt für Wiederaufbau* (KfW) as control group, which remained in liquidity category II throughout the sample period. As Table 8 shows, the liquidity upgrade still has a negative effect on Eurobond repo rates, relative to KfW repo rates, but is slightly smaller (-42bps) than the baseline (-50bps). They are robust to including bond and relationship fixed effects and also point towards strong bond demand factors: when counterparty $\times$ date fixed effects are included to absorb counterparty-specific demand, the coefficient declines to 6bps, while it exceeds the baseline value when including bank $\times$ date fixed effects.

Table 8: Repo Transaction Level: KfW-Bonds as Control

	(1)	(2)	(3)	(4)	(5)
$Post_t \times EU_k$	-42.43***	-29.33**	-23.91*	-6.26***	-47.49***
	(-48.29)	(-2.19)	(-1.94)	(-14.97)	(-56.89)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	No	No
Bank x Counterparty FE	No	No	Yes	No	No
Date FE	No	Yes	Yes	No	No
Maturity x Date FE	Yes	No	No	Yes	Yes
Bank x Date FE	No	No	No	No	Yes
Counterparty x Date FE	No	No	No	Yes	No
R-squared	0.960	0.967	0.975	0.976	0.966
Observations	165,271	165,270	165,252	163,091	165,055
Cluster SE	Mat x Date	Bond	Bond	Mat x Date	Mat x Date

Notes: The table shows coefficients of the regression of borrowing repo rates on treatament indicator EU_k for the implementation window $Post_t$, using *Kreditanstalt für Wiederaufbau* (KFW) bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from of April-01, 2022 to September-14, 2023. All results in basis points. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

We also run bond-level regression for the secondary market with KfW bonds as a control group, complementing Table 6. The coefficients Section 5.1 are largely in line with table 6 and are again most pronounced at the short maturity bucket.

5.2 Lending Rates

Most of our results are based on repo borrowing rates, i.e. transactions where banks are *cash borrowers*. In a lending transaction, banks extend funding to a counterparty against collateral. Banks' effective bargaining power is arguably smaller in such a transaction: if the counterparty is a buy-and-hold investor (e.g. a pension fund) supplying bonds to the repo market rather than a short-seller (e.g. a hedge fund) demanding bonds in the repo market, the trade-specific profits are less specific to a particular bond. We therefore, first, expect effects to be generally smaller for lending rates and, second, expect counterparty $\times$ date fixed effects to be less relevant for the effect size.

Table 9: Bond Level: KfW-Bonds as Control

	(1) Full	(2) Full	(3) $< 5y$	(4) $5 - 10y$	(5) $> 10y$
$Post_t \times EU_k$	-25.93***	-19.42***	-35.50***	-2.14	-8.09*
	(-17.56)	(-2.91)	(-3.27)	(-0.44)	(-1.76)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	Yes	Yes
Date FE	No	Yes	Yes	Yes	Yes
Maturity x Date FE	Yes	No	No	No	No
R-squared	0.602	0.628	0.613	0.453	0.453
Observations	58,088	58,088	29,418	25,751	34,899
Cluster SE	Mat x Date	Bond	Bond	Bond	Bond

Notes: The table shows coefficients of the regression of bond yields on treatament indicator EU_k for the implementation window $Post_t$, using *Kreditanstalt für Wiederaufbau* (KFW) bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from of April-01, 2022 to September-14, 2023. Data source: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Transaction Level: Lending Rates

	(1)	(2)	(3)	(4)	(5)
$Post_t \times EU_k$	-35.72***	-40.35***	-29.91***	-30.58***	-27.03***
	(-30.09)	(-7.37)	(-5.00)	(-25.93)	(-20.23)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	No	No
Bank x Counterparty FE	No	No	Yes	No	No
Date FE	No	Yes	Yes	No	No
Maturity x Date FE	Yes	No	No	Yes	Yes
Bank x Date FE	No	No	No	No	Yes
Counterparty x Date FE	No	No	No	Yes	No
R-squared	0.991	0.993	0.995	0.993	0.992
Observations	349,492	349,491	349,473	346,199	349,341
Cluster SE	Mat x Date	Bond	Bond	Mat x Date	Mat x Date

Notes: The table shows coefficients of the regression of lending repo rates on treatament indicator EU_k for the implementation window $Post_t$, using German government bonds as control group. When bond fixed effects are not included, the coefficient on the treated indicator EU_k is omitted to enhance readability. The sample period runs from of April-01 2022 to September-14 2023. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Section 5.2 shows that the baseline effects are robust to using lending rates, irrespective of using maturity × date fixed effects or bond and date fixed effects. Compared to the baseline effect (-50bps) using borrowing rates, the effect is about one third smaller (-36bps). Importantly, including counterparty × date fixed effects yields and bank × date fixed effects yields similar coefficient estimates, see columns (4) and (5), which is consistent with a generally smaller importance of bond-specific demand factors. In both cases, the coefficient is smaller than in the baseline specification. This sharply contrasts to the case of borrowing rates, where most of the variation could be explained by counterparty-specific factors.

5.3 Announcement Effects

In our baseline specification, we use the sub-sample after July-4, 2023 as treatment window. In this section, we run the same specifications for daily aggregates, transaction level data from the repo market and bond level data from the secondary market, but restricting the post-event window to the sub-sample from December-20, 2022 to June-30, 2023. By choosing these treatment and cutoff dates, we capture the period between announcement and implementation of the liquidity upgrade.

Table 11 reveals that slightly more than half of the total effect can be attributed to the announcement. For the full sample in column (1), approximately 60% of the total effect can be attributed to the announcement: the coefficient decreases from -60bps (see Section 4.1) to -35bps. At the short end, the announcement effect is slightly less pronounced but of a similar order of magnitude.

Furthermore, when compared to Section 4.1 around 72% of the total effect (-44bps) of the liquidity upgrade can be attributed to the announcement (-31bps). This share is similar to the relevance of the announcement effects for repo rates.

Table 12 provides supplementary results on announcement effects at the transaction level. Throughout all specifications, the coefficient of interest is negative and significant, but around a half smaller than the baseline results using the post-implementation window (Table 3). Notably, the decomposition in demand and supply factors (columns 4 and 5) is also present at the announcement level. In unreported results, we also verify that short maturity repo rates are also more responsive to the announcement.

Lastly, Table 13 shows that there are also positive announcement effects at the bond level. While they are generally in line with the announcement effect on the repo market, they are again most pronounced at the short end. Here, Eurobond yields decline by 14bps, compared to a total effect of -21bps.

6 Conclusion

In this paper, we have demonstrated that repo markets play a crucial role in the manufacturing of safe assets. To overcome endogeneity problems regarding repo market activity and the safety and liquidity attributes of government bonds, we exploit a liquidity upgrade of Eurobonds in the

Table 11: Daily Aggregates: Eurobond-Bund Spread, Announcement

Panel A: Repo Market

	(1) Full Sample	(2) $< 5y$	(3) $5 - 10y$	(4) $> 10y$
$Post_t$	-35.20***	-54.67***	-36.43***	-25.32***
	(-29.33)	(-29.08)	(-32.67)	(-19.87)
Constant	Yes	Yes	Yes	Yes
R-squared	0.723	0.756	0.751	0.551
Observations	316	316	316	316
Cluster SE	Date	Date	Date	Date

Panel B: Secondary Market

	(1) Full Sample	(2) $< 5y$	(3) $5 - 10y$	(4) $> 10y$
$Post_t$	-31.52***	-35.11***	-3.39***	3.81***
	(-30.81)	(-31.15)	(-3.79)	(4.57)
Constant	Yes	Yes	Yes	Yes
R-squared	0.717	0.725	0.0362	0.0511
Observations	323	323	323	323
Cluster SE	Date	Date	Date	Date

Notes: The table shows coefficients of the regression of Eurobond-Bund Yield Spread on announcement dummy, see eq. (4). The sample period runs from 1^{st} of April 2022 to the 14^{th} of September 2023. Data source for secondary market: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Transaction Level: Announcement

	(1)	(2)	(3)	(4)	(5)
$Post_t \times EU_k$	-28.41***	-38.09***	-39.71***	-14.75***	-35.61***
	(-33.17)	(-5.98)	(-6.98)	(-21.53)	(-38.51)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	No	No
Bank x Counterparty FE	No	No	Yes	No	No
Date FE	No	Yes	Yes	No	No
Maturity x Date FE	Yes	No	No	Yes	Yes
Bank x Date FE	No	No	No	No	Yes
Counterparty x Date FE	No	No	No	Yes	No
R-squared	0.970	0.975	0.983	0.981	0.972
Observations	459,240	459,240	459,215	456,417	459,012
Cluster SE	Mat x Date	Bond	Bond	Mat x Date	Mat x Date

Notes: The table shows coefficients of the regression of borrowing repo rates on treatement indicator EU_k for the announcement window $Post_t$, using German government bonds as control group. The sample period runs from 1^{st} of April 2022 to the 14^{th} of September 2023. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: Bond Level: Announcement, Maturity Decomposition

	(1)	(2)	(3) 0-5	(4) 5-10	(5) 10+
$Post_t \times EU_k$	-13.59***	-28.00***	-32.52***	-4.82**	-0.85
	(-11.65)	(-4.35)	(-4.36)	(-2.14)	(-0.44)
Constant	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	Yes	Yes	Yes
Date FE	No	Yes	Yes	Yes	Yes
Maturity x Date FE	Yes	No	No	No	No
R-squared	0.897	0.884	0.873	0.993	0.990
Observations	43,199	43,199	16,876	12,296	14,027
Cluster SE	Mat x Date	Bond	Bond	Bond	Bond

Notes: The table shows coefficients of the regression of bond yields on treatament indicator EU_k for the announcement window $Post_t$ using German government bonds as control group, see eq. (4). The sample period runs from 1^{st} of April 2022 to the 14^{th} of September 2023. Data source: LSEG. All results in basis points. t-statistics in parentheses. Significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Eurosystem collateral framework that is arguably unrelated to the fundamentals of Eurobonds. Using a transaction-level dataset from the German repo market, we show that the liquidity upgrade substantially reduces the repo rate on Eurobonds, relative to a control group of German central government bonds or AAA-rated agency bonds. These effects are economically large, are also present in repo volumes, and exhibit a large pass-through to secondary market yields and bid-ask spreads. Exploiting the granularity of our dataset, we demonstrate that most of the variation can be attributed to bond demand factors on the repo market, which is consistent with theories of market segmentation. The effects are particularly pronounced at the short end, pointing to a relative scarcity of short-term government bonds during a period of inverted yield curves. We also provide suggestive evidence for fiscal policy implications: the issuance of short-term Eurobonds picked up markedly after the liquidity upgrade. Taken together, our analysis suggests that the repo market plays a crucial role in the manufacturing of safe assets and has real implications for bond markets and, subsequently, for fiscal policy. In the context of Eurobonds, our result lend support to the European Commission's plan to introduce a Eurobonds repo facility by 2024, which can be expected to strengthen Eurobonds' safe asset status.

References

Adler, Martin et al. (2023). "The valuation haircuts applied to eligible marketable assets for ECB credit operations." *ECB Occasional Paper* (312).

Arrata, William, Benoît Nguyen, Imène Rahmouni-Rousseau, and Miklos Vari (2020). "The Scarcity Effect of QE on Repo Rates: Evidence from the Euro Area." *Journal of Financial Economics* 137(3), 837–856.

Beber, Alessandro, Michael Brandt, and Kenneth Kavajecz (2009). "Flight-to-Quality or Flight-to-Liquidity." *Review of Financial Studies* 22(3), 925–957.

Benigno, Pierpaolo, and Salvatore Nisticò (2017). "Safe Assets, Liquidity, and Monetary Policy." *American Economic Journal: Macroeconomics* 9(2), 182–227.

Bindseil, Ulrich, Macro Corsi, Benjamin Sahel, and Ad Vissser (2017). "The Eurosystem Collateral Framework Explained." *ECB Occasional Paper Series.*

Bindseil, Ulrich, Kjell Nyborg, and Ilya Strebulaev (2009). "Repo Auctions and the Market for Liqudity." *Journal of Money, Credit and Banking* 41(7), 1391–1421.

Bletzinger, Tilman, William Greif, and Bernd Schwaab (2022). "Can EU Bonds Serve as Euro-Denominated Safe Asset?" ECB Working Paper 2712.

Brand, Claus, Lorenzo Ferrante, and Antoine Hubert (2019). "From Cash- to Securities-Driven Euro Area Repo Markets: The Role of Financial Stress and Safe Asset Scarcity." ECB Working Paper 2232.

Brunnermeier, Markus K. et al. (2016). "The Sovereign-Bank Diabolic Loop and ESBies." *American Economic Review* 106(5), 508–512.

Cassola, Nuno, and François Koulischer (2019). "The Collateral Channel of Open Market Operations." *Journal of Financial Stability* 41, 73–90.

Chen, Hui, Zhuo Chen, Zhiguo He, Jinyu Liu, and Rengming Xie (2022). "Pledgeability and Asset Prices: Evidence from the Chinese Corporate Bond Markets." *Journal of Finance, Forthcoming.*

Corradin, Stefano, and Angela Maddaloni (2020). "The Importance of Being Special: Repo Markets during the Crisis." *Journal of Financial Economics* 137(2), 392–429.

D'Amico, Stefania, Roger Fan, and Yuriy Kitsul (2018). "The Scarcity Value of Treasury Collateral: Repo-Market Effects of Security-Specific Supply and Demand Factors." *Journal of Financial and Quantitative Analysis* 53(5), 2103–2129.

D'Amico, Stefania, and N Aaron Pancost (2021). "Special Repo Rates and the Cross-Section of Bond Prices: The Role of the Special Collateral Risk Premium." *Review of Finance* 26(1), 117–162.

Doerr, Sebastian, Egemen Eren, and Semyon Malamud (2023). "Money Market Funds and the Pricing of Near-Money Assets." mimeo.

Droste, Michael, Yuriy Gorodnichenko, and Walker Ray (2023). "Unbundling Quantitative Easing: Taking a Cue from Treasury Auctions." Working Paper.

Dufour, Alfonso, Miriam Marra, Ivan Sangiorgi, and Frank S. Skinner (2020). "Explaining Repo Specialness." *International Journal of Finance and Economics* 25(2), 172–196.

Eisenbach, Thomas, and Gregory Phelan (2023). "Fragility of Safe Asset Markets." Working Paper.

Eisenschmidt, Jens, Yiming Ma, and Anthony Zhang (2022). "Monetary Policy Transmission in Segmented Markets." ECB Working Paper 2706.

Greenwood, Robin, Samuel Hanson, and Jeremy Stein (2015). "A Comparative Advantage Approach to Government Debt Maturity." *Journal of Finance* 70(4), 1683–1722.

Harpedanne de Belleville, Louis-Marie (2023). "Real Effects of Central Bank Collateral Policy: Liquidity Insurance at Work." mimeo.

He, Zhiguo, Arvind Krishnamurthy, and Konstantin Milbradt (2019). "A Model of Safe Asset Determination." *American Economic Review* 109(4), 1230–1262.

Hüttl, Pia, and Matthias Kaldorf (2023). "The Transmission of Bank Liquidity Shocks: Evidence from the Eurosystem Collateral Framework."

Jiang, Zhengyang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Xiaolon (2021). "Bond Convenience Yields in the Eurozone Currency Union." Working Paper.

Kaldorf, Matthias, and Joost Roettger (n.d.). "Convenient but Risky Government Bonds" ().

Kaufmann, Christoph, Katharina Plessen-Matyas, and Julian von Landesberger (2023). "Funding Behavior of Debt Management Offices and the ECB's Public Sector Purchase Program." *International Journal of Central Banking* 19(4), 339–399.

Lengwiler, Yvan, and Athanasiois Orphanides (2023). "Collateral Framework: Liquidity Premia and Multiple Equilibria." *Journal of Money, Credit and Banking.*

Lou, Dong, Hongjun Yan, and Jinfan Zhang (2013). "Anticipated and Repeated Shocks in Liquid Markets." *Review of Financial Studies* 26(8), 1891–1912.

Mancini, Loriano, Angelo Ranaldo, and Jan Wrampelmeyer (2015). "The Euro Interbank Repo Market." *Review of Financial Studies* 29(7), 1747–1779.

Mésonnier, Jean-Stéphane, Charles O'Donnell, and Olivier Toutain (2021). "The Interest of Being Eligible." *Journal of Money, Credit and Banking* 54(2-3), 425–458.

Monfort, Alain, and Jean-Paul Renne (2013). "Decomposing Euro-Area Sovereign Spreads: Credit and Liquidity Risks." *Review of Finance* 18(6), 2103–2151.

Nyborg, Kjell, and Jiri Woschitz (2023). "The Price of Money: The Reserves Convertibility Premium over the Term Structure."

Pelizzon, Loriana, Max Riedel, Zorka Simon, and Marti Subrahmanyan (2023). "Collateral Eligibility of Corporate Debt in the Euro-system." *Journal of Financial Economics, Forthcoming.*

Phillot, Maxine (2023). "U.S. Treasury Auctions: A High Frequency Identification of Supply Shocks." Working Paper.

Schlepper, Kathi, Heiko Hofer, Ryan Riordan, and Andreas Schrimpf (2020). "The Market Microstructure of Central Bank Bond Purchases." *Journal of Financial and Quantitative Analysis* 55(1), 193–221.

Tischer, Johannes (2021). "Quantitative Easing, Safe Asset Scarcity and Bank Lending." Bundesbank Discussion Paper 035/2021.

Van Bekkum, Sjoerd, Marc Gabarro, and Rustom M. Irani (2018). "Does a Larger Menu Increase Appetite? Collateral Eligibility and Credit Supply." *Review of Financial Studies* 31(3), 943–979.