Safe Asset Scarcity and Monetary Policy Transmission [*]

Benoit Nguyen[†] Davide Tomio,[‡] and Miklos Vari[§]

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Abstract

Most central banks exited their decade-long accommodative monetary policy cycle by first raising rates, rather than starting by reducing their balance sheet. We show that the scarcity of government bonds—which were purchased under QE and held by central banks—reduces the transmission of rate hikes to money market rates. In July 2022, when the ECB increased its policy rates by 50bp for the first time in a decade, rates of repo transactions collateralized by the scarcest bonds increased by only 30bp. We show that this imperfect pass-through to repo rates is priced in treasury yields. Heterogeneous bond holdings across institutions imply that collateralized funding costs vary significantly across European institutions.

[†]Banque de France; Benoit.Nguyen@banque-france.fr.
[‡]University of Virginia, Darden School of Business; tomiod@darden.virginia.edu.
[§]Banque de France; Miklos.Vari@banque-france.fr.

1 Introduction

The Eurosystem's outright holdings of euro area sovereign bonds currently amount to more than a third of the outstanding market (...) As a result, the "scarcity premium" that market participants must pay to obtain these assets has often been considerable, both in the repo and the bond market (...) Such asset scarcity can delay, or even impair, the transmission of monetary policy [and] implies that sovereign yields in the euro area's largest economy remain more accommodative than intended by our policy stance.

—Isabel Schnabel, Member of the Executive Board of the ECB, Money Market Contact Group meeting, Frankfurt am Main, 2 March 2023

In the last 15 years, the expansion of central banks' balance sheet went hand-to-hand with low interest rates. Most central banks decided to exit these accommodative monetary policies by hiking interest rates before shrinking their balance sheets. Under this sequencing, "quantitative tightening" occurs only after policy rates have been increased substantially.[1]

The recent experience, however, suggests that the choice of the sequencing of tightening measures is not trivial, in terms of its impact on the transmission of monetary policy. On July 27, 2022 the Eurosystem increased its policy rates by 50bp, the first hike since 2011 (Figure 1). The pass-through of this rate hike to money markets, however, was imperfect. While unsecured market rates increased one-to-one with the change in policy rates, the largest segment of the money market—the repo market— was sluggish, missing the target by more than 10 basis points, or 20% of the increase.

In this paper, we show that the main driver of this imperfect pass-through of monetary policy to money market rates is the safe asset scarcity that was partly the result of the ECB's QE. We characterize safe asset scarcity by looking at bonds' "specialness premium", the spread between the repo rate quoted for a specific bond and the risk-free rate. The specialness phenomenon was initially characterized by Duffie (1996), who identified it in the context of the US debt issuance cycle. However, it has become a structural feature of the Euro-Area money market, and is far from restricted to on-the-run sovereign bonds: in July 2022, for example, more than 80% of sovereign debt traded on special.

Using transaction-by-transaction data from the repo market, we show that contracts backed by bonds with the lowest repo rate, i.e., by the most special bonds, experienced the lowest pass-through. In other words, market participants that owned a very scarce bond and used

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[1] "Our normalisation process entails a sequence whereby interest rate increases precede the reduction in our balance sheet", Pablo Hernández de Cos, member of ECB Governing Council. See also "Lagarde Says ECB Will Debate QT Once It Has Normalized Rates", Bloomberg, 26 September 2022.

Figure 1. Pass-through of money market rates for the July 2022 rate hike

The bars show the change between the 5-day average before and after the ECB rate hike by 50bp on July 27, 2022. For DFR, ESTR, GC Pooling and Repo rates, we use the relevant implementation dates. For Tbill, we use the announcement date. Repo rates are computed as the volume-weighted repo rates using transactions settled at DFR-5bps and below, ie. below the GC Pooling rate. GC Pooling is against the extended GC basket, from Eurex. Data on repo transactions are obtained from MTS, Brokertec, and MMSR.
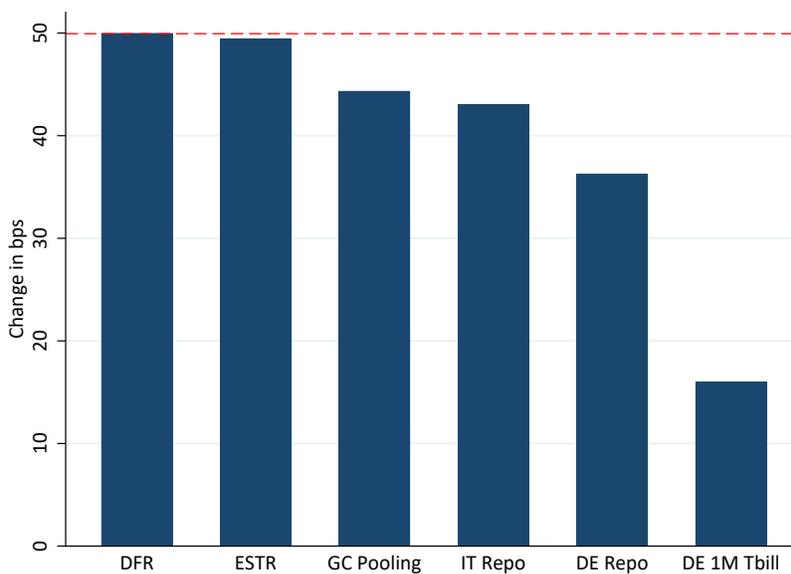

it as collateral to borrow cash saw their borrowing cost increase by less than the change in the main monetary policy rate, contrary to what was experienced by a market participant pledging a widely-available bond.

We trace the source of a bond's specialness to the bond scarcity that resulted from the central bank's QE programs. The fraction of a bond's amount outstanding held by the central bank precisely and persistently predicts that bond's specialness rate and, thus, the extent to which a change in policy rate is passed-through to money market transactions involving that bond. Figure 2 illustrates our main finding: when the central bank increased their policy rate by 50bp in July 2022, the degree to which the rate was reflected in a loan collateralized by a given security depended on the how scarce the central bank purchases had made that security—as measured in December 2021.

We show that scarcity on the repo market has real effects on bond market prices and funding rates. First, since investors value owning a bond that allows them to borrow cheaply, yields

Figure 2. Pass-through fraction by QE purchase quantities

This figure shows the relation between the pass-through of the July 2022 interest rate hike for a given bond and the fraction of that bond's amount outstanding that had been purchased by the ECB in its QE efforts. The pass-through is defined as the change in the rate at which a trader could borrow using a specific asset as collateral—its special repo rate. The rate change is scaled by the increase in monetary policy rate. The plot is a bin-scatter plot, showing the aggregated holdings and pass-through rates of 357 securities issued by Germany, France, Italy, and Spain. We do not show labels for the x-axis as statistics the ECB's holdings at the bond-level are confidential. Sources: MTS, Brokertec, and MMSR.
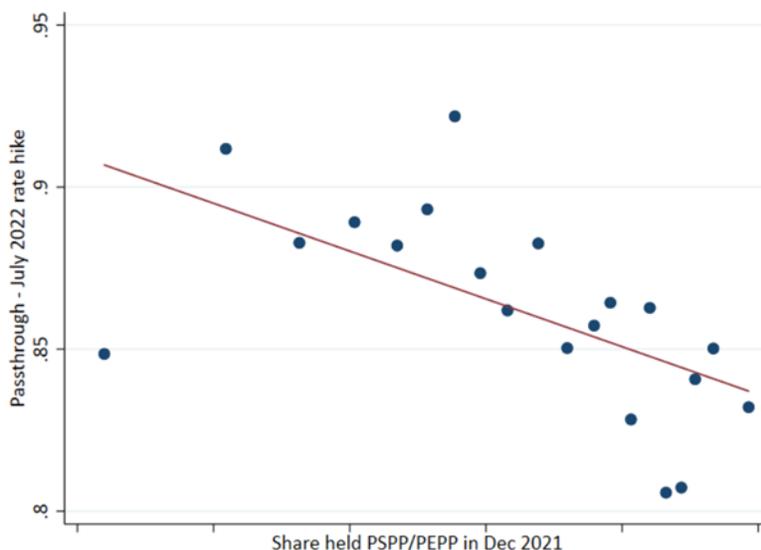
of bonds that are scarce on the repo market declined more around the rate hike compared to bonds that are not scarce. Second, by employing data on bond holdings, we show that the the rate hike had heterogeneous effects on the funding cost of European institutions: Following the 50bp hike, the average funding rates for a country's banks increased by 46bp, while for the banks located in another country it increased by only 41bp, owing to the composition of the banks' sovereign bond portfolios.

The heterogeneity in the pass-through to money market rates stems from varying elasticity of supply of the bonds' holders on the repo market. As interest rates rise, the demand for safe and money-like assets rises (Nagel, 2016). As the demand for repos rises, repo rates increase less than one-for-one with other interest rates (unsecured rates, the central bank deposit facility rates, etc.) We show that scarcer bonds are held by investors whose elasticity to the repo rate is lower.

Our paper is the first to link the demand for safe assets to repo rates and the ability of central banks to tighten monetary policy. At the current juncture, the decision of engaging

in tightening conventional monetary policy separately from Quantitative Tightening (QT) creates a tension between the rate policy and the size of the balance sheet, and concurs to a higher dispersion of repo rates and yields. Our analysis implies clear policy recommendations: in the context of rising interest rates, a central bank may increase the provision of safe assets to the markets to transmit better its monetary policy. To this end, the Eurosystem has several tools, for instance ramping up its securities lending facility, by changing its limits in terms of quantity or by making its princing more favourable.

The remainder of this paper is organized as follows. Section 2 details our contribution to the literature. Section 3 describes the institutional environment of the euro area money markets, how it is affected by monetary policy and the lack of safe assets. Section 4 details our empirical analysis. We offer policy implications in Section 5.

2 Literature Review

Our paper relates to three strands of literature. First, our paper relates to the body of work investigating how well a central bank can control short-term interest rates in an environment when its balance sheet is large. Many papers including by Bech and Klee (2011), Frost, Logan, Martin, McCabe, Natalucci, and Remache (2015) and Copeland, Duffie, and Yang (2021) have investigated the matter in the US since 2008 and showed that such control is more difficult than one would have anticipated, suggesting that the Fed should introduce news tools to ensure a smooth transmission of its interest rate hikes (Bech and Klee, 2011). In the case of the euro area, papers have shown that money market rates may fluctuate within the central bank corridor (Vari, 2020) and even fall below due to asset purchases (Arrata, Nguyen, Rahmouni-Rousseau, and Vari, 2020). Eisenschmidt, Ma, and Zhang (2022) show that competition in the money market has reduced monetary policy pass-through in a context of rate cut. Ballensiefen, Ranaldo, and Winterberg (2020) show that differentiated access to the remuneration of reserves at the central bank and bond eligibility to QE participate to disconnect the repo rates of collateral-driven vs cash-driven transactions.Our paper is the first to document that policy rate hikes are imperfectly transmitted as a consequence of safe asset scarcity.

Second, our paper deal with the specialness premium quoted on the repo market (Duffie, 1996; Krishnamurthy, 2002), specifically in how it is affected by monetary policy (Arrata, Nguyen, Rahmouni-Rousseau, and Vari, 2020; Corradin and Maddaloni, 2020; Pelizzon, Subrahmanyam, Tomio, and Uno, 2018). We show that contrary to US, in the Euro-Area all bonds are special and that specialness reduces the interest rate pass-through.

Third, we also contribute more broadly to the literature on the demand for safe assets (Krishnamurthy and Vissing-Jorgensen, 2012; Greenwood, Hanson, and Stein, 2015). Nagel (2016) shows that demand for short-term safe investment engenders a premium, in particular for short-term Treasuries. Greenwood, Hanson, and Stein (2015) and Caballero, Farhi, and Gourinchas (2017) stress the adverse financial stability and macroeconomic effects of a lack of safe assets. We contribute to this literature by showing the interaction of safe asset scarcity and monetary policy.

3   Tightening Monetary Policy in Times of Safe Asset Scarcity

In this section, we briefly describe the repo market, elaborate on the effect that QE had on the price of collateralized lending,

The secured borrowing market is the main source of funding for European investors, with a daily turnover of around €400bn, dwarfing the market for unsecured borrowing and lending, which averages €125bn of daily transactions. We report quarterly average daily volume for the two market segments in Figure 3. Even when broadening money markets to include derivative transactions such as overnight interest rate swaps and foreign exchange swaps, the euro area repo market has become the predominant form of short-term trading, representing almost 56% of total money market turnover (ECB, 2022). The repo market comprises two segments, the market for General Collateral (GC), where the cash borrower can deliver any bond from a list of eligible securities, and the market for Specific Collateral (SC), where they can deliver a single security.

The largest end-users in these markets are mutual funds, insurance companies, pension funds, and money market funds, yet the net positions of banks and CCPs (which are often banks) are several order of magnitudes larger than the other counterparties, thanks to their role as dealers.

3.1   The impact of central bank asset purchases on the repo market

Since 2015, bond repo rates have declined substantially below the deposit facility rate (Figure 4), a timing that coincided with the Eurosystem foray into large-scale asset purchases. In fact, as the Public Sector Purchase Program (PSPP) and the Pandemic Emergency Purchase Programme (PEPP) started in 2015 and 2020 respectively, the percentage of bonds

Figure 3. Trade Volume of Secured and Unsecured Market

Daily trade volumes reported in MMSR for secured and unsecured money market trans-
actions by European investors. Data are from the ECB's Statistical Data Warehouse.
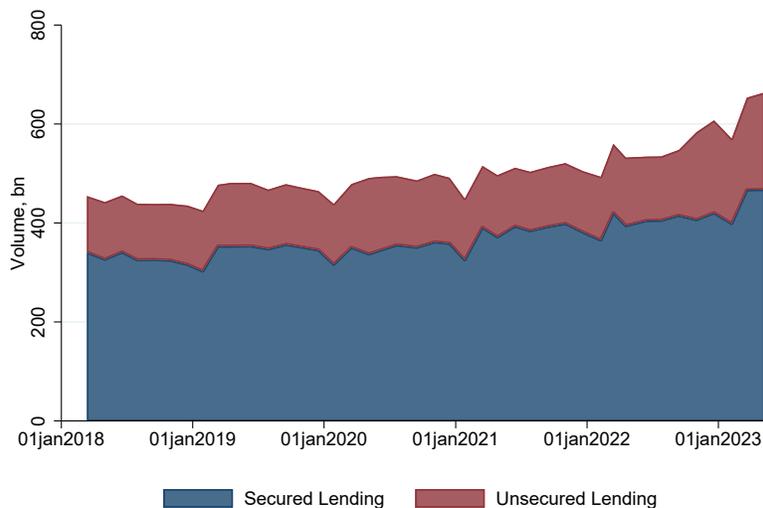
trading "on specials" increased dramatically and reached 100% in 2015 and 2022 for Ger-
many, and 50% and 100% for Italy (other countries follow similar patterns), as shown in
Figure 5. The co-movements between central bank assets purchases and declining repo rates
has several causes.

In the very short run, the large amounts of purchases from the central bank coupled with
search frictions force dealers receiving these orders to borrow these bonds on the SC market
to short-sell them to the central bank (Ferdinandusse, Freier, and Ristiniemi, 2020). Beyond
these flow effects, once dealers have shorted the bonds, they need to roll-over the repo
position until they have managed to purchase the bonds, prolonging their specialness. In
principle, the market could remain structurally short of the bond forever, if dealers prefer to
roll-over their repo position rather than buy the bond. Given the current amount of bonds
held by the Eurosystem, it is likely that dealers face only very inelastic sellers on the bond
market, chiefly the Eurosystem (which never sold any bond it purchased) and other long
term holders such as insurance companies and pensions funds (Koijen, Koulischer, Nguyen,
and Yogo, 2021). In the medium run, central bank asset purchases may structurally increase
demand on the repo market and decrease supply, because the Eurosystem lends its bonds at
market conditions or worse (Arrata, Nguyen, Rahmouni-Rousseau, and Vari, 2020; Baltzer,
Schlepper, and Speck, 2022).

More importantly, repo rates may fall not because of market microstructure mechanism

Figure 4. Security-specific interest rates on the repo market

This figure shows the rates at which repo transactions took place. Each point represents the weighted-average repo rate for a specific sovereign bond issued by Germany, France, Italy, and Spain, the four largest Euro-Area countries. We focus on spot-next transactions. We report the ECB's main policy rate, the deposit facility rate, in red. Data on repo transactions are obtain from MTS, Brokertec, and MMSR.
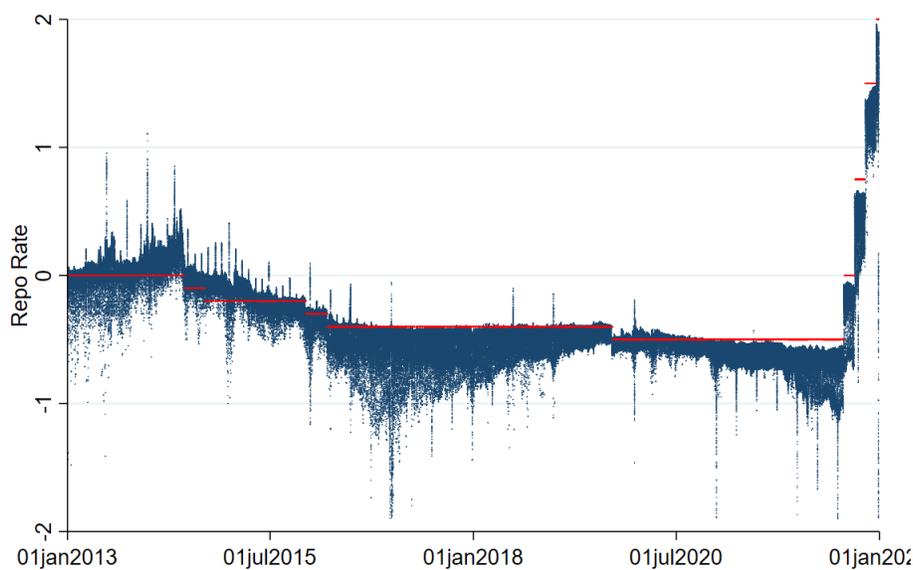

but because of an imbalance between safe asset supply and demand, exacerbated by central banks. As the central bank buys Government bonds, the cash balances of non-bank increases and eventually find their way to the banking system (Koijen, Koulischer, Nguyen, and Yogo, 2021; Acharya and Rajan, 2022). One safe way to hold such large amount of cash in banks may be the repo market. Central bank asset purchases thus lower repo rates as they increase the supply of cash from non-banks and reduce the amount of bonds available. While in theory, this phenomenon should affect only the least scarce of the bonds (those trading on the GC market), recent literature shows that bonds with very low repo rates are also used to secure cash-driven trades, or GC transactions (Ballensiefen, 2022).

3.2 Rate Hikes when Assets Are Scarce

In the next section, we show that when interest rates increase, the repo rates (specialness premia) for the most special bonds do not increase as much as (increase more than) they do for less special bonds. As our finding is consistent with an increase in the demand for repo trades around rate hikes and, alternatively or in addition to it, a decrease in the supply of

Figure 5. Fraction of sovereign debt trading on special

This figure show the fraction of sovereign debt issued by Italy in blue (Germany in red) that trades on special on the repo market. We calculate this quantity on a monthly frequency and identify a bond as trading on special if the volume-weighted average rate for repo transactions using it as collateral is 10bp or more below the ECB's main policy rate, the deposit facility rate. Data on repo transactions are obtained from MTS, BrokerTec, MMSR, while data on debt outstanding are obtained from the ECB's Centralized Securities Database (CSDB).
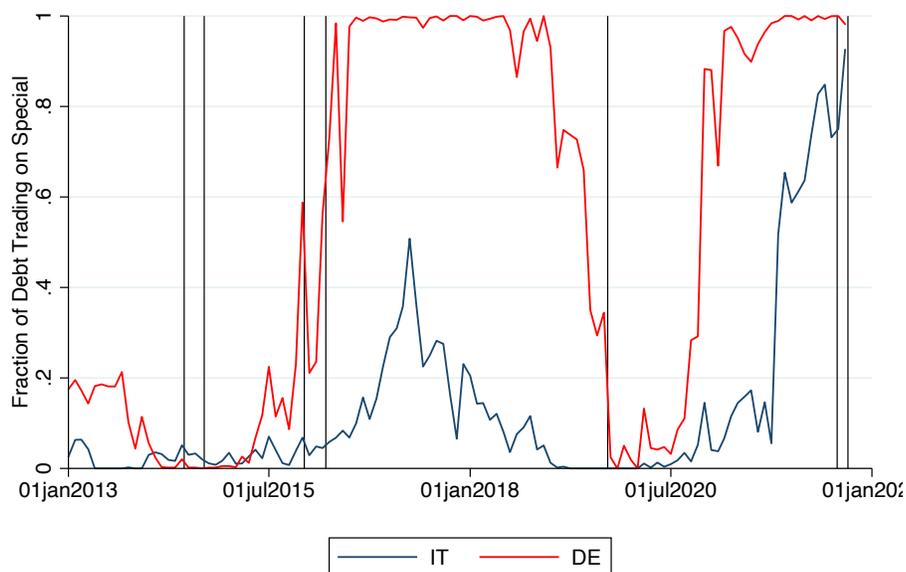
bonds on the repo market, we lay out in this section the theoretical work consistent with this set of styled facts.

Nagel (2016) show that, as interest rate rise, the demand for money-like assets increases, as well. Money-like assets include Treasury bills, certificates of deposit, commercial paper, and repo transactions. As rate increase, investors opportunity cost for holding cash increases as well, and so does their demand for repos, which depresses repo rates. The increase in money-like demand is proportional to the willingness of investors to substitute between cash and a given asset, i.e., with an asset's convenience yield. To the extent that bonds' specialness captures the asset's convenience, we expect that the increase in demand will be most prominent for the most special bonds.

Also, following monetary policy shocks, the demand for hedging against further rate hikes may also increase. Hedging can be done by buying bond futures or short-selling long-dated bonds. Both strategies structurally increase demand for bonds on the repo market. Future require posting collateral (initial margins), while short selling is implemented by borrowing

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a bond on the repo market and selling it on the bond market with the intention to buy at future date.

An increase in interest rates, however, can also affect the supply of securities on the repo market. Duffie and Krishnamurthy (2016) develop a model where the passthrough of changes in interest rates to deposit rates depends on how actively depositors adjust their savings decision, the larger a proportion of depositors is likely to stick with the same bank (the less competitive the market for deposit), the worse the pass-through will be. We expect for a similar mechanism to be at play in the repo market: Investors who are more attentive to a bond's specialness will adjust their supply more aggressively, thus contributing to a more precise pass-through; on the other hand, passive bond holders will not increase their supply to benefit from a bond's richness and impede the pass-through. To the extent that bonds that are more special are held by less sophisticated investors, we expect that repo rates for richer bonds will increase less around rate hikes, owing to the composition of their holders. This argument is similar to the heterogeneous repo supply curves found in Duffie (1996) and Krishnamurthy (2002)—specifically, with more special bonds being held by less elastic investors.

Finally, rate hikes can affect investors' propensity to engage in arbitrage trades, specifically, the special-to-GC arbitrage trade found in Duffie (1996): Rate hikes are passed through to money markets if investors holding a rich bond lend it against cash and invest the cash at the risk free rate (GC or DFR/IOER). To the extent that this arbitrage trade requires capital—for example, because investors fund haircuts at unsecured rates—as rates increase, so does the cost of engaging in this arbitrage, leading to passthroughs that are worse the higher the level or interest rates.

4 Results

Our main data source, is the money market statistical reporting (MMSR). This trade-by-trade reporting was introduced in 2016 to monitor the money market and includes all trades between wholesale market participants in the money market, i.e., borrowing/lending transaction with a maturity lower than one year. MMSR contains repo transactions in Euro conducted by the 50 largest dealers. For each transaction, we can observe its trade date, counterparties, rate, amount, and collateral used. We merge this dataset with the Securities Holdings Statistics (SHS), which reports quarterly data holding for every security, aggregated at the sector-country level. We obtain daily bond prices and yields from Bloomberg.

4.1 Specialness, Scarcity, and Rate Hike Pass-through

We define pass-through as the change in repo rates for each individual bond. We compute the change as the difference between the average rate over five business days before the implementation of the hike and the five days after. $Spec.\,premium_i^{Bef}$ is the average specialness premium for bond-i, averaged over the five business days that preceded the implementation of the rate hike.

Figure 6 provides a graphical representation of our first set of results. As the central bank increased rates by 50bp, the interest rate in repo transactions similarly increased by 50bp, but only for the least special of assets. A trader pledging an asset with a specialness of 60bp, on the other hand, would have only experienced an increase of 28bp in their borrowing rate.

Specialness, however, may be correlated with other bond characteristics, which could similarly impact changes in the bond's repo rate around rate hikes. We regress the pass-through measures on $Spec.\,premium_i^{Bef}$, the bond's coupon rate, initial and residual maturity, and the haircut quoted if the bond was pledged at the ECB for cash:

$$Passthrough_i = \alpha + \beta_1 * Spec.\,premium_i + \beta_2 * X_i + \epsilon_i \tag{1}$$

Allowing for country-specific drivers of changes in repo rates, we include country–fixed effects. We report the results in Table 1, which shows that a bond's scarcity, as measured by its repo specialness, is highly statistically significant in its subsequent change in repo rate: a 50bp-increase in specialness decreases the pass-through by 14bp. The result is robust to including bond- or country-specific controls. In other words, bonds that were the most

Figure 6. Scarcity and Pass-through

In this figure, we show the relation between the repo market specialness prior to the July-2022 rate hike, and the change in repo rate around the rate hike. Repo rates are calculated as a weighted average of transactions that took place five days before or after the rate hike. Data on spot-next repo transactions are obtained from MMSR.
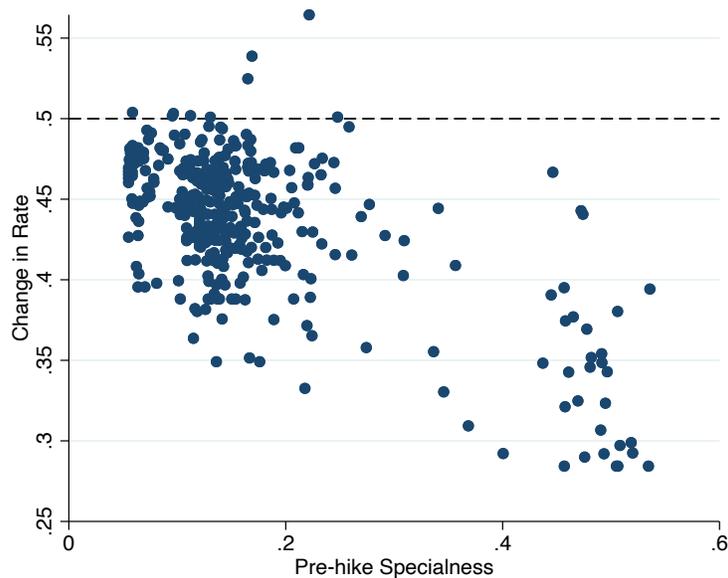
scarce before the hike have witnessed a lower pass-through, and impeded the transmission of monetary policy.

While the focus of this section is the first rate hike, in July 2022, our findings apply to subsequent rate hikes as well, as we show in Table 2. We report the results of a specification similar to that of Eq. 1, where we regress changes in specialness premia surrounding the four rate hikes between July and September on a set of four dummies, each of them equal to one for the change around a specific hike, multiplied by a bond's pre-hike specialness. This specification allows us to compare rate hikes of different magnitude and, similarly to the results in Table 1, we show that specialness increased around all rate hikes, and more so the larger it was prior to the hike, resulting in a passthrough that is inversely proportional to scarcity.

An increase in demand for the repos of scarcer bond should translate in both an increase in price, but also an increase in quantity. This is what Figure 7 shows for the safest assets in the Euro-Area: German government bonds. Figure 7 plots the net amount of German bonds borrowed by the market from the main Euro-Area dealers. Not only the amount of bonds borrowed has increased between the periods before and the after July 2022 rate

Table 1

Pass-through to Money Market Rates and Bond Specialness

This table reports the estimation of Eq.1. The left-hand side variable is the pass-through for each bond i in the repo market, ie. the change in its repo rate between 5 business days before and after the July 2022 rate hike. For each bond i the repo rate is the weighted average repo rate of the transactions reported in MMSR and collateralized by this bond. The pass-through variable takes 1 in case of the 1:1 transmission of the 50bp rate on bond i repo rate. $Specialness_i^{Bef}$ is the average repo rate of bond i the 5 business days preceding the implementation of the rate hike. Initial maturity and residual maturity are expressed in years. Country-FE are issuer-country fixed effects.

	PT_i	PT_i	PT_i
$Specialness_i$	-0.541***	-0.553***	-0.499***
	(-9.23)	(-8.49)	(-6.06)
Coupon rate		0.000677	0.00340
		(0.14)	(0.70)
Init. maturity		-0.000735	-0.00116
		(-0.50)	(-0.82)
Resid. maturity		0.00152	0.00339*
		(0.99)	(1.89)
ECB haircut		-0.00142	-0.00717*
		(-0.80)	(-1.70)
Country FE	No	No	Yes
Adj. R2	0.31	0.31	0.34
Obs	357	357	357

Table 2

**Pass-through to Money Market Rates for Different Hikes**

This table reports the results of a regression of bonds specialness changes around four rate hikes between July and December 2022 on a dummy that equals one for the change surrounding a specific rate hike, and zero, otherwise. The dependent variable measures the change in a bond's repo rate between 5 business days before and after each rate hike. Each hike dummy is interacted with the weighted average repo rate of the transactions reported in MMSR and collateralized by a specific bond five days before the hike. We control for bond-, and time-fixed effects.

	(1) $\Delta Spec_i$	(2) $\Delta Spec_i$	(3) $\Delta Spec_i$
July x $Specialness_i^{Bef}$	0.147***	0.323***	0.428***
	(3.85)	(2.75)	(3.71)
Sept x $Specialness_i^{Bef}$	0.130**	0.191***	0.193***
	(2.27)	(3.04)	(2.96)
Oct x $Specialness_i^{Bef}$	-0.00444	0.166***	0.133
	(-0.07)	(2.72)	(1.30)
Dec x $Specialness_i^{Bef}$	0.0832*	0.355***	0.280***
	(1.95)	(3.44)	(2.90)
ISIN FE		Yes	Yes
Time FE	Yes		Yes
Adj. R2	0.10	0.13	0.14
Obs	1295	1295	1295

hikes, but it did so most markedly for bonds that were most special before the hike. This increased in volumes together with the increase of specialness during this period suggestive of a rise in demand in the repo market.

Figure 7. Repo Volume by Specialness

Trade volumes reported in MMSR on DE, FR, ES, IT government collateral, S/N tenor only.
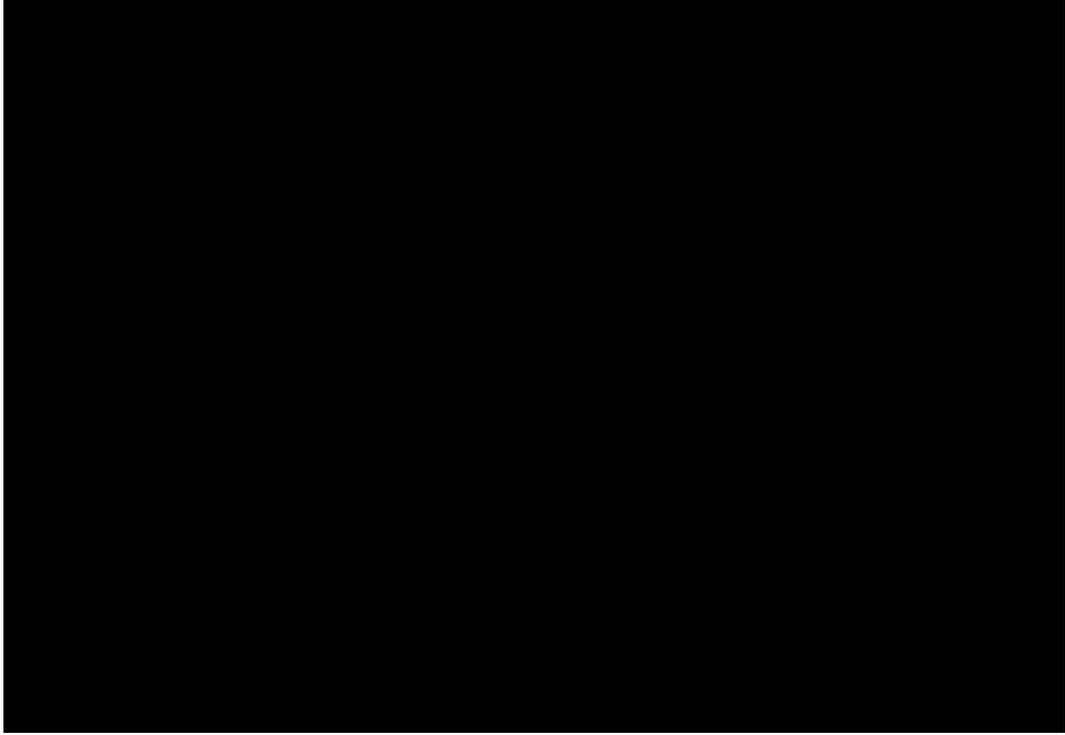
Regressing changes in the repo rates on the previous level of repo rate can give rise to concerns of endogeneity. To address these concerns, we take an instrumental variable approach. Specifically, we use the shares of a bond's outstanding amount held by the central bank in December 2021 to forecast the level of the bond specialness in July 2022. That is, we perform this first-stage regression:

$$Spec.\,premium_i = \alpha + \beta_1 * Share\,held\,ECB_i + \beta_2 * X_i + \epsilon_i \tag{2}$$

and a second stage as in Eq. 1:

$$Passthrough_i = \alpha + \beta_1 * Spec.\,\widehat{premium}_i + \beta_2 * X_i + \epsilon_i \tag{3}$$

We report the reduced form, first- and second-stage regression in Table 3. The reduced form in Column 1 shows the tension between conventional and unconventional monetary

policy: Bonds that have been purchased more aggressively by the central bank well before the rate hike display a significantly decreased pass-through. Column 2 confirms the results including controls. Column 3 shows that the instrument is strong and that ECB holdings positively forecast future specialness many months ahead. Columns 4 and 5 show that central bank-driven scarcity, created by QE purchases and manifested in repo specialness, impedes the pass-through of rate changes: A 50bp increase in rate hikes increases money market rates by only 32bp for bonds with a 50bp level of specialness.

Table 3
Pass-through to Money Market Rates and Bond Specialness - Instrumental Variables

This table reports the estimation of Eq.3. The left-hand side variable is the pass-through for each bond i in the repo market, taking the value 1 in case of the 1:1 transmission of the 50bp rate on bond i repo rate. $Specialness_i^{Bef}$ is the average repo rate of bond i the 5 business days preceding the implementation of the rate hike. The first column is the reduced-form estimation of the 2SLS: Share held by the ECB, at the righ-hand side, is the fraction of bond i amount outstanding held by the Eurosystem in 2021Q4 (APP and PEPP holdings cumulated). In column (2) the first stage instruments $Specialness\_i^{Bef}$ by the share held by the ECB. Columns (3) and (4) report the results of the second stage.

	OLS		1st	2nd stage	
	(1)	(2)	(3)	(4)	(5)
Share held ECB	-0.0909**	-0.0909**	0.137***		
	(-2.32)	(-2.38)	(3.71)		
$Specialness_i^{Bef}$				-0.665***	-0.636***
				(-2.63)	(-2.60)
Coupon rate		0.0144***			-0.00175
		(2.61)			(-0.23)
Init. maturity		-0.00290*			-0.000186
		(-1.89)			(-0.10)
Resid. maturity		0.00218			0.00123
		(1.35)			(0.77)
ECB haircut		0.00382**			-0.00221
		(2.16)			(-0.75)
F-stat	5.4	4.7	13.8	6.9	7.0
Adj. R2	0.02	0.04	0.04	0.29	0.30
Obs	357	357	357	357	357

4.2 Competition and Regulation

We attribute the lack of pass-through to bond scarcity, as measured by high specialness premia. But other phenomena may impede the transmission of monetary policy. Two other explanations have beeen put forward by the literature: the structure of competition of the Euro-Area repo market (Eisenschmidt, Ma, and Zhang, 2022) and the ability of market participants to access the Eurosystem's deposit facility (Ballensiefen, Ranaldo, and Winterberg, 2020). According to Eisenschmidt, Ma, and Zhang (2022), dealers—the large banks that intermediate the repo market and report their trades to the MMSR database— are able to extract rents from their customers. Most notably, they show that dealers did not lower the rate at which they borrowed cash (lent securities) as much as the central bank cut the rate in September 2019. The pass-through, therefore, varied according to whether dealers where trading with other dealers or with non-dealers, and further varied according to the client's degree of sophistication.

In order to control for this phenomenon, we calculate the pass-through at the ISIN-dealer-customer level. We repeat the analysis in Eq. 1 and saturate the regression with dealers-, customers-, and dealers-by-customers-fixed effects to allow for the nature of the business relationship between a customer and a dealer to impact the pass-through. The regression writes as follows:

$$Passthrough_{icd} = \alpha + \beta_1 * Spec.\ premium_{icd} + \beta_2 * X_i + FE_d + FE_c + \epsilon_{icd} \qquad (4)$$

where $Passthrough_{icd}$ is the pass-through of repo contracts backed by bond-i and agreed between between dealer-d and customer-c.

We show the results in Table 4. Although the coefficients associated with specialness are more muted than in baseline regressions shown in Table 1, they are strongly significant and negative, at -0.437 in the most conservative estimation (vis-a-vis -0.499 in Table 1). Moreover, the comparison between the R^2 in Specification 1 and 4 indicate that scarcity explains a larger fraction of the variation in pass-through than competition. It implies that the structure of competition matters for the pass-through of monetary policy to repo rates, but that specialness seems to be a more important factor in this case.

4.3 Passthrough and repo participation

Duffie (1996) and Krishnamurthy (2002) show that limited repo participation entails a larger specialness premium and a larger yield spread. Krishnamurthy (2002) describes

Table 4
Pass-through and Customer-Level Effects

This table reports the estimation of Eq.4. The left-hand side variable is the pass-through for each bond i at the ISIN-customer-dealer level. We define dealers as the reporting banks to MMSR and customers their counterparties in the repo transactions. $Specialness_i^{Bef}$ is the average repo rate of bond i the 5 business days preceding the implementation of the rate hike at the ISIN-customer-dealer level. Columns (1) to (4) report the estimation of Eq.4 introducing fixed-effects once at a time. Column (5) gives the variance explained by the fixed effects and the controls, excluding our specialness variable. Standard errors are clustered at the ISIN level.

	(1)	(2)	(3)	(4)	(5)
$Specialness_i$	-0.442***	-0.445***	-0.430***	-0.437***	
	(-8.60)	(-8.39)	(-8.05)	(-8.28)	
Coupon rate	0.00258	0.00224	0.00196	0.00208	0.0174***
	(0.54)	(0.48)	(0.43)	(0.45)	(3.10)
Init. maturity	-0.000149	-0.000317	-0.000262	-0.000318	-0.00364**
	(-0.10)	(-0.23)	(-0.19)	(-0.23)	(-2.27)
Resid. maturity	0.000570	0.000641	0.000552	0.000669	0.00279*
	(0.38)	(0.43)	(0.37)	(0.44)	(1.67)
ECB haircut	0.000213	0.000518	0.000272	-0.0000345	0.00385**
	(0.14)	(0.33)	(0.18)	(-0.02)	(2.30)
Customer FE	No	No	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Deal.-Cust. FE	No	No	No	Yes	Yes
Adj. R2	0.21	0.22	0.25	0.27	0.13
Obs	4,090	4,090	4,086	4,071	4,071

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the arbitrage for arbitrageurs/bond holders in the repo market: when bonds' supply is unconstrained, *"an investor who has a bond that is available for lending (...) could always take the funds received on lending the bond, invest them at the riskless rate (...) When the supply constraint binds, the financing rate falls below the riskless rate in order to ration the scarce supply of bonds available for borrowing. An investor owning these bonds earns a premium on lending the bonds and is able to borrow funds at the (special repo rate) and invest this at the riskless interest rate"*.

This mechanism is however not only affected by the limited repo participation, but also by the fact not every investor has access to the pure riskless rate that is the DFR, precisely the policy rate hiked by the central bank. To test whether limited repo participation and arbitrage activity may be at play, we take two approaches. First, we approximate repo participation by a bond's holder composition, assuming that an investor's sector approximates for its likelihood to engage in the repo market. Figure 8 plots a bond's passthrough for the July hike against the fraction of the bond held by sophisticated financial investors (Panel A, banks) and less active investors (Panel B, foreign holders). The plots promplty support the hypothesis that bonds that are held to a larger extent by sophisticated investors exhibit better passthrough, compared to bonds whose majority hodlders are less likely to take advantage of its high specialness, like foreign investors (Panel B)—and like the ECB, per Figure 2.

An investor sector, however, is only a rough proxy for its likelihood to engage in the repo market. In the second approach, we aim at capturing repo market participation directly. In Table 5, we interact specialness with the share of trades by investor sector. The coefficient on $Specialness_i^{Bef}$ indicates that a bond with a specialness of 50bp which is entirely only transacted by the central bank (i.e., borrowed from the bank's securities lending desk) experiences a passthrough that was 27.5% of the increase in deposit rate. On the contrary, the passthrough for a bond with a similar level of specialness but which is most heavily traded by banks reflected 95% of the rate change. Results suggest bonds have the best pass-through conditionally of being traded primarily by banks, followed by other financial institutions and lastly the Foreign sector, while bonds traded in the repo market by ICPF, Non-Financial and the Eurosystem have the worst passthrough.

Figure 8. Passthrough and Bond Holder Heterogeneity

This figure shows the relation between a bond's passthrough around the July 2022 rate hike and the composition of its holders. Specialness is measured as the (DFR minus the) average special rate in the five days prior to the rate hike. In Panel A, we focus on the bond holdings by banks, and we focus in Panel B on the fraction of bond holdings held by foreigners. Holding data are from the SHSS dataset as of December 2021. Data on repo transactions are obtained from MTS, Brokertec, and MMSR.
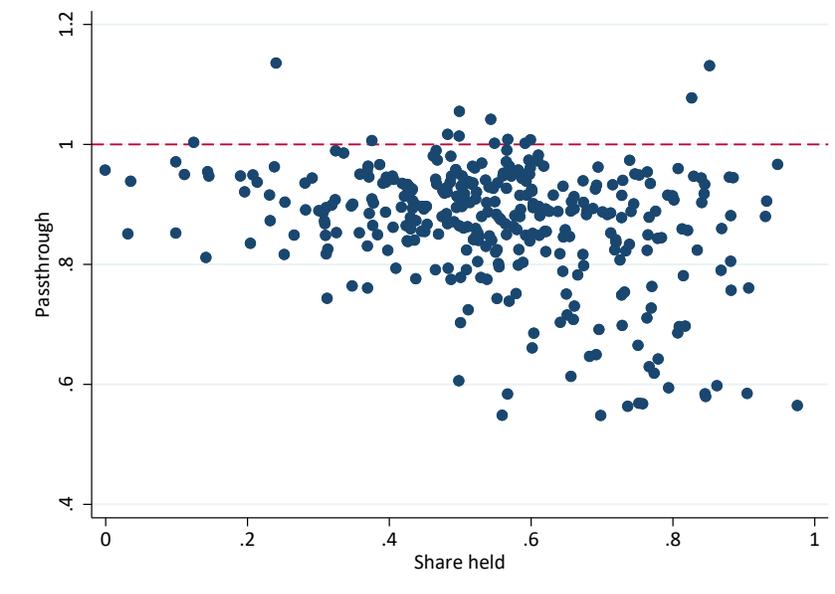
A: Banks
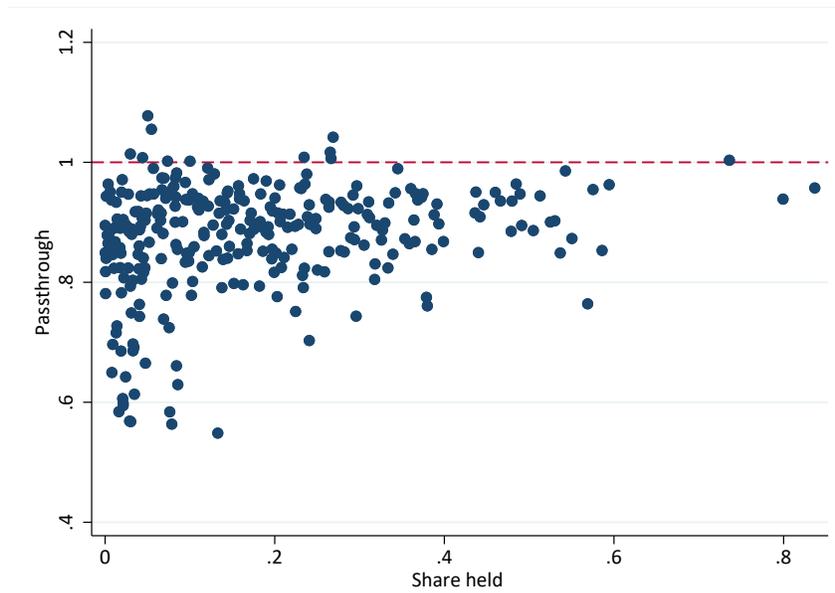
B: Foreigners

Table 5

Pass-through and investor participation in the repo market

This table reports the estimation of Eq.4 where specialness is interacted with the participation of each investor sector in the repo market. The left-hand side variable is the pass-through for each bond i at the ISIN-level. $Specialness_i^{Bef}$ is the average repo rate of bond i the 5 business days preceding the implementation of the rate hike at the ISIN level. Share volume is defined by investor sector and the Eurosystem. "Share volume MFI" is equal to 1 when only MFIs traded this bond as collateral in the repo market. Other comprises Non-financial institutions and Other financial institutions.

|	(1)	(2)
$Specialness_i^{Bef}$	-5.501***	-5.149***
	(-3.34)	(-3.22)
$Specialness_i^{Bef} \times$ Share volume MFI	5.402***	5.070***
	(3.20)	(3.10)
$Specialness_i^{Bef} \times$ Share volume ICPF	2.378	0.306
	(0.89)	(0.13)
$Specialness_i^{Bef} \times$ Share volume OFI	4.761***	4.285***
	(2.92)	(2.64)
$Specialness_i^{Bef} \times$ Share volume Foreign	4.446**	4.230**
	(2.45)	(2.41)
$Specialness_i^{Bef} \times$ Share volume Non-Financials	-16.76	-17.96
	(-1.29)	(-1.37)
Share volume MFI	-0.783**	-0.611**
	(-2.54)	(-2.01)
Share volume ICPF	-0.250	0.0164
	(-0.58)	(0.04)
Share volume OFI	-0.650**	-0.423
	(-2.17)	(-1.34)
Share volume Foreign	-0.595*	-0.427
	(-1.81)	(-1.34)
Share volume Non-Financials	2.359	2.802
	(1.21)	(1.43)
Country FE		Yes
Adj. R2	0.36	0.40
Obs	357	357

4.4 Lack of Pass-through and Bond Yields

We next turn our attention to the link between bonds' scarcity, as measured by their specialness premia, and bond yields. We estimate the following regression:

$$\Delta Y_i = \alpha_i + \beta_1 * Spec.\, premium_i + \beta_2 * X_i + \epsilon_i \tag{5}$$

where ΔY_i is the change in the yield of bond-i around the implementation date of the July 2022 rate hike, based on five-day median yields, and $Spec.\, premium_i$ is defined as before. X_i are controls and include the duration and the convexity of bond-i. We include country-, maturity-, and country-by-maturity-fixed effects, where bonds are grouped by their closest five-year round time-to-maturity for defining maturity fixed effects. We show the raw relation between the two variables of interest in Figure 9. We report the regression results in Table 6.

Figure 9. Yield Change around Rate Hike and Specialness

This figure shows the relation between a bond's specialness and its yield change around the July 2022 rate hike. Specialness is measured as the (DFR minus the) average special rate in the five days prior to the rate hike. The change in yield is the difference between the median yield five days after and before the rate hike. Yield data are from Bloomberg. Data on repo transactions are obtained from MTS, Brokertec, and MMSR.
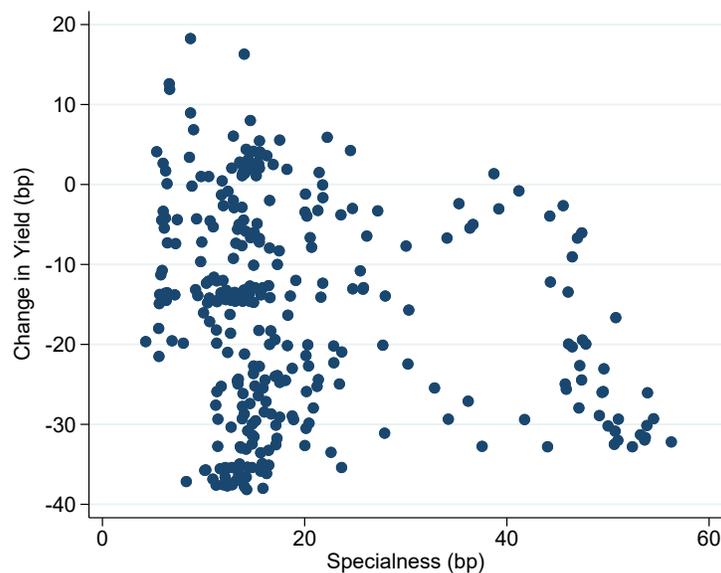
Coefficients are robustly negative and significant indicating that those bonds that were most special before the hike (and had the lowest pass-through) experienced the smallest increase in their yields: every specialness basis point implied a yield 0.2bp lower. This result

Table 6
Yield Change and Specialness

This table shows the result of regressing a bond's changes in yield around the July 2022 rate hike on its specialness prior to the rate change. The yield change is calculated as the change in the median rate five days before and five after the rate chnage. Specialness is the average specialness prior to rate change. We include duration and convexity as controls, and include country-, maturity-, and country-by-maturity-fixed effects, each maturity group (rounded to the closest five-year) is attributed a maturity-fixed effect, We include bonds from Germany, France, Italy and Spain. We obtain yield data from Bloomberg and bond characteristics from CSDB. Data on repo transactions are obtained from MTS, Brokertec, and MMSR.

	(1) ΔY_i	(2) ΔY_i	(3) ΔY_i	(4) ΔY_i	(5) ΔY_i
$Specialness_i^{Bef}$	-0.213^{***}	-0.208^{***}	-0.194^{***}	-0.199^{***}	-0.208^{***}
	(-4.537)	(-5.273)	(-3.366)	(-4.649)	(-3.140)
$Duration_i$		-0.023^{***}	-0.022^{***}		
		(-6.927)	(-7.114)		
$Convexity_i$		0.000^{***}	0.000^{***}		
		(4.839)	(5.070)		
Adj. R^2	0.038	0.269	0.491	0.230	0.489
Obs	312	312	312	311	303
Country FE	No	No	Yes	No	No
Maturity FE	No	No	No	Yes	No
Maturity× Country FE	No	No	No	No	Yes

underscores the impediment that specialness represents for monetary policy transmission: Not only does bond scarcity prevent interest rates on the repo market from rising, it also dampens the response of the yields of government bonds, the keystone of financial markets, to monetary policy.

As in our baseline regressions, concerns over endogeneity could arise. For that purpose we again instrument specialness of bond-i in the run-up to the July rate hike, with the holdings of this bond by the Eurosystem as of December 2021. The first-stage regression is, thus:

$$Spec.\,premium_i = \alpha_i + \beta_1 * Share\,held\,ECB_i + \beta_2 * X_i + \epsilon_i. \tag{6}$$

The second-stage:

$$\Delta Y_i = \alpha_i + \beta_1 * Spec.\,\widehat{premium}_i + \beta_2 * X_i + \epsilon_i \tag{7}$$

where all variables are the same as previously defined. We show the results in Table 7. The instrumental variable analysis confirms the coefficient of interest to be still strongly negative and significant.

Table 7
Yield Change and Specialness - Instrumental Variables

This table reports the estimation of Eq.7. It is the analogue of Table 3 but with the change in yield of bond i at the left hand side. The first column is the reduced-form estimation of the 2SLS: Share held by the ECB, at the righ-hand side, is the fraction of bond i amount outstanding held by the Eurosystem in 2021Q4 (APP and PEPP holdings cumulated). In column (2) the first stage instruments $Specialness_i^{Bef}$ by the share held by the ECB. Columns (3) and (4) report the results of the second stage.

	OLS	1st	2nd stage	
	(1)	(2)	(3)	(4)
Share held ECB	-0.287***	0.137***		
	(-6.54)	(3.71)		
$Specialness_i^{Bef}$			-2.434***	-2.372***
			(-3.17)	(-2.97)
Coupon rate	-0.00905			-0.117***
	(-1.25)			(-2.99)
Init. maturity	-0.000180			0.0230**
	(-0.09)			(2.44)
Resid. maturity	-0.00467**			-0.0212***
	(-2.16)			(-2.82)
ECB haircut	0.0162***			-0.000468
	(8.67)			(-0.08)
F-stat	41.4	13.8	10.0	6.3
Adj. R2	0.32	0.04	-4.13	-3.22
Obs	294	357	294	294

4.5 Lack of Pass-through and Distribution of Funding Rates

As previously shown, specialness implies a low pass-through to repo market rates. Rates that are kept artificially low represent a boon for the holders of special bonds. This in turn might have some distributional consequences between the different groups of financial intermediary depending on which bonds they hold.

We match data on the repo market (MMSR) with securities holdings statistics (SHS) and calculate the average change in repo rate, given a market participant's sovereign bond portfolio. That is, we calculate the rate at which an investor could fund themselves if the were to lend out the entirety of their portfolio. We conduct the analysis at the investor type–country level, the highest level of detail available in SHS.

We plot the distribution of these hypothetical funding rates in figure 10. The plot shows that Other Financial Institutions (OFI) and foreign investors (Foreign) have on average experienced lower increase in the rates at which they borrow on the repo market. Most importantly, banks (MFI) showcase a tremendous dispersion in the pass-through of their funding costs: While some banks have seen their funding cost on the repo market increase by 41bp, other have seen an increase of 46 basis points. These results highlight that a change in monetary policy stance can have vastly heterogenous effects on agents' funding costs in a way that is unrelated to the characteristic of the market participants and solely depend on their holdings.

As a final evidence of the relation between rate hikes and lack of passthrough of moneatry policy, we plot the distribution of repo specialness by level of deposit facility rate. In the spirit of the rate dispersion measure by Duffie and Krishnamurthy (2016), Figure 11 shows that, as the ECB increased their main policy rates, the heterogeneity in funding rates increased as well.

Figure 10. Distribution of pass-through across institutional investor sector

This graph shows the distribution in the theoretical change in collateralized rate for European institutions. We calculate the change in rate as the weighted-average pass-through, based on the institutions bond portfolio, assuming that they lend out their whole portfolio on the repo market. We group each institution type by country and show the distribution of 19 Euro-area countries. ICPF are insurance companies and pension funds, MFI are monetary financial institutions, and OFI, are other financial institutions. Holdings data come from SHS, as of 2021Q4.
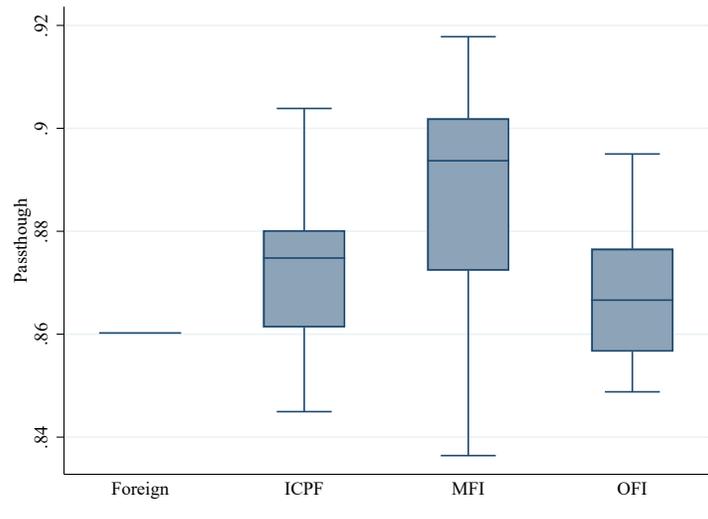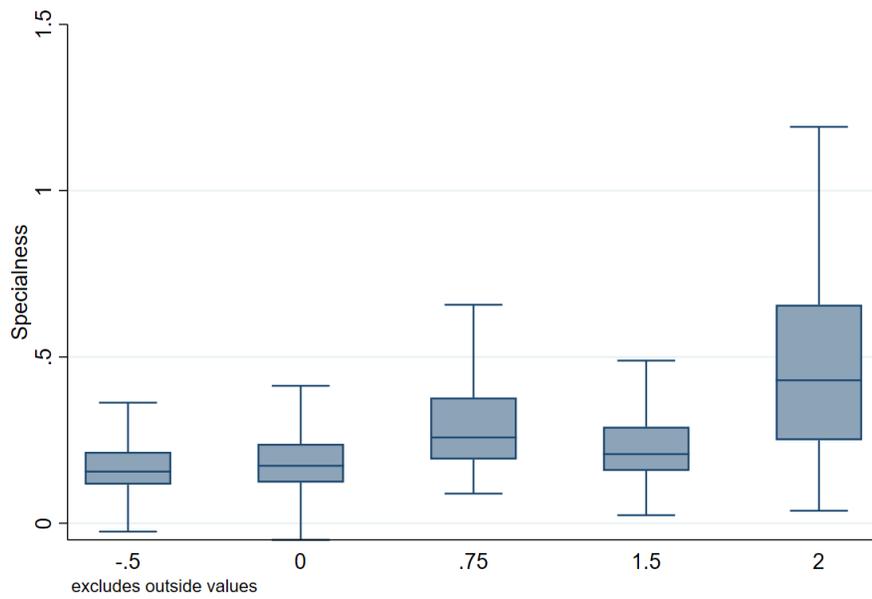
Figure 11. Money Market Rate Dispersion by Policy Rate

This graph shows the distribution of specialness for different levels of deposit facility rate.

5 Conclusion and policy implications

Ensuring an effective pass-through of policy rate changes to money market is key to transmit monetary policy. It is true for the repo market, of course for cash-driven transactions which reflect the price of cash for a large range of market participants, but also for collateral-driven transactions to the extent the specialness premium reflects in the cash bond yields. As such, an imperfect passthrough to special repo rates increases the dispersion of money market rates, even beyond the repo market.

To reduce the imbalance between supply and demand of safe assets, a central bank has several options. One option is to dispose of the safe assets it bought, reducing its balance sheet and the amount of cash in the hand of non-banks, that is, to engage in Quantitative Tightening (QT). QT has clear downsides, however. First, selling a large amount of securities can destabilize bond markets, especially in the most vulnerable countries, an option that is politically fraught with difficulties. Second, QT may materializes losses in the central bank balance sheets. Central bank negative equity was long thought not to be an issue, yet recent literature shows that central bankers may be averse to losses on the back of political economy considerations (Goncharov, Ioannidou, and Schmalz, forthcoming).

If the sovereign portfolio cannot be sold, the ECB can alternatively issue securities, allowing market participants to buy central bank-issued safe assets, rather than placing their cash in the repo market. This process, while legally feasible in the euro area, would however amount to issuing a Eurobond, an option that once again may run into political economy considerations.

A third option is for the Eurosystem to expand its Securities Lending Facility (SLF), modifying its quantities, pricing, and counterparties requirements. For instance, current limits on quantities lent could be removed, and the pricing would be set closer to the deposit facility rate. Moreover, this facility could be made available to non-banks. This would *de facto* provide an access to non-banks to secured deposits with the Eurosystem and would make it closer to the Federal Reserve Overnight Reverse Repo Programme (ONRRP).

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