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Keywords: Investment funds, dash-for-cash, corporate bonds, Eurosystem collateral eligibility

JEL codes: G11, G23

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1 Introduction

Global corporate bond markets witnessed severe price dislocations during the onset of the Covid-19 pandemic. The sudden drop in bond prices was driven by managers of open-end investment funds trying to finance redemptions by selling the underlying assets, and a reluctance of dealers to expand their inventories to accommodate the surge in demand for liquidity. In the euro area, redemption volumes of open-end bond funds reached a peak during the month of March 2020, corresponding to nearly 10 percent of assets under management (see Figure 1).

[Figure 1 about here]

In this study, we examine whether Eurosystem collateral eligibility of corporate bonds played a role in the portfolio choice decisions of euro area asset managers during this so-called dash-for-cash episode. Our broader aim is to improve our understanding as to what extent the Eurosystem collateral framework played a stabilising role during that period and whether there is room for improvement of the current arrangements.

Using a panel regression analysis, we study to what extent asset managers changed their allocation towards ECB-eligible corporate bonds in Q1 2020. Our findings show that managers reduced the share of eligible corporate bonds in their portfolios, while simultaneously increasing their cash holdings. We corroborate these findings by analysing holding level data and confirming that mutual funds reduced their holdings of ECB-eligible corporate bonds in Q1 2020 to a larger extent than they reduced other holdings. Turning to the price impact of these portfolio choices, we find evidence of price pressure for both ECB-eligible and ineligible corporate bonds. Bonds that were held to a larger extent by the investment fund industry in our sample experienced higher price pressure, although the impact was lower for ECB-eligible bonds. These results suggest that the liquidity provided by banks and dealers was not sufficient to mitigate price dislocations in the euro area corporate bond market.

Our findings add weight to the case for extending central bank refinancing facilities to non-bank financial institution (NBFI) counterparties, including asset managers. While it should not be seen as a sufficient measure to address the risks associated with liquidity mismatches in open-end investment funds in and of itself, extending central bank refinancing to asset managers may help to reduce short-term selling pressure during periods of large redemptions. In other words, if asset managers had been able to take out loans directly from the central bank against eligible corporate bonds, they would have needed to divest fewer bonds at distressed prices, reducing the price pressure. This would have alleviated the systemic impact of the redemption wave on other parts of the financial system.

2 Related Literature

As the economic ramifications of the Covid-19 pandemic started to unfold in March 2020, global financial markets experienced a number of dislocations, driven by a common surge in demand for liquidity. This so-called dash-for-cash episode has been widely studied. Severe price dislocations have been documented in the U.S. treasury market, due to forced selling by hedge funds, which had attempted to exploit small yield differences through leverage (Schrimpf et al., 2020). Initial price movements gave rise to variation margin calls, forcing these investors to unwind their positions, leading to a self-reinforcing "margin spiral" of illiquidity, growing price dislocations, and tighter margin requirements (Brunnermeier and Pedersen, 2008).

Price dislocations were particularly pronounced in the corporate bond market. Here, the impetus was driven by large redemptions from open-end investment funds. Between the months of February and March, the average U.S. investment fund experienced cumulative outflows of nearly 10% of net asset value (Falato et al., 2021a). Funds that invested in more illiquid bonds experienced larger outflows, but followed a liquidation pecking order whereby they sold more liquid assets to finance redemptions (Ma et al., 2022). The impact of these flows was compounded by a reluctance of primary dealers to absorb inventory and expand their balance sheets. There was a concomitant shift in trading from risky-principal to agency trades, while the willingness of customers to pay for immediacy rose dramatically (Kargar et al., 2021). Trading volumes shifted to liquid securities, with soaring transaction costs and inverted trade-size pricing, while inventories of non-primary dealers shrank (O'Hara and Zhou, 2021). The price dislocations that resulted from this dynamic caused investment-grade corporate bonds to trade at significant discounts to credit default swaps (Haddad et al., 2021).

Similar patterns have been documented in the euro area (EA), with peak daily redemptions reaching 10 percent of net asset value for individual funds (Claessens and Lewrick, 2021). Figure 2 shows the impact on credit spreads for an index of EA corporate bonds. Using data for Irish investment funds, Dunne et al. (2023) found that funds applying price-based liquidity management tools (such as redemption fees and anti-dilution levies) experienced smaller outflows; bonds held to a larger extent by such funds in turn experienced smaller yield changes. Using euro area data on repo transactions, Breckenfelder and Hoerova (2023) found that banks reduced repo financing to funds during the same period, increasing the need for selling bonds to finance redemptions, although the tightening was smaller for bonds eligible as Eurosystem collateral. However, funds with closer ties to banks experienced lower outflows, as banks compensated redemptions by third party investors in the fund through purchasing fund units (Bagattini et al., 2023).

[Figure 2 about here]

The imbalances in the secondary market also spilled over to the primary market, with a sharp decline in issuance volumes raising concerns about spillovers to the real economy, through hampering the ability of non-financial corporates to raise the credit needed to bridge the anticipated demand shock. In response to these disruptions, the ECB announced that it would purchase up to EUR 750 billion worth of bonds under its Pandemic Emergency Purchase Programme, and the Federal Reserve introduced new facilities allowing it to outright purchase investment-grade bonds issued by U.S. corporates. These measures were designed to bolster liquidity and reduce the costs and risks of intermediating corporate debt, and had a near-immediate effect upon their announcement, leading to a sharp decline in demand for liquidity and a concomitant rise in primary issuance volumes. A discussion about the policy implications of these events has followed, with proposals ranging from those arguing that central banks should act as a market maker of last resort (MMLR), to those more modest in scope, proposing that they should instead enhance existing refinancing facilities, with respect to what collateral and which counterparties to accept in these operations.

O'Hara and Zhou (2021) argue that the actions of the Federal Reserve during the Covid-19 crisis already constitute a *de facto* testament to central banks' new MMLR role, claiming that such a new direction is warranted by how the nature of crises has changed. The notion of a MMLR was first articulated by Buiter and Siebert (2007). The authors suggested that central banks should stand ready to tackle dysfunction in securities markets relevant to monetary or financial stability by making two-way prices to buy and sell those securities. Critics of this notion argue that buying assets may be warranted under a loose monetary policy stance, but would not be called for in a high-inflation environment. The promise of future outright purchases may also create moral hazard, giving investors incentives to take more risk, knowing that the central bank will act as a backstop, taking on both credit and liquidity risk in case of market dysfunction. Furthermore, purchases can have detrimental effects on market liquidity in the longer run, by creating uncertainty around the central bank's exit date, i.e., whether ownership of the bonds will be rolled, held until maturity, or sold as and when market conditions improve (Tucker, 2014).

By contrast, when the central bank provides liquidity through repurchase agreements (repos) or loans against collateral, prices are still determined by market forces. Providing liquidity through an enhanced standing facility would thus not affect the monetary policy stance to the same extent as through an MMLR. In addition, the term and pricing of the loans are known *ex ante*, although they can be rolled if needed. Prior to the pandemic, there were already commentators arguing for the role of central bank balance sheets as a macroprudential tool to mitigate liquidity shocks, and the importance of increasing *ex ante* transparency around the terms and conditions for its refinancing operations (Fisher, 2018). The core idea goes back to the notion that central banks are natural candidates for acting as a lender of last resort (LOLR), commonly attributed to the 19th century economist Walter Bagehot. Tucker (2014) has summarised his core dictum as follows: to avert panic, central banks "should lend freely to solvent but illiquid firms against good collateral at a high rate of interest". Critics of an enhanced refinancing facility argue that it can still give rise to moral hazard, through giving incentives to invest in less liquid assets, knowing that they can be refinanced with the central bank in a crisis. However, as argued by Fisher (2018), these incentives can be reduced if the central bank makes it clear that it will only provide refinancing against high quality collateral, along with being transparent about the terms and conditions (i.e., haircuts and lending rates).

The ECB's collateral framework is often highlighted as an example in this context, because of a number of features that makes it stand out from peers. The ECB provides liquidity through overnight funding or through its main refinancing operations. Overnight funding is made available to eligible banks in the Eurosystem, against a broad list of collateral published on its website on a daily basis, together with the applicable haircuts.

Crucially, the list of eligible collateral has included a broad universe of investment-grade corporate bonds from the start. The loans provided in its main refinancing operations are made against the same collateral, have a fixed term of one week and are priced below the rate on its marginal lending facility, but above the rate on its deposit facility. The ECB has also operated under a fixed rate-full allotment regime since 2008, meaning that it provides unlimited reserves to eligible counterparties on demand, sometimes referred to as an *ample reserves regime*. Moreover, since there is virtually no repo market for corporate bonds in the euro area, there is no stigma attached to entering into refinancing transactions with the ECB, using corporate bonds as collateral (Bindseil et al., 2017). As noted by Cecchetti and Schoenholtz (2022), the transparency of the Eurosystem collateral framework reduces moral hazard, compared to the case where the ECB would, say, commit to provide refinancing on a more discretionary basis: when it declares there is a crisis, and against whatever collateral the eligible counterparties might have.

Prior studies have shown that corporate bonds that become eligible as collateral in the Eurosystem trade at lower yields, a so-called eligibility premium that arises because of the near cash-like feature the bonds acquire on account of being pledgeable with the ECB. Eligibility also increases activity in the securities lending market, but reduces trading activity and hence the liquidity of newly issued bonds, as banks increase their inventories, hoarding the assets on account of their usefulness for refinancing purposes (Pelizzon et al., 2023).

A key question that has been raised in the aforementioned policy discussion is whether central banks should provide liquidity on demand to counterparties other than banks. Proponents of this idea argue that NBFIs have come to play a more prominent role in the financial system, after the reforms implemented following the Global Financial Crisis of 2008-2009 (GFC), accounting for nearly half of global financial assets according to a recent estimate (FSB, 2022). Moreover, fluctuations in liquidity demand increasingly stem from corresponding parts of the financial sector these days, driven, inter alia, by fund redemptions and margin requirements on derivatives transactions (Hall, 2021; Bailey, 2021). Critics argue that banks can act as an intermediary between the central bank and the NBFI sector, so there is no need to extend a direct facility, and that doing so would unduly increase moral hazard (Tucker, 2014). But the evidence from the dash-for-cash episode indicates that banks do not sufficiently fill the role of intermediary during episodes of severe market strain.

There may be several reasons why banks choose not to fully satisfy demand for liquidity during times of crisis. Firstly, banks may be worried about their own ability to meet regulatory liquidity requirements during episodes of market strain, choosing to hoard liquidity for themselves, rather than act as a conduit between central banks and the NBFI sector. Secondly, repo transactions are a low-margin business, and capital requirements for market risk have increased, meaning that banks may have lower incentives to engage in securities lending or repos than before. This can create frictions, forcing NBFIs to sell assets at distressed prices, which might have been avoided had they been able to borrow funds using the assets as collateral (Fontaine et al., 2021).

In a recent report by the Advisory Scientific Committee of the European Systemic Risk Board, Buiter et al. (2023) make the case that central banks in advanced economies should consider formalising the terms and conditions according to which they would intervene in securities markets in the future. A number of key design features are discussed for an enhanced LOLR, as well as a MMLR facility. For the LOLR facility, they argue that the list of counterparties should be restricted to regulated and supervised entities, in order to ensure their solvency. Beyond this limitation, the "facility could be open to brokers, dealers, asset managers, MMFs, pension funds, insurance companies, finance companies and certain types of investment companies, including hedge funds" (Buiter et al., 2023). The goal of both facilities would be to ensure that financial markets function normally.

When choosing between the two, "the natural choice would be to lend and, to the extent possible, allow private agents to determine securities prices and allocate capital resources" (ibid). In other words, an enhanced LOLR would be preferable whenever possible.

Our paper contributes to this discussion, as well as to the empirical literature on strains in the corporate bond market during the dash-for-cash episode. Since the Eurosystem already included corporate bonds in its list of eligible collateral – unlike the Federal Reserve – the episode provides a case study as to what extent the framework contributes to stabilising the market during large redemption waves. While previous studies have shown that US investment funds divested primarily more liquid bonds to finance redemptions (Ma et al., 2022), this paper is the first to study the role Eurosystem collateral eligibility played in portfolio adjustments by asset managers.

We focus our empirical study on the corporate bond market, for two reasons. First, funds that invest in corporate bonds are known to be particularly susceptible to runs, since corporate bonds are typically less liquid than sovereign bonds, which aggravates strategic complementarities in redemption decisions (Chen et al., 2010; Goldstein et al., 2017). These arise from the fact that investors can typically redeem their fund units at a daily fixed net asset value, with the cost of subsequent portfolio adjustments borne by remaining investors, creating a first-mover advantage. The second, and related reason is that the corporate bond market is of crucial importance for financial stability. Following the GFC, euro area firms have increasingly turned to financing themselves using corporate bonds, and less with bank loans (Cappiello et al., 2021). The dash-for-cash episode showed that, by flooding the secondary market with an excess of supply, a wave of fund redemptions can also spill over to the primary market, making it more difficult or costly for firms to issue new bonds. Runs on investment funds can thus contribute to a corporate credit crunch, in a similar way to runs on banks. In addition, fire sales by mutual funds more generally hurt the performance of all financial agents holding the same assets (for evidence of systemic spillovers in debt markets, see Falato et al., 2021b).

Finally, the results of our empirical study have broader policy implications for the discussion on how central banks can mitigate such liquidity shocks in the future. In line with Buiter et al. (2023), we argue that an enhanced LOLR facility has significant advantages over outright asset purchases, and believe that our study is relevant for the discussion as to which counterparties should be included as eligible for such a facility – specifically whether it should be extended to asset managers. On the one hand, corporate bonds eligible as collateral in the Eurosystem are more valuable to dealers, since they can be pledged with the ECB in exchange for funding. We would therefore expect dealers to have shown a preference for purchasing such bonds during the studied period. By increasing the willingness of dealers to expand their inventories of eligible assets during episodes of market strain, the collateral framework might be seen to perform a stabilising role. On the other hand, asset managers would benefit more from being able to fund redemptions without having to sell assets at distressed prices. This would also reduce the price pressure in the corporate bond market, causing fewer spillovers and higher systemic stability. In Appendix A, we elaborate on this argument by developing a theoretical model, in which asset managers have the choice to fund redemptions either by selling their risky holdings at distressed prices or by obtaining the necessary funds via collateralised borrowing. Our results suggest that collateral pledgeability reduces asset managers' need to divest assets at unfavourable prices and improves the overall social welfare in the economy. To the extent that asset managers trust banks/dealers to act as intermediaries with the ECB and provide them with liquidity, we would hence expect funds to have divested proportionally less high-quality bonds that might be used as collateral for such funding.

Whether asset managers increased or decreased their allocation to ECB-eligible corporate bonds thus provides us with an indication as to what extent banks/dealers were willing to provide the mutual fund sector with liquidity against these, versus to what extent they were draining the sector of high-quality assets at distressed prices, for which they had access to a guaranteed source of funding. If the latter were the case, it would imply that banks did not act sufficiently as a conduit between the central bank and other parts of the financial system, supporting the argument that an enhanced LOLR facility should be extended to asset managers.

3 Pledgeability in practice

We use the term *pledgeability* to denote an asset manager's ability to obtain funding against a risky asset pledged as collateral with the lender, as a means to finance redemptions. Due to the fact that asset managers are not eligible as counterparties in the Eurosystem, the source of funding would in practice be a private bank or dealer. There are a number of different ways such funding could be arranged in practice, each with different implications in terms of ownership and right to dispose of the asset being pledged as collateral. These in turn have different implications for the hypotheses we will be testing in the empirical study. The main alternatives are i) obtain a loan; enter into ii) a repo agreement; or iii) a securities lending agreement. These are briefly discussed under separate headings below.

Margin loans or lines of credit

Under this option, the asset manager would obtain a loan from a lender, pledging the risky asset as collateral. The collateral would typically be deposited in a custodian account and the asset manager would retain legal ownership of the asset. Following the implementation of Directive 2002/47/EC on financial collateral arrangements, EU lenders have been given the right to reuse collateral on certain conditions, making such loans more attractive to the lender. In concrete terms, it means that a bank could pledge securities obtained as collateral for a margin loan to an asset manager as collateral for ECB refinancing. We would expect asset managers who are fully able to fund redemptions using this means to retain an unchanged allocation to bonds eligible as Eurosystem collateral, since they would retain legal ownership of the assets pledged as collateral for the loans and would not have to sell any risky assets to finance the redemptions. To the extent that asset managers would also have to sell risky assets to finance the redemptions, we would expect them to sell bonds not eligible as Eurosystem collateral, because lenders would be likely to prefer collateral pledgeable with the ECB.

Repo agreements

Under this option, the asset manager would i) sell the risky asset to a dealer and ii) simultaneously agree to buy it back at a fixed price in the future. The repurchase price would be based on the sales price plus an accrued interest rate (the repo rate). In this case, the legal ownership of the risky asset would change hands, meaning that the dealer can dispose of it freely and use as collateral to obtain secured funding itself. We would expect an asset manager able to fully fund redemptions using this means to have a lower allocation to bonds eligible as Eurosystem collateral following the transaction. This is because the dealer is likely to have a preference for entering into a repo on a bond pledgeable with the ECB, knowing that it comes with a guaranteed source of funding. It should be noted that there is virtually no private repo market for corporate bonds in the euro area, meaning that this option would not be available for asset managers in the case of this asset type.

Securities lending

The securities lending market allows dealers to obtain access to assets without purchasing them outright, by borrowing them in exchange for another asset or (less commonly in Europe) cash as collateral. In order to use this approach as a means to finance redemptions, an asset manager could lend a risky asset to a dealer, in exchange for cash as collateral. The asset manager would retain the legal ownership of the asset but the dealer would obtain the right to dispose of it, meaning that it could be used to obtain secured funding. We would expect asset managers to have an unchanged or increased allocation to bonds eligible as Eurosystem collateral following this transaction, since they would retain legal ownership of the loaned assets. In case they would also need to sell other assets to finance redemptions, it is likely that they would be selling bonds not eligible as Eurosystem collateral, knowing that dealers would have a preference for borrowing assets pledgeable with the ECB.

To summarise the above discussion, we would expect asset managers who were able to finance redemptions by either loans or securities lending agreements to have an unchanged or higher allocation to corporate bonds pledgeable with the ECB, following said transactions. Since there is no private repo market for corporate bonds in the euro area, these would be the two main alternatives to finance redemptions, other than selling the bonds outright. This leads us to derive a set of testable hypotheses for the empirical analysis in the following sections.

Hypothesis 1: Asset managers were able to finance redemptions – to a considerable extent – by obtaining loans from banks or through securities lending agreements with dealers. Their allocation to corporate bonds pledgeable with the ECB increased as a consequence of this, on account of higher demand for these assets as collateral for bank loans, or from dealers wishing to borrow them.

Hypothesis 2: Asset managers were not able to finance redemptions by obtaining loans from banks or through securities lending agreements with dealers, at least not to a significant extent. They were instead forced to sell risky assets. Their allocation to corporate bonds pledgeable with the ECB decreased as a consequence of this, due to higher demand for these assets from dealers.

4 Data and Methodology

4.1 Data sources

The three main data sources used in this study are the European Central Bank (ECB) list of eligible marketable assets, Refinitiv Lipper, and Refinitiv Workspace.

The ECB's list is a comprehensive collection of financial instruments that are eligible to be used as collateral in the Eurosystem's operations. The list is maintained and updated on a daily basis by the ECB and is used as a reference for financial institutions that participate in Eurosystem's operations, such as lending and monetary policy operations.

Refinitiv Lipper is a commercial financial database that provides comprehensive and up-to-date information on investment funds. Among other information, it includes data on funds' characteristics and performance, granular holding-level data on funds' portfolios.

Refinitiv Workspace is a commercial financial time series database that provides historical information on transaction volumes, prices, and bid-ask spreads of financial assets and securities.

Both the ECB list of marketable assets and Refinitiv Lipper's holdings contain the International Securities Identification Number (ISIN) of the individual securities which allows a one-to-one merge of both sources, as well as obtaining historical price information from Refinitiv Workspace.

4.2 Data processing and descriptive statistics

We compile the daily lists of Eurosystem-eligible marketable assets into a quarterly panel covering the period Q1 2015 to Q2 2020. In each quarter, an asset is considered ECB-eligible if it appears on the list at least once in that quarter.

In the Lipper database, we define the scope of our study by identifying euro area-domiciled, corporate bond-holding investment funds that reported at least ten different holdings in Q4 2019 and among them at least one ECB-eligible bond, resulting in a universe of more than 2,000 candidate funds for the analysis. All available holdings for these funds were extracted for the quarter-end reporting dates between Q1 2015 and Q2 2020. We categorise the fund holdings into cash, corporate bonds, sovereign bonds, term notes, derivatives, repurchase agreements, and other using both Lipper's asset type variable and supplementary sources of information.[1] Within the corporate bond category, we differentiate between bank bonds and non-bank corporate bonds. There are several reasons for doing so. To start with, many prior studies of the dash-for-cash have not made this differentiation (Breckenfelder and Hoerova, 2023; O'Hara and Zhou, 2021). Our paper thus contributes to the empirical literature by examining whether the impact of the redemption wave was stronger for bonds issued by banks or non-financial corporates. Second, we are primarily interested in examining the impact on bonds issued by the latter category, since the potential spillover to the primary market for these issuers was cited as a key reason for the policy measures taken by central banks to mitigate the

[1] Asset categorisation is not a trivial exercise as, depending on the source of information, the same asset can be assigned into different categories. We employ different approaches to categorise the assets, which are described in more detail in Appendix B.1. As a general rule, assets are referred to as cash if Lipper's asset type is one of the following: "Cash", "Cash Equivalent", "Currency". Assets are referred to as corporate bonds if asset type is: "Corporate Medium Term Notes", "CORP", "Global Bonds", or "Corporate Intermediate and Long Term Debt", "Bank Debt". Assets are referred to as sovereign debt (in a broad sense) if asset type is: "Treasury STRIPS", "Supranational", "Treasury Bills", "Sovereign Bond", "MUNI", "Government other", "Agency Medium Term Notes", "Agencies".

liquidity strain in the corporate bond market. Since then, it has been highlighted as a key transmission channel for systemic risk. While banks that run into financing problems may also contribute to systemic risk, the policy implications are fundamentally different, as there is a comprehensive safety net in place to deal with liquidity problems in banks.

We furthermore restrict the fund sample by requiring the average quarterly share of corporate (sovereign) bonds to be above (below) 25% over the considered sample period, which reduces our final sample to 766 individual funds. We supplement the holding-level data with quarterly ECB-eligibility information using the above-mentioned list of eligible marketable assets and construct a dummy variable *ECB-eligible* that equals one if an asset is Eurosystem-eligible in a given quarter, and zero otherwise. The proportion of eligible and ineligible corporate bonds in each fund's portfolio is then calculated in terms of aggregated par value for each quarter within the sample period; we refer to this variable as *ECB-eligible corporate bond share*. The reason for using par value as opposed to market value, is that we are interested in portfolio changes due to discretionary allocation choices. Hence, we want to avoid contaminating the results with changes caused by diverging relative price fluctuations in the groups. Finally, we define a *COVID* dummy variable taking the value of one for Q1 2020, and zero otherwise. In the following, we refer to the aggregated data set with fund-quarter observations as the fund-level panel, while the disaggregated data set with fund-holding-quarter observations is called the holding-level data set.

For the price analysis, we obtain for all corporate bonds held by the sample of our funds in Q1 2020 the daily information on the yield to maturity and the bid-ask spreads from Refinitiv Workspace for the period 31.12.2019 to 31.03.2020. We define the yield spread as the difference between the bond's end-of-day yield to maturity and the maturity-matched risk-free rate, derived from the German Bund yield curve.[2] The bonds are supplemented

[2]The risk-free rate is based on the Nelson-Siegel-Svensson yield curve, with the parameters estimated from Bund yields and taken from the Deutsche Bundesbank's website. We compute the yield spread

with daily ECB-eligibility information. Furthermore, we construct for each bond the variable *% held by industry in 2019*, which is the defined as the aggregate percentage share of the outstanding bond amount that was held by mutual investment funds in the Lipper database at the end of December 2019.

The descriptive statistics are reported in Table 1. Panel A presents the statistics at the fund level; the average fund has a market value of EUR 731.5 million and holds about 287 individual assets. Cash represents about 2% of total holdings, while corporate and sovereign bonds comprise 80% and 6% of the portfolio's market value, respectively. About 26% of corporate holdings are ECB-eligible. During the sample period, we observe on average net fund inflows of about 3%. The holding level sample, Panel B, is comprised of 52,750 individual bonds. The funds' mean par value corporate bond exposure is about EUR 2.1 million. The quarter-on-quarter change in the par value exposure is -10%. In terms of bond currency (not reported in the table), the sample consists of 53.6% USD-, 33.5% EUR-, 5% GBP-, 1.7% CHF-, 1.5% CAD-, and 1.1% SEK-denominated bonds. About 46% (26.8%) of EUR (GBP)-denominated bonds are ECB-eligible. Panel C reports the summary statistics for the 6,032 corporate bonds that are used in the price-level analysis. The average bond's principal amount is EUR 633 million, the yield to maturity is 1.48% and the bid-ask spread is 0.27. At the end of year 2019, the mutual fund industry held on average 5% of the bonds' outstanding amount, with certain bonds being clearly the preferred choice (as shown by the 28%-share in the 99th percentile).

[Table 1 about here]

following Dick-Nielsen et al. (2012) and Friewald et al. (2012).

4.3 Methodology

4.3.1 Fund-level analysis

The methodology applied for the fund-level analysis is based on Ordinary Least Squares (OLS). To study the mutual funds' allocation decisions during redemption waves, we use the following baseline regression equation:

$$y_{it} = \alpha + \beta COVID_t + Fund\ controls_{it} + Trend_t + \gamma_i + \delta_{ih} + \epsilon_{it}, \tag{1}$$

where the variable of interest, y_{it}, is defined as the proportion of ECB-eligible corporate bonds relative to the total face value of all corporate bonds held in the portfolio by fund i at time t. $COVID_t$ is a dummy variable that equals one in Q1 2020, and is zero otherwise. $Fund\ controls_{it}$ account for fund-specific time-varying characteristics. These include the lagged dependent variable, lagged fund size, and lagged sovereign bond share. The former variable accounts for autocorrelation, fund size absorbs any size-specific portfolio allocation effects, and lagged sovereign share controls for asset managers' preference to sell the more liquid assets first. The time trend variable, $Trend_t$, accounts for aggregate time-specific trends in the mutual fund industry. The fund fixed effects, γ_i, absorb any unobserved fund-specific characteristics such as management style or investment strategy. The fund-half-year fixed effects, δ_{ih}, account for any variables that are specific to a particular fund, and that vary at a low, bi-annual frequency. ϵ_{it} is the error term.

4.3.2 Holding-level analysis

To study the mutual funds' allocation decisions at the holding level, we use the following baseline regression equation:

$$y_{ijt} = \alpha + \beta \mathit{COVID}_t * \mathit{ECB\text{-}eligible}_{jt} + \mathit{Bond\ controls}_{ijt} + \zeta_{it} + \theta_{jh} + \epsilon_{ijt}, \tag{2}$$

where the variable of interest, y_{ijt}, is either (i) the relative quarter-on-quarter change in the par value of holding j in fund i at time t, or (ii) the logarithm of the corporate bond par value of holding j in fund i at time t. $\mathit{ECB\text{-}eligible}_{jt}$ is a dummy variable indicating whether bond j is pledgeable with the Eurosystem at time t. $\mathit{Bond\ controls}_{ijt}$ are: (i) the lagged logarithm of the holding j's par value held by fund i at time t and (ii) a dummy variable that equals one if a bond matured in time t. The former covariate controls for autocorrelation, while the latter accounts for the mechanical reduction in the bond holding due to the bond having matured. Fund-quarter fixed effects, ζ_{it}, absorb any unobserved time-varying fund-specific characteristics, such as fund's popularity among investors. The bond-half-year fixed effects, θ_{jh}, account for unobserved low-frequency time-varying bond-specific characteristics, such as credit rating changes.

4.3.3 Price impact analysis

To study the impact of mutual fund redemption waves on secondary market bond prices, we use the following regression equation:

$$\begin{aligned} y_{jt} = \alpha &+ \beta_1 \mathit{COVID}_t * (\%\ \mathit{held\ by\ industry})_j * \mathit{ECB\text{-}eligible}_{jt} \\ &+ \beta_2 \mathit{COVID}_t * (\%\ \mathit{held\ by\ industry})_j + \beta_3 \mathit{COVID}_t * \mathit{ECB\text{-}eligible}_{jt} \\ &+ \beta_4 \mathit{COVID}_t + \beta_5 \mathit{ECB\text{-}eligible}_{jt} + \beta_6 (\%\ \mathit{held\ by\ industry})_j \\ &+ \beta_7 \mathit{Principal\ amount}_j + \beta_8 \mathit{Time\text{-}to\text{-}maturity}_{jt} + \omega_i + \tau_t + \epsilon_{jt} \end{aligned} \tag{3}$$

where the variable of interest, y_{jt}, is either (i) the yield spread of bond j on day t, or (ii) the bid-ask spread. $COVID_t$ is a dummy variable that equals one in March 2020, and is zero otherwise. $ECB\text{-}eligible_{jt}$ is a dummy variable indicating whether bond j is pledgeable with the Eurosystem on day t. $\%\ held\ by\ industry_j$ denotes the share of the bond's outstanding value held by mutual fund industry at the end of the year 2019. To control for any size or time-related price effects, we include (i) $Principal\ amount_j$, which is defined as the logarithm of the principal amount of bond j and (ii) $Time\text{-}to\text{-}maturity_{jt}$, which measures the remaining time to maturity of bond j at time t. The bond fixed effects ω_i absorb any unobserved bond-specific characteristics, such as credit rating or country of risk. The day fixed effects τ_t control for any aggregate market movements that are not bond-specific.

5 Results

Fund-level findings

As described in the previous section, we run panel regressions to determine whether the asset managers in our sample increased or decreased their allocation to bonds eligible as Eurosystem collateral during the redemption wave in Q1 2020. The results are presented in Table 2.

[Table 2 about here]

The first model focuses only on two periods, Q4 2019 and Q1 2020, and motivates our analyses. We can observe that during the COVID outbreak mutual funds' share of ECB-eligible bonds (measured as a percentage of all corporate bond holdings in the portfolio) dropped by 1 percentage point. In the second model, we extend the time period to cover the full sample, controlling for fund fixed effects and the presence of a linear time trend. The inclusion of the time trend is motivated by the fact that there is a general decline of ECB-eligible corporate bond holdings in mutual funds' portfolio holdings over time, as shown by Figure 3.

[Figure 3 about here]

We also control for fund size, the allocation to ECB-eligible corporate bonds in the previous quarter, as well as the lagged share of sovereign bonds in the total investment portfolio. The rationale for the latter is that a higher share of sovereign bonds in the prior quarter may affect asset managers' propensity to change the allocation to ECB-eligible corporate bonds. The results tell us that the *COVID* dummy remains statistically significant, with a coefficient of -0.014.

To better understand the driving forces behind our findings, we run Models 3 to 4. In Model 3, we test whether asset managers' propensity to reduce the allocation to ECB-eligible corporate bonds is affected by the share of sovereign bonds at their disposal. Considering that sovereign bonds are typically more liquid than corporate bonds, it would be natural to follow a liquidation pecking order to finance redemptions, whereby sovereign bonds are sold prior to corporate bonds, in line with the findings of Ma et al. (2022). We define the variable *Outflows > Sov. share* as a dummy that equals one if fund outflows in a given quarter are larger than the share of sovereign bonds held by the fund in the previous quarter, and zero otherwise. The variable acts as a proxy for the fund's (in)ability to cover the outflows by selling its (more liquid) sovereign bond holdings. The variable has a significant and negative coefficient of -0.004, suggesting that funds experiencing outflows exceeding their sovereign bond holdings in general tend to reduce their allocation to ECB-eligible corporate bonds. However, the interaction term *COVID*(Outflows > Sov. share)* in Model 4 is both small in terms of magnitude and insignificant, suggesting that the scale of this behaviour did not differ during the dash-for-cash.

Studies have shown that bank-affiliation played a mitigating role in terms of the redemption volumes faced by euro area mutual funds during the dash-for-cash (Bagattini et al., 2023). To test whether bank-affiliation also affected the allocation to ECB-eligible corporate bonds, we introduce the variable *Bank-affiliated* in Model 4. *Bank-affiliated* is a dummy variable that equals one if the fund belongs to an investment company that (i) is a direct subsidiary of a bank, (ii) has a bank as the main shareholder, or (iii) is part of holding company that also holds a bank.[3] We would expect funds with a bank affiliation to keep their ECB-eligible assets in their portfolios as they could be pledged with the bank against a short-term loan that could finance the outflows. Our results, however, do not show any significant relationship between bank-affiliation and the allocation decision.

Our findings suggest that mutual funds reduce their relative share of ECB-eligible corporate bonds during redemption waves irrespective of the share of more liquid holdings or bank-affiliation. Potentially, we underestimate the immediate impact of redemptions on asset managers' allocation decisions since our panel is at quarterly frequency, while the market turmoil reached its peak in mid-March 2020 and then began to stabilise. Therefore, the end-of-March 2020 holdings partially reflect a market normalisation. In the Appendix C, we study whether a similar allocation decision takes place in times of idiosyncratic redemption shocks. For this purpose, we focus on individual funds experiencing large redemption flows. We define a large fund redemption as an outflow that exceeds 20% of the previous quarter fund size (measured at market prices). Fund-specific large redemption shocks are spread throughout the whole sample period and affect almost all funds at some point in time. The results of this analysis are presented in Table C1

[3]For instance, BNP Paribas Asset Management belongs to the first category since it is a subsidiary of BNP Paribas, Amundi Asset Management belongs to the second category since its main shareholder is Crédit Agricole, and Columbia Management Investment Advisers belongs to the third category since it is owned by Ameriprise Financial, which also owns Ameriprise Bank. One might argue that the third category is a very loose definition of bank-affiliation. For robustness purposes, we re-ran the analyses by defining bank-affiliation using only the first two categories. However, the results do not differ quantitatively or qualitatively and are available upon request.

and the findings suggest that the relative reduction of ECB-eligible corporate bonds in the portfolio also takes place at individual fund level; whenever a fund experiences high redemptions, it tilts its holdings towards ECB-ineligible corporate bonds.

Holding-level findings

One limitation with the above fund-level analysis is that the reduced allocation to ECB-eligible corporate bonds that we observe in Q1 2020 is not by itself evidence that asset managers were selling these bonds. A lower allocation could, in theory, also be caused by buying more ECB-ineligible bonds, although this is not likely to have been the case, given that we know that the funds experienced a redemption shock and had to sell assets to finance it. Nevertheless, in order to verify the extent to which asset managers actually sold ECB-eligible corporate bonds, we now turn to the individual holdings.

In the following analyses, we use two different dependent variables. The first one is defined as the quarter-on-quarter change in the par value of a bond held by a fund. This variable helps us to measure the relative change of a fund's exposure to an individual holding. The second variable is defined as the logarithm of a bond's par value. We use this variable for robustness purposes and to estimate the absolute EUR-value change in the fund's exposure to an individual asset. The results using the first dependent variable are presented in Table 3, while the results using the second one are reported in Table 4. In both cases, we restrict the sample to holdings of corporate bonds only and ignore funds' exposures to sovereign bonds and other asset categories.

[Table 3 about here]

[Table 4 about here]

The results in Table 3 and 4 are broadly consistent with the analysis at the fund level presented in Table 2. Model 1 in Table 3 suggests that during our sample period, funds are likely to increase their holdings of ECB-eligible bonds by 8.7 percentage points less compared to ineligible bonds. This is confirmed by the negative regression coefficient in Table 4, Model 1. The coefficient of -1.154 indicates that, all other factors being equal, a fund is likely to have approximately 68% less exposure to an eligible bond compared to one that is not. Model 2 in both tables, indicates that there was a significant reduction in the par value of ECB-eligible corporate bonds in Q1 2020, as measured by the interaction term *COVID*ECB-eligible*. This is evidence that asset managers sold these bonds to finance the redemption shock, and not only reduced their allocation to them.

Similar to the fund-level analysis, we also examine a number of additional interaction terms. In Model 3, we test whether our findings are driven by bank bonds. The positive coefficient of *Bank bond*ECB-eligible* reveals that asset managers in general tend to purchase and hold more ECB-eligible bank bonds as opposed to ECB-eligible bonds issued by non-financial corporates. However, during the Covid-19 outbreak, both bond categories were equally likely to be sold, as indicated by the insignificant triple interaction term. As before, bank affiliation does not seem to affect the results. Similar to the fund-level analysis, we find a significant negative relationship between the interaction of outflows exceeding the share of sovereign bonds held with ECB eligibility and both dependent variables. This indicates that mutual funds suffering outflows that exceed their sovereign bond holdings sell ECB-eligible corporate bonds in order to finance the redemptions, regardless of whether the redemption shock was systemic or idiosyncratic. In the Appendix, Tables C2 and C3, we find support for the above findings also on a broader scale, where we use large idiosyncratic fund outflows instead of the COVID dummy as the covariate of interest.

Taken together, our findings suggest that asset managers reduced their allocation to corporate bonds eligible as Eurosystem collateral during the dash-for-cash episode at the onset of the Covid-19 pandemic, selling them in order to finance the redemptions. The results hold up to a number of robustness checks, pointing to a rejection of Hypothesis 1 in Section 3, in favour of Hypothesis 2.

Price-level findings

In addition to the analysis of changes in fund allocation and holdings, we attempt to study the price impact of these portfolio choices. For this purpose, we focus on corporate bonds held by the mutual funds in our sample and study their price response during the COVID-induced market turmoil. The results are presented in Tables 5 and 6, where we focus on the bonds' daily yield spread and the bid-ask spread, respectively.

[Tables 5 and 6 about here]

Model 1 in Table 5 tells us that there was a general increase in the yield spread in March 2020, with a coefficient for the *COVID* dummy of 0.744. This corresponds to a yield increase of 74.4 bp. Turning to Model 2, we see that the increase was larger for ineligible corporate bonds (81.3 bp) and lower for ECB-eligible corporate bonds, with an increase of 61 bp. In Model 3, we introduce an interaction term between the COVID dummy and the percentage share of a bond's outstanding amount held by investment funds in our sample, as of Q4 2019. The coefficient of *COVID*(% held by industry)* is significant and positive at 3.230, telling us that bonds held to a larger extent by the investment fund industry experienced higher price pressure and spread increases during the dash-for-cash episode. In Model 4, we interact this term with the ECB-eligibility dummy. The results indicate that fund-driven price pressures were higher for ineligible bonds (coefficient of 3.900), but there was still a material and significant positive relationship between the aggregate fund exposure towards ECB-eligible bonds and their yield spread increase in March 2020. In Model 5, we introduce a distinction between corporate bonds issued by banks and those issued by non-financial corporates.

The coefficient of *COVID*ECB-eligible*Bank bond* is significant and negative at −0.474, indicating that ECB-eligible bonds issued by banks experienced lower spread increases during the dash-for-cash. On the other hand, the coefficient of *COVID*(% held by industry)*ECB-eligible*Bank bond* is significant and positive at 1.590. This suggests that ECB-eligible bonds issued by banks and held to a larger extent by the investment fund industry experienced higher spread increases, compared to bonds issued by non-financial corporates.

In terms of bid-ask spreads, Model 1 in Table 6 documents an increase during the dash-for-cash episode, while Model 2 suggests a slightly smaller positive net effect for ECB-eligible bonds. ECB-eligible corporate bonds had lower bid-ask spreads overall during the studied period, and the share of the outstanding amount held by the investment fund industry also bears a negative relationship with the size of the bid-ask spread. Model 3 tells us that the increase in the bid-ask spread during the dash-for-cash was higher, the larger the share of the outstanding amount held by investment funds, while Model 4 indicates that ECB-eligible bonds suffered a lower increase in the bid-ask spread. Model 5 shows that ECB-eligible bonds issued by banks faced a higher increase in the bid-ask spread, compared to those issued by non-financial corporates. Overall, the impact of the mutual fund industry is to increase the bid-ask spread during the dash-for-cash, but we do not observe any significant difference depending on whether the bonds are issued by banks or non-financial corporates.

Discussion of findings

One way to interpret our results is that asset managers of euro area investment funds follow a liquidation pecking order during periods of large redemptions, whereby corporate bonds eligible as Eurosystem collateral are sold prior to other corporate bonds. As discussed in Section 3, this is likely because they are more attractive to dealers, as they can in turn pledge the bonds as collateral in exchange for loans from the ECB, providing them with a guaranteed source of funding. Nevertheless, the sale of these bonds still generated significant price pressure, as evidenced by the results in Table 5.

In this context, it should be noted that there is a high degree of overlap between ECB-pledgeability and asset quality. The Eurosystem collateral framework only includes corporate bonds that have an investment grade credit rating. The fact that dealers were more willing to acquire bonds in this category may hence not necessarily be on account of their pledgeability as such, but could in fact be related to their higher credit quality more broadly. We have two reasons to believe that our results are not driven exclusively by the credit rating. First, the majority of the bonds in our holding level analysis is not EUR-denominated and therefore not ECB-eligible (with a few exceptions such as the GBP bonds). However, the foreign currency denominated bonds comprise both investment grade and non-investment grade bonds. This means that asset quality cannot be the main driver behind our findings. Second, to further verify what role pledgeability played, we examine ECB data on collateral usage. Figure 4 shows that usage of corporate bonds as Eurosystem collateral increased sharply between Q1 and Q2 2020. While one might have expected the increase to show up already in Q1, this may be impacted by the interval between the time that a dealer acquired a bond and entered into a refinancing agreement with the ECB. It may be noted that the peak in bond fund redemptions occurred around the middle of March (see Figure 1), meaning it is quite plausible that the time lags in question caused the reported collateral usage to spill over into Q2. Overall, the data indicate that dealers were using the ECB-pledgeable bonds they acquired from asset managers to obtain funding from the ECB, providing tentative support for our interpretation that pledgeability was indeed a key factor in increasing their willingness to acquire these.

[Figure 4 about here]

At the same time, the funds in the sample increased their cash holdings substantially in the first quarter of 2020, more than doubling them (see Figure 5). This means that, while the funds followed a pecking order in terms of the bonds they chose to divest, they simultaneously increased their cash holdings, meaning that they sold more bonds than strictly necessary for financing redemptions. These results confirm prior studies finding evidence of pro-cyclical cash hoarding by asset managers, during periods of large redemption volumes (Morris et al., 2017).

[Figure 5 about here]

Our findings contribute to previous studies of price dislocations in the corporate bond market during the onset of the Covid-19 pandemic, and have relevant implications for the policy discussion about the role of central banks in mitigating similar types of liquidity shocks. To start with, the fact that asset managers followed a pecking order in terms of the corporate bonds they chose to divest improves our understanding of asset managers' portfolio choices during periods of stress, adding nuance to existing evidence of distress in the corporate bond market during the pandemic (Falato et al., 2021a; Haddad et al., 2021; Kargar et al., 2021; O'Hara and Zhou, 2021), suggesting that dealers were more prone to increase their inventories of bonds eligible as Eurosystem collateral, likely because of higher demand for these on account of their pledgeability with the ECB and consequent near cash-like features. By increasing the willingness of dealers to expand their inventories of eligible assets during episodes of market strain, the Eurosystem collateral framework might thus be seen to fill a stabilising role.

The fact that asset managers simultaneously increased their cash holdings, at the same time adds nuance to the findings of Pelizzon et al. (2023), who show that corporate bonds that become eligible as Eurosystem collateral acquire near cash-like features due to their pledgeability with the ECB. Our results suggest that while they may acquire cash-like features for banks in the Eurosystem, this is not the case for asset managers

- who are not eligible as counterparties in the ECB's main refinancing operations. In our theoretical model, the utility of asset managers increases with the extent to which they can pledge assets as collateral in exchange for funding to finance redemptions, and decreases with the extent to which they have to divest assets at distressed prices to do so. The fact that asset managers sold proportionally more bonds eligible as Eurosystem collateral thus suggests that they were unable to pledge corporate bonds in exchange for funding from banks or dealers, considering that it would otherwise have been more valuable to hold on to assets with such high degree of fungibility, given their higher likelihood of being accepted as collateral.

Turning to the policy implications, the results add weight to the argument that central banks considering to set up an enhanced LOLR facility should consider the benefits of extending it to asset managers.[4] If asset managers had been able to take out loans directly from the ECB against corporate bonds eligible as Eurosystem collateral, they would have needed to divest fewer bonds at distressed prices, reducing the price pressure. This would have improved the utility of asset managers (and the fund investors) themselves, and reduced the systemic impact of the redemption wave on other parts of the financial system. Extending refinancing facilities to asset managers would thus strengthen the function of central bank balance sheets as a macroprudential tool during periods of surging demand for liquidity.

While the theoretical model we present in Appendix A implies a continuous increase in asset manager utility, the more redemptions can be financed with loans against collateral, there are important real-world limitations to this case that should be considered. As an overall constraint, the UCITS directive (2009/65/EC) stipulates that UCITS funds may borrow up to 10 percent of the net asset value of the fund on a temporary basis. In addition, asset managers may have internal or supervisory limits on the amount of

[4] In fact, the Federal Reserve Act of 1913, Section 13(3), provides for this possibility under unusual and exigent circumstances (Labonte, 2020).

leverage they can assume, in addition to limitations in the form of the haircuts the ECB imposes. In case the volume of redemptions financed with loans becomes so large that these limits are close to being reached, it may trigger increasing first-mover incentives to redeem fund shares prior to the point where the fund has to start divesting assets. In case the asset manager has reasons to believe an initial redemption shock to be permanent, it would thus be more prudent to use central bank refinancing as a short-term solution to finance redemptions, i.e. as a means to buy the time to spread bond divestments out over a longer period, thus reducing the price impact - as opposed to rolling the loans until the point when the assets backing them mature (as implied by the theoretical model).

As such, extending central bank liquidity facilities to asset managers should not be considered in isolation, but as part of a broader range of regulatory and supervisory policy reforms to address the structural problems associated with liquidity mismatches in open-end investment funds. These include measures such as swing-pricing, redemption gates and generally matching redemption terms to the liquidity of the assets invested in by the fund. Notwithstanding these caveats, to the extent that it may help to reduce the selling pressure during periods of large outflows, we argue that extending central bank refinancing to asset managers can be considered as a component of the broader solution, as it would improve financial stability through the greater flexibility it confers on investment funds to finance redemptions.

6 Conclusion

In this paper, we study the role of the Eurosystem collateral framework in the portfolio choices of euro area asset managers during the dash-for-cash episode. We find that asset managers reduced their allocation to corporate bonds pledgeable with the ECB, selling them in order to finance redemptions, while simultaneously increasing their cash holdings.

We also find evidence of price pressure associated with these portfolio choices, although the yield impact was lower for ECB-eligible corporate bonds. These findings improve our understanding of asset manager portfolio choices during redemption waves, suggesting that euro area asset managers follow a liquidation pecking order when selling bonds to finance redemptions, whereby corporate bonds pledgeable with the ECB are divested prior to non-pledgeable bonds. On the one hand, the Eurosystem collateral framework may thus be seen to have played a stabilising role in the corporate bond market during the dash-for-cash, in that pledgeability increased the willingness of dealers to expand their inventories of corporate bonds. On the other hand, it also implies that banks/dealers were unwilling to either extend credit or enter into securities lending agreements with investment funds against cash collateral. Asset managers were hence forced to sell the bonds at distressed prices instead, contributing to further price pressure. We argue that these findings add weight to the case for central bank liquidity facilities to be extended to asset managers. If asset managers had been able to take out loans directly from the central bank against corporate bonds eligible as Eurosystem collateral, they would have needed to divest fewer bonds at distressed prices, reducing the overall price pressure. This would have improved the utility of asset managers (and the fund investors) themselves, and reduced the systemic impact of the redemption wave on other parts of the financial system. However, such a measure should not be considered in isolation, but as part of a broader range of regulatory and supervisory policy reforms to address the structural problems associated with liquidity mismatches in open-end investment funds; including measures like swing-pricing, redemption gates and generally matching redemption terms to the liquidity of the assets invested in by the fund.

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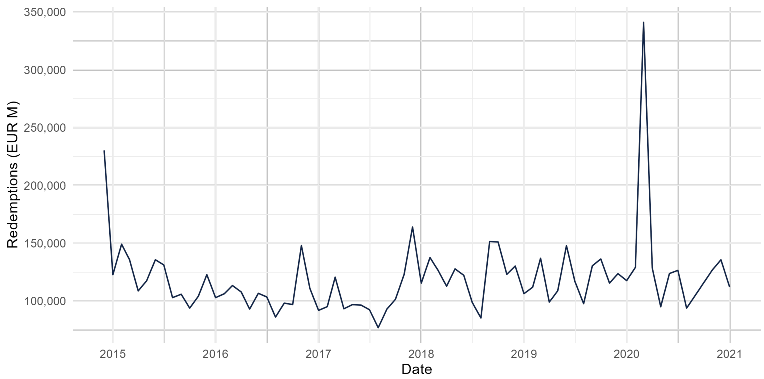
Figures

Figure 1: Monthly redemptions of EA bond funds

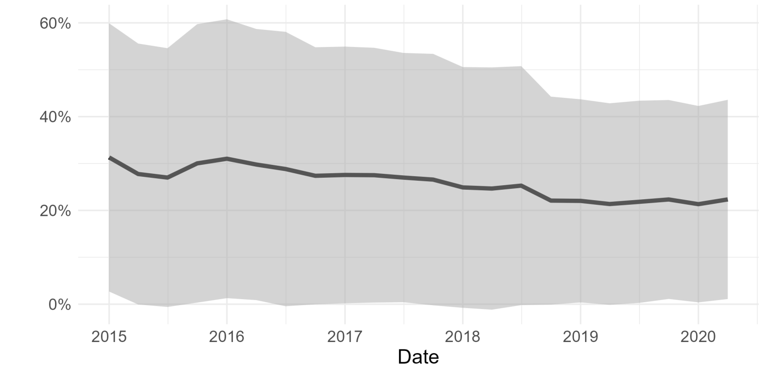


The figure depicts the aggregate monthly redemptions of euro area bond funds. The sample period spans Q1 2015 - Q4 2020. The data come from the European Central Bank.

Figure 2: Evolution of Z-spread of iBoxx EUR Corporates

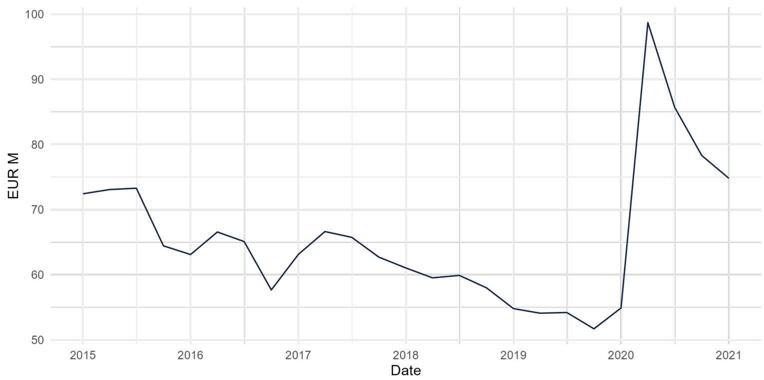
The figure depicts the monthly Z-spread of iBoxx EUR Corporates index. The sample period spans Q1 2015 - Q4 2020. The data come from Refinitiv Eikon.

Figure 3: Evolution of the ECB-eligible asset share in mutual fund portfolios



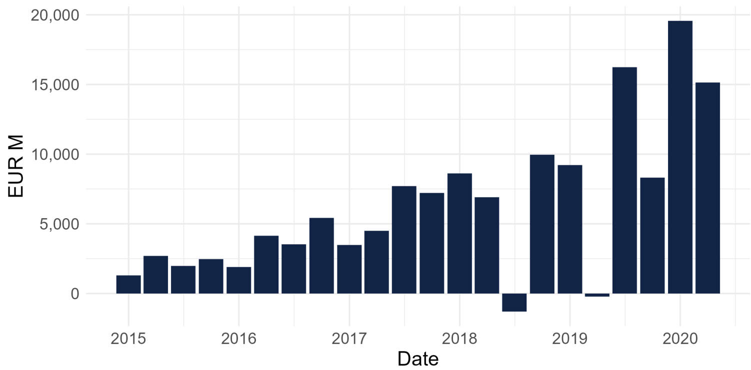
The figure illustrates the mean (represented by the black line) along with the standard deviation (depicted by the grey shaded area) of the proportion of ECB-eligible corporate bonds in euro area corporate bond mutual funds. The sample period spans Q1 2015 - Q4 2020. The data come from Refinitiv Lipper.

Figure 4: Eurosystem collateral usage of corporate bonds



The figure depicts the aggregate usage of corporate bonds as collateral with the Eurosystem. The sample period spans Q1 2015 - Q4 2020. The data come from the European Central Bank.

Figure 5: Evolution of cash holdings



The figure depicts the aggregate evolution of cash holdings of funds in scope. The data includes holdings classified as "Cash", "Cash Equivalent", "Cash Options" or "Currency". The sample period spans Q1 2015 - Q2 2020. The data come from Refinitiv Lipper.

Tables

Table 1: Descriptive statistics

Variable	Mean	SD	p1	p99	Obs
Panel A: Fund characteristics					
Cash share	0.02	0.07	-0.15	0.20	10,694
Corporate bond share	0.80	0.18	0.21	1.00	10,694
ECB-eligible corporate bond share (% of corp. par value)	0.25	0.25	0.00	0.95	10,694
Fund flows	0.03	0.18	-0.38	0.83	8,787
Market value fund (million EUR)	731.50	2,341.66	6.42	6,602.94	10,694
No. asset holdings	287	497	23	2,539	10,694
Sovereign bond share	0.06	0.09	0.00	0.36	10,694
Panel B: Corporate bond holdings					
ΔPar value (qoq)	-0.10	0.45	-1.00	1.25	2,686,550
Market value (million EUR)	2.54	22.54	-0.06	29.65	3,231,543
Par value (million EUR)	2.15	5.35	0.00	26.18	3,465,145
Panel C: Corporate bond prices and characteristics					
Bid-ask spread	0.27	0.32	0.01	1.63	382,399
ECB-eligibility dummy	0.35	0.48	0.00	1.00	390,029
Principal amount (million EUR)	633.08	394.19	50.00	1,750	390,029
Time-to-maturity (years)	4.89	7.03	0.06	26.02	388,281
Yield spread (%)	2.07	1.72	0.23	10.09	375,016
% held by industry in 2019	0.05	0.06	0.00	0.28	390,029

The table presents summary statistics at the level of mutual fund characteristics (Panel A), corporate bond holdings (Panel B), and corporate bond prices and characteristics (Panel C). Panels A and B (C) report descriptives for the period from Q1 2015 to Q2 2020 (31.12.2019 to 31.03.2020). *Cash share* (Corporate bond share) is the relative proportion of cash (corporate) holdings to total fund holdings (measured at market value).*ECB-eligible corporate bond share* measures the relative proportion of ECB-eligible bonds to total corporate bond holdings of a fund (measured at par value). *Fund flows* measures a fund's aggregate in- and outflows in the current quarter relative to the fund size (measured at market value) in the previous quarter. *Sovereign bond share* is the relative proportion of sovereign holdings to total fund holdings (measured at market value). *No. asset holdings* is number of individual assets held by a fund at time t. *Market value fund (million EUR)* reports the net total market value of a fund's holdings. Δ*Par value (qoq)* is the relative quarter-on-quarter change in corporate bond holdings. *Market value (million EUR)* (*Par value (million EUR)*) measures the end-of-quarter market (par) value of the holding position. *Bid-ask spread* is the difference between the bond's daily ask and bid price. *ECB-eligibility dummy* equals one if the bond is ECB-eligible. *Principal amount (million EUR)* is the face value of the bond. *Time-to-maturity* is the number of years to repayment of principal.*Yield spread* is the difference between the bond's yield to maturity and the maturity-matched risk-free rate, derived from the German Bund yield curve. *% held by industry in 2019* measures a bond's share of outstanding amount held by mutual fund industry at the end of December 2019. The data comes from Refinitiv Lipper and Refinitiv Workspace.

Table 2: ECB-eligible corporate bond allocation during the COVID outbreak

	ECB-eligible corporate bond share			
	(1)	(2)	(3)	(4)
COVID * (Outflows > Sov. share)			0.004	
			[0.004]	
Outflows > Sov. share			-0.004**	
			[0.002]	
COVID * Bank-affiliated				0.002
				[0.003]
COVID	-0.010***	-0.014***	-0.014***	-0.016***
	[0.002]	[0.002]	[0.003]	[0.003]
Eligible corp. bond share (t-1)		-0.098	-0.098	-0.098
		[0.075]	[0.076]	[0.075]
Size (t-1)		-0.005	-0.003	-0.005
		[0.005]	[0.005]	[0.005]
Sov. share (t-1)		0.009	0.004	0.009
		[0.024]	[0.024]	[0.024]
Time trend		-0.005***	-0.005***	-0.005***
		[0.001]	[0.001]	[0.001]
Observations	1,532	7,750	7,750	7,750
R-squared	0.984	0.987	0.987	0.987
No. clusters	766	745	745	745
Fund FE	Yes	No	No	No
Fund-Half-Year FE	No	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of the COVID outbreak in Q1 2020 on mutual funds' asset allocation decisions. The dependent variable is the share of ECB-eligible corporate bonds as percentage of total corporate bond holdings. *COVID* is a dummy that equals one in Q1 2020, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Size (t-1)* is the total market value of the fund's portfolio holdings at the end of the previous quarter. *Sov. share (t-1)* is the share of sovereign holdings (as % of fund size) in t-1. *Time trend* is a linear time-varying control variable. Fund and fund-half-year fixed effects are included where indicated. Model 1 is restricted to two periods: Q4 2019 and Q1 2020. The remaining models cover the whole sample period. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table 3: ECB-eligible corporate bond holding changes during the COVID outbreak

	ΔPar value				
	(1)	(2)	(3)	(4)	(5)
COVID * Bank bond * ECB-eligible			-0.014		
			[0.031]		
Bank bond * ECB-eligible			0.124**		
			[0.062]		
COVID * Bank bond			-0.016*		
			[0.008]		
COVID * (Outflows > Sov. share) * ECB-eligible				-0.008	
				[0.020]	
(Outflows > Sov. share) * ECB-eligible				-0.007**	
				[0.003]	
COVID * Bank-affiliated * ECB-eligible					0.020
					[0.015]
Bank-affiliated * ECB-eligible					-0.004
					[0.005]
COVID * ECB-eligible		-0.037***	-0.034***	-0.028**	-0.047***
		[0.010]	[0.008]	[0.011]	[0.016]
ECB-eligible	-0.087***	-0.082***	-0.094***	-0.080***	-0.079***
	[0.021]	[0.021]	[0.022]	[0.021]	[0.021]
Log par value (t-1)	-0.037***	-0.037***	-0.037***	-0.037***	-0.037***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Bond matured	-0.883***	-0.884***	-0.884***	-0.884***	-0.884***
	[0.016]	[0.016]	[0.016]	[0.016]	[0.016]
Observations	2,168,181	2,168,181	2,168,181	2,168,181	2,168,181
R-squared	0.329	0.329	0.329	0.329	0.329
No. clusters	741	741	741	741	741
Fund-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Bond-Half-Year FE	Yes	Yes	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of the COVID outbreak in Q1 2020 on mutual funds' asset purchases. The dependent variable is the relative quarter-on-quarter change in corporate bond holdings. *COVID* is a dummy that equals one in Q1 2020, and is zero otherwise. *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Log par value (t-1)* is the logarithm of the fund's portfolio holdings' par value at the end of the previous quarter. *Bond matured* is a dummy that equals one if the bond matures in quarter *t*. Fund-year-quarter and holding-half-year fixed effects are included where indicated. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table 4: ECB-eligible corporate bond holdings during the COVID outbreak

	Log par value				
	(1)	(2)	(3)	(4)	(5)
COVID * Bank bond * ECB-eligible			-0.099		
			[0.303]		
Bank bond * ECB-eligible			1.192*		
			[0.625]		
COVID * Bank bond			-0.166**		
			[0.083]		
COVID * (Outflows > Sov. share) * ECB-eligible				-0.193	
				[0.175]	
(Outflows > Sov. share) * ECB-eligible				-0.123***	
				[0.038]	
COVID * Bank-affiliated * ECB-eligible					0.199
					[0.131]
Bank-affiliated * ECB-eligible					-0.066
					[0.051]
COVID * ECB-eligible		-0.390***	-0.378***	-0.201*	-0.493***
		[0.086]	[0.085]	[0.109]	[0.126]
ECB-eligible	-1.154***	-1.100***	-1.211***	-1.056***	-1.056***
	[0.264]	[0.265]	[0.285]	[0.265]	[0.270]
Log par value (t-1)	0.532***	0.532***	0.532***	0.532***	0.532***
	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]
Bond matured	-10.931***	-10.933***	-10.933***	-10.933***	-10.933***
	[0.310]	[0.310]	[0.310]	[0.310]	[0.310]
Observations	2,215,958	2,215,958	2,215,958	2,215,958	2,215,958
R-squared	0.410	0.410	0.410	0.410	0.410
No. clusters	741	741	741	741	741
Fund-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Bond-Half-Year FE	Yes	Yes	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of the COVID outbreak in Q1 2020 on mutual funds' asset holdings. The dependent variable is the logarithm of the corporate bond par value (in EUR) held by the fund. *COVID* is a dummy that equals one in Q1 2020, and is zero otherwise. *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Log par value (t-1)* is the logarithm of the fund's portfolio holdings' par value at the end of the previous quarter. *Bond matured* is a dummy that equals one if the bond matures in quarter t. Fund-year-quarter and holding-half-year fixed effects are included where indicated. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table 5: Price response of corporate bonds during the COVID outbreak

	Yield spread				
	(1)	(2)	(3)	(4)	(5)
COVID * (% held by industry in 2019) * ECB-eligible * Bank bond					1.590***
					[0.467]
COVID * (% held by industry in 2019) * ECB-eligible				-1.389***	-2.369***
				[0.374]	[0.488]
COVID * ECB-eligible * Bank bond					-0.474***
					[0.040]
COVID * (% held by industry in 2019)			3.230***	3.900***	3.878***
			[0.212]	[0.299]	[0.300]
COVID * ECB-eligible		-0.203***		-0.188***	0.065**
		[0.020]		[0.022]	[0.033]
COVID * Bank bond					0.049*
					[0.030]
COVID	0.744***	0.813***			
	[0.011]	[0.016]			
ECB-eligible		-0.636***			
		[0.038]			
% held by industry in 2019		2.129***			
		[0.287]			
Principal amount		-0.217***			
		[0.026]			
Time-to-maturity	-0.023	0.016***	-0.012	-0.007	-0.007
	[0.022]	[0.003]	[0.021]	[0.021]	[0.021]
Constant	2.018***	6.272***	2.169***	2.166***	2.157***
	[0.102]	[0.528]	[0.100]	[0.100]	[0.102]
Observations	351,720	351,720	351,720	351,720	351,720
R-squared	0.856	0.526	0.892	0.894	0.894
No. clusters	5622	5622	5622	5622	5622
Bond FE	Yes	No	Yes	Yes	Yes
Day FE	No	No	Yes	Yes	Yes
Controls	No	Yes	No	No	No

The table presents the results of daily panel regressions on the effect of the COVID outbreak in March 2020 on corporate bond secondary market prices. The dependent variable is the yield spread (in %). *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *COVID* is a dummy that equals one in March 2020, and is zero otherwise. *(% held by industry)* measures a bond's share of outstanding amount held by the mutual fund industry at the end of December 2019. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Principal amount* is the logarithm of the bond's principal amount (in EUR). *Time-to-maturity* is the number of years to repayment of principal. Additional control variables are industry sector, currency, and a dummy indicating whether the bond is callable. Bond and daily time fixed effects are included where indicated. The sample period spans 31. December 2019 to 31. March 2020. The data come from Refinitiv Lipper and Refinitiv Workspace. Standard errors are clustered at asset level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table 6: Liquidity response of corporate bonds during the COVID outbreak

	Bid-ask spread				
	(1)	(2)	(3)	(4)	(5)
COVID * (% held by industry in 2019) * ECB-eligible * Bank bond					-0.005
					[0.035]
COVID * (% held by industry in 2019) * ECB-eligible				0.023	0.017
				[0.028]	[0.038]
COVID * ECB-eligible * Bank bond					0.013***
					[0.005]
COVID * (% held by industry in 2019)			0.034**	0.034	0.042*
			[0.016]	[0.023]	[0.024]
COVID * ECB-eligible		-0.007***		-0.010***	-0.016***
		[0.002]		[0.002]	[0.004]
COVID * Bank bond					-0.017***
					[0.003]
COVID	0.034***	0.042***			
	[0.001]	[0.002]			
ECB-eligible		-0.100***			
		[0.012]			
% held by industry in 2019		-0.188***			
		[0.073]			
Principal amount		-0.047***			
		[0.007]			
Time-to-maturity	-0.000	0.019***	0.002	0.002	0.002
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]
Constant	0.270***	1.162***	0.271***	0.271***	0.274***
	[0.006]	[0.142]	[0.006]	[0.006]	[0.006]
Observations	357,006	357,008	357,006	357,006	357,006
R-squared	0.962	0.297	0.967	0.967	0.968
No. clusters	5544	5546	5544	5544	5544
Bond FE	Yes	No	Yes	Yes	Yes
Day FE	No	No	Yes	Yes	Yes
Controls	No	Yes	No	No	No

The table presents the results of daily panel regressions on the effect of the COVID outbreak in March 2020 on corporate bond secondary market liquidity. The dependent variable is the spread between the ask and the bid price. *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *COVID* is a dummy that equals one in March 2020, and is zero otherwise. *(% held by industry)* measures a bond's share of outstanding amount held by the mutual fund industry at the end of December 2019. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Principal amount* is the logarithm of the bond's principal amount (in EUR). *Time-to-maturity* is the number of years to repayment of principal. Additional control variables are industry sector, currency, and a dummy indicating whether the bond is callable. Bond and daily time fixed effects are included where indicated. The sample period spans 31. December 2019 to 31. March 2020. The data come from Refinitiv Lipper and Refinitiv Workspace. Standard errors are clustered at asset level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Appendix

A Theoretical model

To motivate our empirical analysis, we construct a theoretical model that allows asset managers to use collateralised borrowing to fund redemptions. We use the model to study the relationship between asset pledgeability, aggregate investment, liquidation volume during redemption waves, and the overall welfare implications. Our model builds on the work of Aldasoro et al. (2021).

Assume a three-period economy with two types of market participants; asset managers (AMs) and dealers (Ds). There are two types of assets; a risk-free and a risky asset. The risk-free asset pays a zero return and can be considered cash, while the risky asset's payoff structure is given as $R = \{1, R_1, \tilde{R}_2\}$. That is, the price of the risky asset at $t = 0$ is 1. $R_1 < 1$ is secondary-market price in $t = 1$ and $\tilde{R}_2$ is the uncertain payoff in $t = 2$, with mean $R_2 > 1$ and variance σ^2. Furthermore, assume that an exogenously given fraction, $p \in [0, 1]$, of the risky asset can be pledged by the AM as collateral for borrowing. The borrowing costs are denoted by c. The order of events is the following. In $t = 0$, AMs allocate their capital across the two asset types. In $t = 1$, each asset manager i is exposed to redemption risk with outflows of size o_i. Depending of the size of o_i, the AM faces one of the three options to fund the redemptions: (i) use the fund's cash holdings, (ii) borrow additional cash against pledgeable collateral, or (iii) sell the risky asset to a dealer. In $t = 2$, the uncertain payoff of the risky asset materialises and the final payoffs to AMs and Ds are revealed.

A.1 Asset managers

There is a continuum of risk-neutral asset managers with unit mass. Each AM i is endowed with one unit of risk-free asset in $t = 0$, of which she allocates α_i units into the risky asset and $1 - \alpha_i$ units into the risk-free asset. The decision to buy the risky asset depends on the AM's risk of early liquidation at $t = 1$. There is no liquidation if the AM's risk-free asset holding is sufficient to fund the redemptions in $t = 1$. The probability of this event is $1 - \epsilon_i$, where ϵ_i is independent across AMs and follows a continuous uniform distribution, i.e., $\epsilon_i \sim U[0, 1]$. If redemptions exceed the risk-free holding, the AM is exposed to a liquidity mismatch and faces one of the two options: either engage in collateralised borrowing or sell the risky asset. In the former case, assume that with probability $p\epsilon_i$ the redemptions can be covered by the risk-free asset and the pledgeable part of the risky asset. The AM incurs borrowing costs c but remains exposed to the risky asset's final payoff. With probability $(1 - p)\epsilon_i$, collateralised borrowing is insufficient to cover the outflows. In this case, the AM sells the risky asset and thus liquidates the fund in $t = 1$. Both, ϵ_i and p are known to the AM in $t = 0$. The AM's total payoff is therefore given as:

$$\text{AM's payoff} = \begin{cases} 1 - \alpha_i + \alpha_i \tilde{R}_2 & \text{with } \mathbb{P}(o_i \leq 1 - \alpha_i) = 1 - \epsilon_i \\ 1 - \alpha_i + \alpha_i \tilde{R}_2 - \alpha_i p R_1 c & \text{with } \mathbb{P}(1 - \alpha_i < o_i \leq 1 - \alpha_i + \alpha_i p R_1) = p\epsilon_i \\ 1 - \alpha_i + \alpha_i R_1 & \text{with } \mathbb{P}(o_i > 1 - \alpha_i + \alpha_i p R_1) = (1 - p)\epsilon_i \end{cases}$$

The AM's expected utility is the probability-weighted sum of the above payoffs:

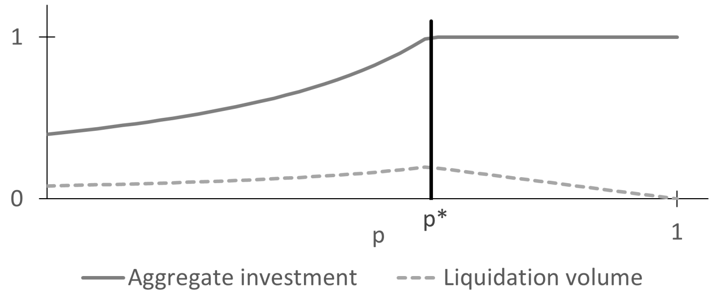
$$\mathbb{E}[U_i] = 1 \underbrace{+\alpha_i(R_2 - 1)}_{\substack{\text{gain from investing} \\ \text{in risky asset}}} \underbrace{-\epsilon_i \alpha_i s(1 - p)}_{\substack{\text{loss from} \\ \text{early liquidation}}} \underbrace{-\epsilon_i \alpha_i p R_1 c}_{\substack{\text{cost of collateralised} \\ \text{borrowing}}}, \tag{4}$$

where the spread $s = R_2 - R_1$ is the market-clearing risk premium in $t = 1$.

An AM will fully invest in the risky asset ($\alpha_i = 1$) only if her expected utility is above one, otherwise she will choose to hold only the risk-free asset ($\alpha_i = 0$). Rearranging eq. (4) with respect to ϵ_i yields an interior threshold probability $\hat{\epsilon} = \min\left(\frac{R_2 - 1}{s(1-p) + pR_1 c}, 1\right) \in [0, 1]$, suggesting that AMs invest in the risky asset if and only if $\epsilon_i < \hat{\epsilon}$. Consequently, the total demand for the risky asset is given as $q = \int_0^{\hat{\epsilon}} d\epsilon_i = \hat{\epsilon}$ and the overall risky asset liquidation amount is $y_{AM} = \int_0^{\hat{\epsilon}} (1-p)\epsilon_i d\epsilon_i = \frac{1}{2}(1-p)\hat{\epsilon}^2$.

Figure A1 depicts q and y_{AM} as a function of p. With increasing p, the demand for the risky asset and the corresponding liquidation amount rise. However, aggregate investment experiences a stronger increase than the liquidation volume, which means that the liquidation amount as percentage share of total amount invested drops with increasing p. At p^*, investors are fully invested in the risky asset and the liquidation amount starts dropping. When p reaches 100%, AMs do not need to liquidate the risky asset at all as they can borrow up to the total portfolio value to fund any redemption volumes. In practice, pledgeability p can be either interpreted as a fraction of assets in a fund that can be used for collateralised borrowing or it can be regarded as a haircut at the level of the individual asset. For an individual asset, $p = 0$ is equivalent to a haircut of 100%, while $p = 1$ means that a 0%-haircut is applied to the asset. The latter case does not exist in practice as any risky asset is subject to a positive haircut.

Figure A1: Asset pledgeability and investor demand for the risky asset



This figure depicts the asset managers' aggregate investment demand for the risky asset in $t = 0$ and the corresponding liquidation volume in $t = 1$ as a function of pledgeability p.

The threshold probability $\hat{\epsilon}$ is a monotonically increasing function in p if the return on the risky asset is above the borrowing costs (i.e., $\frac{R_2}{R_1} - 1 > c$). In this case, there exists an upper bound p^* such that the threshold probability simplifies to

$$\hat{\epsilon} = \frac{R_2 - 1}{s(1-p) + pR_1 c} \tag{5}$$

where $p \in [0, p^*]$ and $\hat{\epsilon} \in [0, 1]$. For traceability of the model, but without loss of generality, we will use eq. (5) henceforth.

A.2 Dealers

There is a continuum of dealers with constant absolute risk aversion (CARA) utility. Their purpose is to make the markets in $t = 1$, when AMs are forced to liquidate their risky asset holdings. All dealers are unconstrained in their purchases; they can use their capital and borrow additional funds at a risk-free rate if necessary. Each dealer j is competitive and takes the market clearing spread s as given when deciding on the purchase amount of the risky asset y_j. The dealer's expected utility is given as:

$$U_j = \mathbb{E}[\tilde{R}_2 - R_1]y_j - \frac{\rho}{2}Var(\tilde{R}_2 - R_1)y_j^2 = sy_j - \frac{\rho\sigma^2}{2}y_j^2, \tag{6}$$

where $\rho > 0$ is the dealer's relative risk aversion parameter. The utility-maximising purchase amount for each dealer is given as $y_j = \frac{s}{\rho\sigma^2}$ if $s \geq 0$ and zero otherwise. Since dealers can buy but not sell the risky asset in this setting, their demand is bounded at zero. Given that there is a unit mass of dealers, the dealers' aggregate purchase volume is $y_D = \int_0^1 y_j dj = \frac{s}{\rho\sigma^2}$.

A.3 Equilibrium

In equilibrium, markets clear (i.e., $y_{AM} = y_D$) such that the spread s is given as:

$$s = \frac{1}{2}(1-p)\rho\sigma^2\hat{\epsilon}^2 \tag{7}$$

Solving equations (5) and (7) in terms of exogenous fundamentals yields:

$$\hat{\epsilon} = \left(\frac{2(R_2-1)}{\rho\sigma^2}\right)^{\frac{1}{3}} \left(\frac{1}{(1-p)(1-p+pR_1r)}\right)^{\frac{1}{3}} \tag{8}$$

$$s = \left(\frac{\rho\sigma^2}{2}\right)^{\frac{1}{3}} (R_2-1)^{\frac{2}{3}} \left(\frac{1-p}{(1-p+pR_1r)^2}\right)^{\frac{1}{3}} \tag{9}$$

where the cost of collateralised borrowing is defined as $c = rs$, with parameter $r > 0$. c can be interpreted as AM's monitoring and overhead costs that move proportionally with the risky asset's spread.

A.4 Welfare

From eq. (4) and (7), we obtain asset managers' aggregate utility as:

$$U_{AM} = 1 + q(R_2-1) - \rho\sigma^2\frac{\hat{\epsilon}^4}{4}\left((1-p)^2 + p(1-p)R_1r\right) \tag{10}$$

From eq. (6), we obtain dealers' aggregate utility:

$$U_D = \frac{s^2}{2\rho\sigma^2} \tag{11}$$

Asset managers' aggregate utility is given as:

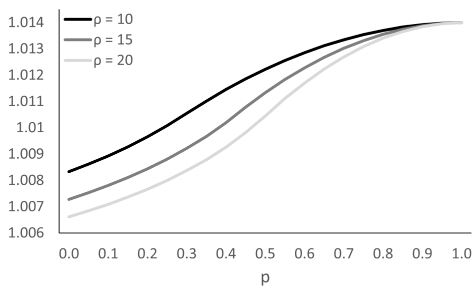
$$\begin{aligned}
U_{AM} = \int_0^1 \mathbb{E}[U_i]d\epsilon_i &= \int_0^1 1 + \alpha_i(R_2-1) - \epsilon_i\alpha_i s(1-p) - \epsilon_i\alpha_i pR_1 c d\epsilon_i && (12)\\
&= 1 + \int_0^{\hat{\epsilon}} (R_2-1) - \epsilon_i s(1-p) - \epsilon_i pR_1 c d\epsilon_i && (13)\\
&= 1 + \hat{\epsilon}(R_2-1) - \frac{1}{2}\hat{\epsilon}^2 s(1-p) - \frac{1}{2}\hat{\epsilon}^2 pR_1 c && (14)\\
&= 1 + q(R_2-1) - y_{AM}(s + \frac{p}{1-p}R_1 c) && (15)\\
&= 1 + q(R_2-1) - \frac{1}{4}\rho\sigma^2\hat{\epsilon}^4((1-p)^2 + p(1-p)R_1 r) && (16)
\end{aligned}$$

The social welfare is then given as the sum of the two utilities U_{AM} and U_D:

$$W = 1 + \hat{\epsilon}(R_2 - 1) - \rho\sigma^2 \frac{\hat{\epsilon}^4}{8} \left((1-p)^2 + 2p(1-p)R_1 r\right) \tag{17}$$

To illustrate the impact of the risky asset's pledgeability on the aggregate social welfare of the economy, we calibrate the model using market data. As a proxy for the risky asset, we employ an investment grade corporate bond index for the euro area covering the period Q4 2007 to Q1 2020.[5] Using quarterly data, $R_0 = 1$ is defined as the price of the index in Q4 2019. $R_1 = 0.953$ is the realised price in Q1 2020 and $R_2 = 1.014$ is the expected two-period return of the risky asset at the date of the initial investment in $t = 0$. The historical return variance is $\sigma^2 = 0.0056$. Following the ECB's securities lending arrangements, we set the borrowing cost, c, equal to the fixed minimum fee of 5 basis points (bp), which results in $r = \frac{c}{s} = 0.0082$.

Figure A2: Asset pledgeability and aggregate welfare



This figure depicts for different risk aversion parameters, ρ, the aggregate welfare as a function of pledgeability p.

Figure A2 illustrates the improvement in overall welfare with increasing pledgeability of the risky asset. The welfare is calculated for three types of dealers with different levels of risk aversion. We can observe that for $p = 0$, dealers' risk aversion affects welfare negatively. More risk averse dealers are less willing to buy the distressed risky asset, thus reducing overall welfare. As pledgeability increases, the role of dealers diminishes as

[5] The data for the MSCI IG EUR Corporate Bond Index come from Bloomberg.

asset managers are more likely to fund redemptions via collateralised borrowing. In the extreme case, when 100% of the risky asset is pledgeable as collateral, asset managers will prefer not to sell the asset at all, rendering dealers meaningless. Overall, our model predicts that going from no pledgeability ($p = 0$) to full pledgeability ($p = 1$), will improve welfare by 0.56% (for $\rho = 10$) to 0.73% (for $\rho = 20$).

B Data

B.1 Asset categorisation

All mutual fund holdings in the Lipper database are accompanied by asset type information. This information is not consistently assigned across mutual funds and does not necessarily align with asset categories from other sources. For instance, we observe that the same bond held by two different funds is categorised as a corporate bond in one fund and a sovereign bond in the other. This can happen when the government is the ultimate shareholder of the company, while the company (e.g. a utility company) is considered by certain market participants as a corporate bond issuer. In other cases, we observe derivatives or mortgage-backed securities being assigned to the corporate bond category.

To achieve a cleaner separation of the assets into unique categories, we first employ two different asset categorisations: (i) using Lipper's asset type information, and (ii) using ISIN-level information from Refinitiv Workspace. We refer to the former as Lipper-based categorisation and the latter as our own categorisation. In the second step, we compare the two categorisations and allocate those assets that we consider to be incorrectly categorised by Lipper into more appropriate asset type categories.

Using Lipper's asset type variable, we define the following seven categories: cash, corporate bonds, derivatives, repurchase agreements, term notes, sovereign bonds, and other. Holdings are defined as cash if Lipper's asset type is one of the following: "Cash", "Cash Equivalent", and "Currency". Corporate bonds are: "Corporate Medium Term Notes", "CORP", "Global Bonds", or "Corporate Intermediate and Long Term Debt", "Bank Debt". Derivatives are: "Commodity Future", "Commodity Future Option", "Futures", "FX Forward", "Asset Swap", "Cash Options", "Credit Default Swap", "Currency Future", and similar categories. Repurchase agreements are: "Repurchase Agreement". Term notes are: "Time / Term Deposit", "Treasury Notes/Bonds", "Discount Note", "Commercial Paper", "Certificate of Deposit", and "Agency Notes/Bonds". The remaining assets are allocated to the category other.

In the following step, we focus on fund holdings that are accompanied with an ISIN and use Refinitiv Workspace to obtain for these assets their asset category (Data Item Codes: TR.AssetCategory and TR.AssetCategoryCode), the industry sector of the issuer (TR.FiIndustrySector), the industry sector of the immediate parent (TR.FiParentImmedIndustrySector), the general description of the company's industry from the Standard and Poor's (TR.FiSPIndustryDescription), and the issuer's company name (TR.CompanyName). Using this information, we construct our own five asset categories: bank bonds, derivatives, liquid assets, non-bank corporate bonds, and residual assets. We begin with liquid assets, which we define as bonds with the following industry sectors: sovereign, municipality, agency, or supranational. In addition, we assign certificates of deposit and money market funds to the liquid asset category. We classify all assets with an asset category that resembles derivatives (e.g., futures, options) in the derivatives category. The residual assets category is used for all remaining assets that are not corporate bonds: e.g., various types of asset-backed securities, equities, exchange-traded notes and funds, closed/open-end funds, credit card receivables, to name a few. Then, we identify bank bonds using the industry sector variables and by scanning for banks using the issuer's company name. In the last step, we identify non-bank corporate bonds that were not assigned to either of the previous four asset categories.

In the last step, we compare the two asset type categorisations and assign those assets that we consider to be incorrectly categorised by Lipper into the more suitable asset type category. For instance, we find that the Lipper-based categorisation incorrectly labelled some derivative instruments as corporate bonds. We therefore remove these derivatives from the corporate bond category and assign them to the derivatives category. We do the same exercise for all other categories and eventually arrive with a much cleaner Lipper-based asset categorisation. In particular, this approach gives us confidence that our final sample of bonds in the corporate bond category is not contaminated by derivatives, asset-backed securities, agency bonds, and the like. In addition, we achieve a clean separation of corporate bonds into one of the two subcategories: bank bonds and non-bank corporate bonds.

C Idiosyncratic large outflows

Table C1: ECB-eligible corporate bond allocation during large outflow periods

	ECB-eligible corporate bond share		
	(1)	(2)	(3)
(Outflows ≥ 20%) * (Outflows > Sov. share)		0.093	
		[0.057]	
Outflows > Sov. share (t-1)		-0.007***	
		[0.002]	
(Outflows≥ 20%) * Bank-affiliated			-0.005
			[0.008]
Outflows ≥ 20%	-0.011**	-0.098*	-0.008
	[0.004]	[0.057]	[0.005]
Eligible corp. bond share (t-1)	-0.110	-0.114	-0.110
	[0.075]	[0.075]	[0.075]
Size (t-1)	-0.006	-0.003	-0.006
	[0.004]	[0.005]	[0.004]
Sov. share (t-1)	0.002	0.006	0.003
	[0.024]	[0.023]	[0.024]
Time trend	-0.003***	-0.003***	-0.003***
	[0.001]	[0.001]	[0.001]
Observations	7,750	7,750	7,750
R-squared	0.987	0.987	0.987
No. clusters	745	745	745
Fund-Half-Year FE	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of large outflows on mutual funds' asset allocation decisions. The dependent variable is the share of ECB-eligible corporate bonds as percentage of total corporate bond holdings. *(Outflows ≥ 20%)* is a dummy that equals one if a fund experiences an outflow of 20% or more of its (previous quarter) fund size, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Size (t-1)* is the total market value of the fund's portfolio holdings at the end of the previous quarter. *Sov. share (t-1)* is the share of sovereign holdings (as % of fund size) in t-1. *Time trend* is a linear time-varying control variable. Fund and fund-half-year fixed effects are included where indicated. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table C2: ECB-eligible corporate bond holding changes during large outflow periods

	ΔPar value				
	(1)	(2)	(3)	(4)	(5)
(Outflows ≥ 20%) * Bank bond * ECB-eligible			0.009		
			[0.016]		
Bank bond * ECB-eligible			0.128**		
			[0.062]		
(Outflows ≥ 20%) * Bank bond			-0.002		
			[0.015]		
(Outflows ≥ 20%) * (Outflows > Sov. share) * ECB-eligible				-0.083	
				[0.053]	
(Outflows > Sov. share) * ECB-eligible				-0.009**	
				[0.004]	
(Outflows ≥ 20%) * Bank-affiliated * ECB-eligible					0.008
					[0.015]
Bank-affiliated * ECB-eligible					-0.003
					[0.005]
(Outflows >= 20%) * ECB-eligible		-0.020***	-0.023**	0.068	-0.025**
		[0.007]	[0.010]	[0.053]	[0.010]
ECB-eligible	-0.087***	-0.086***	-0.097***	-0.083***	-0.084***
	[0.021]	[0.021]	[0.022]	[0.021]	[0.021]
Log par value (t-1)	-0.037***	-0.037***	-0.037***	-0.037***	-0.037***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Bond matured	-0.883***	-0.883***	-0.883***	-0.883***	-0.883***
	[0.016]	[0.016]	[0.016]	[0.016]	[0.016]
Observations	2,168,181	2,168,181	2,168,181	2,168,181	2,168,181
R-squared	0.329	0.329	0.329	0.329	0.329
No. clusters	741	741	741	741	741
Fund-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Bond-Half-Year FE	Yes	Yes	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of large outflows on mutual funds' purchases. The dependent variable the relative quarter-on-quarter change in corporate bond holdings. *(Outflows ≥ 20%)* is a dummy that equals one if a fund experiences an outflow of 20% or more of its (previous quarter) fund size, and is zero otherwise. *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Log par value (t-1)* is the logarithm of the fund's portfolio holdings' par value at the end of the previous quarter. *Bond matured* is a dummy that equals one if the bond matures in quarter *t*. Fund-year-quarter and holding-half-year fixed effects are included where indicated. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

Table C3: ECB-eligible corporate bond holdings during large outflow periods

	Log par value				
	(1)	(2)	(3)	(4)	(5)
(Outflows $\geq$ 20%) * Bank bond * ECB-eligible			0.219		
			[0.134]		
Bank bond * ECB-eligible			1.227*		
			[0.626]		
(Outflows $\geq$ 20%) * Bank bond			-0.195*		
			[0.111]		
(Outflows $\geq$ 20%) * (Outflows > Sov. share) * ECB-eligible				-0.794	
				[0.505]	
(Outflows > Sov. share) * ECB-eligible				-0.140***	
				[0.042]	
(Outflows $\geq$ 20%) * Bank-affiliated * ECB-eligible					0.010
					[0.158]
Bank-affiliated * ECB-eligible					-0.047
					[0.050]
(Outflows $\geq$ 20%) * ECB-eligible		-0.377***	-0.442***	0.501	-0.381***
		[0.079]	[0.094]	[0.493]	[0.119]
ECB-eligible	-1.154***	-1.134***	-1.237***	-1.080***	-1.103***
	[0.264]	[0.265]	[0.287]	[0.264]	[0.269]
Log par value (t-1)	0.532***	0.532***	0.532***	0.532***	0.532***
	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]
Bond matured	-10.931***	-10.932***	-10.932***	-10.932***	-10.932***
	[0.310]	[0.310]	[0.310]	[0.310]	[0.310]
Observations	2,215,958	2,215,958	2,215,958	2,215,958	2,215,958
R-squared	0.410	0.410	0.410	0.410	0.410
No. clusters	741	741	741	741	741
Fund-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Bond-Year-Half-Year FE	Yes	Yes	Yes	Yes	Yes

The table presents the results of quarterly panel regressions on the effect of the COVID outbreak in Q1 2020 on mutual funds' asset holdings. The dependent variable is the logarithm of the corporate bond par value (in EUR) held by the fund. *(Outflows $\geq$ 20%)* is a dummy that equals one if a fund experiences an outflow of 20% or more of its (previous quarter) fund size, and is zero otherwise. *Bank bond* is a dummy that equals one if the bond was issued by a bank, and is zero otherwise. *ECB-eligible* is a dummy that equals one if the bond is listed in the Eurosystem's list of eligible marketable assets, and is zero otherwise. *Outflows > Sov. share* is a dummy that equals one if the fund's outflows are larger than the fund's sovereign holdings (as % of fund size) in the previous quarter, and is zero otherwise. *Bank-affiliated* is a dummy that equals one if the fund is affiliated with a bank, and is zero otherwise. *Log par value (t-1)* is the logarithm of the fund's portfolio holdings' par value at the end of the previous quarter. *Bond matured* is a dummy that equals one if the bond matures in quarter t. Fund-year-quarter and holding-half-year fixed effects are included where indicated. The sample period spans Q1 2015 to Q2 2020. The data come from Refinitiv Lipper. Standard errors are clustered at fund level and are reported in squared brackets. Statistical significance is denoted by ***, **, and * at the 1%, 5%, and 10% levels, respectively.

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