Heterogeneous Intermediaries in the Transmission of Central Bank Corporate Bond Purchases*

Fédéric Holm-Hadulla
European Central Bank

Matteo Leombroni
Boston College

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Abstract

This paper studies the role of financial intermediaries in the transmission of central bank corporate bond purchases to bond yields. Contrary to standard expectations, we find that mutual funds—typically viewed as price-elastic investors—amplify, rather than dampen, the effects of these interventions on bond spreads. Following the ECB's corporate bond purchase announcements in 2016 and 2020, bonds predominantly held by mutual funds experienced significantly larger and more persistent declines in spreads compared to those held by price-inelastic investors such as insurance companies, even after controlling for a broad set of bond characteristics. Drawing on additional empirical evidence and an equilibrium asset pricing model, we show that the state-contingent nature of the policy reduces perceived market risk for procyclical investors like mutual funds, thereby boosting demand and compressing risk premia.

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Non-Technical Summary

This paper examines how the composition of bond market investors shapes the transmission of central bank asset purchases to corporate bond yields. We focus on the European Central Bank's (ECB) corporate bond purchase programs—launched in 2016 under the Corporate Sector Purchase Programme (CSPP) and expanded in 2020 with the Pandemic Emergency Purchase Programme (PEPP)—and investigate how the distribution of bond holdings across financial intermediaries affects the yield responses to these announcements.

A widely held view in the literature is that bond markets dominated by price-inelastic investors, such as insurance companies, exhibit stronger price effects following central bank purchases, since these investors tend to maintain stable portfolios. In contrast, price-elastic investors like mutual funds are expected to dampen the impact by adjusting their portfolios more aggressively in response to price changes.

Contrary to this expectation, we find that bonds predominantly held by mutual funds experienced significantly larger and more persistent declines in yield spreads following the ECB's announcements, compared to bonds primarily held by insurance companies. These differences are not accounted for by observable bond characteristics—such as credit quality or duration—nor by changes in default risk, effectively ruling out a selection-based explanation. Instead, our findings suggest a distinct transmission channel: mutual funds respond to the reduction in downside risk and the improvement in market liquidity brought about by the ECB's interventions by increasing their demand for corporate bonds, thereby amplifying the price effects of the policy.

We quantify this amplification and show that a bond with a mutual fund ownership share 50 percentage points above the average exhibits a yield spread response approximately 60% stronger than the average bond. This effect becomes more pronounced over time. Using granular data on mutual fund portfolios, we show that mutual funds rebalanced into eligible bonds immediately following the ECB announcements. Furthermore, mutual funds with higher pre-announcement exposure to eligible bonds received significantly greater inflows, reinforcing the upward pressure on demand and prices.

To interpret these findings, we develop an equilibrium asset pricing model featuring two types of investors: long-term, inelastic investors (insurance companies) and procyclical, risk-sensitive investors (mutual funds). The central bank operates as a third agent, purchasing bonds in a countercyclical manner. The model shows that such a policy reduces market risk for risky assets, particularly for volatility-sensitive investors. As a result, mutual funds increase their demand when perceived risk falls, amplifying the effect of the policy. Insurance companies, in contrast, adjust their portfolios only weakly—or even reduce their exposure—as yields decline.

Our findings contribute to the broader policy debate on the design and effectiveness of corporate bond purchase programs. First, we show that even in markets with a greater presence of elastic investors, asset purchases can exert strong effects when they reduce perceived risk or enhance market liquidity. Second, this suggests that central banks may exert substantial influence on bond markets through state-contingent commitments – and, provided these are credible, even with relatively lean balance sheets. Third, the yield response to these interventions varies across bonds depending on investor composition, highlighting the importance of granular holdings data for evaluating policy effectiveness.

Overall, our analysis underscores that the transmission of unconventional monetary policy depends critically on the heterogeneity of financial intermediaries and their endogenous responses to evolving risk conditions. Ignoring this heterogeneity may lead to an incomplete understanding of how central bank interventions influence asset prices.

1. Introduction

A substantial body of literature has shown that central banks can influence bond yields through large-scale asset purchases, evident from significant yield changes around policy announcements.[1] To rationalize these empirical findings, several studies highlight the importance of investor heterogeneity (Koijen and Yogo, 2019) and market segmentation (Vayanos and Vila, 2021) in shaping asset prices.

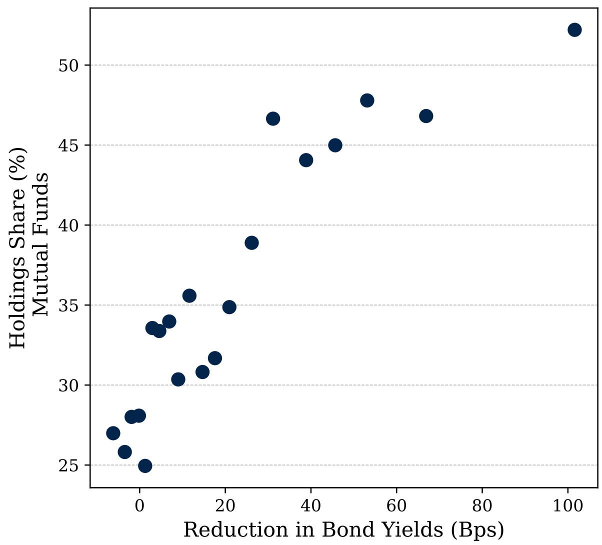
In this paper, we study how the distribution of bond holdings across the financial sector influences the transmission of corporate bond purchases to yields. Prior research has shown that investors in the corporate bond market differ markedly in their price elasticities: insurance companies typically exhibit a low elasticity, whereas mutual funds display a high elasticity (Koijen et al., 2021; Bretscher et al., 2021). These differences suggest that a greater presence of mutual funds relative to insurance companies increases the overall market elasticity, thereby *dampening* the effect of central bank asset purchases on yields. In a segmented market such as that for corporate bonds, this implies that bonds more heavily held by mutual funds should experience a smaller decline in yields.

We test these predictions by analyzing the European Central Bank's (ECB) initial announcement of its corporate bond purchase program in March 2016 using holdings data from the Securities Holding Statistics by Sector (SHSS). Contrary to expectations, we find that corporate bonds with higher mutual fund ownership experienced a significantly *larger* decline in yield spreads following the ECB announcement, compared to those predominantly held by insurance companies (Figure 1). This differential effect is substantial, persistent, and even intensifies in the months following the announcement. Moreover, we rule out the possibility that this effect is merely driven by differences in the types of bonds held by different investors (e.g., mutual funds systematically selecting into riskier bonds). The ownership effect remains statistically significant and sizable after controlling for bond characteristics such as duration, credit rating, liquidity, and issuer identity (Coppola, 2021). Moreover, the differential impact is not explained by changes in default risk, as measured by CDS spreads.

To rationalize these empirical findings, it is essential to recognize that markets may interpret ECB announcements as readiness to provide support in times of financial stress

[1] Among others, see Krishnamurthy and Vissing-Jorgensen (2011); Gagnon et al. (2011); Krishnamurthy et al. (2017); Altavilla et al. (2015)

Figure 1: Mutual Funds Holdings and Bond Yield Response



Note: The figure plots the reduction in bond yields following the announcements against the shares held by mutual funds. We rank bonds into percentiles based on their response and organize them into 20 bins.

in the corporate bond market (Haddad et al., 2023, 2024). As such, these announcements should not be seen merely as static interventions in market supply, but rather as state-contingent dynamic policy measures that reduce the risk and volatility of corporate bond returns.

The central bank footprint in the corporate bond market leads to heterogeneous shifts in demand across investor types. The demand for corporate bonds from insurance companies is mainly influenced by rating-based capital requirements. As neither capital requirements nor credit ratings underwent significant changes after the announcement, we do not anticipate a substantial shift in their demand. By contrast, mutual funds benefit from the perception of reduced risk, and their demand for corporate bonds may *increase* in response to the policy announcement. Since mutual funds tend to sell during downturns (Timmer, 2018; Coppola, 2021), central bank purchases play a crucial role in stabilizing markets precisely when mutual fund outflows intensify. Moreover, higher bond prices and lower perceived risk can attract inflows into the mutual fund sector, further amplifying the effect.

Overall, our findings align with the Lucas Critique by underscoring the importance of accounting for the endogenous response of economic agents' demand to policy announcements.

While this may initially seem at odds with the demand-based asset pricing literature, our results emphasize that understanding how different intermediaries adjust their demand in response to such announcements is crucial. These policies should not be viewed simply as exogenous static shifts in supply.

To formalize this concept, we develop a simple dynamic asset pricing framework with two assets: a risk-free bond and a risky bond, the latter representing corporate bonds. The model features two types of investors. Long-term investors, representing insurance companies, maintain a target allocation to the risky asset and adjust their holdings based on the trade-off between yield-to-maturity and adjustment costs. Mutual funds, by contrast, follow standard mean-variance preferences. We also introduce the central bank as a third type of investor that follows a policy rule: purchasing bonds during economic downturns (Quantitative Easing) and selling them during periods of economic expansion (Quantitative Tightening).

The model shows that, due to its countercyclical nature, the policy reduces corporate bond volatility. Because of this transmission mechanism, the presence of insurance companies —which do not increase their demand due to the policy—*dampens* the policy's effect on the risk premium. In fact, in the model, insurance companies decrease their demand as bond yields fall; but, under plausible calibrations, this does not reverse the direction of the aggregate price impact. Finally, if the policy induces inflows into the mutual fund sector, it can further contribute to lowering the risk premium.

We also demonstrate how the model can be mapped onto the demand-based asset pricing framework (Koijen and Yogo, 2019; Bretscher et al., 2021). The key determinant of the policy's effect on bond yields is the market share of investors who adjust their demand following the announcement.

In line with our findings, Corell et al. (2023) provide evidence that mutual funds rebalanced toward bonds eligible for purchase under the corporate QE programme in the quarters following the announcement.[2] Building on their approach and using granular mutual fund holdings from Lipper, we show that mutual funds began rebalancing toward eligible bonds already in the month of the announcement, which is the main focus of our analysis.

We also provide new evidence that mutual funds with higher pre-announcement holdings

[2]Eligible bonds are defined as investment-grade corporate bonds issued by non-bank corporations within the eurozone.

of eligible bonds received significantly greater inflows than those with lower exposure. These findings indicate that the ECB announcement, along with the subsequent bond market rally, triggered fund inflows that further amplified the impact of mutual fund demand on bond yields. Finally, we analyze the 2020 announcement of the Pandemic Emergency Purchase Programme (PEPP) and validate the mechanism developed in this paper.

Detailed findings The main contribution of the paper is to shed light on how the bond yield response to corporate QE is shaped by the distribution of bond holdings across intermediaries, also controlling for their systematic selection based on bond characteristics.

Our analysis indicates that a bond with a mutual fund holding share 10 percentage points above the average exhibits an unconditional additional yield response of 5.4 basis points. When controlling for duration and credit rating, this yield differential decreases to 4.2 basis points. The overall reduction in spreads is approximately 35 basis points. These findings suggest that a bond with a mutual fund share 50 percentage points higher than average experiences a 21 basis point stronger reaction compared to a similar bond with no mutual fund ownership, thus accounting for 60% of the overall bond response.[3]

We extend our analysis by examining the marginal effects of mutual fund ownership over various time lags following the ECB's announcement. In our baseline regression, which includes duration and rating fixed effects, we find that the coefficient remains stable for the first 20 days post-announcement. After around 20 days, the coefficient starts to increase in magnitude, nearly doubling one month after the announcement. This pattern persists across all regression specifications, regardless of the fixed effects applied. We also use alternative identification strategies to ensure the robustness of our findings. We also examine the marginal effects of other intermediaries. As anticipated, bonds held by insurance companies exhibited a more subdued response to the policy announcement.

Then, we decompose the change in bond spreads into two distinct components: the CDS spread and the residual CDS basis. The CDS spread is designed to reflect changes in the market's perceived probability of default, while the residual CDS basis captures the additional compensation associated with holding the bond, encompassing risk premia, liquidity premia, or other potential risk premia. This decomposition yields a clear outcome: the differential changes in spreads for bonds held by mutual funds are fully attributed to changes in the CDS basis.

[3]Such a large discrepancy in ownership is not uncommon in the corporate bond market.

Our findings provide insights into the impact of corporate bond purchase programs. First, as the composition of investors shifts and the share of corporate bonds held by long-term investors declines, these policies become more effective, even as overall market elasticity increases. Mutual fund investors, while more elastic (implying smaller price effects from changes in supply), are also more sensitive to bond volatility (or risk). Consequently, they may increase their demand for bonds as riskiness decreases—a channel we find to be dominant.

Second, central banks can effectively reduce bond risk premia by implementing countercyclical policies, without needing to maintain a large balance sheet. Our results indicate that a relatively 'lean' balance sheet, along with a credible commitment to purchase bonds during downturns, can lower risk premia. This challenges the notion that the primary determinant of the effectiveness of QE is the 'stock' of holdings.

Third, the transmission of monetary policy displays heterogeneous cross-sectional effects. Bonds with lower ownership by insurance companies benefit more from these policies. Fourth, the effects of these policies on asset prices are highly non-linear and depend on whether they trigger fund flows, which amplify their impact.

The reminder of the paper is organized as follows: Section 2 describes the data, Section 3 provides institutional details on the ECB's CSPP program, Section 4 presents the main results on the effects of intermediaries on asset prices, Section 5 discusses mutual funds' allocation and flows, Section 6 examines the results during the pandemic crisis, Section 7 presents the theoretical model and Section 8 concludes.

1.1 Literature Review

Our paper contributes to three strands of literature.

First, we contribute to the demand-based asset pricing literature. A growing body of research emphasizes the role of heterogeneous financial intermediaries in shaping asset prices (Koijen et al., 2021; Koijen and Yogo, 2019; Koijen et al., 2020). Bretscher et al. (2021), in particular, focus on the corporate bond market. The low elasticity of investor demand is often used to rationalize the significant effects of QE, as documented using high-frequency identification strategies (Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011).[4]

[4]Altavilla et al. (2015) and Krishnamurthy et al. (2017) focus on the ECB's government bond purchase program. Other related studies include Fratzscher et al. (2018); d'Amico et al. (2012); Swanson (2011);

To the best of our knowledge, this is the first paper to link the announcement effects of asset purchases on the cross-section of asset prices to intermediary holdings. We provide robust evidence that bonds mostly held by mutual funds—considered inelastic investors—experienced a larger reduction in yields following the ECB's announcement of corporate bond purchases.

Coppola (2021) show that corporate bonds predominantly held by insurers, rather than mutual funds, experience milder losses during downturns. Our findings highlight that the composition of bond ownership plays a critical role in the transmission of central bank purchases to corporate bond yields.

We emphasize the importance of understanding how the policy announcement changes the demand for bonds by different investors. In complementary work, Corell et al. (2023) makes progress along this dimension, showing that different investors obtain different non-pecuniary benefit from corporate bonds (Mota, 2023). Corell et al. (2023) also provide evidence that mutual funds rebalance toward corporate bonds that are eligible to be purchased under the central bank's QE programme. Breckenfelder and De Falco (2024) examine the implementation of the ECB's government bond purchase programme and show that yield effects are stronger for bonds held by more inelastic investors when analyzing supply shifts within a given quarter. A key distinction between our paper and those by Corell et al. (2023); Breckenfelder and De Falco (2024) is our focus on announcement effects. Our motivation lies in the view that ECB announcements play a central role in driving adjustments in the corporate bond market.

We also provide empirical evidence that corporate bond purchases affect mutual fund flows—an important margin that must be considered when evaluating such policies.[5] Darmouni et al. (2022) develop a two-layer asset demand system that incorporates fund flows and explore the role of the Federal Reserve's interventions in the corporate bond market. Fang (2023) studies the role of fund flows for the transmission of conventional monetary policy.[6]

Second, by focusing on announcement effects, we contribute to the literature that em-

Falagiarda and Reitz (2015); Rogers et al. (2018); Braun et al. (2024); Leombroni et al. (2021); D'Amico and Seida (2024).

[5] Goldstein et al. (2017) illustrates how corporate bond fund flows—the focus of this paper—respond to historical performance.

[6] Zhang et al. (2023) also discusses the role of fund flows around monetary policy announcement.

phasizes the state-contingent role of central bank quantitative easing (QE) (Hanson et al., 2020; Haddad et al., 2023, 2024). According to these studies, the significant impact on bond yields at the time of the announcement is driven by market expectations that QE will reduce risk or volatility in the bond market. We argue that this channel has heterogeneous effects across investor types and provide empirical evidence showing that this channel is crucial for understanding the role of investor heterogeneity in the transmission of monetary policy. Indeed, it has been documented that announcement effects tend to exceed any subsequent flow effects associated with the implementation of purchases (D'Amico and King, 2013; De Santis and Holm-Hadulla, 2020).

Third, we contribute to the literature focusing on corporate bond purchases. Todorov (2020) and Zaghini (2020) showed the effects of the ECB announcement on corporate bond yields.[7] Haddad et al. (2021); Gilchrist et al. (2024); Darmouni and Siani (2022); Rebucci et al. (2022) examine the effects of the Fed's announcement during the pandemic crisis. These papers also discuss how the Fed's announcement was important to provide liquidity to mutual funds during the fire sale. We provide direct evidence that mutual funds also played key role in the ECB announcement in 2016, which did not take place during a recession.

We demonstrate that market segmentation within the corporate bond market plays a crucial role in shaping the effects of QE announcements. This also links to Faia et al. (2022) and Veghazy (2024) who emphasize how institutional investors' mandates drive bond demand, with granularity effects ultimately influencing bond prices.

2. Data

We use a range of data sources, including holdings data, fund flows, bond characteristics, and asset pricing data. In this section, we provide an overview of these data sources, while summary statistics and additional details are deferred to the Appendix.

Securities Holdings Statistics by Sector (SHSS) We calculate the proportions of bonds held by various intermediaries using confidential data from the ECB Securities Holding Statistics by Sector (SHSS). SHSS provides a comprehensive overview of security-level

[7] Other papers studying the CSPP announcements include Abidi and Miquel-Flores (2018); De Santis et al. (2018); Grosse-Rueschkamp et al. (2019); De Santis and Zaghini (2021). D'Amico and Kaminska (2019) studies the corporate sector purchase announcement in the UK.

portfolio holdings for all Euro-area investors. Each security is uniquely identified by an International Securities Identification Number (ISIN). The dataset encompasses information on government and corporate bonds, equities, and mutual fund shares. Reported at a quarterly frequency, our analysis spans from 2013Q4 to 2023Q2. Securities Holding Statistics presents portfolio holdings categorized by country of domicile and investor sector. We aggregate data for all Euro area countries, distinguishing only by investor sector. In terms of investor sectors, we focus on mutual funds, insurance companies and pension funds (ICPF) and monetary financial institutions (referred to as banks).

Lipper We use granular information on mutual fund holdings from Refinitiv Lipper. Lipper includes monthly holdings at the fund level. Lipper also includes information on mutual fund flows at daily frequency.

Markit iBoxx We collect data on corporate bonds from Markit iBoxx. The dataset provides detailed information on the universe of bonds used in their index. We only include bonds denominated in Euros. The data are available at a daily frequency and include the bonds' bid price, ask price, accrued interest, yield to maturity, option-adjusted spread (OAS), duration and ratings. We compute a measure of illiquidity using the bid-ask spread. Appendix C.3 provides summary statistics on these data.

Centralised Securities Database (CSDB) We obtain bond information from the ECB Central Securities Database (CSDB). We include information on ratings from three agencies (Fitch Ratings, Moody's, and Standard & Poor's (S&P)), the notional amount issued, and the sector of issuance according to ESA 2010. For each bond, we define the *best rating* of the three rating agencies, the *worst rating*, and an average rating.[8]

CDS We use daily CDS data from ICE Data Services (formerly CMA). We match corporate bonds to the CDS insuring the bond based on issuer and seniority. We then interpolate the CDS curve for each issuer and seniority to exactly match each bond with a CDS of equal maturity. The CDS basis is constructed as follows:

$$\mathrm{bs}_{i,t} = \mathrm{cds}_{i,t} - ys_{i,t}, \tag{1}$$

[8]We follow the standard practice of converting ratings into numeric values, assigning 1 to AAA, 2 to AA, and so forth.

where $ys_{i,t}$ represents the option-adjusted spread (OAS) of bond i at time t and $\text{cds}_{i,t}$ is the CDS spread with equal maturity (based on the interpolation of the term structure of CDS spreads) and same seniority of bond i. Appendix C.3 provides summary statistics on the dataset.

3. The Corporate Sector Purchase Progamme

We next examine empirically the heterogeneous effects of the ECB corporate bond purchases on bond yields and their relation to heterogeneous intermediary holdings. The primary focus is on the initial announcement of the Corporate Sector Purchase Programme (CSPP). This section provides an overview of intermediary holdings prior to the ECB announcement and details on the CSPP announcement and its implementation.

Intermediary Holdings We use the Securities Holdings Statistics by Sector (SHSS) to compute the aggregate nominal holdings by investor type. Bonds are stratified by their best rating. Holdings in billions of euros at the end of Q4 2015 (the last quarter before the announcement) for the subsets of eligible bonds are reported in Figure 2a. The figure also shows the distribution of bonds across different rating categories. The most common rating is BBB+ (€250 bn), followed by A- (€163 bn) and A+ (€139 bn). In terms of holdings, mutual funds hold less than 15% of bonds rated AA, 23% of bonds rated A, and 31% of bonds rated BBB. In contrast, insurance companies and pension funds hold a large share of bonds rated AA (50%) and A (40%), but a smaller share of bonds rated BBB (33%). This is particularly true for bonds with a best rating of BBB-, where their share is just 23%. Foreign investors also held a notable amount of bonds. Like mutual funds, they maintain larger shares of BBB (25%) bonds compared to A (23%) and AA (22%).

CSPP The ECB announced the Corporate Sector Purchase Programme (CSPP) on March 10, 2016, as part of its broader efforts to support the eurozone economy and address low inflation. Under the CSPP, the ECB purchased only investment-grade corporate bonds issued by non-bank corporations within the eurozone (*eligible* bonds). The CSPP operated alongside other programs within the Asset Purchase Programme (APP). The ECB started purchasing bonds in July 2016.

The ECB considers investment-grade bonds to be those with a first-best rating of BBB-/Baa3/BBBL. There is no prescribed minimum issuance volume for corporate bonds to be eligible for purchase under the CSPP. Eligibility is restricted to debt instruments issued by firms incorporated in the Euro area. To be eligible, the issuer of a corporate sector debt instrument must not be a credit institution, nor have any parent undertaking that qualifies as a credit institution, as defined in relevant EU regulations and guidelines. Insurers that meet these criteria are considered eligible issuers.

The ECB pursues a market-neutral implementation of the APP, and consequently, CSPP purchases adhere to a benchmark that proportionally reflects the market value of eligible bonds. This means that the distribution of CSPP holdings by country matches the respective country shares in the CSPP-eligible bond universe. Similarly, there are no significant deviations between CSPP holdings and their respective shares in the CSPP-eligible universe concerning sectors of economic activity or rating groups.[9]

The ECB did not hold any corporate bonds before 2016. By 2019, the ECB held more than 22% of the outstanding amount of eligible investment grade bonds. Although the share began to decline in 2019, it spiked again at the onset of the Covid crisis, reaching 27% in 2023. In March 2020, the ECB began purchasing corporate bonds under the Pandemic Emergency Purchase Programme (PEPP). The launch of this additional program significantly increased the volume of purchases. By 2023, the ECB's holdings totaled €400 billion.

In Appendix C.1, we provide additional information on the evolution of investor holdings over time. Furthermore, in Appendix C.2, we use confidential data on ECB holdings to document the share of the outstanding amount of eligible bonds held by the ECB.

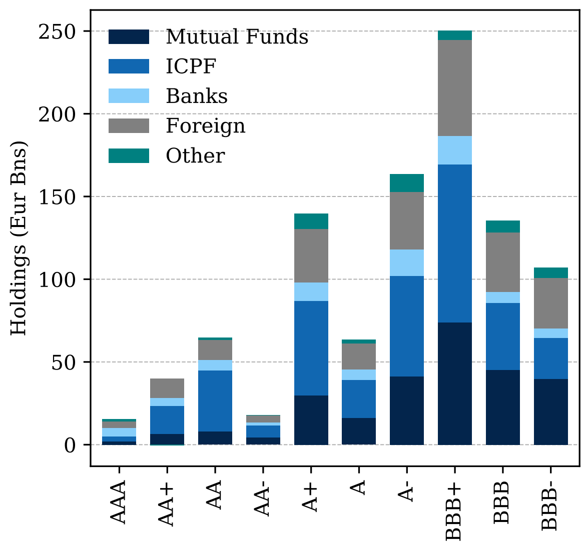
CSPP Announcement The announcement in March 2016 led to a significant decline in corporate bond yields (see Figure 2b). Within three days of the March 10, 2016 announcement, value-weighted average bond yields fell by approximately 35 basis points, with yields continuing to decline in the weeks that followed. This reduction was driven almost entirely by a decrease in corporate bond spreads, rather than by changes in the credit-risk-free component of yields.

In Appendix D.1 we provide additional details on the CSPP measures and discuss the decomposition of the yield response into the credit-risk-free rate component and the residual spread.

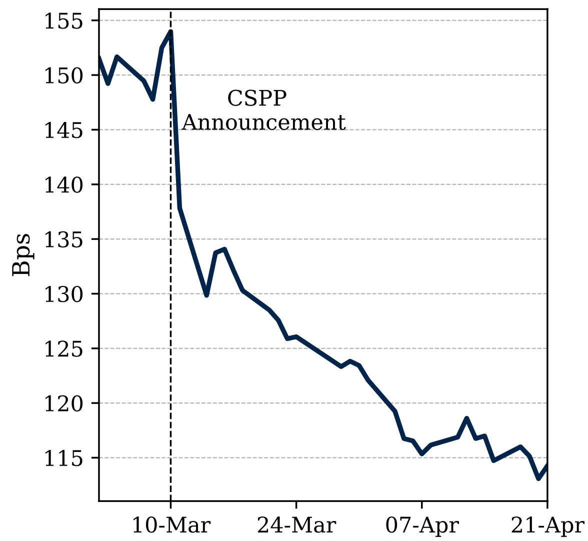
[9]In line with the goals of the Paris Agreement, the Eurosystem announced in July 2022 its intention to gradually decarbonize its corporate bond holdings. This involves tilting purchases toward issuers with better climate performance through the reinvestment of significant redemptions expected in the coming years.

Figure 2: Allocation of Corporate Bonds

(a) Holdings by Ratings



(b) CSPP Announcement



Note: Panel (a) plots the holdings in €billions by different types of intermediaries for eligible bonds, stratified by rating. The numbers reflect the allocation in 2015-Q4. Panel (b) shows the evolution around the Corporate Sector Purchase Programme (CSPP) announcement on March 10, 2016.

4. Intermediaries Holdings and the Effects of Asset Purchases on Bond Yields

Figure 2b displays a significant drop in corporate bond yields across the aggregate corporate bond market. To assess how the bond price reaction correlates with the holdings of different intermediaries, we collect all bonds (both eligible and non-eligible) within the Markit iBoxx Euro-denominated corporate bond indexes, and match each bond to the intermediary sector holding it. This sorting reveals a clear pattern: bonds held by mutual funds showed a more pronounced reduction in yields compared to those held by other intermediaries. Figure 1 illustrates the correlation between mutual fund ownership shares and the reduction in bond yields following the announcements. To reduce noise, we rank bonds into percentiles based on their response, grouping them into 20 bins. The y-axis shows the average mutual fund share for bonds within each bin.[10]

The response to the announcement varied significantly among bond yields. While a subset of bonds remained largely unaffected by the policy, others experienced a notable decrease in bond yields, in some cases declining by as much as 100 basis points. The distribution of bonds held by mutual funds demonstrates an almost monotonically increasing trend. On average, mutual funds hold approximately 25% of bonds with no reaction, and this proportion rises to 50% for bonds that witnessed the most substantial reduction in bond yields.

4.1 Bond Characteristics and Intermediary Holdings

As Figure 2a shows, mutual funds and other investors hold different bonds. As a consequence, the observed correlation in Figure 1 may simply be driven by the fact that bonds with different characteristics, such as ratings, are affected differently. Alternatively, bonds may react differently depending on whether they are held by mutual funds versus other investors. To disentangle these two channels, we control for the characteristics of the bonds and assess the marginal impact of bond ownership.[11]

Specifically, we regress the change in bond spreads around the CSPP announcements on mutual funds' holdings, including a set of interacted fixed effects. In our analysis, we use the OAS yield spread and focus exclusively on eligible bonds. We run the following cross-sectional regression:

$$\Delta ys_i^n = \beta_n^{MF}\theta_i^{MF} + \text{Interacted Fixed Effects} + \varepsilon_i^n, \tag{2}$$

where Δys_i^n is the n-days change in OAS of bond i around the announcement of CSPP, θ_i^{MF} are the shares of bond i held by mutual funds at the end of the quarter prior to the announcement (i.e., 2015-Q4). The coefficient of interest is β_n^{MF}, which measures the additional change in yields around the CSPP announcement for bonds held by mutual funds.

We incorporate various lags, ranging from one day to thirty days after the announcement, in our analysis. Our regression model includes dummies for a set of bond characteristics:

[10]In this plot, shares are calculated as the holdings of mutual funds divided by the total holdings of mutual funds, insurance companies, pension funds, and banks.

[11]To ensure that our results are not driven by a small number of extreme observations, we eliminated all observations with OAS below -40bps and above 3000 basis points. We also exclude bonds with maturity longer than 20 years and maturity shorter than one year.

duration group (0y-1y, 1y-3y, 3y-5y, 5y-8y, 8y+), issuer country, average rating, worst rating, size, callability, and issuer identity. Additionally, we control for bond liquidity using the bid-ask spread prior to the announcement, which helps address concerns about differential effects due to liquidity. Specifically, we rank bonds by their bid-ask spread and divide them into quintiles, ranging from low to high spreads. However, it is important to note that liquidity is endogenous and depends on the intermediaries holding the bonds. This implies we are controlling for a factor influenced by mutual fund ownership shares, which might introduce potential bias into the results. We should only control for exogenous bond characteristics. Nevertheless, we include this control for completeness, keeping in mind the limitations of this approach.

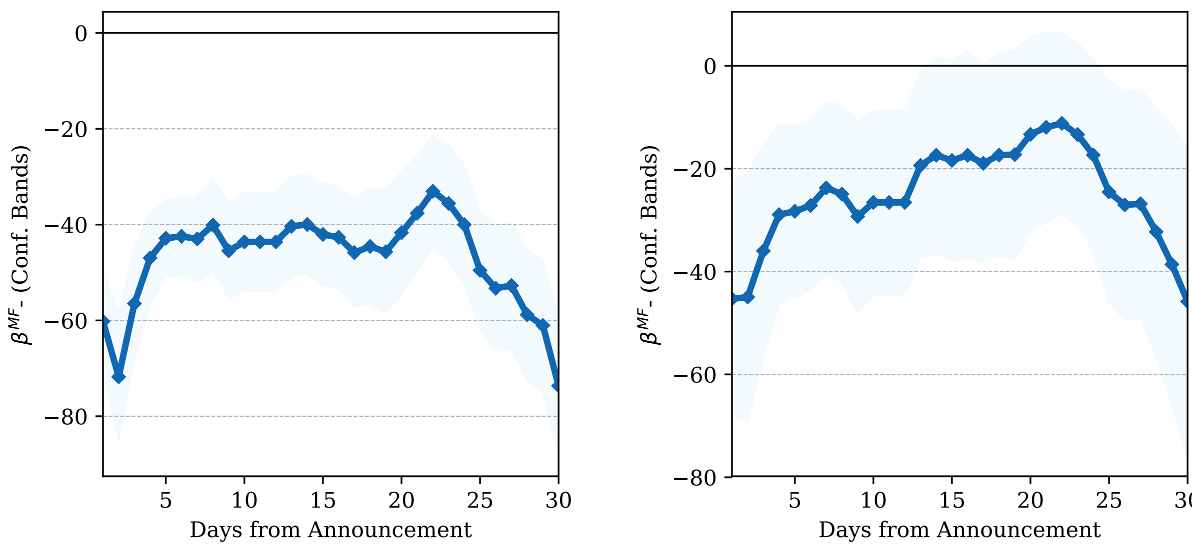
Results The results are presented in Table I. The table reports the coefficient β^{MF} for various control specifications, each interacted with others. In Panel A, the coefficients represent the effects with a 5-day lag (i.e., a weekly effect considering only business days). For bonds with a 50% share held by mutual funds, we observe a more pronounced decrease in spreads of 27 basis points (half the coefficient reported in the table). Moving from column (1) to column (2), we notice that the coefficient barely changes, implying that duration does not appear to be relevant. However, as expected, when controlling for the bond rating, the effect decreases to 20 basis points (the coefficient drops from -54.7 to -42.8). One could argue that bonds in different countries are affected differently due to the heterogeneity of sovereign yield curves. Therefore, we control for country fixed effects, which appear to be irrelevant. We keep this set of fixed effects (duration, rating and country) and now in turn add a set of interacted fixed effects.[12]

The fact that some bonds are callable does not impact the estimates (Column (7)), but both size and liquidity exhibit similar effects. These characteristics also tend to correlate with ownership, as insurance companies and mutual funds typically hold a larger (or smaller) proportion of bonds depending on the size of the issuance. We also observe an effect at the issuer level. It's important to note that this specification is highly restrictive, yet we find a statistically significant coefficient of -28. Additionally, we explore a 10-day lag, and the coefficients remain remarkably stable. This consistency across the 5-day and 10-day

[12]The results remain unchanged when all fixed effects are included simultaneously; however, this approach reduces the number of observations (e.g., it is challenging to find bonds issued by the same issuer with significantly different sizes).

Figure 3: Effects Over Time

(a) Duration / Rating Fixed Effects (b) Duration / Issuer Fixed Effects



Note: The figure displays the estimated coefficients from Equation 2, along with the 10% confidence intervals. Panel (a) shows the coefficients from the regression model that includes duration and rating fixed effects. Panel (b) presents the coefficients from the regression model that includes duration and issuer fixed effects. The estimates cover the period from 1 day to 30 days after the announcement.

indicates that the effects are not merely driven by noise in the immediate days following the announcement. Although the coefficient estimates are somewhat less precise, resulting in slightly larger standard errors, the overall pattern remains robust.

In Figure 3, we plot the estimated β_n^{MF} over different days following the announcement. Figure 3a shows the estimated coefficients when we include duration and rating fixed effects (as in column (3) of Table I). The plot indicates an immediate overreaction for bonds with higher mutual fund shares, with the coefficient jumping to between -60 and -70 in the two days after the announcement. It then stabilizes around -40 before increasing to approximately -80 after 30 business days. A similar pattern is observed when using a more stringent set of fixed effects: Figure 3b displays the coefficient when issuer fixed effects are included (as in column (8) of Table I). Here, we observe an initial overreaction to -40, followed by stabilization around -25, and then a further increase to -40 after 30 days.

Quantiles We then sort the bonds based on the proportion held by mutual funds and rank them into quintiles. The first quintile represents bonds with the lowest share held by

Table I: Mutual Funds Holdings and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	-54.764***	-53.956***	-42.845***	-44.373***	-39.559***	-42.774***	-49.681***	-28.274***	-25.428***
	(4.69)	(3.80)	(4.82)	(6.78)	(7.26)	(6.94)	(8.05)	(10.16)	(9.15)
Observations	860	860	858	837	780	726	816	472	628
Adj. R-squared	0.136	0.157	0.294	0.345	0.402	0.349	0.393	0.821	0.553
	Panel B: 10 days lag								
θ_i^{MF}	-58.537***	-57.496***	-43.603***	-45.740***	-38.654***	-42.764***	-52.256***	-26.555**	-24.525**
	(5.62)	(4.63)	(6.20)	(7.69)	(8.15)	(7.20)	(8.73)	(10.88)	(9.66)
Observations	860	860	858	837	780	726	816	472	628
Adj. R-squared	0.111	0.129	0.259	0.327	0.385	0.321	0.363	0.830	0.526
	Panel C: 30 days lag								
θ_i^{MF}	-100.041***	-97.197***	-73.640***	-76.546***	-62.233***	-73.736***	-83.957***	-45.817**	-31.247**
	(9.09)	(7.51)	(8.80)	(11.80)	(11.35)	(12.04)	(13.01)	(18.17)	(13.18)
Observations	847	846	845	824	769	718	804	460	616
Adj. R-squared	0.124	0.148	0.272	0.355	0.464	0.332	0.410	0.796	0.635
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

mutual funds, while the fifth quintile includes those with the highest share. The results, shown in Table II, reveal that the coefficients for the second and third quintiles are small and, in most cases, not statistically significant, using the first quintile as the baseline.

For the fourth quintile, the coefficients are approximately -10 at the 5-day and 10-day lags and around -20 at the 30-day lag, depending on the specification. Notably, the fifth quintile shows a much stronger response, with coefficients of around -20 at the 5-day and 10-day lags and -40 at the 30-day lag. These results suggest that the effect of the policy intervention is primarily concentrated in bonds with the highest levels of mutual fund ownership. In other words, bonds with a larger mutual fund presence (those in the fifth quintile) exhibit a significantly stronger reaction to the policy changes, indicating that mutual funds play a critical role in driving the differential response observed.

Active Mutual Funds We use granular holdings data from Lipper to calculate the shares held by mutual funds, excluding ETFs. Mutual fund holdings from Lipper are aggregated to determine the proportion of each bond held by mutual funds. The resulting figures differ from the total mutual fund holdings for several reasons: (i) Lipper includes both Euro area mutual funds and foreign mutual funds, (ii) we exclude ETF holdings, (iii) Lipper includes only a subset of mutual funds. Specifically, Lipper does not account for mutual funds that are no longer active or those that are not available to the general public. An example of the latter includes mutual funds created by insurance companies for their own investment purposes, which are not marketed publicly.

We conduct a regression 2 and present the results in Table E20 for θ_i^{AMF}, which indicates the share of active mutual funds. The magnitude of the coefficients is now significantly greater. In the specification without any fixed effects, the coefficient is -160 at the 5-day lag and -326 at the 30-day lag. When including rating and duration fixed effects, the coefficient is -133 at the 5-day lag and -259 at the 30-day lag.

There are a number of reasons for the higher magnitude of the coefficients. First, active mutual funds are likely driving the strong price effects observed following the announcement of the CSPP. Second, due to data limitations, we may only capture a subset of mutual fund shares. If these shares are correlated, the estimates in Table E20 could overestimate the true coefficient. Third, the advantage of Lipper data is that it allows us to select only active mutual funds that are not directly managed by insurance companies, which could bias our estimate downward in Table I. In summary, we believe that the true estimate lies between the estimates in Table I and Table E20.

4.2 Alternative Specification

In relation to the above results, one could argue that changes in spreads and the observed effects on mutual funds may be influenced by factors unrelated to the policy announcements. To address this, we employ an alternative identification strategy, comparing the differential effects between eligible and non-eligible bonds, following an approach similar to Todorov (2020) and Corell et al. (2023). This expanded analysis includes the full set of euro-denominated bonds in the Markit iBoxx index. We run the following cross-sectional

Table II: Mutual Funds Quintiles and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MF Quintile 2	-1.182	-0.668	-0.177	0.039	0.407	0.312	-0.784	0.118	2.832**
	(2.06)	(0.91)	(0.67)	(1.13)	(1.26)	(1.44)	(1.23)	(0.94)	(1.38)
MF Quintile 3	-5.538***	-4.368*	-3.536*	-4.360**	-4.504**	-3.989**	-5.760***	-0.796	-3.845**
	(2.06)	(1.60)	(1.90)	(1.71)	(1.75)	(1.95)	(1.93)	(1.09)	(1.52)
MF Quintile 4	-11.937***	-10.667***	-8.389***	-7.771***	-7.293***	-8.854***	-9.811***	-2.075	-5.371***
	(2.06)	(0.56)	(2.09)	(1.87)	(1.90)	(1.87)	(2.17)	(1.47)	(1.51)
MF Quintile 5	-23.500***	-23.217***	-17.987***	-18.985***	-16.935***	-18.100***	-20.513***	-14.881***	-9.018***
	(2.27)	(1.97)	(1.49)	(3.20)	(3.50)	(3.29)	(3.83)	(5.38)	(2.91)
Observations	860	860	858	837	780	726	816	472	704
Adj. R-squared	0.143	0.167	0.297	0.352	0.407	0.361	0.394	0.831	0.598
	Panel B: 10 days lag								
MF Quintile 2	-1.481	-0.816	0.009	-0.245	0.083	-0.186	-1.290	0.061	2.078
	(2.47)	(1.15)	(0.68)	(1.32)	(1.43)	(1.56)	(1.31)	(1.09)	(1.42)
MF Quintile 3	-6.862***	-5.644**	-4.363*	-4.995**	-5.600***	-4.780**	-6.581***	-1.963	-4.964***
	(2.47)	(1.78)	(2.36)	(2.09)	(1.90)	(2.25)	(2.19)	(1.21)	(1.73)
MF Quintile 4	-12.600***	-11.196***	-8.289**	-6.821***	-5.767***	-8.069***	-9.131***	-1.495	-3.445*
	(2.47)	(2.17)	(2.91)	(2.05)	(2.12)	(2.07)	(2.23)	(1.60)	(1.75)
MF Quintile 5	-25.315***	-24.896***	-18.334***	-20.013***	-16.950***	-18.234***	-21.982***	-13.539**	-9.157***
	(2.73)	(2.73)	(2.32)	(3.63)	(3.87)	(3.42)	(4.06)	(5.75)	(2.69)
Observations	860	860	858	837	780	726	816	472	704
Adj. R-squared	0.115	0.134	0.260	0.333	0.388	0.325	0.362	0.833	0.573
	Panel C: 30 days lag								
MF Quintile 2	-2.804	-1.231	0.326	0.180	0.598	0.121	-1.585	-0.496	2.201
	(3.98)	(3.49)	(2.16)	(1.82)	(2.06)	(2.22)	(1.73)	(2.39)	(2.00)
MF Quintile 3	-11.180***	-8.835*	-6.501	-6.734**	-7.289***	-7.972**	-9.276***	-3.223	-6.750***
	(4.00)	(3.37)	(3.84)	(3.01)	(2.55)	(3.30)	(3.09)	(2.71)	(2.38)
MF Quintile 4	-27.402***	-24.230***	-19.179***	-15.166***	-11.136***	-16.594***	-19.243***	-7.266	-8.492***
	(4.00)	(3.26)	(4.69)	(3.58)	(3.09)	(3.59)	(3.77)	(4.81)	(2.50)
MF Quintile 5	-40.573***	-39.620***	-28.852***	-31.478***	-26.342***	-30.856***	-33.350***	-20.360**	-13.403***
	(4.39)	(5.23)	(3.88)	(5.39)	(5.21)	(5.24)	(5.97)	(8.47)	(4.22)
Observations	847	846	845	824	769	718	804	460	693
Adj. R-squared	0.131	0.155	0.276	0.359	0.467	0.341	0.409	0.795	0.664
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2 where instead of the share held by mutual funds we include a dummy for the quintile. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

regression:

$$\Delta ys_i^n = \gamma_n^{elig}\ \mathbb{1}_{elig} + \gamma_n^{MF}\ \mathbb{1}_{elig} \times \theta_i^{MF} + \beta_n^{MF}\theta_i^{MF} + \text{ Interacted Fixed Effects} + \varepsilon_i^n, \qquad (3)$$

where Δys_i^n is the n-days change in OAS of bond i around the announcement of CSPP, $\mathbb{1}_{elig}$ is an indicator function that is equal to one if the bond is eligible, θ_i^{MF} are the shares of bond i held by mutual funds at the end of the quarter prior to the announcement (i.e., 2015-Q4). The coefficient of interest is now γ_n^{MF}. The results are displayed in Table III for the 10-day change. The estimated coefficient for the interaction between the eligibility indicator function $\mathbb{1}_{elig}$ and mutual fund ownership share θ_i^{MF} is -18 when no fixed effects are included. Depending on the fixed effects applied, the estimated values range from -18 bps to -26 bps. All coefficients are statistically significant, except in column (8), where we control for the bond's bid-ask spread. In this case, the coefficient remains negative but is smaller and not statistically significant. As discussed earlier, this specification is less reliable because liquidity is an endogenous variable influenced by bond ownership rather than an exogenous characteristic.

In Appendix E.2, we explore potential non-linearities by sorting bonds into quintiles based on mutual fund ownership. The results reveal a non-linear pattern, with the strongest effects concentrated among bonds with the highest levels of mutual fund ownership.

4.3 Bond spread, CDS spread, CDS basis and Bid-Ask Spread

The variation in bond OAS documented in Table I can be decomposed into changes in CDS spreads and the CDS basis, which is the difference between the bond spread and the CDS spread of equal maturity, as defined in Equation 1. We conduct the same regression as specified in Equation 2 for the subset of bonds where the CDS spread is available, using as dependent variables the OAS ($\Delta Y^n i$), the CDS basis ($\Delta bs^n i$), and the CDS spreads (Δcds_i^n).

We estimate the model:

$$\Delta Y_i^n = \beta_n^{MF}\theta_i^{MF} + \text{Interacted Fixed Effects} + \varepsilon_i^n, \qquad (4)$$

The coefficient $\beta^{MF}n$ captures the additional change in the CDS basis around the CSPP announcement for bonds held by mutual funds.

Table III: Mutual Funds Holdings and CSPP Announcement, Alternative Identification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eligible	-3.846	-3.682	-0.601	-2.030	-3.292	-4.282	-2.067	-6.089**
	(2.48)	(1.98)	(2.25)	(3.03)	(2.83)	(2.89)	(3.18)	(2.45)
Eligible x θ_i^{MF}	-18.846***	-18.953***	-21.300**	-25.932***	-19.672**	-23.421**	-29.450***	-4.821
	(7.20)	(4.05)	(7.76)	(8.95)	(9.16)	(9.12)	(9.87)	(7.57)
θ_i^{MF}	-39.691***	-38.986***	-22.482***	-19.292***	-17.267***	-18.573***	-21.145***	-20.860***
	(5.13)	(2.56)	(3.61)	(4.34)	(4.65)	(5.97)	(4.37)	(4.30)
Observations	1735	1735	1733	1660	1541	1469	1625	1502
Adj. R-squared	0.152	0.159	0.276	0.336	0.444	0.330	0.360	0.516
Duration		✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓
Rating Worst					✓			
Size						✓		
Callable							✓	
Liquidity								✓

Note: The table shows the estimated coefficients and standard errors from Equation 3. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

CDS and CDS Basis Table IV presents the results, with columns (1) to (3) reporting the OAS (Δys_i^n), columns (4) to (6) reporting the CDS spreads (Δcds_i^n), and columns (7) to (9) reporting the CDS basis (Δbs_i^n). Because we restrict our sample to bonds that are (i) included in the Markit iBoxx index, (ii) CSPP-eligible, and (iii) have a corresponding CDS, the sample size is reduced to 298 bonds. In this analysis, we include fixed effects for duration and rating.

The first column replicates the first column in Table I, but for the restricted sample of bonds. The coefficient on $\theta^{MF}i$ is -37bps. For the same bonds and fixed effects, the variation attributed to the CDS basis is 25bps, as shown in column (4) (note that the sign is opposite due to the definition of the CDS-bond basis). The coefficient on the CDS is -11bps and is not statistically significant. Overall, this suggests that most of the variation in bond spreads is driven by bond basis changes rather than variations in default insurance, as indicated by the CDS. This effect becomes more pronounced when fixed effects for duration and rating are included.

The additional reduction in bond spread associated with mutual fund holdings is -27bps. The variation explained by the bond basis is 22bps, as reported in column (5). When we include the fixed effect for the worst rating, this pattern becomes even more pronounced.

Table IV: Decomposition in CDS and CDS Basis

	Δ OAS			Δ CDS			Δ Basis		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	-37.297***	-35.690***	-27.907***	-11.561	-10.491	-5.917	25.736***	25.199***	21.990***
	(6.66)	(4.64)	(7.67)	(7.26)	(7.13)	(7.94)	(6.13)	(3.68)	(4.58)
Observations	298	298	297	298	298	297	298	298	297
Adj. R-squared	0.093	0.141	0.286	0.005	0.025	0.156	0.053	0.048	0.056
Duration		✓	✓		✓	✓		✓	✓
Rating			✓			✓			✓

Note: The table presents the estimation of Equation 4. with columns (1) to (3) reporting the OAS, columns (4) to (6) reporting the CDS basis, and columns (7) to (9) reporting the CDS spreads. Standard errors are double clustered by time and bond groups.

The decomposition provides insights into the nature of monetary policy transmission. The central bank's purchase policy may impact financial markets by either lowering a firm's default probability or by reducing the compensation investors demand to hold the bonds. The fact that the transmission mainly operated through the latter channel reinforces the idea that the type of bondholder can influence transmission strength.

Bid-Ask Spread We also examine the impact on bid-ask spreads as a potential transmission channel through improved bond liquidity. Since bond liquidity is challenging to measure directly, we use bid-ask spread data from Markit iBoxx to assess the announcement's effects and how these vary with intermediary holdings. We employ the regression framework described in Equation 4, using the bid-ask spread of individual bonds as the dependent variable. The results are displayed in Table V, which shows the effects on bid-ask spreads after 5 days, 10 days, or 30 days. We use as fixed effects duration, rating, and size.[13] The results show a significant reduction 10 days after the announcement. The average bid-ask spread ranges from 50bps for bonds rated AA to 64bps for bonds rated BBB (75bps for bonds whose best rating is BBB-). In the first five days following the announcement, no significant differential effects were observed for bonds held by mutual funds. The coefficient is positive but not statistically significant if we include duration and rating fixed effects, but it is negative and significant once we include the size fixed effect. The magnitude is roughly -9bps. Once we examine the bid-ask spread after 10 days, we find a statistically significant coefficient ranging

[13]Size is often used as a proxy for liquidity. By controlling for size, we compare changes in liquidity among bonds that, ex ante, are expected to have similar liquidity levels but differ in ownership.

Table V: Mutual Funds Holdings and Bid-Ask Spread

	bid-ask (5 days)			bid-ask (10 days)			bid-ask (30 days)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	3.188	0.757	-8.943*	-10.372	-8.229**	-9.006*	-9.137**	-9.472***	-10.098*
	(6.12)	(6.30)	(4.89)	(5.10)	(3.26)	(4.56)	(1.83)	(2.74)	(5.77)
Observations	860	858	726	860	858	726	846	845	718
Adj. R-squared	0.036	0.054	0.120	0.011	0.033	0.212	0.010	0.020	0.057
Duration	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rating		✓	✓		✓	✓		✓	✓
Size			✓			✓			✓

Note: The table shows the estimated coefficients and standard errors from Equation 4. The dependent variable is bid-ask spread. Standard errors are double clustered by time and bond groups.

from -8bps to -10bps under different specifications. The results imply a more pronounced decline in bid-ask spreads for bonds held by mutual funds after the announcement.

4.4 Other Investors

To extend the analysis to other types of intermediaries, we run the following cross-sectional regression:

$$\Delta ys_i^n = \beta_n^j \theta_i^j + \text{Interacted Fixed Effects} + \varepsilon_i^n, \tag{5}$$

where θ_i^j is the share of bond i held by j = Foreign, ICPF (insurance companies and pension funds) at the end of the quarter prior to the announcement (i.e., 2015-Q4). Table VI presents the results for foreign investors.

Foreign Investors The results indicate that bonds held by foreign investors exhibit more pronounced effects in response to the CSPP announcement than the average bond. Without any fixed effects, the coefficient on the foreign investors' share is -39bps. When including the rating fixed effect, the coefficient is approximately -33bps. Given that other investors are likely mutual funds, this consistency suggests that the policy was particularly effective for bonds held by mutual funds. The magnitude is roughly in line with the magnitude documented for mutual funds in Table I. The coefficient is around -30bps to -40bps depending on the specification. We find a similar magnitude with 5 and 10 days lag. Similarly to mutual funds, we find an increase in the magnitude after 30 days, where the coefficients range from -70bps to -80bps. We find a pattern and an economic magnitude similar to what we find for

Table VI: Foreign Investors Holdings and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\theta_i^{Foreign}$	-39.005***	-40.467***	-33.650***	-41.154***	-42.736***	-39.607***	-45.885***	-31.148***	-36.273***
	(5.18)	(3.70)	(9.00)	(8.13)	(7.99)	(7.67)	(8.80)	(10.63)	(10.73)
Observations	860	860	858	837	780	726	816	472	628
Adj. R-squared	0.061	0.089	0.267	0.324	0.399	0.329	0.366	0.820	0.567
	Panel B: 10 days lag								
$\theta_i^{Foreign}$	-38.042***	-40.148***	-32.607***	-40.598***	-42.253***	-37.248***	-45.076***	-30.142***	-34.129***
	(6.18)	(5.04)	(10.02)	(8.68)	(9.22)	(8.49)	(9.47)	(11.15)	(12.46)
Observations	860	860	858	837	780	726	816	472	628
Adj. R-squared	0.041	0.066	0.235	0.307	0.384	0.302	0.334	0.830	0.534
	Panel C: 30 days lag								
$\theta_i^{Foreign}$	-75.846***	-79.752***	-67.679***	-75.768***	-69.503***	-74.613***	-82.688***	-51.678***	-45.917***
	(10.06)	(7.19)	(16.42)	(12.58)	(12.57)	(13.25)	(13.57)	(16.86)	(15.68)
Observations	847	846	845	824	769	718	804	460	616
Adj. R-squared	0.062	0.098	0.262	0.344	0.464	0.322	0.395	0.796	0.642
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 5. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

mutual funds.

Insurance Companies and Pension Funds Table VII presents the results for insurance corporations and pension funds (ICPF). As expected, the coefficient has the opposite sign. Bonds held by insurance corporations tend to be less affected by the policy. Without any fixed effects, the coefficient is +26bps. When we incorporate duration and rating, the coefficient decreases to +21bps. The coefficient is both economically and statistically significant. The results indicate that the pattern significantly differs for insurance companies and pension funds compared to mutual funds.

Mutual Funds and Other Investors We estimate a regression that includes both holdings of mutual funds and other investors:

$$\Delta ys_i^n = \beta_n^{MF}\theta_i^{MF} + \beta_n^j\theta_i^j + \text{Interacted Fixed Effects} + \varepsilon_i^n. \tag{6}$$

We display the results in Appendix E.1. The results are displayed in Table E18 for insurance companies and pension funds, and Table E19 for foreign investors. Table E18 indicates that when controlling for foreign investors, the holdings of mutual funds have similar effects on bonds. The coefficients for mutual funds are generally larger in magnitude. For example, the coefficient when we include duration and rating controls (column (3)) is -35 bps (-54 bps) for mutual funds and -17 bps (-41 bps) for foreign investors at a 5-day lag (30-day lag). The only exception occurs in column (8), where issuer fixed effects are included, and the coefficients are comparable for both mutual funds and foreign investors. The coefficients in column (8) are -18 at a 5-day lag and approximately -30 at a 30-day lag. These findings are not surprising: Foreign investors are likely international mutual funds, so we anticipate similar behavior to that of Euro area mutual funds.

In Table E18 in the Appendix, we present the coefficients for the regression model that includes holdings of both mutual funds and insurance companies and pension funds. The coefficient on mutual fund holdings in this setting is broadly in line with what we estimated in the baseline specification for mutual funds (Table I). This suggests that the mechanism is primarily driven by the behavior of mutual funds rather than insurance companies and pension funds.

5. Mutual Funds Portfolios and Flows

In the previous section, we analyzed the heterogeneous impacts of the ECB's corporate bond purchase program on bond yields, highlighting how these impacts differ according to bond ownership. In this section, we provide evidence on the portfolio rebalancing activities of mutual funds following the ECB's announcements. For this investigation, we use mutual fund holdings data sourced from Lipper. Our sample comprises all mutual funds with holdings in corporate bonds. We integrate these mutual fund bond holdings with the corporate bond data from SHSS/CSDB. Using the Lipper dataset, we calculate the monthly nominal

Table VII: ICPFs Holdings and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{ICPF}	26.345***	28.954***	21.317***	23.677***	20.175***	26.180***	26.207***	11.867*	20.727***
	(3.53)	(1.98)	(5.79)	(5.51)	(5.17)	(5.17)	(5.70)	(6.17)	(5.55)
Observations	860	860	858	837	780	726	816	472	704
Adj. R-squared	0.060	0.093	0.258	0.306	0.371	0.325	0.344	0.808	0.596
	Panel B: 10 days lag								
θ_i^{ICPF}	27.682***	30.793***	22.287***	22.892***	18.524***	25.844***	25.687***	10.421	18.837***
	(4.20)	(3.43)	(7.56)	(5.63)	(5.07)	(5.41)	(6.07)	(6.58)	(5.74)
Observations	860	860	858	837	780	726	816	472	704
Adj. R-squared	0.047	0.076	0.233	0.293	0.361	0.303	0.319	0.820	0.571
	Panel C: 30 days lag								
θ_i^{ICPF}	51.724***	57.558***	43.606***	45.126***	34.350***	48.550***	48.875***	17.801*	31.374***
	(6.82)	(6.38)	(14.46)	(9.97)	(8.68)	(8.37)	(10.41)	(9.41)	(8.68)
Observations	847	846	845	824	769	718	804	460	693
Adj. R-squared	0.063	0.103	0.253	0.329	0.444	0.316	0.377	0.785	0.666
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 5. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

holdings for each mutual fund. Subsequently, we measure the portfolio rebalancing as the log-change in holdings from the month prior to the announcement (February 2016) to n months following the announcement. We use the nominal amount of bonds held, rather than their market value, to distinguish the effects arising from actual portfolio changes and to eliminate mechanical effects caused by asset price fluctuations.

The primary advantage of utilizing Lipper data lies in its granularity and higher frequency. In contrast, SHSS data is only available on a quarterly basis. The announcement of the CSPP occurred during the ECB meeting on March 10, 2016. By employing monthly data, we can reduce the level of noise, enabling a more precise isolation of the effects from the end of February onwards.

In this section, we examine the portfolio rebalancing effects of mutual funds by comparing eligible bonds with non-eligible bonds. We follow the approach of Corell et al. (2023). By contrasting these two groups, we can better control for trends and portfolio choices that are unrelated to the ECB's CSPP impact. This approach is particularly relevant here, as there are ongoing trends in investor shares that are independent of the announcement and the lower frequency of the data on volumes compared to prices does not allow us to study the effects in a narrow window around announcements. For example, mutual funds are generally expanding at the expense of other investors, which suggests an overall increase in their shares. Our focus is on determining whether mutual funds are more likely to buy eligible bonds compared to other bonds following the announcement, a behavior that could create price pressure on eligible bonds.

Formally, we run the following regression:

$$\Delta \text{Log Holdings}_i^j(n) = \gamma_n^{elig}\ \mathbb{1}_{elig} + \text{Interacted Fixed Effects} + \varepsilon_i^j(n), \tag{7}$$

where ΔLog Holdings$_i^j(n)$ are the changes in holdings of bond i by mutual fund j, n months after the announcement, $\mathbb{1}_{elig}$ is an indicator whether the bond is eligible.

We present results for the change in holdings from one month to four months following the announcement. To minimize noise, our analysis is restricted to cases where mutual funds actively adjusted their bond positions. Table VIII reports these results. We measure the log-change in holdings in percentage points, based on nominal holdings, which are therefore unaffected by valuation changes.

The results indicate that mutual funds rebalanced toward eligible bonds by 11.2% (relatively more than into non-eligible bonds) in the month of the announcement, as shown in Column (1) of Panel A. When fixed effects for duration and ratings are added, this figure decreases to 6.8%, as reported in Column (2). These percentages represent the average log-change in holdings of eligible versus non-eligible bonds. This portfolio rebalancing appears persistent, with consistent results across different time periods and regression specifications.

We also use SHS aggregate data to test these channels, and the results align with those obtained using more granular, high-frequency Lipper data. These findings are presented in Table F23 in the Appendix. Furthermore, the SHS data reveal that insurance companies and pension funds were net sellers of eligible bonds during this period (see Table F24 in the

Appendix), consistent with the mechanism proposed in the model.

Overall, these results suggest that mutual funds rebalanced their portfolios toward eligible bonds following the ECB announcement. This finding aligns with the predictions of the model and the price reactions discussed in Section 4.

Table VIII: Mutual Fund Portfolio Rebalancing

	Panel (A)							
	Δ log Holdings (1)				Δ log Holdings (2)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eligible	11.230***	10.877***	9.006**	8.657**	7.272***	7.201***	4.657***	4.482***
	(3.76)	(3.79)	(3.95)	(4.04)	(1.52)	(1.53)	(1.61)	(1.64)
Observations	4855	4855	4855	4855	5297	5297	5297	5297
Adj. R-squared	0.002	0.001	0.008	0.008	0.004	0.005	0.011	0.015

	Panel (B)							
	Δ log Holdings (3)				Δ log Holdings (4)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eligible	8.739***	8.843*	7.092**	7.431***	8.971***	9.212**	8.004**	8.624***
	(1.93)	(3.34)	(1.87)	(1.91)	(1.93)	(2.85)	(2.55)	(1.96)
Observations	5977	5977	5977	5977	6413	6413	6413	6413
Adj. R-squared	0.003	0.004	0.006	0.007	0.003	0.004	0.005	0.006
Duration		✓		✓		✓		✓
Rating			✓	✓			✓	✓

Note: The table shows the estimated coefficients and standard errors from Equation 7. Panel (A) reports the results for the 1-month and 2-months change in Log Holdings. Panel (B) reports the results for the 3-months and 4-months change in Log Holdings. The set of fixed effects for both Panel (A) and Panel (B) are reported at the bottom of Panel (B).

5.1 Mutual Fund Flows

Using daily fund flow data from Lipper, we compute the average fund flows for all mutual funds in our sample. We focus exclusively on Mixed Assets funds and Bond funds, as these are the most likely to hold corporate bonds. This is clear from Table C17 in the Appendix, which provides detailed summary statistics on the number of funds, their fund flows, and assets under management. The table also categorizes funds by asset type (e.g., Mixed Assets funds, Bond funds), domicile (Euro area or outside), and whether they hold eligible bonds.

We leverage the design of the ECB policy to disentangle the effects of the ECB announcement on fund flows. Specifically, we classify as *eligible* those funds that hold at least one eligible bond.[14] To ensure robustness and minimize the influence of outliers, we trim the bottom and top 1% of flows as a percentage of total net assets (TNA). We then compute average fund flows for the entire set of funds and the subset of eligible funds. Specifically, we calculate rolling monthly fund flows as a percentage of total assets under management for both groups.

Figure 4a displays the standard deviation of monthly fund flows (as a percentage of TNA) from the average. The figure indicates that, at the start of 2016, monthly flows into eligible and non-eligible funds were below average. However, immediately following the CSPP announcement, flows began to increase, particularly into eligible funds. The two lines (eligible and non-eligible) are virtually identical until the announcement, after which we observe a divergence, with flows into eligible funds accelerating. Fund flows were particularly high at the beginning of April.

Before April, the volume of fund flows remained below €8 billion, slightly less than one standard deviation above the mean. During this period, the amounts were roughly similar for eligible and non-eligible funds. However, at the beginning of April, fund flows for eligible funds surged to €12.5 billion, representing an increase of nearly 1.5 standard deviations for the year. This sharp rise was significantly higher than the inflows observed for non-eligible funds.

To formally assess the effects of CSPP on fund flows, we calculate the monthly flow for each fund from March 10 to April 10, scaled by total assets. We then perform the following regression:

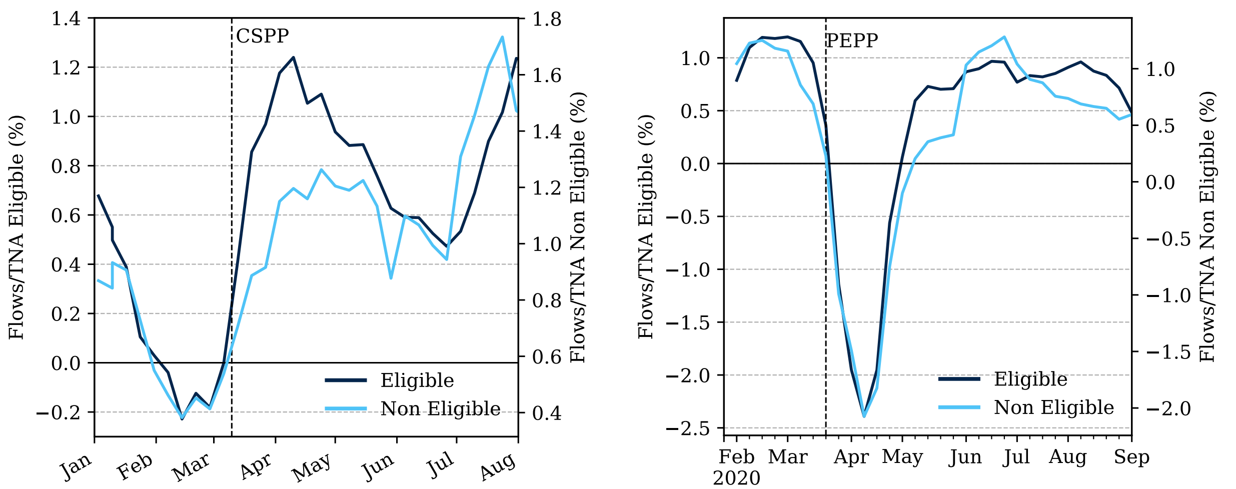
$$\frac{Flow_i}{TNA_i} = \gamma_0 + \gamma^{elig}\ \mathbb{1}_{elig} + \varepsilon_i, \tag{8}$$

where γ^{elig} captures the potential additional flows to mutual funds holding eligible bonds. This effectively represents a Difference-in-Differences (DiD) specification. Rather than adding fixed effects, we stratify the sample based on fund characteristics. The results are presented in Table IX. The table shows an additional 0.4 percentage point increase in fund flows to eligible funds, primarily driven by bond funds, where the effect is 0.56 percentage points.

[14] A fund is considered eligible if it holds at least one of the eligible bonds.

Figure 4: Fund Flows

(a) Fund Flows CSPP (b) Fund Flows PEPP



Note: The figure presents the rolling monthly fund flows for all funds and eligible funds as percent of total asset under management.

Eligible bond funds likely experienced relatively higher returns compared to non-eligible bond funds, as eligible bonds generated higher returns than their non-eligible counterparts (Todorov, 2020). This performance discrepancy, in turn, spurred fund flows into eligible funds.

We further stratify the sample by considering subsets of funds domiciled within the Euro area and those domiciled outside the Euro area. The results indicate that our findings are primarily driven by funds domiciled in the Euro area. These funds likely allocate a relatively higher share of their portfolios to eligible bonds compared to funds domiciled outside the Euro area that hold at least one eligible bond. This is consistent with the results presented in Table F25 in the appendix. The table displays the results of regressing fund flows on the overall share of eligible bonds in their portfolios, revealing a positive and statistically significant relationship. A positive coefficient indicates that funds with higher shares of eligible bonds prior to the announcement experienced greater fund inflows.

This channel aligns with the notion that funds holding eligible bonds achieved higher returns, subsequently attracting flows. We further repeat this exercise by stratifying the sample into bond funds, mixed funds, and Euro-domiciled or foreign-domiciled funds.

Table IX: Fund Flows to Eligible Funds

	All	Bond Fund	Euro Domicile	Foreign Domicile
	(1)	(2)	(4)	(5)
Eligible	0.412***	0.558***	0.461***	0.220
	(0.12)	(0.18)	(0.14)	(0.26)
Observations	27470	6779	11651	15819
Adj. R-squared	0.000	0.001	0.001	-0.000

Note: The table presents the results of the estimated model in Equation 8, where fund flows over total net assets (TNA) are regressed on eligibility status for the period from March 10, 2016, to April 10, 2016. Column (1) includes all funds, Column (2) focuses on the subset of bond funds, Column (3) examines funds domiciled within the Euro area, and Column (4) includes funds domiciled outside the Euro area.

6. Pandemic Emergency Purchase Program

PEPP Announcement Amid the challenges posed by the Covid-19 pandemic in 2020, the European Central Bank (ECB) responded with a substantial policy package that encompassed corporate bond purchases. The crisis prompted the ECB to reinforce its interventions by expanding its asset purchase program. During the scheduled governing council meeting on March 12, 2020, ECB President Christine Lagarde unveiled a series of measures designed to support the economy. The ECB announced its decision to "add a temporary envelope of additional net asset purchases of €120 billion until the end of the year, ensuring a strong contribution from the private sector purchase programs." However, following this announcement, bond market prices witnessed a significant downturn, as financial markets perceived the ECB's response as insufficient to address the magnitude of the shocks.

In response, the ECB took further action on March 18, 2020, outside of its regular schedule. During this announcement, the ECB revealed its decision to significantly amplify its interventions through the Pandemic Emergency Purchase Program (PEPP), starting with an initial envelope of €750 billion. The two vertical lines in Figure 5a denote the dates of these pivotal events. The figure visually depicts the surge in yields observed in March 2020, which intensified after the ECB Governing Council meeting on 12 March. However, with the introduction of the PEPP in the subsequent week, the sharp increase in bond yields was curtailed, leading to a sudden reversal and a subsequent reduction in corporate bond yields. Figure D.7b in the Appendix also illustrates that the relative contribution of the credit risk component far surpassed that of the interest rate component at the launch of the PEPP programme. As expected, the rise in bond yields at the onset of the Covid crisis was entirely driven by a surge in credit spreads. The timely interventions of the ECB halted the spike in credit spreads and resulted in a gradual reduction in yields.

Figure 5b shows the allocation, prior to the announcement, of eligible bonds for mutual funds, insurance corporations and pension funds (ICPF), and banks. We note that the distribution has notably changed compared to the pre-CSPP announcement (Figure 2), as the ECB now represents an important investor holding a large amount of corporate bonds. Since 2016, mutual funds have also increased their holdings of bonds at the expense of insurance companies and pension funds. Overall, this implies that the market is relatively more prone to fire sales. Figure C.4b in the Appendix plots the aggregate holdings of corporate bonds for domestic investors over time, showing the rise in ownership by mutual funds and the ECB.

PEPP and Mutual Funds We investigate the impact of the PEPP announcement on bond yields by using the regression outlined in Equation 2. In this case, we use the change in OAS in the week following the PEPP announcement. We assess the response from the Monday following the announcement (March 23) for 5 business days (one week), 10 business days (two weeks), and 30 business days (approximately one month). The findings reveal a more pronounced reduction in bond spreads for bonds with higher mutual fund shares.

The magnitude is large. For a 10 percentage point increase in mutual fund holdings, we observe a further 4.8 basis point reduction in bond yields when fixed effects are not included. The effects are even larger when we consider more saturated regressions, with the coefficients ranging from -48 to -72. As expected, the coefficient is smaller when we control for the bid-ask spreads, as it is more likely that bonds sold through fire sales experienced a widening of the bid-ask spread prior to the announcement.

The results hold true even for bonds issued by the same entity. In this case, the magnitude is very large, with an increase in responsiveness of 6.6 basis points per 10 percentage points increase in mutual fund holdings. As indicated by Coppola (2021), bonds held by mutual funds experience more significant losses during recessions as mutual funds engage in fire sales. This phenomenon leads to a contraction in the liquidity of the corporate bond market, particularly for bonds held by mutual funds. With the ECB's intervention through the PEPP announcement, the fire sales are halted, contributing to the normalization of liquidity in the corporate bond market.

It is not surprising that, in this case, the results with issuer fixed effects are larger compared to those found for the CSPP announcement. In this instance, the market dynamics are affected by the sharp recession, withdrawals from mutual funds, and the intensification of fire sales. The dislocation in the bond market leads to significant mispricing in segmented markets, whereby similar bonds may experience different dynamics.

We also consider the alternative identification of Equation 3 to study the effects of mutual funds on the transmission to bond yields. The results are displayed in Table XI. The coefficient of interest is the interaction of eligibility status and mutual fund shares. The coefficient is -137 basis points, indicating that the decline in spreads was significantly larger for bonds held by mutual funds. The coefficient has a similar magnitude across all sets of interacted fixed effects, ranging from -125 basis points to -137 basis points. These results show that the reduction in spreads occurred primarily for eligible bonds held by mutual funds.

The mutual funds sector learned it could sell a large portion of risky bonds to the ECB, which helped calm the market. In contrast, insurance companies tend to have more stable capital and do not engage in fire sales during recessions. In fact, as spreads widen, they may purchase bonds. Notably, the regulatory framework for insurance companies does not increase required capital as volatility widens, allowing higher spreads to secure greater profitability with limited or no additional cost. We can therefore expect that for bonds with higher mutual fund ownership and lower insurance company ownership, the fire sales and the subsequent effects of the ECB purchases are more pronounced.

The corporate bond market is highly segmented, meaning insurance companies may not purchase bonds they do not already hold but instead increase their ownership of bonds they already held. This phenomenon may explain the results we observe. For bonds with limited insurance ownership (and higher mutual fund ownership), we find a stronger benefit from the PEPP announcement.

The coefficient on the non-interacted shares of mutual funds is positive, large, and statistically significant. In the unconditional estimate, the coefficient is +73 basis points. This implies that mutual funds were still selling bonds, applying downward pressure on prices for bonds that were not eligible, while the selling pressure was contained for eligible bonds. This is a key result of the paper, which directly demonstrates the benefit of corporate bond purchases.

The results provide insights into the mechanism through which the PEPP affected the corporate bond market. The PEPP announcement played a crucial role in halting the fire sales initiated by mutual funds. This impact was particularly effective for market segments with higher mutual fund shares, as these segments were under heightened stress. The intervention by the ECB through the PEPP not only mitigated the adverse effects of fire sales but also contributed to stabilizing and restoring normalcy in these specific market segments.

The set of results presented in this section corroborates the mechanism detailed in the model in Section 7 and our interpretation of the findings. Financial markets anticipated that they could offload corporate bonds to the ECB in case of financial market distress. As investors are forward-looking, in 2016, when the CSPP was announced, they anticipated lower volatility in corporate bonds and, therefore, required a lower risk premium to hold these bonds.

In Appendix G, we compute the realized volatility for BBB Euro area corporate bonds, isolating the returns from the effects due to changes in risk-free interest rate term-structure. The returns are computed for each bond as the return in excess of the return on a maturity-matched swap rate, and the index then aggregates these excess returns. The plot shows how the volatility of BBB corporate bonds diminished after 2016, and the volatility in 2020 was significantly smaller than during the 2008 global financial crisis and the Euro area sovereign debt crisis in 2011–2012. This demonstrates the success of corporate bond purchases in reducing the riskiness of the bonds and confirms the mechanism advanced in this paper.

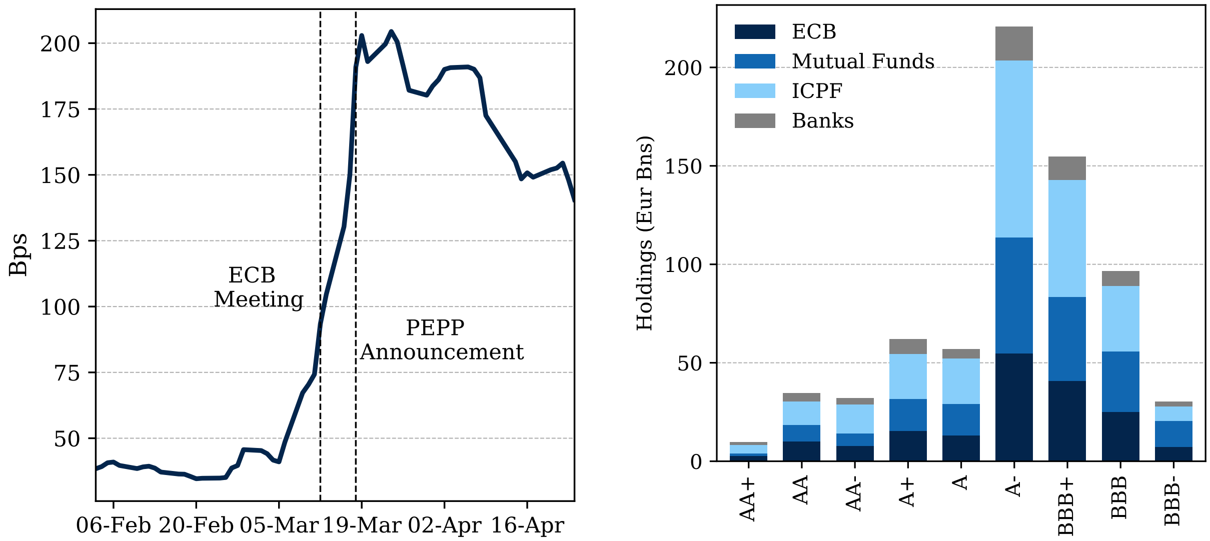
6.1 Fund Flows During the Pandemic Crisis

We demonstrated that bonds held by mutual funds exhibited a more pronounced recovery following the announcement of the PEPP by the ECB. We also measured mutual fund flows around the PEPP announcement, with the results displayed in Figure 4b. The figure indicates that flows to mutual funds holding eligible bonds rebounded more rapidly. Naturally, the recovery occurred with a lag, as flows responded to returns. The announcement of the pandemic package halted the rise in bond yields (as shown in Figure 5a), resulting in positive returns on bond holdings. This, in turn, stemmed outflows from funds, leading to a subsequent rebound in April.

While the observed difference may appear small due to the substantial drop in flows in March, we argue that this differential is significant, as fund flows for eligible funds recovered

Figure 5: ECB PEPP Announcements and Corporate Bond Yields

(a) PEPP Announcement (b) Allocation pre PEPP announcement



Note: Panel (a) shows the evolution of the value-weighted Euro area non-banks corporations bond yields. The plot shows the evolution around the Pandemic Emergency Purchase Programme (PEPP) announcement on March 20, 2020. Panel (b) shows the allocation of eligible bonds before the announcement of the Pandemic Emergency Purchase Programme (PEPP).

over a month earlier than those for non-eligible funds. In the aftermath of a crisis, such an earlier recovery can meaningfully impact spreads.

Additionally, the flow-to-performance relationship typically exhibits a convex shape. Specifically, inflows to funds are highly responsive to strong past performance, whereas outflows are generally less sensitive to poor past performance. During a crisis, investors tend to withdraw money from mutual funds broadly. However, in the recovery phase, they are more likely to invest in funds that have delivered better returns—namely, those holding eligible bonds.

In a counterfactual scenario without central bank corporate bond purchases, it is likely that outflows would have been even more substantial. However, quantifying this counterfactual remains challenging. Instead, the primary advantage of our analysis lies in the ability to distinguish between eligible and non-eligible bonds, providing direct evidence of the effects of these policies.

The ability of financial markets to absorb bond supply during a crisis is of critical im-

Table X: Mutual Funds Holdings and PEPP Announcement

Dependent Variable: OAS spread									
					Panel A: 5 days lag				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	-48.624***	-46.353*	-44.655***	-57.802***	-47.797***	-57.404***	-72.096***	-66.898***	-21.785*
	(8.40)	(20.45)	(15.11)	(16.58)	(14.53)	(14.28)	(18.76)	(12.44)	(11.48)
Observations	1375	1375	1374	1355	1301	1243	1326	927	1140
Adj. R-squared	0.023	0.037	0.048	0.071	0.189	0.154	0.169	0.787	0.449
					Panel B: 10 days lag				
θ_i^{MF}	-63.986***	-62.434*	-62.526**	-81.018***	-59.861**	-79.001***	-107.191***	-92.297***	-21.835
	(13.21)	(29.22)	(21.80)	(23.51)	(23.87)	(21.20)	(25.22)	(18.73)	(18.07)
Observations	1375	1375	1374	1355	1301	1243	1326	927	1140
Adj. R-squared	0.016	0.027	0.036	0.084	0.232	0.152	0.186	0.835	0.472
					Panel C: 30 days lag				
θ_i^{MF}	-76.310***	-77.594	-79.131**	-89.292***	-66.460***	-91.961***	-122.333***	-103.089***	-21.983
	(14.44)	(35.52)	(27.85)	(22.22)	(24.83)	(21.64)	(24.74)	(20.11)	(18.09)
Observations	1358	1357	1357	1341	1290	1235	1315	914	1130
Adj. R-squared	0.019	0.029	0.047	0.087	0.212	0.169	0.201	0.818	0.457
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2 for the PEPP announcement. We assess the response from the Monday following the announcement (March 23) for 5 business days, 10 business days and 30 business days. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

portance. Corporate bond purchases during such periods are particularly valuable because (i) they help absorb the substantial new supply of bonds issued by corporations, and (ii) they reduce outflows from mutual funds. These mechanisms mutually reinforce each other, creating favorable conditions for firms. Indeed, Figure D.6 in the Appendix highlights the sharp increase in bond financing during economic downturns.

Table XI: Mutual Funds Holdings and PEPP Announcement, Alternative Identification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eligible	47.914***	48.849***	43.546***	55.270***	53.719***	45.471***	33.652***	50.287***
	(6.18)	(3.24)	(6.41)	(10.40)	(9.72)	(9.67)	(10.83)	(8.13)
Eligible x θ_i^{MF}	-137.949***	-137.946***	-128.345***	-129.358***	-132.695***	-108.044***	-125.079***	-67.708***
	(18.22)	(18.41)	(17.61)	(30.97)	(32.40)	(27.81)	(34.20)	(23.14)
θ_i^{MF}	73.963***	72.929***	59.003**	39.472*	60.078***	18.167	7.895	40.023**
	(13.36)	(12.02)	(22.24)	(20.76)	(20.08)	(22.13)	(21.54)	(18.01)
Observations	2805	2805	2802	2728	2595	2511	2672	2557
Adj. R-squared	0.021	0.031	0.053	0.109	0.249	0.177	0.217	0.290
Duration		✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓
Rating Worst					✓			
Size						✓		
Callable							✓	
Liquidity								✓

Note: The table shows the estimated coefficients and standard errors from Equation 3 for the PEPP announcement. We assess the response from the Monday following the announcement (March 23) for 5 business days, 10 business days and 30 business days. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, size, liquidity, callability. Standard errors are double clustered by time and bond groups, where bond groups are based on the set of interacted fixed effects.

7. Asset Pricing Model

We present a simple dynamic asset pricing model to guide the interpretation of our empirical results. The model is stylized to emphasize the core economic mechanisms. We begin by outlining its key components, followed by the solution and main economic intuition.

Furthermore, in Appendix B, we explicitly model a demand-based asset pricing framework, establishing a connection to the approach used here.

State of the Economy The state of the economy is determined by the variable z_t and follows the autoregressive process in log:

$$z_{t+1} = \rho_z z_t + \sigma_t^z \varepsilon_{t+1}^z, \qquad \varepsilon_{t+1}^z \sim N(0,1). \tag{9}$$

The volatility of the process σ_t^z is time varying and depends on the state of the economy itself, resulting in high volatility during economic downturns (low realization of z_t) and low volatility during economic expansions (high realization of z_t).

Asset Space We consider an economy with two types of securities: a risk-free asset and a risky bond. The risk-free asset yields a return R_t^f, whereas the risky bond provides stochastic coupon (cash flows) payments denoted by δ_t, with the bond's price indicated by P_t. The return on the risky bond from time t to $t+1$ is given by:

$$R_{t+1} = \frac{P_{t+1} + \delta_{t+1}}{P_t} - 1. \tag{10}$$

We assume that the payoff of the risky asset is:

$$\delta_{t+1} = \frac{\bar{\delta}}{1 + e^{-z_{t+1}}}, \tag{11}$$

where $\bar{\delta}$ is a scale parameter. We can conceptualize the risky bond as a bond with a stochastic coupon. This bond represents a portfolio of defaultable corporate bonds. If none of the bonds default, the portfolio pays out the full amount, which we denote as $\bar{\delta}$. However, if a subset of bonds defaults, the payout δ_t, is a fraction of $\bar{\delta}$. While we do not explicitly model bond liquidity, the volatility in payoffs and the implied risk of returns can also be equivalently interpreted as liquidity risk. The formulation implies the risky bond yield is given by $\frac{\bar{\delta}}{P_t}$.

Bond Managers Bond managers have mean-variance preferences and decide the proportion of assets to allocate to the risky bond. The optimal allocation is derived using the standard formula:

$$X_t^M = \frac{E_t\left[R_{t+1} - R_t^f\right]}{\gamma^M Var_t(R_{t+1})}. \tag{12}$$

where γ^M is the risk-aversion parameter. This optimal portfolio allocation implies a downward-sloping demand function, as a lower bond price increases the expected return, thereby raising demand. Bond managers' assets under management are denoted by A_t^M.

Long-Term Investors The second group of investors consists of long-term investors. These investors aim for a target allocation to the risky asset, denoted by $\bar{X}$. Their allocation problem follows the structure of Gârleanu and Pedersen (2013). However, in our context, the target allocation is viewed as the result of an optimal portfolio decision influenced by asset-liability management (ALM) considerations and regulatory capital requirements, which we do not model explicitly.[15] As long-term investors care about long-term profitability, they only consider the yield of the bond $\frac{\bar{\delta}}{P_t}$. The optimal allocation is given by:

$$X_t^L = \frac{\left(\frac{\bar{\delta}}{P_t} - R_t^f\right)}{\psi} + \bar{X}. \tag{13}$$

Long-term investors deviate from their target allocation when bond yields are high (i.e., when prices are low), consistent with reaching-for-yield behavior (Becker and Ivashina, 2015). This behavior generates a downward-sloping demand function. The parameter $\bar{X}$ anchors the allocation, making it sticky, while the cost parameter ψ governs responsiveness: a higher ψ implies a lower demand elasticity with respect to price changes. Long-term investors manage a total asset base denoted by A_t^L.

Central Banks We assume the central bank holds a quantity of credit-risky bonds, denoted by X_t^{CB}, which follows the policy rule:

$$X_t^{CB} = \bar{X}^{CB} + \beta^{CB} z_t. \tag{14}$$

Here, $\bar{X}^{CB}$ represents a fixed allocation, while β^{CB} governs a state-contingent component. A negative β^{CB} implies countercyclical policy: the central bank increases its holdings in bad economic times (Quantitative Easing) and reduces them in good times (Quantitative Tightening).

Supply We assume an infinitely elastic supply of the risk-free asset and take the risk-free rate as exogenous. The risky bond is available in a fixed supply, denoted by S. Its price is determined endogenously in equilibrium.[16]

Market Clearing The market clearing condition is expressed as:

$$\sum_j A_t^j X_t^j = P_t S, \tag{15}$$

[15] Koijen and Yogo (2015, 2023) provide models for the optimal asset allocation of insurers, accounting for the regulatory cost of holding risky assets.

[16] While incorporating supply dynamics is straightforward, doing so would not yield additional insights and would merely complicate the model.

where S denotes the supply of the risky bond, and $A_t^j X_t^j$ represents the dollar allocation of the various investors indexed by j. The overall demand, $\sum_j A_t^j X_t^j$, is the sum of investors' assets under management multiplied by their portfolio share in the risky bond.

7.1 Solution

Equilibrium Prices The equilibrium price of the risky asset is determined by a non-linear equation that links the bond's risk premium to its expected risk. Substituting the optimal portfolio allocations from Equation 12 and Equation 13 into the market clearing condition in Equation 15, we obtain:

$$E_t[R_{t+1} - R_t^f] = \frac{\left(P_t S - A^{CB} X_t^{CB} - A_t^L \frac{\left(\frac{\bar{\delta}}{P_t} - R_t^f\right)}{\psi} - A_t^L \bar{X}\right)}{A_t^M} \gamma^M Var_t(R_{t+1}), \tag{16}$$

where the equilibrium condition incorporates both bond managers' and long-term investors' demand functions. The equilibrium risk premium depends on the price P_t and the variance of returns, both of which are endogenous. To illustrate the model's mechanism, we solve it numerically.

Calibration The details of the calibration and solution methods are provided in Appendix A.2. We solve the model using global solution methods and calibrate its parameters to match key moments in the Euro-denominated corporate bond market. To this end, we construct an index of excess returns for BBB-rated corporate bonds relative to a default-free benchmark. The data show an annual average excess return of 2% and a standard deviation of 4%. We calibrate the model to replicate these moments in the stochastic steady state (i.e., $z_t = 0$) without central bank intervention, which we refer to as the *baseline* equilibrium. The model also incorporates time-varying volatility: return volatility increases during downturns and decreases during expansions.[17] Additionally, we calibrate the relative size of bond managers and long-term investors to be approximately equal, consistent with evidence from our holdings data.

[17] Using our corporate bond index, we compute realized volatility based on daily returns within each quarter. We observe that volatility ranges from 2% in expansions to peaks of 12% during crises.

Baseline Equilibrlium The light blue line in Figure 6 shows the value of volatility and risk-premium in the baseline calibration. Figure 6a illustrates the conditional volatility for various realizations of the state variable. It is important to note that return volatility is endogenous and different from the volatility of the state variable itself. Consistent with the empirical evidence, volatility increases during adverse economic conditions. Figure 6b illustrates the baseline risk premium, defined as the expected excess return of risky assets over the risk-free rate.

A key aspect of the model is its ability to generate distinct allocation dynamics for the two types of investors over the economic cycle. Asset managers decrease their holdings of risky assets during downturns due to the increase in volatility. Conversely, long-term investors help stabilize the market by absorbing the reduction in allocation by asset managers. During these periods, falling prices make bonds more attractive in terms of long-term yields, incentivizing long-term investors to expand their holdings. However, their allocation remains somewhat rigid due to rebalancing costs.[18] Overall, for the market to clear, the risk premium must rise. The distinct allocation patterns over the economic cycle make asset managers procyclical and long-term investors countercyclical (Timmer, 2018; Coppola, 2021).

The Effects of Cental Bank Asset Purchases We analyze the effects of central bank asset purchases by comparing the baseline economy to a counterfactual scenario in which the central bank purchases bonds according to the rule in Equation 14.[19] The parameters are chosen such that the central bank's holdings reach approximately 20% in downturns, consistent with peak levels observed following the Covid-19 crisis.

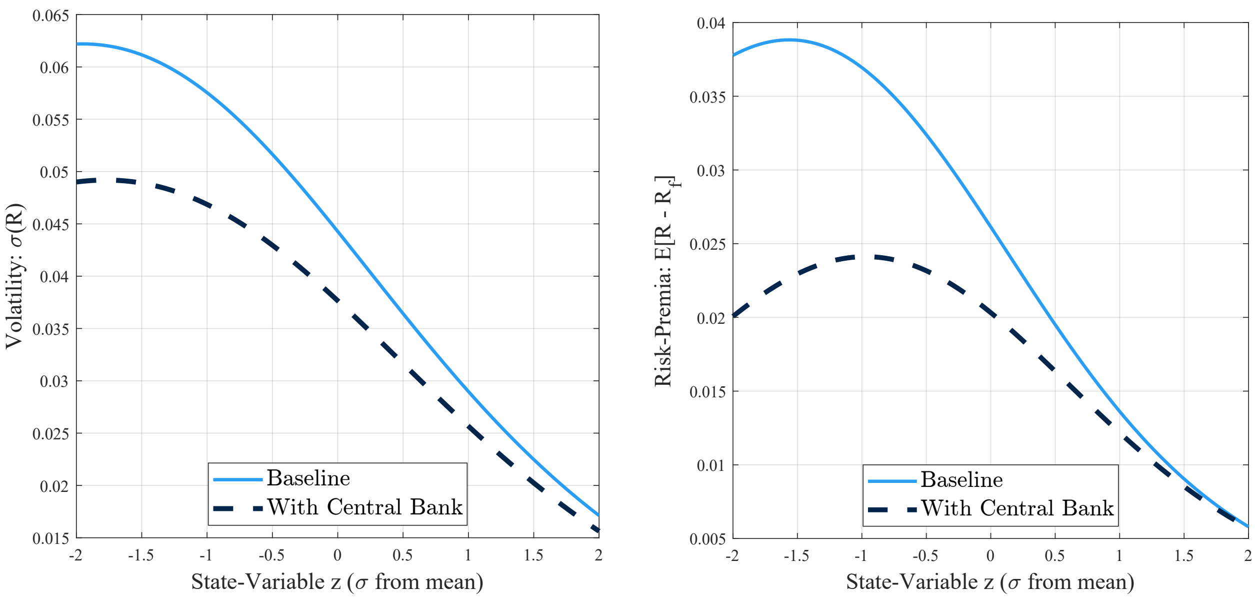
The volatility of bond returns and the equilibrium risk premium are depicted by the dashed dark blue line in Figure 6. As shown in Figure 6a, volatility decreases significantly when the central bank intervenes. This is the first key insight of the model. In a dynamic setting, countercyclical policies stabilize the market by reducing price declines in downturns. During adverse economic conditions, bond managers reduce their allocations to risky bonds, which increases the risk premium. When the central bank intervenes, it absorbs part of the supply, mitigating the selling pressure from bond managers. This dampens the decline in

[18]This is consistent with the *low price elasticities* of insurance companies that have been previously documented in the literature (Bretscher et al., 2021; Koijen and Yogo, 2019; Koijen et al., 2021).

[19]We set $\bar{X}^{CB} = 0.1$ and $\beta^{CB} = -0.1$, implying that the central bank purchases 20% of the market when $z_t = -1$ (i.e., during a recession) and holds no assets when $z_t = 1$ (i.e., during an expansion).

Figure 6: Effects of Central Banks Purchases

(a) Volatility (b) Risk-Premium



Note: The figure presents the effects of central bank purchases on risk-premium and volatility. Panel 6a illustrates the expected volatility while Panel 6b depicts the risk premium. The x-axis represents the state variable, where values to the left of zero correspond to economic downturns, while values above zero indicate favorable economic conditions.

prices and the associated increase in the risk premium.

7.2 Connection to Empirical Findings

The model delivers several insights that help rationalize our empirical findings. In this section, we reinterpret these findings through the lens of the theoretical framework developed above.

Announcement Effects As discussed in the previous section, the key transmission mechanism of central bank corporate bond purchases operates through a reduction in bond return volatility. This finding suggests that, upon policy announcements, markets interpret central bank actions as a commitment to comprehensive, state-contingent market support (Haddad et al., 2023, 2024). In particular, these policies signal that central banks will actively intervene to stabilize financial markets during periods of distress, thereby lowering the perceived risk and volatility of corporate bonds.

Portfolio Rebalancing Upon announcement, expectations of lower volatility lead bond managers to increase their demand for corporate bonds (see Equation 12). This rise in demand pushes up equilibrium prices and reduces the risk premium. However, this effect is dampened by the presence of long-term investors. Unlike bond managers, long-term investors do not respond to changes in volatility; their allocations depend solely on bond yields (see Equation 13). As prices rise and yields decline, long-term investors reduce their demand, partially offsetting the initial price increase. This mechanism is consistent with our empirical findings.

Insurance companies exhibit highly sticky allocations, primarily driven by asset-liability management (ALM) considerations and rating-based capital requirements. We do not observe any significant changes in insurance regulation or bond rating migration during our sample period.[20]

Taken together, these observations suggest that we should expect a positive shift in demand from mutual funds, while the response from insurance companies is likely to be more muted and potentially negative. Moreover, the reduction in bond return volatility can also be interpreted as an improvement in corporate bond liquidity. According to the findings of Corell et al. (2023), enhanced liquidity further contributes to increased demand from mutual funds.

Effects on Risk-Premium To provide intuition on why higher holdings by long-term investors reduce the effects on the risk-premium, we can simplify Equation 16 assuming that at time t the central bank does not hold any bond and that assets under management of both intermediaries are equal to the price level.[21] Under these simplifying assumptions, Equation 16 simplifies to:

$$E_t[R_{t+1} - R_t^f] = \left(S - \frac{\left(\frac{\bar{\delta}}{P_t} - R_t^f\right)}{\psi} - \bar{X} \right) \gamma^M Var_t(R_{t+1}). \tag{17}$$

[20] Insurance companies in the Euro area are regulated under Solvency II. There were no significant changes in capital requirements for corporate bonds. Moreover, the bulk of our effects are driven by movements in the CDS basis rather than in CDS spreads.

[21] The assumptions imply $X_t^{CB} = 0$ and $A_t^L = A_t^M = P_t$.

Suppose that at time t the central bank announces its bond purchases. This announcement reduces the expected return volatility for period $t+1$, which in turn lowers the risk premium. The strength of this response depends negatively on the target holdings of long-term investors, $\bar{X}$. Since long-term investors' demand does not respond to changes in volatility, the impact on the risk premium is dampened. Moreover, the increase in demand from bond managers raises prices, which reduces the demand from long-term investors—further attenuating the effects of the policy.

In Appendix A.3.2, we estimate the impact of the central bank's policy on the risk premium under varying levels of long-term investors' target portfolio shares. The results clearly show that a higher share of long-term investor holdings weakens the effect of the policy on the risk premium.

Note that, while in this model long-term investors do not consider volatility, a variant of the model where long-term investors have mean-variance preferences but also still face adjustment costs would yield the same insights regarding the relationship between risk premium and volatility (see Appendix A.5).

Segmentation and Cross-Section We can extend our model to consider multiple segmented markets. In our empirical analysis, we primarily focus on a single event and leverage market segmentation within the corporate bond market to gain insights into the role of diverse investors. Consider a collection of segmented markets, indexed by i. Each segmented market is populated by a set of investors. All assets carry the same risk, with the only distinction being the target allocation of long-term investors, $\bar{X}_i$. The risk premium for each asset i is given by:

$$E_t[R_{i,t+1} - R_t^f] = \left(S_t - \frac{\left(\frac{\bar{\delta}}{P_{i,t}} - R_t^f\right)}{\psi} - \bar{X}_i \right) \gamma^M Var_t(R_{t+1}). \tag{18}$$

This equation indicates that for two assets j and k, if $\bar{X}_j > \bar{X}_k$, asset j exhibits lower sensitivity to changes in volatility.[22]

The assumption of full segmentation may appear strong but can be related to the notion

[22]This statement holds for sufficiently large ψ. Under extreme parameter conditions, it is possible for an increase in the target allocation $\bar{X}$ to raise prices sufficiently to reduce the overall allocation of long-term investors.

of investment sets commonly used in the demand-based asset pricing literature (Koijen and Yogo (2019); Bretscher et al. (2021)). The tendency of investors to allocate their portfolios within a small, highly sticky subset of bonds implicitly generates segmentation.

Fund Flows In the baseline model, we hold fixed the assets under management of fund managers. However, if bond managers receive inflows F_t, which increase their assets under management, the new demand by bond managers becomes $(A_t + F_t)X_t^M$. These fund inflows increase the demand by bond managers, driving prices higher and reducing the risk premium. If the policy generates fund inflows, this effect will amplify the impact of the announcement.

For instance, if the policy reduces the riskiness of the bond, the bond manager's overall portfolio becomes safer. Additionally, the increase in price generates a positive return, which could attract further inflows into the fund—though these flows are not explicitly modeled here. Fund inflows may amplify or dampen the policy's effect on the risk premium, depending on their magnitude and persistence.

Spillover Effects The model includes one risky bond and one risk-free asset. Extending the model to multiple assets is straightforward. In Appendix A.4, we clarify how to interpret spillover effects. Suppose the policy affects the risk of bond j but not bond k. If the two assets are correlated, the policy also reduces the risk premium on bond k, with the strength of the transmission increasing with bond manager ownership. This mechanism functions as previously described. As a result, the policy not only exerts a greater effect on eligible bonds that are directly targeted but also impacts non-eligible bonds. The strength of this spillover effect increases with the share of the asset held by bond managers.

Relation to Demand-Based Asset Pricing In Appendix B, we explicitly model a demand-based asset pricing framework. The key determinant of the policy's effect on bond yields is the market share of investors who adjust their demand following the announcement, rather than the proportion of inelastic investors.

8. Conclusion

This paper explores how central banks, particularly the European Central Bank (ECB), impact bond yields through large-scale asset purchases. By analyzing the ECB's initial corporate bond purchase announcement in March 2016, the study demonstrates that bonds held by mutual funds saw a sharper decline in yields compared to those held by other investors, such as insurance companies, with this pattern persisting after controlling for key bond characteristics. This finding underscores that mutual funds, recognized for their higher demand elasticity and responsiveness to market signals, play a crucial role in the transmission of monetary policy to corporate bond markets.

The study emphasizes the market's forward-looking nature. Although the ECB's announcement specified bond purchases would start four months later, immediate price reactions reflected expectations of future policy impacts. This reaction spurred mutual fund demand, which subsequently triggered fund inflows and amplified bond yield changes over the following weeks. The analysis shows that these inflows magnified price responses, with bond yields dropping further and fund inflows peaking approximately one month after the announcement. Mutual funds' behavior contrasts with insurance companies, which exhibited a more subdued reaction to policy announcements due to their conservative investment approach.

The paper also applies this analysis to the 2020 pandemic crisis when the ECB's Pandemic Emergency Purchase Program (PEPP) was introduced. Similar patterns emerged: bonds held by mutual funds experienced more significant yield reductions, highlighting the role of mutual funds in amplifying market reactions during crises. These findings reveal that during downturns, mutual funds are more prone to selling assets, but central bank interventions can mitigate fire sales and stabilize the market.

A theoretical model supports these empirical findings, demonstrating how investor heterogeneity and market segmentation affect asset price reactions to policy announcements. The key metric is the *elasticity to risk*, which assesses how demand reacts to a change in the riskiness of the corporate bond market.

Overall, this research demonstrates that central bank asset purchases have complex and heterogeneous effects on the corporate bond market, driven by the differing responses of various types of investors. The study's insights are crucial for understanding how future policy measures may affect financial markets, emphasizing the significant role of investor composition and market structure in the transmission of monetary policy.

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A. Dynamic Model

We provide the additional details of the model in Section 7.

A.1 Setting

The fundamental settings are explained in Section 7. In this appendix, we will detail the additional features of the infinite-horizon model.

State of the Economy The state of the economy is determined by the variable z_t and follows the autoregressive process in log:

$$z_{t+1} = \rho_z z_t + \sigma_t^z \varepsilon_{t+1}^z.$$

The volatility of the process σ_t^z is time varying and depends on the state of the economy itself:

$$\sigma_t^z = \frac{\bar{\sigma}^z}{1 + \beta^\sigma e^{z_t}}.$$

This formulation results in high coupon volatility during economic downturns and low volatility during economic expansions. The parameter β^σ determines the sensitivity of volatility to the state variable, while the parameter $\bar{\sigma}^z$ scales the average volatility.

Payoff In the dynamic model, we assume that the payoff of the risky asset is:

$$\delta_{t+1} = \bar{\delta} e^{z_{t+1}}, \tag{19}$$

where $\bar{\delta}$ is a scale parameter.[23]

Assets under Management We assume that assets under management for both the bond managers and the long-term investors are fixed over time. This assumption indicates that bond managers and long-term investors return all profits and losses to the ultimate

[23]The assumption does not alter the intuition of the model but ensures that the coupon process follows a log-normal distribution, while Equation 11 represents its inverse-lognormal transformation. Since we numerically solve for the standard deviation of returns, the inverse-lognormal transformation introduces instability in the standard deviation. This, in turn, affects the asset allocation of managers, leading to ill-defined allocations in certain states and causing instability in convergence.

holders of the fund. Consequently, in the absence of fund flows, the assets under management remain unchanged.

Allocation of Investors At each time t, the long-term investors optimal allocation is still defined by Equation 13. The allocation of the bond manager is by solving a mean-variance problem and the optimal portfolio is still determined by Equation 12.

Central Banks We assume that the central bank holds a quantity of bonds that are credit risky X_t^{CB} which follows the policy rule in Equation 14.

The central bank maintains a fixed allocation, denoted as $\bar{X}^{CB}$, and may also have a state-dependent component determined by β^{CB}. The central bank's assets are normalized to one. Notably, Equation 14 suggests that the central bank's holdings can be negative. Generalizing to include a non-negative holdings constraint is straightforward, given the exogenous nature of the process. However, we will use this process to further show that even when the central bank's average holdings are zero (i.e., when $\bar{X}^{CB} = 0$), asset purchases can still significantly influence risk premia if $\beta^{CB} < 0$. This effect arises from the state-contingent nature of the policy rather than the average level of holdings. See the discussion in the model results (A.3).

A.2 Discussion and Calibration

Investors Bond managers can be understood as corporate bond mutual funds, which generally allocate the majority of their portfolios to corporate bonds. In contrast, long-term investors primarily consist of insurance companies and pension funds, with banks also partially fitting into this category. The key distinction between long-term investors and bond managers lies in the stability of their portfolio allocations. For long-term investors, stickiness arises from adjustment costs associated with deviations from their target allocation, denoted as $\bar{X}$. These adjustment costs lead to allocations that are less responsive to market conditions and demonstrate distinct behaviors throughout the business cycle.

During economic downturns, characterized by increased volatility, bond managers typically reduce their exposure to risky assets. In contrast, long-term investors are less affected by volatility and are more likely to act as net buyers during these periods. Their investment decisions are influenced by the long-term yield of the bond rather than by short-term expected returns. During downturns, heightened volatility in risky bonds results in lower prices, making them relatively more appealing to long-term investors. The model illustrates the time variation in holdings, showing that long-term investors tend to buy in adverse conditions, while asset managers are more likely to sell. The differing characteristics of the two investors arise due to the varying stability of their capital structures. The capital of insurance companies and pension funds is stable, allowing them to look through temporary increases in volatility. In contrast, ample empirical evidence has documented the fragility of mutual fund capital.

Solution and Calibration We use a global solution method to numerically solve the model, employing Chebyshev polynomial approximation and projection methods as described in Judd (1992, 1996). The polynomial is approximated using 11 nodes, while the state variable is discretized with a Gauss-Hermite quadrature using 13 nodes. With parallel optimization, the model is solved in under three minutes.

We calibrate the model so that, on average, the allocations X_t^M and X_t^L are both equal to 90% to 95% of their assets in the risky bonds. This indicates that both investors allocate most of their assets to risky investments. We do not take into account leverage; on average, both investors maintain 5% to 10% in cash to invest in the risk-free asset. Using data from the Euro area sector account we find that in average insurance companies hold 10% of their assets in cash. Mutual funds hold about 5% of their funds in cash. Chernenko and Sunderam (2016) find that the median bond fund has a cash-to-assets ratio of 5.3%.

We calibrate A^M and A^L to be roughly equal, ensuring that the two sectors hold approximately 50% of the market. This calibration ensures that mutual funds hold approximately 50% of the corporate bond market.[24] Note that this does not imply that the overall balance sheet size of the two sectors must be equal in the data. Rather, it indicates that the portion of the balance sheet used for corporate bond purchases is similar, which is supported by the data.

We use an index of Euro-denominated corporate bond BBB excess returns over the benchmark. The index excess return over the trading day, calculated as the weighted average difference between the bond month to date total return and the Markit SWAP curve. The Markit SWAP curve is constructed from Overnight Indexed swap (OIS) rates and ICAP swap rates rate of all constituent bonds. We find an annual average excess return of 1.5% and

[24]In the Euro area mutual funds hold approximately 40% of the riskier investment grade bonds. As we assume that foreign investors are mostly mutual funds, in the model we assume a higher share of 50%.

Table A12: Parameters

Parameter	Value	Role
A_M	1	Asset Manager Assets
A_L	1	Long-Term Investors Assets
γ^M	15	Asset Manager Risk-Aversion
ψ	0.3	Long-Term Investors Adjustment Cost Parameter
β^z	2	Cash Flow Volatility Sensitivity to State Variable
σ_z	0.6	Cash Flow Volatility Scaler
ρ_z	0.5	Persistence of z
R_f	5%	Risk-Free Rate

an annual standard deviation of 3.5%. We calculate the realized volatility of daily returns within a quarter. We observe that the volatility ranges between 2% and 12%. We calibrate the model so that the price of the risky security equals 1 in the stochastic steady state. We use a risk-free rate of 5%. We calibrate: $\left(\psi, \gamma^M, \bar{\delta}, \bar{\sigma}^z, \beta^\sigma\right)$ to match the simulated moments. The parametrization is detailed in Table A12.

A.3 Results

We first present results based on the baseline calibration, in which asset purchases by the central bank are inactive.

Expected Returns and Volatility Figure A.1b illustrates the conditional volatility for various realizations of the state variable. In the stochastic steady state (when $z_t = 0$), the conditional volatility is approximately 4%, which aligns with its empirical counterpart. It is important to note that return volatility is endogenous and different from the volatility of the state variable itself. Consistent with empirical evidence, volatility increases during adverse economic conditions.

In the Data Appendix G, Figure G.8 illustrates the empirically estimated realized volatility, indicating that volatility is time-varying and experiences spikes during economic downturns. In the figure, we use daily returns for BBB-rated corporate bonds in excess of the benchmark, with the benchmark defined as the return on a maturity-matched swap rate. This method focuses on isolating variation in credit risk instead of duration risk. The realized quarterly volatility is subsequently calculated as the realized volatility of daily returns within each quarter.

In the model the volatility of cash flows depend on z, the state of the economy, Without accounting for this state-dependent volatility, the model would fail to capture the observed correlation between economic conditions and the risk premium. In this scenario, the model would incorrectly predict a higher risk premium during favorable economic conditions rather than in downturns. In fact, during good times, as the price of the risky security rises, asset managers must allocate a larger share of their portfolios to risky bonds. Consequently, the risk premium must increase for markets to clear.

Figure A.1a illustrates the baseline risk premium, defined as the expected excess return of risky assets over the risk-free rate. In the baseline model, the expected return is approximately 1.5% in the stochastic steady state, consistent with the calibrated baseline. In line with empirical evidence, the risk premium increases during economic downturns (i.e., when the state variable is below zero) and decreases during favorable conditions (i.e., when the state variable is above zero). The slope of the risk premium is a key moment in the discussion on the role of central banks' asset purchases.

Investors' Allocation A key aspect of the model is its ability to generate distinct allocation dynamics for the two types of investors over the economic cycle. Figure A.1c illustrates the asset managers' allocation, demonstrating that they decrease their holdings of risky assets during downturns and increase them in expansions. In bad times, heightened asset risk prompts mutual funds to reduce their exposure to risky assets.

Conversely, long-term investors help stabilize the market by absorbing the reduction in allocation by asset managers. Figure A.1d shows that long-term investors *increase* their allocation during downturns. During these periods, falling prices make bonds more attractive in terms of long-term yields, incentivizing long-term investors to expand their holdings. However, their allocation remains somewhat rigid due to rebalancing costs. Overall, for the market to clear, the risk premium must rise. This is consistent with the *low price elasticities* of insurance companies that have been previously documented in the literature (Bretscher et al., 2021; Koijen and Yogo, 2019; Koijen et al., 2021).

The distinct allocation patterns over the economic cycle make asset managers procyclical and long-term investors countercyclical, a key feature of the model.

A.3.1 The Effects of Cental Banks' Purchases

We analyze the effects of central bank asset purchases by comparing the baseline economy to a counterfactual scenario in which the central bank purchases bonds according to the rule specified in Equation 14, experimenting with different parameterizations. We set $\bar{X}^{CB} = 0.1$ and $\beta^{CB} = -0.1$, which implies that the central bank purchases 20% of the market when $z_t = -1$ (i.e., during a recession) and holds no assets when $z_t = 1$ (i.e., during an expansion). Notably, central bank holdings amounted to approximately 20% during the COVID-19 downturn, aligning with our model calibration.

Additionally, we consider an alternative calibration where $\bar{X}^{CB} = 0.0$ and $\beta^{CB} = -0.2$. Under this specification, the central bank does not hold assets on average but acts purely in a countercyclical manner, given that the average realization of z_t is zero. The risk premium is reduced by 80 basis points when the realization of the state variable is one standard deviation below the mean. The quantification is broadly consistent with the observed effects of the CSPP announcement that reduced risk-premium by 50 percentage points.

Figure A.2 presents the results for volatility and the risk premium. As shown in Figure A.2b, volatility significantly decreases when the central bank intervenes. In adverse economic conditions, when the volatility of exogenous cash flows δ_t rises, asset managers seek to reduce their allocation, leading to an increase in the risk premium. In the baseline model, this increase is partially mitigated by long-term investors, who help counterbalance the effect.

In the scenario with central bank intervention, the central bank absorbs part of the supply of risky bonds. Since prices still decline during a recession, long-term investors remain net buyers alongside the central bank, albeit to a lesser extent. Consequently, asset managers hold a smaller quantity of these bonds, leading to a lower risk premium.

It is notable, and perhaps the most interesting insight of the model, that the scenario where the central bank does not hold any bonds on average—only purchasing in bad times and selling in good times—yields similar effects. The dashed line in Figure A.2b indicates that the asset's volatility is reduced, which in turn leads to a decrease in the average risk premium (as illustrated in Figure A.2a). Also in this case, the risk premium is reduced by 0.8 percentage points when the realization of the state variable is one standard deviation below the mean.

A.3.2 The Role of Long-Term Investors

Finally, we re-estimate the baseline model and the effects of the policy with a different share of long-term investors. We reduce the sticky investment $\bar{X}$. The results are shown in Figure A.3a where we illustrate the effect of asset purchases in percentage points.

Figure A.3a illustrates the effectiveness of central bank purchases in reducing the risk premium under two scenarios: a baseline level of $\bar{X} = 0.85$ and a lower level of $\bar{X} = 0.65$. The dark blue line lies below the light blue line (baseline), indicating that with a lower share of long-term investors, the policy becomes even more effective. When z is one standard deviation below the mean, the effects of central banks decrease the risk premium by 80 basis points with a high share of long-term investors and 130 basis points with a low share of long-term investors. Roughly, a 10% reduction in long-term investors translates to a 50 basis points increase in the effectiveness of the policy.

The rationale is that, in the absence of central bank purchases, long-term investors act as a stabilizing force by retaining a larger share of bonds regardless of risk. During downturns, they refrain from selling, which helps mitigate the rise in the risk premium. Consequently, the central bank's influence is reduced when a greater proportion of countercyclical investors are present. Conversely, when the holdings of long-term investors decline (dark blue line), central bank purchases become increasingly important in stabilizing the market.

A.4 Model Extension and Additional Results

Spillover with Multiple Assets Suppose that each market segment is composed of two risky assets. The bond managers and the long-term investors then choose how much to allocate to the two risky assets and the risk-free assets. It is useful to rearrange the optimal allocation of the bond manager that relates the risk-premium commanded on the two assets. Suppose we have two assets i and j. The risk-premia are:

$$E_t\left[R_{t+1,j} - R_t^f\right] = \gamma \cdot \sigma_j^2 \cdot X_{t,j}^M + \gamma \cdot \rho \cdot \sigma_j \cdot \sigma_k \cdot X_{t,k}^M$$

$$E_t\left[R_{t+1,k} - R_t^f\right] = \gamma \cdot \sigma_k^2 \cdot X_{t,k}^M + \gamma \cdot \rho \cdot \sigma_j \cdot \sigma_k \cdot X_{t,j}^M$$

The two equations make clear that if, all else equal, we alter the risk of asset j, this will spill over to the risk-premium of asset k and this spillover will be larger the higher is the portfolio share $X^M_{t,j}$.

A.5 Mean-Variance Long-Term Investors

In the baseline model, we assume that the long-term investor takes into account the yield of the bond. We can assume that investors also have mean variance preference and a target allocation to the risky $\bar{X}$. They incur a quadratic adjustment cost proportional to the parameter ψ. Their optimization problem is as follows:

$$\max_{X^L_t} \quad X^L_t \left(R_{t+1} - R^f_t\right) + R^f_t - \frac{\gamma^L}{2} \operatorname{Var}_t(R_{t+1}) {X^L_t}^2 - \underbrace{\frac{\psi}{2} \left(X^L_t - \bar{X}\right)^2}_{\substack{\text{Holding} \\ \text{Cost}}},$$

where γ^L is the cost proportional to the variance of the return.

Here, X^L_t represents the portfolio weight of the risky bond. The optimal portfolio weight is therefore:

$$X^L_t = \frac{E_t\left[R_{t+1} - R^f_t\right]}{\psi + \gamma^L \operatorname{Var}_t(R_{t+1})} + \frac{\psi \bar{X}}{\psi + \gamma^L \operatorname{Var}_t(R_{t+1})}$$

In this case, Equation 17 is replaced by the by the following equation:

$$E_t\left[R_{t+1} - R^f_t\right] = \left(S - \frac{\psi \bar{X}}{\psi + \gamma^L \operatorname{Var}_t(R_{t+1})}\right) \frac{1}{\frac{1}{\gamma^M \operatorname{Var}_t(R_{t+1})} + \frac{1}{\psi + \gamma^L \operatorname{Var}_t(R_{t+1})}} \tag{20}$$

In this case, a higher $\bar{X}$ would also reduce the sensitivity of risk-premium to a change in volatility.

B. Connection To Demand Approach

In this section, we lay out a model that connects our findings to a demand approach and demand elasticities.

The model is based on Bretscher et al. (2021). The economy features multiple bonds and multiple investors. Bonds are indexed by $n = 0, \ldots, N$, where $n = 0$ corresponds to the outside asset. The (log) price of asset n is denoted by p_n. Each bond is associated with a vector of observed characteristics, $\mathbf{x}(n)$. There are I investors, indexed by $i = 1, \ldots, I$, where each investor chooses an allocation to assets $w_i(n)$. The economy consists of two periods: a pre-announcement period and a post-announcement period. We assume that, in the pre-announcement period, investors choose their portfolio allocations based on their demand for assets. The announcement of central bank policies may subsequently influence their asset demand in the post-announcement period. We determine both the pre-announcement and post-announcement equilibria.

Portfolio Allocations Each investor has a subset of assets within their investment mandate. Let Υ_i denote the set of assets included in the mandate of investor i. The portfolio weights for a given bond n are defined as:

$$w_i(n) = \frac{\delta_i(n)}{1 + \sum_{m=1}^{N} \delta_i(m)}, \tag{21}$$

where

$$\delta_i(n) = \exp\left(\alpha_i(n) + \beta_i p(n)\right) \qquad if\ n \in \Upsilon \tag{22}$$

$$\delta_i(n) = 0 \qquad if\ n \notin \Upsilon \tag{23}$$

and where β_i is the elasticity of investor i, while $\alpha_i(n)$ is an investr-specific taste for asset n that depends on the characteristics of the asset, $\alpha_i(n) = f_i(\mathbf{x}(n))$ for some function f_i specific to investor i.[25] Moreover, by the budget constraint, the portfolio weight in the outside asset equals:

$$w_i(0) = \frac{1}{1 + \sum_{m=1}^{N} \delta_i(m)}. \tag{24}$$

Market Clearing The supply of each asset is fixed and is equal to $S(n)$. Market clearing for bond n is given by:

$$M(n) = \sum_{i=1}^{I} A_i w_i(n), \tag{25}$$

[25] The function f_i can be a linear function of characteristics. In that case $\alpha_i(n) = \boldsymbol{\beta}'_{i,x}\mathbf{x}(n)$ where $\boldsymbol{\beta}_{i,x}$ is a vector of loadings.

where $M(n)$ is the market value of bond n, $S(n)e^{p(n)}$. The quantity demanded by each investor is, in log:

$$q_i(n) = \log(A_i w_i(n)) - p_t(n),$$

and the aggregate log of demand is:

$$q(n) = \log\left(\sum_i A_i w_i(n)\right) - p(n).$$

Post Announcement After the announcement, investors can modify their demand functions. We define $(\hat{\alpha}_i, \hat{\beta}_i)$ as the set of parameters following the announcement. Note that the supply of assets $S(n)$ remains constant. After the announcement we also allow for flows that can increase/decrease the asset under management of investors. Define the return on the portfolio of investor i:

$$R_i = \sum_j w_i(j) e^{(\hat{p}(j) - p(j))}$$

Asset under management post announcements are given by the flows:

$$\hat{A}_i = A_i R_i + Flows_i, \tag{26}$$

where

$$Flows_i = \mathbb{1}_{|R_i| > \xi} \gamma_i R_i \tag{27}$$

According to Equation 27, investor i experiences inflows if their portfolio achieves positive returns and outflows if it incurs negative returns. However, these inflows or outflows occur only when the magnitude of returns exceeds a threshold ξ, reflecting the idea that flows respond only when returns are sufficiently large or salient. The parameter γ_i represents the sensitivity of flows to returns.

Segmentation For an asset n, total holdings are given by $\sum_i A_i w_i(n)$. Note that for two assets with identical characteristics $(\mathbf{x}(n) = \mathbf{x}(m))$, each investor has the same demand $(\alpha_i(n) = \alpha_i(m))$. However, the investor composition may change because the two assets may be differently allocated to the investor mandate set Υ. The investor mandate introduces segmentation as some investors may be specifically invest in some bond but not others.

B.0.1 Predictions

Shifts in Demand and Price Change First, note that there are no changes in supply before or after the announcement. This implies that if the set of parameters remains unchanged, no price effects will occur. The first implication is as follows: if we observe any price changes at the time of the announcement, they must be driven by a shift in investor demand. Specifically, this means that for at least one group of investors, either $\boldsymbol{\alpha}_i \neq \hat{\boldsymbol{\alpha}}_i$ or $\boldsymbol{\beta}_i \neq \hat{\boldsymbol{\beta}}_i$. We define announcement-sensitive those investors that have altered their demand function after the announcement.

Shifts in Demand and Price Change Assume there was a shift in demand for a certain asset by investor i. Based on the pre-shift demand allocation, we can examine the price effects of a change in $\alpha_i(n)$ on the price $p(n)$:

$$\frac{\partial \mathbf{p}}{\partial \alpha_i(n)} = \underbrace{\left[-\frac{\partial \mathbf{q}}{\partial \mathbf{p}}\right]^{-1}}_{Elasticity} \underbrace{\frac{A_i w_i(n)}{\sum_j A_j w_j(n)}}_{Market\ Share} \mathbf{1}_n, \tag{28}$$

where $\mathbf{1}_n$ is a vector of zeros but with the n-entry equal to 1. As the equation shows, the price impact depends not only on the elasticity of each asset but also on the shares held by investors who adjust their demand. Consider two bonds, m and n, with identical characteristics. Since these bonds share the same attributes, it follows that $\alpha_i(m) = \alpha_i(n)$ for each investor i.[26] Even with the same characteristics and an identical shift in demand, $\hat{\alpha}_i(m) = \hat{\alpha}_i(n)$, the price reactions of the two bonds post-announcement may differ. This can happen if the bonds are held by different sets of investors, Υ, resulting in distinct equilibrium investor compositions. The price reaction depends on three factors: (i) the bond-specific elasticity, (ii) the market share of sensitive investors, and (iii) the sensitivity of these investors to the announcement.

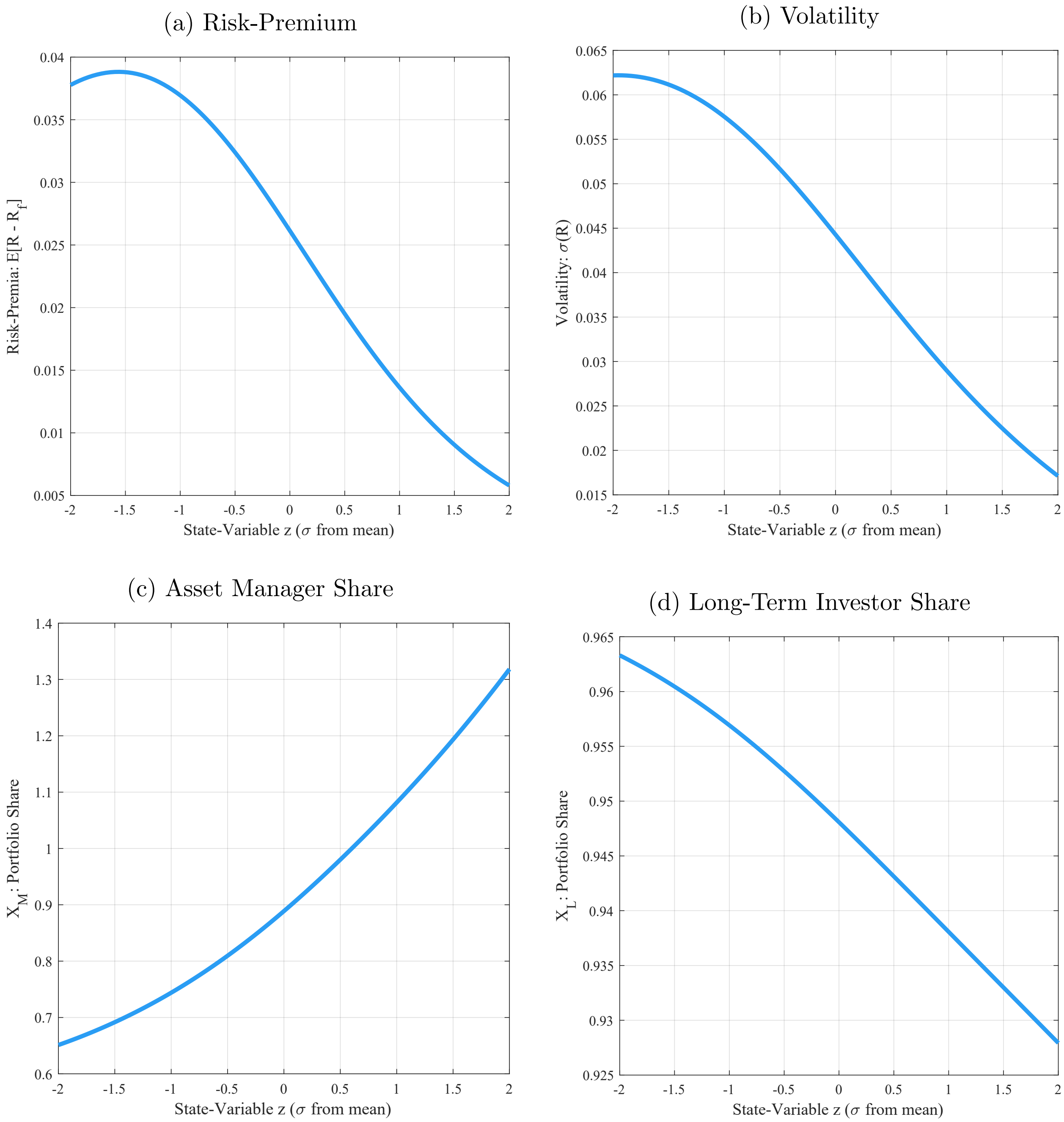
Flows Amplification or Dampening The prediction is that if the announcement affects bond prices $\hat{p}$, this can, in turn, influence the flows into the assets under management of investors. An increase in the prices of certain bonds generates positive returns, leading

[26]Note that identical characteristics do not imply identical preferences across different investors.

to greater assets under management for investors with higher exposure (i.e., larger portfolio weights) to these bonds. These investor flows increase the overall demand for assets, potentially amplifying the price effects. However, the overall impact remains uncertain. If these flows are directed toward elastic or less sensitive investors, the announcement effects may be dampened. On the other hand, if flows are directed toward inelastic or more sensitive investors, the price effects will be amplified. The extent of amplification or dampening depends on the distribution of investors in the economy. Nonetheless, we are more likely to observe larger price effects ($\hat{p}(n) - p$) for bonds held by more sensitive investors, as they drive the price changes. As a result, it is likely that flows will amplify the effects of the announcement.

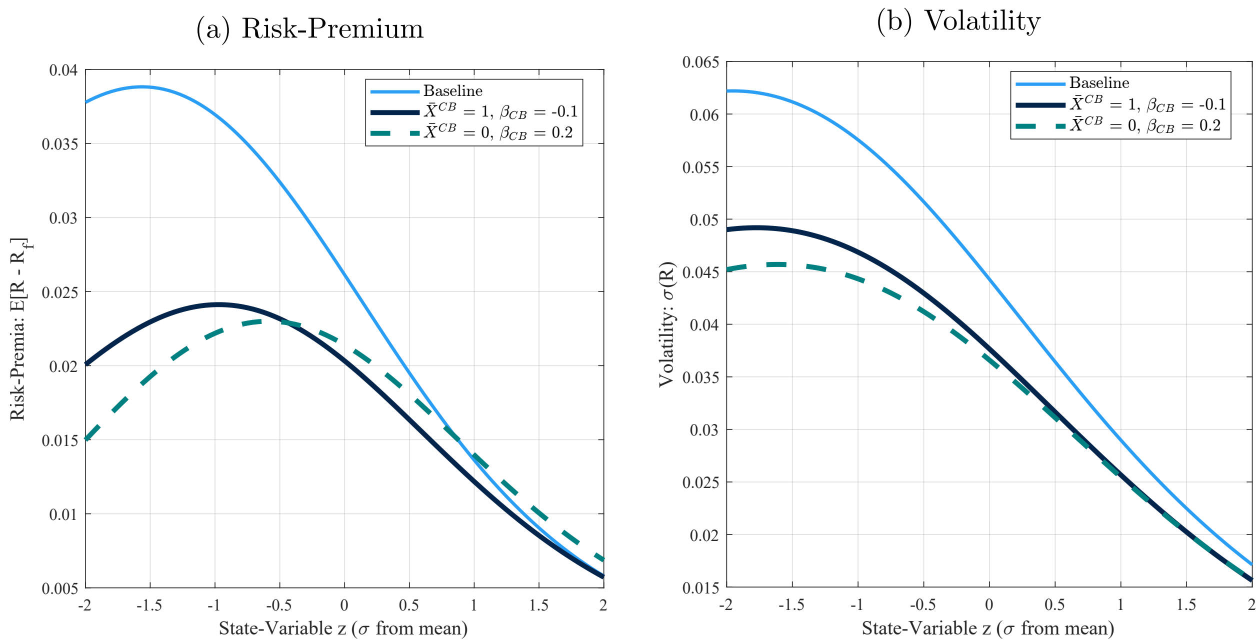
This simple framework illustrates that the strength of monetary policy transmission—whether conventional or unconventional to financial markets depends on several factors, namely, the elasticity of investors in the economy, their sensitivity to monetary policy, and their distribution across different market segments.

Figure A.1: Baseline Model



Note: The figure presents the calibrated outcomes of the baseline model. Panel A.1a depicts the risk premium, Panel A.1b illustrates the expected volatility, Panel A.1c shows the asset allocation of managers, and Panel A.1d displays the allocation of long-term investors. The x-axis represents the state variable, where values to the left of zero correspond to economic downturns, while values above zero indicate favorable economic conditions.

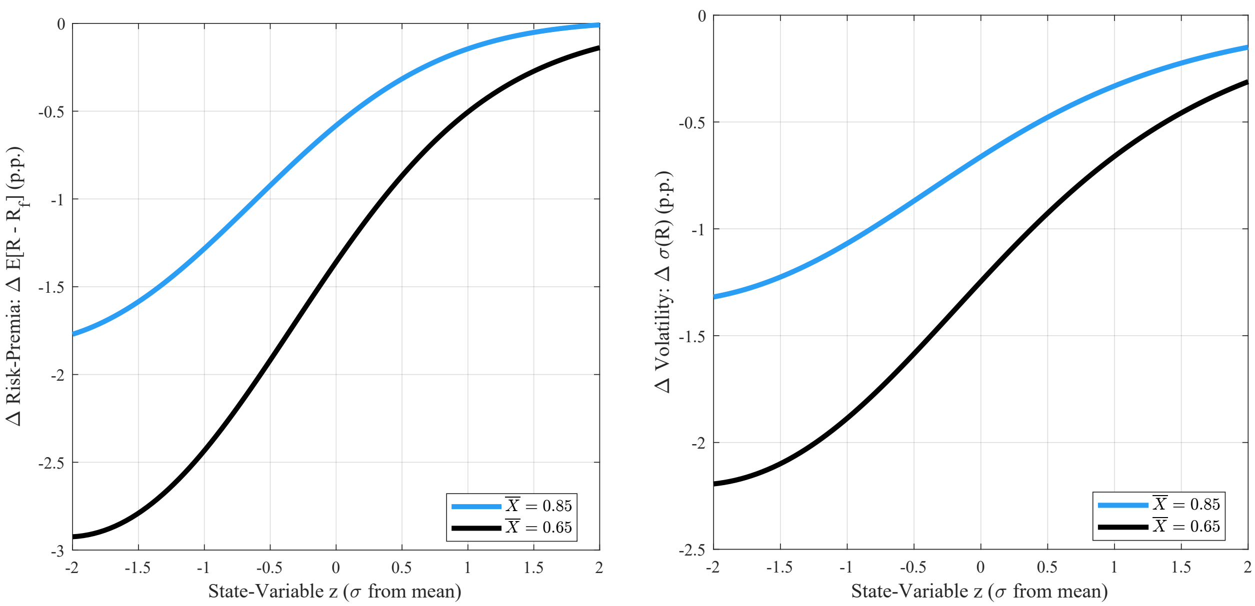
Figure A.2: Effects of Central Banks Purchases



Note: The figure presents the effects of central bank purchases on risk-premium and volatility. Panel A.2a depicts the risk premium, Panel A.2b illustrates the expected volatility. The x-axis represents the state variable, where values to the left of zero correspond to economic downturns, while values above zero indicate favorable economic conditions.

Figure A.3: The Role of Long-Term Investors

(a) Risk-Premium (b) Volatility



Note: The figure presents the effects of investment by Long-Term Investors on the strength of the transmission of central bank asset purchases. Panel A.3a plots the effects on risk-premium while Panel A.3b illustrates the effects on expected volatility. Note that the y-axis is the Δ in risk-premium or volatility compared to the baseline due to central banks' purchases. The x-axis represents the state variable, where values to the left of zero correspond to economic downturns, while values above zero indicate favorable economic conditions.

C. Data Appendix

C.1 Aggregate Holdings

The Euro area corporate bond market has been growing over the past two decades and is increasing its role in the debt financing of non-financial corporations. See Darmouni and Papoutsi (2022) for a discussion on the rise of bond financing in Europe. Bank loans have historically been the primary source of debt financing for firms in the Euro area. However, the corporate bond market is gaining share: In 2021, corporate bonds accounted for 15% of non-financial corporations' long-term debt financing.[27] Figure C.4a shows the rising share of market financing for non-financial corporations. The figure also shows how bond financing became even more relevant during the recent euro area recessions (the shaded area in Figure C.4a), which were characterized by impaired access to bank loans.[28]

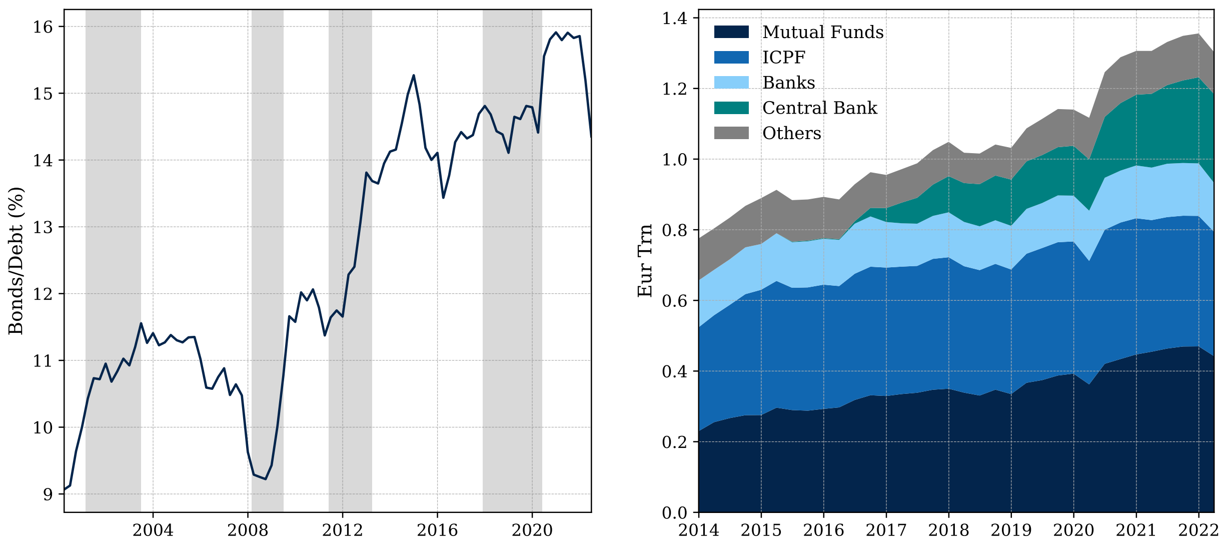
The leading investors in corporate bonds issued by Euro area non-financial corporations are mutual funds, and insurance companies and pension funds (ICPF) followed by banks and the ECB. At the end of 2021, the total amount of bonds held by Euro area investors totaled €1.36Tn. The largest Euro area investors in corporate bonds were mutual funds (34.7%), followed by ICPFs (27.2%). Of the total amount held by ICPFs, insurance corporations account for 89% while pension funds for the remaining 11%. The third largest investor is the ECB, which at the of 2021 held 18%. Finally, banks held 11%. The rest of the world holds an additional €0.35Tn. Figure C.4b splits the amount of long-term corporate bonds issued by Euro area non-financial corporations and held by Euro area investors.

[27] We consider long-term, any loans or bonds with a maturity greater than one year, in accordance with the European System of Account (ESA) 2010 definition.

[28] While recessions do not necessarily see more bond financing, the specific bank nexus of these recessions resulted in an increase in bond issuance.

Figure C.4: Euro area non-financial corporate bonds

(a) NFC Corporate Bonds (b) NFC - Holdings by Sector



Note: Figure C.4a shows the total amount of bonds issued by Euro area non-financial corporations as a share of total non-financial corporations' debt. Figure C.4b splits the total amount of bonds issued by Euro area non-financial corporations by holding sector: mutual funds, insurance corporations and pension funds (ICPF), banks, central bank, and others. Source: Quarterly Sector Account.

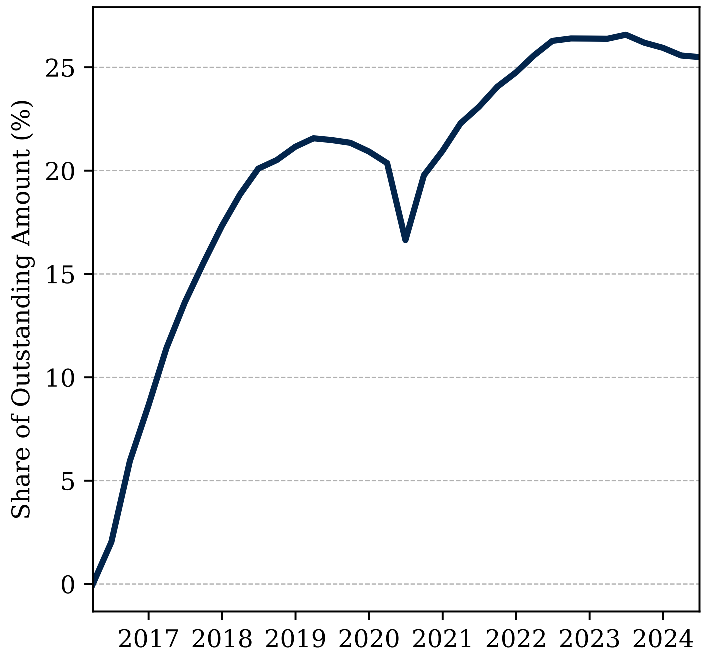
C.2 ECB Holdings

Figure C.5 plots the shares of the outstanding amount of eligible bonds held by the ECB. The share was 0% at the beginning of 2016, prior to the start of the CSPP and peaked to 27% in 2023.

C.3 Bonds

We use data on single name corporate bonds from iBoxx and match to CDS data from ICE. We match bonds based on the issuer and the seniority of the CDS / bonds. Table C13 presents summary statistics of bonds categorized by credit ratings: All, AAA, AA, A, BBB, and HY. Table C14 presents the same summary statistics for the subsample of eligible bonds. It includes the number of issuers and ISINs, and the notional amount in billions. It also shows the percentage shares of bonds held by various financial entities: NFC, ICPF, MFI, Financial Auxiliaries, OFI, and Captives. Additionally, it indicates the percentage of

Figure C.5: Shares Held by ECB



Note: Figure C.5 shows the shares of eligible bonds held by the ECB.

bonds matched with CDS (Credit Default Swaps).

Table C15 presents summary statistics of bonds by credit ratings: All, AAA, AA, A, BBB, and HY. Table C16 presents the summary statistics for the subset of eligible bonds. Metrics include Average, Median, and Standard Deviation (Std) for Yield, Option-Adjusted Spread (OAS), Credit Default Swap (CDS), and Basis. Average yields, reported in basis points, range from 70.50 (AA) to 574.10 (HY), while median yields are lower, peaking at 512.45 (HY). OAS averages are highest for HY (623.11) and lowest for AAA (82.00). CDS averages follow a similar pattern, highest for HY (390.31) and lowest for AAA (27.07). The basis, representing bond-CDS spread differences, is most negative for HY (-172.01) and least negative for AAA (-38.52).

Table C13: Bonds: Summary statistics

	All	AAA	AA	A	BBB	HY
N of issuer	893	3	45	196	330	384
N of ISIN	2272	5	167	683	814	603
Notional Amount (bn)	1717.04	5.80	174.05	594.87	629.58	312.73
Share NFC (%)	42.69	80.00	40.72	37.34	50.61	38.31
Share ICPF (%)	1.80	0	0	1.61	2.95	1.00
Share MFI (%)	21.74	0	30.54	33.09	15.60	14.93
Share Financial Auxiliaries (%)	1.80	0	1.80	1.02	2.83	1.33
Share OFI (%)	15.18	0	16.77	17.28	8.48	21.39
Share Captive (%)	16.77	0	10.18	9.66	19.53	23.05
Share Bond-CDS matched (%)	38.95	40.00	32.93	45.10	42.26	29.19

Note: The table presents summary statistics of bonds categorized by credit ratings: All, AAA, AA, A, BBB, and HY. It includes the number of issuers and ISINs, and the notional amount in billions. It also shows the percentage shares of bonds held by various financial entities: NFC, ICPF, MFI, Financial Auxiliaries, OFI, and Captives. Additionally, it indicates the percentage of bonds matched with CDS (Credit Default Swaps).

Table C14: Eligible Bonds: Summary statistics

	All	AA	A	BBB	HY
N of issuer	269	14	80	176	14
N of ISIN	867	60	271	493	43
Notional Amount (bn)	667.27	54.31	212.99	367.68	32.28
Share NFC (%)	57.44	45.00	64.58	56.39	41.86
Share ICPF (%)	3.23	0	3.69	3.65	0
Share MFI (%)	0.00	0	0	0	0
Share Financial Auxiliaries (%)	3.69	5.00	2.58	4.46	0
Share OFI (%)	7.27	21.67	8.12	3.85	20.93
Share Captive (%)	28.37	28.33	21.03	31.64	37.21
Share Bond-CDS matched (%)	34.49	13.33	39.48	35.29	23.26

Note: The table presents summary statistics for the subset of eligible bonds. It includes the number of issuers and ISINs, and the notional amount in billions. It also shows the percentage shares of bonds held by various financial entities: NFC, ICPF, MFI, Financial Auxiliaries, OFI, and Captives. Additionally, it indicates the percentage of bonds matched with CDS (Credit Default Swaps).

Table C15: Summary statistics of Bonds

	All	AAA	AA	A	BBB	HY
Average Yield	367.85	80.65	70.50	101.76	186.20	574.10
Median Yield	142.39	37.26	59.92	90.73	138.69	512.45
Std Yield	2607.33	73.79	57.68	80.77	157.12	387.15
Average OAS	400.50	82.00	92.64	128.10	214.37	623.11
Median OAS	160.64	80.84	89.99	113.40	160.49	556.42
Std OAS	2608.61	18.00	29.66	66.75	147.87	387.44
Average CDS	218.29	27.07	64.77	87.40	120.21	390.31
Median CDS	100.86	27.07	67.40	79.17	103.12	295.30
Std CDS	736.84	20.65	29.61	46.69	77.70	416.31
Average Basis	-88.37	-38.52	-23.78	-32.50	-48.45	-172.01
Median Basis	-38.15	-38.52	-20.95	-27.25	-44.12	-119.23
Std Basis	589.95	11.67	22.63	41.50	60.87	261.87

Note: The table presents summary statistics of bonds by credit ratings: All, AAA, AA, A, BBB, and HY. The reported metrics include the Average, Median, and Standard Deviation (Std) for Yield, Option-Adjusted Spread (OAS), Credit Default Swap (CDS), and Basis. The units are in basis points. .

Table C16: Summary Statistics: Eligible Bonds

	All	AA	A	BBB	HY
Average Yield	367.85	64.55	101.96	181.89	361.87
Median Yield	142.39	53.46	83.36	126.14	350.01
Std Yield	2607.33	56.88	87.05	160.89	197.92
Average OAS	400.50	86.80	124.99	209.75	397.12
Median OAS	160.64	83.60	108.10	148.79	401.94
Std OAS	2608.61	29.75	70.84	150.44	187.69
Average CDS	218.29	60.82	81.39	108.43	174.31
Median CDS	100.86	57.24	74.56	81.84	170.42
Std CDS	736.84	29.50	38.50	82.40	60.71
Average Basis	-88.37	-27.95	-33.96	-46.70	-63.27
Median Basis	-38.15	-22.51	-23.57	-41.12	-65.01
Std Basis	589.95	14.63	48.40	51.27	28.15

Note: The table presents summary statistics for the set of eligible bonds by credit ratings: All, AA, A, BBB. Metrics include Average, Median, and Standard Deviation (Std) for Yield, Option-Adjusted Spread (OAS), Credit Default Swap (CDS), and Basis. The units are in basis points.

C.4 Lipper Fund Flows

Table C17 reports summary statistics on fund flows. The first column distinguishes the asset type, the second column indicates whether the funds are domiciled in the Euro area or outside the Euro area (Ex Euro), and the third column specifies whether the funds are *eligible*, meaning they hold at least one eligible bond. For each group, we report the number of observations, the average assets under management (TNA), and the average flows. Additionally, we compute flows as a percentage of TNA both on average and in aggregate, where the aggregate measure is calculated by first summing fund flows and then dividing by the total TNA.

Table C17: Flows Summary Stats

Asset Type	Domicile	Eligible	N Obs	TNA (Avg)	Flows (Avg)	Flows/Tna (Avg)	Flows/Tna (Agg)
Alternatives	Ex Euro		457	551.09	-6.30	1.57	-1.14
		✓	12	5095.94	-88.15	1.60	-1.73
	Euro		434	266.80	10.18	2.81	3.82
		✓	24	453.61	15.17	2.52	3.34
Bond	Ex Euro		3784	769.49	7.10	1.13	0.92
		✓	288	1538.64	23.58	1.31	1.53
	Euro		1974	366.29	2.90	1.40	0.79
		✓	1039	507.10	7.11	1.71	1.40
Commodity	Ex Euro		56	344.67	10.16	1.93	2.95
	Euro		40	184.88	5.43	4.17	2.94
		✓	1	30.92	-0.01	-0.02	-0.02
Equity	Ex Euro		7787	913.92	-0.10	0.83	-0.01
		✓	11	1048.43	-2.77	1.21	-0.26
	Euro		4496	288.17	-0.10	0.64	-0.04
		✓	18	219.68	-2.64	2.58	-1.20
Mixed Assets	Ex Euro		3300	613.44	2.44	1.67	0.40
		✓	113	1837.43	4.50	1.30	0.25
	Euro		2939	179.25	1.05	0.89	0.59
		✓	630	427.47	2.07	0.41	0.49
Money Market	Ex Euro		479	3864.14	34.94	1.19	0.90
	Euro		317	2608.42	-58.67	-0.11	-2.25
		✓	8	473.21	-27.44	-1.09	-5.80
Other	Ex Euro		58	10.68	-0.11	-0.22	-1.03
	Euro		52	56.85	-0.46	-0.65	-0.81
		✓	1	41.10	0.00	0.00	0.00
Real Estate	Ex Euro		80	1139.71	1.08	0.61	0.10
	Euro		128	753.75	6.57	0.67	0.87

Note: The table presents summary statistics for fund flows by Asset Type, Domicile, and Eligibility where Eligible means that they hold eligible bonds. The column reports the number of observation, average TNA and Flows and Flows/Tna. Flows/Tna is calculated by summing across flows and TNAs and then computing the ratio.

D. Monetary Policy Measures

D.1 CSPP

The ECB announced its Corporate Sector Purchase Programme (CSPP) on March 10, 2016, as part of its broader efforts to stimulate the eurozone economy and address low inflation. Under the CSPP, the ECB buys investment-grade corporate bonds issued by non-bank corporations within the eurozone. The CSPP operates alongside other measures within the

Asset Purchase Programme (APP).

Between 8 June 2016 and 19 December 2018, the Eurosystem conducted net purchases of corporate sector bonds under the Corporate Sector Purchase Programme (CSPP). From January to October 2019, it only reinvested the principal payments from maturing securities in the CSPP portfolio. Purchases under the CSPP resumed on 1 November 2019 and continued until the end of June 2022. Between July 2022 and February 2023, the Eurosystem fully reinvested principal payments from maturing securities. From March 2023, it began partial reinvestments of principal payments from maturing CSPP securities, eventually discontinuing all CSPP reinvestments as of July 2023.

Elegibility Eligibility for the corporate sector purchase programme (CSPP) includes instruments issued by entities incorporated within the euro area. This requirement specifies that issuers must be residents of the euro area, irrespective of the location of their ultimate parent company. Therefore, corporate debt instruments issued by euro area-incorporated entities remain eligible for purchase even if their ultimate parent is situated outside the euro area, as long as all other eligibility criteria are met.

To qualify for purchase under the CSPP, debt instruments must satisfy one of the following maturity conditions: (i) an initial maturity of 365/366 days or less with a minimum remaining maturity of 28 days at the time of purchase, or (ii) an initial maturity of 367 days or more with a minimum remaining maturity of six months and a maximum remaining maturity of less than 31 years at the time of purchase. This upper maturity limit aligns with that of the public sector purchase programme (PSPP), while the lower limit ensures the inclusion of debt instruments issued by small and medium-sized corporations.

There is no minimum issuance volume for corporate bonds to be eligible for purchase under the CSPP, enabling the inclusion of bonds with small issuance volumes, typically issued by small firms. However, for commercial paper securities to be eligible, they must have a minimum outstanding issuance amount of €10 million.

Market Neutral Approach The ECB pursues a market-neutral implementation of the APP, and consequently, CSPP purchases adhere to a benchmark that proportionally reflects the market value of eligible bonds. In the initial year, the composition of CSPP holdings closely mirrored that of the CSPP-eligible bond universe. As of June 7, 2017, CSPP holdings amounted to €92 billion, representing approximately 11% of the CSPP-eligible bond universe. These holdings exhibit a robust diversification across about 950 securities issued by approximately 200 issuer groups. In line with the goals of the Paris Agreement, the Eurosystem announced in July 2022 its intention to gradually decarbonize its corporate bond holdings. This involves tilting purchases toward issuers with better climate performance through the reinvestment of significant redemptions expected in the coming years.

Initial Market Reaction We examine the overall reaction of corporate bond yields to the ECB announcement by studying an aggregate corporate bond yield for Euro area nonfinancial corporations. Subsequently, we decompose the index into an interest rate (default-free) component and a credit spread component. It is important to note that the credit spread component also encompasses the liquidity premium component. The construction of the aggregate index and its decomposition is detailed as follows:

$$\underbrace{Y_t}_{\substack{\text{Market Corporate} \\ \text{Yield}}} = \sum_i w_{i,t} \times y_{i,t} = \underbrace{\sum_i w_{i,t} \times \iota_{i,t}}_{\substack{\text{Interest Rate} \\ \text{Component}}} + \underbrace{\sum_i w_{i,t} \times ys_{i,t}}_{\substack{\text{Credit Spread} \\ \text{Component}}}. \tag{29}$$

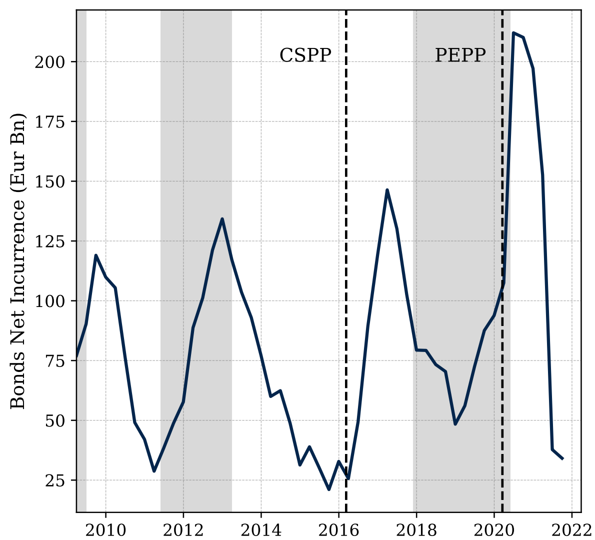
Here, $y_{i,t}$ represents the yield-to-maturity of bond i at time t, and $w_{i,t}$ denotes the notional outstanding amount of bond i as a share of the total outstanding amount of all bonds in the sample. Additionally, $\iota_{i,t}$ stands for the swap yield with maturity equal to the maturity of bond i, while $ys_{i,t}$ signifies the spread of corporate bond i in excess of the default-free rate.

Figure 2b illustrates the progression of the aggregate index, showcasing the impact of the CSPP announcement in effectively reducing corporate bond yields. A significant drop in bond yields occurred on the day of the announcement, followed by a more gradual decrease in the subsequent weeks. Notably, the decline was predominantly driven by a reduction in the spread component, as evidenced by Figure D.7a. The decomposition also reveals the mechanism through which the transmission of corporate bond purchases unfolded, resulting in a decrease in credit spread or liquidity risk premium.

The policy package not only impacted prices, but the period following the announcements also witnessed an increase in the volume of bond issuance by Euro area nonfinancial corporations. This observation aligns with findings in several papers in the literature, which have demonstrated the causal link between CSPP announcements and their effects on both bond yields and bond issuance volumes (Abidi and Miquel-Flores (2018); Grosse-Rueschkamp et al. (2019); Zaghini (2020); De Santis et al. (2018); Todorov (2020); De Santis and Zaghini (2021)).

Bond Volumes The impact of the policy was not limited to corporate bond prices but also extended to bond issuances. Figure D.6 illustrates the issuance of bonds by non-financial corporations, revealing a noticeable spike following the announcement of CSPP, an occurrence distinct from periods outside of recessions.

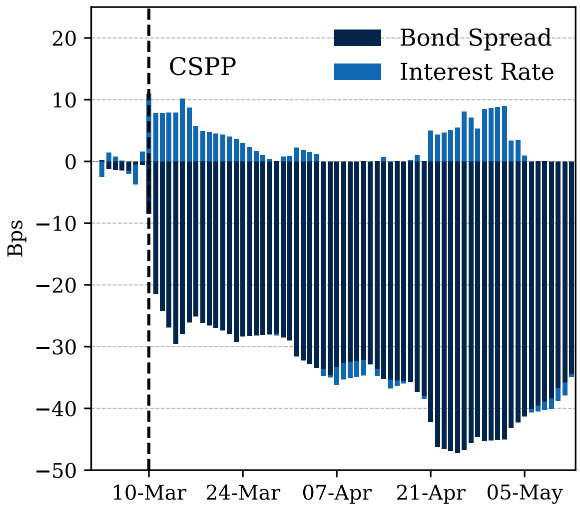
Figure D.6: Corporate Bond Volumes, CSPP and PSPP



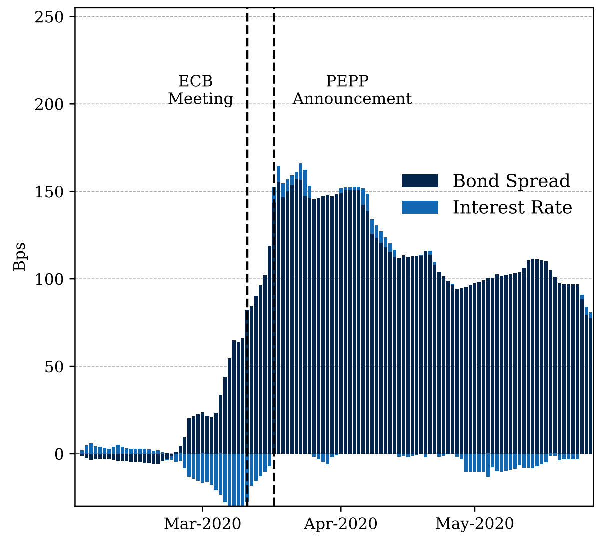
Note: The figure plots the issuance of bonds by non-financial corporations. Source: Quarterly Sector Account.

Figure D.7: Decomposition

(a) Decomposition: CSPP Announcement



(b) Decomposition: PEPP Announcement



Note: We decompose the market corporate bond yield into an interest rate component and a credit spread component. The figure plots the individual contributions of the two components to the observed variation in overall corporate bond market yields. Panel (a) shows the decomposition of bond yields around the CSPP announcement, while Panel (b) shows the decomposition of bond yields around the ECB PEPP announcement.

E. CSPP, Additional Results

E.1 Other Investors

In this section, we gather a set of results for additional investors.

Table E18: Mutual Funds and ICPF Holdings and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	-51.501***	-49.009***	-40.953***	-44.130***	-42.855***	-35.853***	-49.474***	-40.688***	-16.978***
	(5.89)	(7.40)	(6.55)	(9.67)	(12.58)	(8.39)	(10.72)	(12.57)	(5.99)
θ_i^{ICPF}	3.885	5.850	2.042	0.264	-3.479	7.213	0.227	-10.791*	10.416*
	(4.25)	(4.54)	(6.23)	(7.25)	(8.96)	(5.89)	(6.96)	(5.57)	(5.81)
Observations	860	860	858	837	780	726	816	472	795
Adj. R-squared	0.136	0.158	0.294	0.344	0.401	0.350	0.392	0.823	0.541
	Panel B: 10 days lag								
θ_i^{MF}	-55.682***	-52.309***	-40.704***	-48.216***	-44.235***	-36.486***	-55.326***	-40.537***	-15.879**
	(7.07)	(8.43)	(8.77)	(11.96)	(15.58)	(9.60)	(12.60)	(13.33)	(6.29)
θ_i^{ICPF}	3.398	6.133	3.130	-2.689	-5.891	6.542	-3.365	-12.153**	9.803
	(5.09)	(6.02)	(8.70)	(8.34)	(10.59)	(6.97)	(8.28)	(5.88)	(6.73)
Observations	860	860	858	837	780	726	816	472	795
Adj. R-squared	0.110	0.129	0.258	0.326	0.385	0.321	0.362	0.831	0.514
	Panel C: 30 days lag								
θ_i^{MF}	-90.372***	-80.909**	-59.193***	-69.133***	-62.853***	-55.732***	-75.932***	-71.582**	-20.549
	(11.53)	(14.50)	(13.97)	(18.35)	(19.74)	(18.10)	(19.41)	(28.72)	(12.48)
θ_i^{ICPF}	11.381	19.064	15.597	8.097	-0.660	18.859	8.790	-22.381*	23.606*
	(8.36)	(10.84)	(17.58)	(14.52)	(14.96)	(12.54)	(14.64)	(13.42)	(13.49)
Observations	847	846	845	824	769	718	804	460	782
Adj. R-squared	0.125	0.152	0.274	0.355	0.463	0.335	0.410	0.798	0.610
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓				
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, best rating, issuer sector, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

Table E19: Mutual Funds and Foreign Investors Holdings and CSPP Announcement

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{MF}	-47.749***	-46.247***	-34.799***	-33.860***	-26.085***	-32.502***	-38.149***	-18.281*	-19.008***
	(5.17)	(4.93)	(3.49)	(5.62)	(7.02)	(6.23)	(7.01)	(10.08)	(5.36)
$\theta_i^{Foreign}$	-17.236***	-18.780**	-17.260*	-22.246***	-26.156***	-21.549***	-24.501***	-18.817*	-16.561*
	(5.47)	(5.94)	(8.62)	(6.58)	(7.30)	(6.88)	(6.74)	(9.65)	(8.37)
Observations	860	860	858	837	780	726	816	472	795
Adj. R-squared	0.145	0.168	0.302	0.356	0.414	0.360	0.406	0.825	0.543
	Panel B: 10 days lag								
θ_i^{MF}	-52.863***	-50.793***	-36.392***	-36.074***	-25.109***	-34.017***	-42.164***	-16.435	-19.415***
	(6.22)	(5.79)	(4.12)	(6.84)	(8.01)	(7.11)	(7.72)	(10.71)	(5.27)
$\theta_i^{Foreign}$	-13.941**	-16.329*	-15.467	-20.454***	-26.293***	-18.348**	-21.442***	-19.056*	-12.269
	(6.58)	(6.87)	(9.04)	(7.18)	(8.73)	(8.59)	(7.37)	(9.98)	(9.80)
Observations	860	860	858	837	780	726	816	472	795
Adj. R-squared	0.115	0.134	0.263	0.334	0.394	0.327	0.370	0.833	0.514
	Panel C: 30 days lag								
θ_i^{MF}	-85.374***	-80.031***	-54.116***	-55.653***	-39.638***	-52.286***	-61.191***	-28.823	-30.869***
	(10.08)	(9.55)	(5.77)	(11.18)	(11.64)	(12.85)	(12.08)	(20.26)	(9.35)
$\theta_i^{Foreign}$	-35.431***	-41.191**	-41.975**	-44.518***	-44.122***	-45.332***	-48.224***	-31.887*	-25.782
	(10.78)	(12.53)	(15.95)	(11.80)	(12.58)	(15.57)	(12.21)	(17.07)	(17.32)
Observations	847	846	845	824	769	718	804	460	782
Adj. R-squared	0.134	0.162	0.285	0.368	0.474	0.348	0.425	0.799	0.609
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating			✓	✓	✓	✓	✓	✓	✓
Country				✓	✓	✓	✓	✓	✓
Rating Worst					✓				
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, best rating, issuer sector, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

Table E20: Mutual Funds and CSPP Announcement, Lipper

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{AMF}	-160.399***	-105.538***	-133.905***	-94.088***	-94.088***	-120.104***	-137.897***	-151.769*	-71.123**
	(23.24)	(13.49)	(35.47)	(22.79)	(22.79)	(35.68)	(34.65)	(76.19)	(27.14)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	0.121	0.210	0.317	0.685	0.685	0.317	0.407	0.793	0.744
	Panel B: 10 days lag								
θ_i^{AMF}	-167.481***	-98.824***	-128.759***	-79.357**	-79.357**	-152.532***	-129.753***	-111.983	-49.513
	(29.61)	(21.10)	(34.06)	(30.00)	(30.00)	(39.34)	(37.38)	(88.80)	(32.65)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	0.084	0.205	0.284	0.556	0.556	0.298	0.340	0.779	0.585
	Panel C: 30 days lag								
θ_i^{AMF}	-326.512***	-221.296***	-259.512***	-158.421***	-158.421***	-254.011***	-253.029***	-194.597*	-86.385*
	(49.99)	(28.36)	(48.01)	(49.70)	(49.70)	(56.45)	(54.76)	(107.35)	(46.71)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	0.110	0.209	0.422	0.739	0.739	0.348	0.504	0.839	0.804
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating		✓	✓	✓	✓	✓	✓	✓	✓
Country					✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2. We use holdings data from Lipper. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, best rating, issuer sector, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

Table E21: ETF and CSPP Announcement, Lipper

Dependent Variable: OAS spread									
	Panel A: 5 days lag								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
θ_i^{ETF}	-231.437	-210.479*	-50.785	193.994	193.994	-23.102	37.605	10.460	36.010
	(144.45)	(98.82)	(192.23)	(116.45)	(116.45)	(193.63)	(184.52)	(137.80)	(112.30)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	0.005	0.174	0.243	0.652	0.652	0.252	0.325	0.733	0.725
	Panel B: 10 days lag								
θ_i^{ETF}	-177.894	-145.445	80.226	288.514*	288.514*	135.139	142.027	209.433	166.337
	(180.70)	(177.99)	(192.40)	(156.81)	(156.81)	(225.08)	(206.27)	(166.19)	(160.15)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	-0.000	0.182	0.233	0.545	0.545	0.231	0.289	0.756	0.581
	Panel C: 30 days lag								
θ_i^{ETF}	19.727	136.010	477.282*	748.194***	748.194***	566.789**	612.715**	439.894	572.514***
	(309.89)	(270.99)	(236.31)	(164.90)	(164.90)	(275.25)	(243.31)	(299.96)	(161.58)
Observations	339	338	320	295	295	262	307	177	251
Adj. R-squared	-0.003	0.169	0.362	0.732	0.732	0.283	0.449	0.820	0.808
Duration		✓	✓	✓	✓	✓	✓	✓	✓
Rating		✓	✓	✓	✓	✓	✓	✓	✓
Country					✓	✓	✓	✓	✓
Rating Worst					✓			✓	✓
Size						✓			
Callable							✓		
Issuer								✓	
Liquidity									✓

Note: The table shows the estimated coefficients and standard errors from Equation 2. We use a independent variable the shares of bonds held by ETF. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating, best rating, issuer sector, size, liquidity, callability and issuer identity. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

E.2 Alternative Identification

We also account for potential nonlinearities by computing quintiles based on mutual fund bond holdings. The first quintile again consists of bonds with the lowest mutual fund ownership, while the fifth quintile consists of those with the highest mutual fund ownership. We then repeat the regression analysis outlined in Equation 3, incorporating dummy variables for each mutual fund holdings quintile. We regress the change in OAS spreads on the eligibility dummy, the dummy for mutual fund ownership quintiles, and their interaction. The results, shown in Table E22, indicate that the coefficient for the interaction between eligibility and the fifth quintile is both economically and statistically significant, with coefficient estimates ranging from -5.6bps to -10bps, depending on the specification. This suggests that the policy was particularly effective for bonds with higher mutual fund ownership. Additionally, the results in Table E22 indicate that bonds held by mutual funds experienced a more pronounced decline in yields, irrespective of their eligibility status. This finding aligns with the spillover effects described in the model, at the end of Section 7.

Table E22: Mutual Funds Holdings and CSPP Announcement, Alternative Identification

	(1) Δys^5	(2) Δys^5	(3) Δys^5	(4) Δys^5	(5) Δys^5
Eligible	-7.399***	-7.399***	-4.106***	-3.901*	-4.352**
	(1.92)	(1.27)	(1.37)	(2.28)	(1.84)
Eligible x Quintile 2	2.080	2.147*	0.683	2.030	2.336
	(2.70)	(0.83)	(0.99)	(1.70)	(1.70)
Eligible x Quintile 3	4.118	4.259***	3.540**	3.632	2.064
	(2.70)	(0.51)	(1.54)	(2.41)	(2.24)
Eligible x Quintile 4	-0.758	-0.710	-2.774	-3.400	-3.033
	(2.70)	(1.64)	(2.31)	(3.00)	(2.64)
Eligible x Quintile 5	-5.918**	-5.653***	-7.308**	-9.845***	-8.257**
	(2.71)	(0.42)	(2.68)	(3.17)	(3.45)
Quintile 2	-3.534*	-3.378***	-1.646**	-2.537***	-2.370***
	(1.83)	(0.64)	(0.60)	(0.90)	(0.90)
Quintile 3	-7.687***	-7.404**	-5.396***	-5.920***	-4.597***
	(1.85)	(1.74)	(1.73)	(1.67)	(1.45)
Quintile 4	-10.156***	-9.671***	-5.393***	-4.240***	-4.319***
	(1.86)	(1.37)	(1.45)	(1.55)	(1.50)
Quintile 5	-14.318***	-14.249***	-8.019***	-5.553***	-4.762**
	(1.89)	(1.36)	(1.77)	(1.80)	(2.05)
Observations	1735	1735	1733	1660	1541
Adj. R-squared	0.154	0.161	0.286	0.323	0.441
Duration	No	Yes	Yes	Yes	Yes
Rating	No	No	Yes	Yes	Yes
Country	No	No	No	Yes	Yes
Rating Worst	No	No	No	No	Yes

Note: The table shows the estimated coefficients and standard errors from Equation 3. Our regression model includes dummies for a set of characteristics of the bonds, namely the duration group, issuer country, average rating, worst rating. Standard errors are double clustered by time and bond groups, where bond groups is based on the set of interacted fixed effects.

F. Portfolio Rebalancing

F.1 SHS Holdings

Table F23 shows the change in the share of eligible bonds held by mutual funds in the quarters following the announcement. We run the following regression:

$$\Delta\theta_i^j(n) = \gamma_n^{elig}\ \mathbb{1}_{elig} + \text{Interacted Fixed Effects} + \varepsilon_i^j(n), \tag{30}$$

where $\Delta\theta_i^j(n)$ represents the changes in the share of bond i held by investor j, n months after the announcement, and $\mathbb{1}_{elig}$ is an indicator for whether the bond is eligible. The first column in Table F23 represents the change in shares in the quarter following the announcement when using duration fixed effects, while column (2) shows the results when using both duration and rating fixed effects. Columns (3) and (4) present the same results two quarters after the announcement. The results indicate that mutual funds were rebalancing toward eligible bonds in the quarter of the announcement. Although the data are less precise when using granular holdings data from Lipper, the results are consistent with the observed effects.

We repeat this analysis for insurance corporations and pension funds in Table F24, which indicates that these investor groups were net sellers in the two quarters following the announcement.

Table F23: Mutual Funds Holdings and CSPP Announcement (SHSS data)

	(1) $\Delta\theta^{MF}$ (1) b/se	(2) $\Delta\theta^{MF}$ (1) b/se	(3) $\Delta\theta^{MF}$ (2) b/se	(4) $\Delta\theta^{MF}$ (2) b/se
Eligible	0.004***	0.005***	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	1633	1631	1438	1435
Adj. R-squared	0.023	0.024	0.023	0.027
Duration	Yes	Yes	Yes	Yes
Rating	No	Yes	No	Yes

Note: The table shows the estimated coefficient of Equation 7 on SHSS data. We regress the change in shares held by mutual funds on a dummy for eligible bonds.

Table F24: ICPF Holdings and CSPP Announcement (SHSS data)

	(1) $\Delta\theta^{ICPF}$ (1)	(2) $\Delta\theta^{ICPF}$ (1)	(3) $\Delta\theta^{ICPF}$ (2)	(4) $\Delta\theta^{ICPF}$ (2)
	b/se	b/se	b/se	b/se
Eligible	0.002	0.001	-0.004	-0.004***
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	1649	1647	1361	1359
Adj. R-squared	0.065	0.074	0.032	0.035
Duration	Yes	Yes	Yes	Yes
Rating	No	Yes	No	Yes

Note: The table shows the estimated coefficient of Equation 7 on SHSS data. We regress the change in shares held by insurance corporations and pension funds on a dummy for eligible bonds.

F.2 Fund Flows and the Share of Eligible Bonds

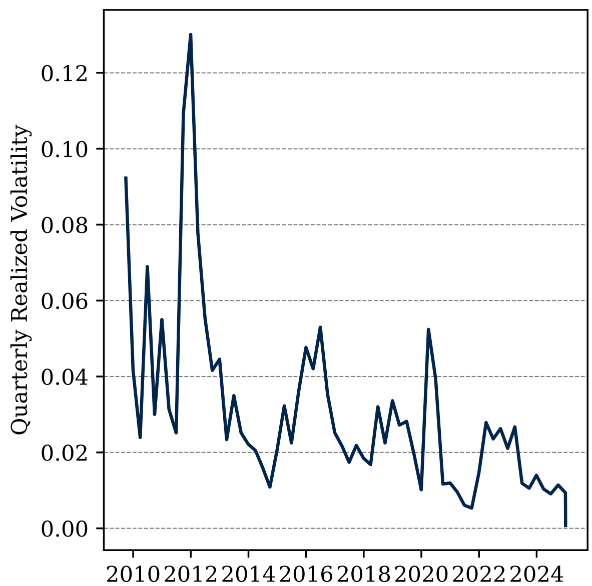
Table F25 presents the results of a regression analyzing fund flows based on the share of eligible bonds prior to the announcement. A positive coefficient signifies that funds with higher shares of eligible bonds before the announcement saw positive fund flows. This finding aligns with the notion that funds holding eligible bonds realized higher returns, subsequently attracting more flows. We replicate the analysis by stratifying the sample into bond funds, Euro-domiciled funds, or foreign-domiciled funds.

Table F25: Share of Eligible Bonds and Flows

	All	Bond Fund	Euro Domicile	Foreign Domicile
	(1)	(2)	(4)	(5)
Shares of Eligible	0.473***	0.564***	0.556***	-0.167
	(0.13)	(0.15)	(0.13)	(0.45)
Observations	2913	1691	2398	515
Adj. R-squared	0.005	0.008	0.007	-0.002

Note: The table presents the results of the estimated model in Equation 8, where we regress fund flows over assets for the period March 10, 2016 to April 10, 2016 on the shares of eligible bonds held.

Figure G.8: Realized volatitlity



Note: The figure displays the realized volatility in the corporate bond returns. We use the daily returns for BBB corporate bonds in excess of the benchmark, where the benchmark is the return on a maturity-matched swap rate. We then compute the realized quarterly volatility as the realized volatility of daily data within the quarter.

G. Realized Volatility in Corporate Bonds

In this section, we use aggregate data on corporate bond market returns. We use the daily returns for BBB corporate bonds in excess of the benchmark, which is the return on a maturity-matched swap rate. This approach isolates the variation in credit risk, excluding duration risk. We then calculate the realized quarterly volatility as the realized volatility of daily data within the quarter. The results are presented in Figure G.8.

H. Additional Results: Interest Rate Shocks

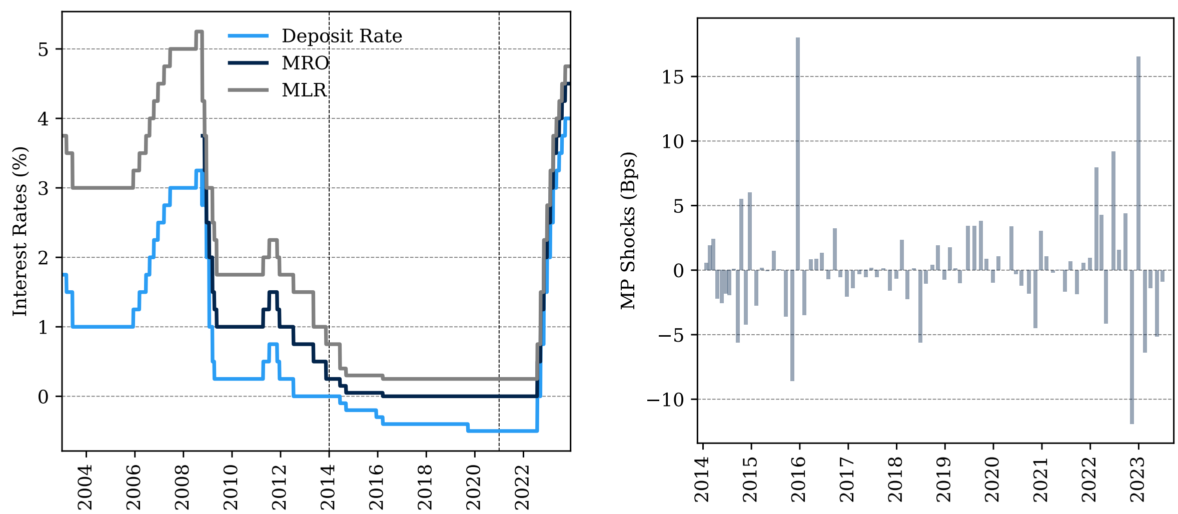
Up to now, we have demonstrated that mutual funds play a crucial role in the transmission of unconventional monetary policy. However, they may also affect the transmission of conventional monetary policy. Fund flows may react to returns when the impact on returns is significant enough to be noticeable to investors. An easier monetary policy may trigger fund flows that push up prices.

Holm-Hadulla et al. (2023); Giuzio et al. (2021) demonstrate that the size of the mutual fund sector, measured by total assets under management, responds to monetary policy shocks, contracting (expanding) following a monetary policy tightening (easing). We then expect an amplification of the response in bond spreads after a monetary policy shock. To test this mechanism, we use a proxy for conventional monetary policy shocks (Jarociński and Karadi, 2020).

The ECB's data on asset holdings has been available since the last quarter of 2013. Consequently, the first monetary policy shock under consideration aligns with the January 2014 ECB governing council meeting. Figure H.1a illustrates the three ECB policy rates: The interest rate on deposits, the ECB Main Refinancing Operations Rate (MRO), and the Marginal Lending Facility Rate (MLR). The ECB's easing cycle commenced in 2011, in the midst of the sovereign debt crisis, and lasted through 2020 and large parts of 2021, marked by the pandemic crisis. Throughout this period, there is small variability in monetary policy shocks, particularly after 2016 (see Figure H.1b). A notable exception was the monetary policy shock in December 2015 when financial markets anticipated an expansion in the size and scope of the ECB asset purchase program and a signal indicating lower interest rates. However, the ECB adopted a somewhat more hawkish stance than market expected, leading to an upward shift in the OIS interest rate curve.

Figure H.1: ECB Policy Rates and Interest Rate Shocks

(a) ECB Interest Rates (b) Monetary Policy Shocks



Note: Panel (a) displays the ECB policy rates: the interest rate on the deposit facility (Deposit Rate), the ECB rate on the main refinancing operations (MRO) andthe rate on the Marginal Lending Facility (MLR). The two vertical lines correspond to the beginning of 2014 and the end of 2020. Panel (b) displays the interest rate shocks by Jarociński and Karadi (2020) using the 2-year OIS.

At the end of 2021, the ECB began signaling a shift to tighter monetary policy, first by scaling back its asset purchases and, from July 2022 on, by raising the deposit rate (with which it steers the monetary policy stance) from -0.5% to 4.0%. The surge in post-pandemic inflation prompted the ECB to raise its policy rates, moving from 0% to 4.5%. This period was marked by significant volatility in monetary policy shocks.

Before examining the role of intermediaries in the transmission of standard monetary policy shocks to corporate bonds, we first estimate the aggregate effects on the Markit iBoxx index. To do this, we conduct a regression analysis using the change in the Markit iBoxx corporate bond OAS index, regressing it on the monetary policy shock:

$$\Delta YS_t^n = \alpha^n + \beta^{MP,n} MP_t + \varepsilon_t^n. \tag{31}$$

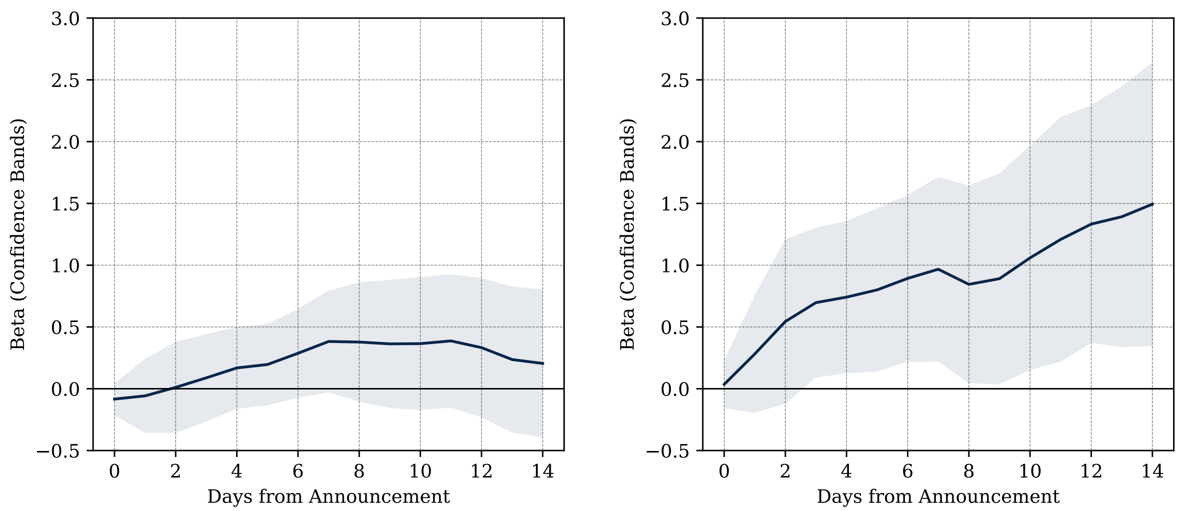
Here, ΔYS_t^d denotes the change in OAS from the day before the announcements to $n-$ days after the announcements, and MP_t represents the standard policy rate shock by Jarociński and Karadi (2020). We employ the 2-year OIS rate as a measure of interest rate, a standard tenor commonly used in the monetary policy literature (e.g., Hanson and Stein (2015)). We partition the sample into two distinct periods: 2014-2020 and 2020-2023. Figure H.2 illustrates the estimated $\beta^{MP,n}$ at various lags ($n = 0, \ldots, 15$). Consistent with established findings in the literature, a monetary policy tightening is associated with an increase in corporate bond spreads (e.g., Gertler and Karadi (2011); Gilchrist et al. (2015)). Furthermore, while the credit spread response is smaller upon impact, it tends to grow over the days following the announcement (Bauer et al., 2023), a phenomenon observed in other markets such as treasuries and referred to as the post-FOMC announcement drift (Brooks et al., 2018). After 14 days, a 1 basis point increase in the monetary policy rate leads to a 1.5 basis points increase in OAS.

We also observe that in the 2014-2020 sample, monetary policy shocks exert significantly lower effects on corporate bond spreads (Figure H.2a). During this period, short-term interest rates in the Euro area remained close to the effective lower bound. Consequently, monetary policy shocks were small in magnitude (i.e., the standard deviation of the shocks was small compared to the full sample), resulting in a muted bond response. This stands in contrast to the 2020-2023 sample (Figure H.2b), characterized by the recent ECB monetary policy tightening. In this period, we find that a 100 bps monetary policy shock (tightening) leads to a 100 bps increase in spreads 6 days from the announcement and a 150 bps increase 15 days from the announcement (note that lags are measured in business days from announcements). The standard deviation of monetary policy shocks in the 2020-2023 sample period is double the one of 2014-2020.

One potential explanation for the significant difference between the 2014-2020 sample and the 2020-2023 sample could be associated with the intermediaries' response to monetary policy shocks. A monetary policy shock of small magnitude may not elicit a substantial reaction in the capital intermediated by mutual funds, consequently resulting in a more subdued response in corporate bond spreads. By contrast, the decisive tightening cycle initiated by the ECB in 2021 could prompt a portfolio rebalancing of households and intermediaries, ultimately exerting a heightened influence on the corporate bond market. In summary, Figure H.2 demonstrates that the transmission of monetary policy to spreads is highly non-linear. This suggests that the magnitude of the shock plays a crucial role in determining the pass-through. Large monetary policy shocks, potentially stemming from decisive tightening measures, exhibit significantly different effects compared to the impact

Figure H.2: Corporate Bond Spread Response to Monetary Policy Shocks

(a) Spread Response (2014-2020) (b) Spread Response (2020-2023)



Note: The figure displays the estimated $\beta^{MP,d}$ coefficients from the regression:

$$\Delta YS_t^n = \alpha^n + \beta^{MP,n} MP_t + \varepsilon_t^n.$$

Here, ΔYS_t^n denotes the change in Markit-iBoxx corporate bonds OAS from the day before the announcements to $n-$days after the announcements, and MP_t represents the conventional interest rate shock by Jarociński and Karadi (2020). The shaded area corresponds to 90% confidence bands. Panel (a) reports the estimates for the sample 2014-2020, while panel (b) is estimated over the sample 2020-2023.

of a gradual monetary policy easing cycle, as observed in the 2014-2020 sample.

The model suggests that a larger mutual fund sector amplifies the sensitivity of corporate bond risk premia to monetary policy. Cross-sectionally, monetary policy impacts are expected to be more pronounced for bonds held by mutual funds. A monetary policy tightening leads to a contraction in the assets under management of mutual funds, compelling them to sell their bonds. Although mutual funds may attempt to sell these bonds to insurance companies or banks, equilibrium requires larger price adjustments in market segments with relatively lower shares of these investors.

Following a similar approach to our previous analysis, we assessed the potential role of mutual funds by running the following regression model:

$$\begin{aligned}\Delta ys_{i,t}^{n} &= \alpha + \beta_n^{MP} MP_t + \beta_n^{MF} \theta_{MF,i,t} \times MP_t + \text{Interacted Fixed Effects} \\ &\quad + \eta_n^{MF} \theta_{MF,i,t} + \varepsilon_{i,t}^{n}, \end{aligned} \tag{32}$$

where $\Delta ys_{i,t}^{n}$ is the n-day change in the OAS of bond i around announcement t, and $\theta^{MF,i,t}$ represents the shares of bond i held by mutual funds at time t.

We estimate Equation 32 across different lags and with various sets of interacted fixed effects. The coefficients of interest are β_n^{MF}, which capture the interaction of the monetary policy shocks with the shares of the bond held by mutual funds.

In order to show the dynamics of the coefficient, we plot them for different lags from the announcement and under different sets of fixed effects. The coefficients are illustrated in Figure H.3. Figure H.3a includes rating and duration fixed effects, Figure H.3b includes rating, duration, and bond size fixed effects, Figure H.3c includes rating, duration, and bond bid-ask fixed effects, while Figure H.3d includes duration, rating, and issuer fixed effects.

The coefficient $\beta^{MF,n}$ is indicative of the additional impact of monetary policy shocks on corporate bond spreads attributed to mutual fund holdings. The magnitude of this coefficient suggests that a bond with a 10% ownership by mutual funds experiences an additional 50 basis points effect on spreads in response to a 100 basis points shock induced by monetary policy. These effects are large in magnitude, as they represent 50% of the shocks. The effects remain robust even when issuer fixed effects are included (Figure H.3d). However, the magnitude is noticeably reduced in this highly saturated regression. In this highly restricted regression, our primary focus is to establish a direct link between mutual fund ownership and the effect—controlling for any differences in risk—rather than emphasizing the magnitude of the effect. Nevertheless, the results highlight the large degree of segmentation as well as the important role of mutual funds in shaping the response of bond spreads to conventional monetary policy.

A key dynamic is that bonds with higher mutual fund ownership display a more significant post-announcement drift. As demonstrated by Brooks et al. (2018), the post-announcement drift is relevant in the treasury market and is discussed in relation to mutual funds' investments. Our use of mutual funds' holdings data indicates that this pattern is indeed more pronounced for bonds held by mutual funds. In fact, the effects are essentially null on impact but become noticeable days after the announcement. Our findings directly show—using holdings data—that it is, in fact, mutual funds that generate this pattern.

Note how these results differ from the CSPP announcement. In that case, there was a large drop on impact and a subsequent increase in response after the announcement. The model illustrates that CSPP mainly affects the risk of the bond, prompting a rebalancing by mutual funds—even without fund flows. Fund flows only amplified the effects in the weeks following the announcement.

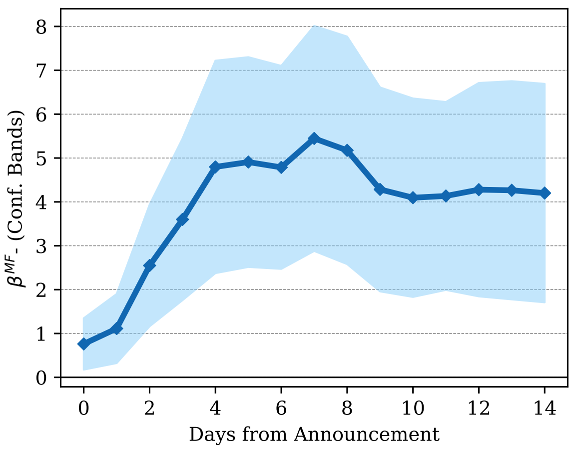
This contrasts with standard monetary policy. Here, the effects on impact appear to be null, indicating that mutual funds delay rebalancing until fund flows materialize. The model in Brooks et al. (2018) explains this second channel. Fang (2023) has also studied the effects of fund flows on the transmission of monetary policy. Their study focuses on lower frequencies, such as the quarters following the announcement. We complement the findings of Fang (2023) by studying the announcement effects, which are the main focus of our paper.

By looking at short windows around the announcement, we are, however, more subject to the issue of differential liquidity between bonds. Mutual funds typically hold bonds that are either more liquid or enhance the liquidity of the bonds endogenously. In this context, we would anticipate observing a greater impact on these bonds compared to others. However, our results indicate the opposite, as the effects manifest days after the announcement. This implies that portfolio rebalancing and fund flows, rather than liquidity, primarily drive the observed effects.

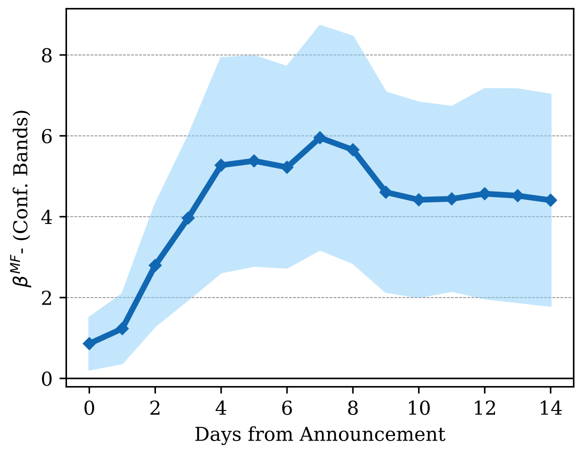
Finally, while standard monetary policy shocks are not the primary focus of this paper, these results illustrate the influence of investor heterogeneity in shaping the corporate bond market's response to monetary policy. These recent findings complement our main results, which analyze asset purchase announcements.

Figure H.3: Marginal Effects of Mutual Fund Shares

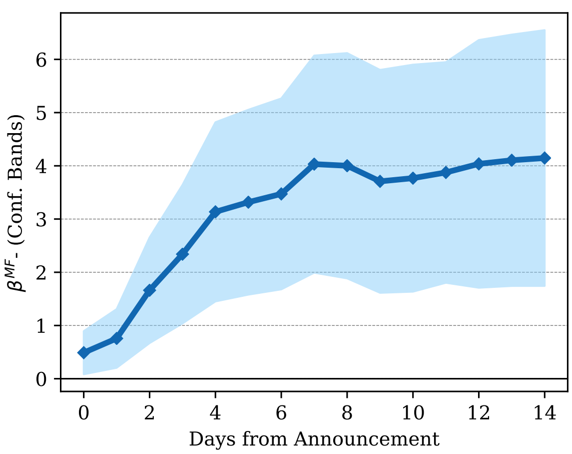
(a) Duration/Rating Fixed Effects



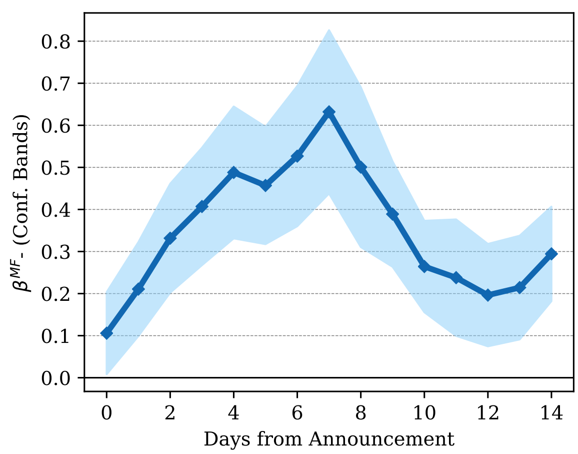
(b) Duration/Rating/Size Fixed Effects



(c) Duration/Rating/Bid-Ask Fixed Effects



(d) Duration/Rating/Issuer Fixed Effects



Note: The figure shows the estimated β^{MF} coefficient from Equation 32, together with the 90% confidence bands. Confidence bands are based on standard errors double clustered by time and the bond group defined by interacted fixed effects. The sample runs from 2014 to 2023.