Heterogeneous Intermediaries and Bond Characteristics in the Transmission of Monetary Policy *

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Abstract

This paper studies the transmission of monetary policy to the corporate bond market. We show that the yields of bonds held by mutual funds are more responsive to corporate bond purchases by the central bank. We attribute this phenomenon to (i) systematic variations in the bond selection of heterogeneous intermediaries and (ii) market segmentation. Our findings reveal that central bank corporate bond purchases primarily influence credit spreads. As the mutual fund sector holds securities carrying higher credit risk, it naturally experiences a more pronounced impact. Additionally, due to market segmentations, bonds with similar risk but higher mutual fund shares may exhibit different price responses. As insurance companies and banks refrain from investing in certain securities, mutual funds are forced to intermediate them. This leads to a higher compensation for risk and stronger sensitivity to policy changes. We also find that both selection and market segmentations are crucial in comprehending the stronger effects of conventional monetary policy on bonds held by mutual funds vis-á-vis bonds held by other investors.

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1. Introduction

A fundamental transmission mechanism of monetary policy lies in its impact on the cost of capital for firms. An influential body of literature has established that central banks can influence corporate bond yields through conventional or unconventional monetary policies. These effects have been empirically established by examining changes in asset prices around policy announcements, often referred to as a high-frequency approach.[1] Concurrently, the role of intermediaries and the heterogeneity of investors have become focal points in the extensive literature on asset pricing, with a specific emphasis on monetary policy (e.g., through different assets' demand (Koijen and Yogo (2019)) or preferred habitats (Vayanos and Vila (2021))).

Nonetheless, there is limited empirical evidence on the price response of assets held by different investors around policy announcements and, consequently, the connection between these two strands of literature. In this paper, we delve into the response of the cross-section of corporate bond yields held by various intermediaries following different policy announcements by the European Central Bank (ECB).

First, we demonstrate that corporate bonds with higher mutual fund shares exhibit an intensified reaction to ECB corporate bond purchase announcements. Subsequently, we delve into investigating the underlying nature of this relationship. We present a streamlined model to illustrate that this correlation can arise due to *selection* (i.e., how heterogeneous intermediaries choose different bonds) and market *segmentations*. Empirically, we provide evidence that both factors played a role.

The model predicts that, among the purchased bonds, riskier ones naturally exhibit more pronounced price reactions, regardless of the intermediaries investing in them. Simultaneously, we demonstrate that these riskier bonds are, in fact, more likely to be held by mutual funds (i.e., selection). At the same time, the model predicts that if market segmentations arise due to certain investors avoiding specific securities, bonds with similar riskiness but different ownership may display disparate responses. In line with this hypothesis, our findings indicate that bonds with comparable characteristics (i.e., riskiness) but higher mutual funds ownership exhibit more robust responses.

Our findings, for example, elucidate the reasons behind the comparatively stronger impact of corporate bond purchases on bonds situated just above the investment-grade cutoff.[2] The hesitation of insurance companies and banks to invest in these bonds, given the risk of a downgrade to high-yield, leads to mutual funds serving as the primary intermediaries. Consequently, mutual funds demand higher compensation to hold these securities, rendering the risk premium of these corporate bonds more responsive to corporate bond purchases.

[1] Gertler and Karadi (2015); Gilchrist et al. (2015); Smolyansky and Suarez (2021); Anderson and Cesa-Bianchi (2020) study the effect of conventional monetary policy on corporate bonds. The effects of quantitative easing are discussed, among others in Krishnamurthy and Vissing-Jorgensen (2011); Gagnon et al. (2011); Krishnamurthy et al. (2017); Altavilla et al. (2015)

[2] This observation aligns with findings in the US by Acharya et al. (2022).

In addition to examining the impact of corporate bond purchases, we investigate the response of corporate bond spreads to conventional monetary policy, specifically interest rate shocks. Our findings reveal significant effects on corporate bond spreads, with the effects intensifying in the days following the announcements. This pattern is consistent with observations in U.S. treasuries, often referred to as the post-announcement drift (Brooks et al. (2018)), and is believed to arise due to a shift in demand by mutual funds. Our model further suggests that the demand from mutual funds can exert more pronounced effects on credit spreads, particularly in segmented markets. In line with this hypothesis, we find that this pattern is more accentuated for bonds with higher mutual fund shares.[3]

To provide a theoretical foundation for our empirical analyses, we introduce a simplified economic model. This model includes two categories of investors: (i) a group referred to as "mutual funds" and (ii) a group labeled as "others," mainly consisting of non-mutual funds investors such as insurance companies and banks. These investors engage in a mean-variance portfolio optimization, strategically allocating their portfolios among risky assets and a risk-free bond. The model explores the implications of asset purchases, representing an exogenous shift in asset supply. An important takeaway from the model is that, without market segmentations, the impact of asset purchases on risk premia depends on the total assets intermediated by mutual funds and other investors, considering their risk aversion (or demand elasticity, which directly depends on the risk aversion parameters in our framework). The cross-sectional effects are solely dictated by the riskiness of the assets, with riskier bonds exhibiting a more pronounced response. This implies that all bonds with similar riskiness share the same ownership structures and are equally affected by central bank actions.

Subsequently, we introduce market segmentation by specifying that only a subset of the 'others' investors can participate in specific asset investments. Consequently, mutual funds are forced to mediate a more substantial supply of those assets, thus commanding higher risk premia. Simultaneously, the risk premia of those bonds exhibit greater sensitivity to central bank actions. The underlying rationale is based on the observation that central banks predominantly transact with mutual funds for certain bonds, as other investors refrain from absorbing or selling these assets. As a result, these bonds are expected to display higher sensitivity to central bank actions compared to bonds with similar riskiness or characteristics.

In our empirical analysis, we initially examine the impact of ECB corporate bond purchases, with a particular emphasis on the primary ECB announcement, the Corporate Sector Purchase Programme (CSPP), in March 2016. We measure the change in yields surrounding the ECB announcement for the subset of corporate bonds constituting the Markit iBoxx bond index. Utilizing proprietary data from the ECB, we link each bond to the intermediary sectors through which they are held, such as

[3] Our findings extend the work of Holm-Hadulla et al. (2023), highlighting the mutual fund sector's high sensitivity to monetary policy shocks. Our mechanism aligns with the one proposed by Brooks et al. (2018). Fang (2023) investigates the amplification effects of mutual fund flows at a lower frequency, providing evidence on both the price response and fund flows.

mutual funds, banks, insurance companies, and pension funds. This categorization reveals a robust correlation between the holdings intermediaries and their respective responses to the announcement. Specifically, the yields of bonds held by mutual funds experienced a more substantial decline compared to those held by insurance companies and pension funds (ICPFs) and banks.

Next, we explore the nature of the connection between bond holdings and price response, with a key aspect being bond selection. Initially, we show that mutual funds tend to hold larger shares of credit-riskier bonds, while insurance companies and pension funds preferentially hold larger shares of long-maturity, high-duration risk bonds. Furthermore, we provide evidence that the transmission of ECB corporate bond purchases primarily occurs through a reduction in corporate bond credit spreads (note that our credit spread measure encompasses both liquidity premium and credit risk premium) rather than term premium. Focusing on investment-grade bonds, which are the only eligible category for purchases, BBB bonds exhibit the most pronounced response to the policies. This fact was originally established by Todorov (2020), who conducted the first study on the cross-sectional response of corporate bond yields to the announcement. However, as more than 50% of bonds fall into the BBB category, we further delve into the cross-sectional dispersion within this rating bucket.

In the BBB category, the response varies significantly among bonds with different risk levels. Bonds rated BBB- by one of the three rating agencies considered (Fitch Ratings, Moody's, and Standard&Poor's) demonstrate an average response of 40bps, which is twice the 20bps response observed for BBB bonds. Notably, the difference between BBB- and BBB is three times greater than the spread in response between BBB and BBB+. This difference becomes even more pronounced when we rank the bonds based on their credit spread, revealing a significant reduction in spread for the riskier tranches of BBB bonds. Importantly, these riskier tranches of BBB bonds are precisely where we observe relatively higher holdings by mutual funds. This pattern aligns with the notion that insurance companies and banks avoid purchasing bonds that are more likely to become high-yield due to the higher regulatory costs associated with holding such bonds.

This pattern underscores the emergence of market segmentation within the corporate bond market. When certain insurance companies or banks choose not to invest in specific riskier bonds, mutual funds are compelled to intervene and hold them. Additionally, market segmentation in the Euro area can arise due to various other factors. Insurance companies and banks often exhibit a notable home bias in their investments, showing a preference for corporate bonds issued by companies in their own country. Consequently, bonds issued by countries with a smaller insurance industry are less likely to be held by insurers. Moreover, since insurance companies are more inclined to purchase bonds in the primary market, variations in the ownership structure can be observed even for bonds from the same issuer.

These considerations provide the rationale for our second empirical exercise. In this analysis, we conduct regressions of the change in bond yields around the CSPP announcements on the shares held by mutual funds, while simultaneously controlling for various bond characteristics. These include duration, rating, worst rating, callability, liquidity, issuer sector, and even the identity of the issuer. The primary aim of this exercise is to explore whether, for bonds with similar risk profiles, we observe a differential price response. This empirical investigation is aligned with the predictions of the theoretical framework. In the presence of market segmentations, bonds held by mutual funds are expected to exhibit a more pronounced response to asset purchases, considering risk, and extending beyond the pure selection effect.

The empirical exercise reveals that both *selection* and segmentations contribute to the observed dynamics. Bonds with higher mutual fund shares exhibit significantly greater responsiveness to the policies, even when controlling for bond characteristics. To illustrate the magnitude, a bond with a 50% higher share of mutual fund holdings unconditionally responds by an additional 28bps. This gap diminishes to 20bps once we incorporate controls for the country and ratings (both average and worst) and to 10bps when we control for the sector or industry. The persistent significance of the coefficient, even after accounting for bond characteristics, underscores the crucial role of market segmentation.

Our strategy involves examining the impacts of CSPP in the initial days following the announcement, with a primary emphasis on understanding the roles of selection and market segmentation. It's worth noting that CSPP may introduce additional effects, such as influencing 'servicing flows' of corporate bonds (Mota (2023)) and prompting specific investors to rebalance their portfolios toward eligible bonds instead of selling them, resulting in effects that extend beyond the initial price reactions. This complementary perspective is explored by Corell et al. (2023).

We extend our analysis to include the introduction of the Pandemic Emergency Purchase Program (PEPP). This initiative, announced in March 2020 outside the regular ECB governing council meeting schedule, was in response to the sudden surge in corporate (and sovereign) bond yields. Examining the change in bond yields during the week following the announcement, we observe a pattern similar to that seen with the CSPP. Notably, bonds held by mutual funds exhibit a more pronounced reduction in bond yields compared to other investors. It is crucial to emphasize that this observation aligns with earlier findings indicating that bonds held by mutual funds tend to experience larger losses during a recession (Coppola (2021)). This highlights the success of the ECB announcements in counteracting the fire sales of bonds by mutual funds and elucidates how these policies are transmitted to the corporate bond market.

Finally, we explore the impact of conventional monetary policy on corporate bond spreads, utilizing monetary policy shocks as outlined by Jarociński and Karadi (2020). The stylized model predicts that the bond response is stronger for bonds primarily held by mutual funds because of market segmentation. Additionally, it suggests that a larger aggregate mutual fund sector increases the sensitivity of risk premia to monetary policy. These predictions stem from the high sensitivity of the size of the mutual fund sector to monetary policy, a phenomenon established by Holm-Hadulla et al. (2023). Following a tightening in monetary policy, the overall demand from mutual funds contracts, leading to an increase in risk premiums. The rise in risk premiums stimulates increased demand from other investors, thereby mitigating the overall effects. However, this second-round effect becomes less relevant if markets are segmented. In market segments where insurance companies or banks abstain from investing, mutual funds encounter challenges in offloading the bonds they wish to sell. Consequently, risk premia must adjust more significantly to facilitate market clearing.

Empirically, we study the sensitivity of corporate bond spreads to ECB interest rate shocks. Our preliminary examination focuses on the Euro area corporate bond index, revealing that its sensitivity to monetary policy increases in the days following the announcement. This observed pattern aligns with findings in the US Treasury market, known as the post-announcement drift (Brooks et al. (2018)).[4] We then study the effects of interest rate shocks on the cross-section of bond yields and find that bonds with higher mutual funds ownership also exhibit stronger sensitivity. The magnitude of the coefficients suggests that a bond with a 50% ownership by mutual funds experiences an additional 50 basis points effect in response to a 100 basis points shock induced by monetary policy.

In conclusion, our findings underscore the importance of both selection and market segmentations in shaping the impact of monetary policy on corporate bonds. The transmission of central bank purchases, resulting in a reduction in the overall market risk premia, notably influences bonds with higher credit risk, commonly held by mutual funds. However, market segmentations emerge as a crucial factor in influencing policy transmission. If certain investors, such as insurance companies and banks, avoid certain securities, the expected returns on these bonds need to increase. Additionally, these bonds become more susceptible to the effects of central bank policies.

Likewise, market segmentations can impact the transmission of conventional monetary policy. Changes in interest rates can influence the size of the mutual fund sector, prompting adjustments to their portfolios in response to monetary policy shocks. When other investors refrain from participating in specific market segments, mutual funds are unable to modify their holdings. As a result, risk premia must adjust to facilitate market clearing.

1.1 Literature Review

We contribute to the vast literature on large-scale asset purchases and the role of intermediaries (among others, Krishnamurthy and Vissing-Jorgensen (2011), Gagnon et al. (2011) in the US and Altavilla et al. (2015); Krishnamurthy et al. (2017), in the Euro area). Our paper also focuses on the effects of ECB corporate bond purchases. We hence relate to a set of papers that investigate the impact of the announcement of ECB CSPP; Todorov (2020) is the first study on the cross-sectional effects on corporate bond yields. Other papers include: Abidi and Miquel-Flores (2018); De Santis et al. (2018); Grosse-Rueschkamp et al. (2019); Zaghini (2020); De Santis and Zaghini (2021). A set of different papers also studied the effects of Fed bond market stimulus (Haddad et al. (2021);

[4]Notably, Bauer et al. (2023) identifies a similar pattern in the US corporate bond market.

Darmouni and Siani (2022)). We contribute by examining the effects on assets held by different intermediaries and exploring the roles of selection and market segmentations. Corell et al. (2023), investigates the impact of ECB purchases on the service flows of corporate bonds. By focusing on a longer horizon, their paper also explores how various intermediaries rebalanced their portfolios by investing in eligible bonds instead of selling them.

The preferred habit model proposed by Vayanos and Vila (2021) explores the role of segmentation in the term structure of interest rates. Additionally, Costain et al. (2022) investigates the impact of sovereign default risk on the transmission of ECB government bond purchases. The study by Greenwood et al. (2018) delves into market segmentation effects across asset classes to understand the impact of QE on both corporate bonds and government bonds. Simultaneously, several studies analyze market segmentation *within* the corporate bond market, (Kisgen (2006); Kisgen and Strahan (2010); Chernenko and Sunderam (2012)) with specific attention to the role of insurance companies Ellul et al. (2011)). Our contribution connects the literature on market segmentations in the corporate bond market to the effects of QE announcements, an aspect that has not been explored.

A growing body of literature underscores the pivotal role of heterogeneous intermediaries in shaping asset pricing through variations in their demand (Koijen and Yogo (2019); Koijen et al. (2020, 2021)), with specific attention to corporate bonds (Bretscher et al. (2021)). Our study establishes a linkage between demand elasticities and the price reactions to monetary policy announcements, whether conventional or unconventional. Furthermore, we delve into the implications of these demand elasticities in conjunction with market segmentations within the corporate bond market.

Our result extends the work of Coppola (2021) to different types of shock, i.e., monetary policy shocks. Faia et al. (2022) also stresses how institutional investors' mandates determine bond demand, which, through granularity, affects bond prices.Siani (2021) estimates a model of differentiated investors in segmented primary bond markets.

In the context of our research, understanding how heterogeneity among investors influences the corporate bond market response to shifts in interest rates is particularly significant. Mutual funds, unlike other investors, are notably sensitive to monetary policy (Bretscher et al. (2021)). Holm-Hadulla et al. (2023) finds that the size of the mutual fund sector contracts when interest rates rise.

In fact, central banks can affect credit spreads also through conventional monetary policy (Gertler and Karadi (2015); Gilchrist et al. (2015); Smolyansky and Suarez (2021); Anderson and Cesa-Bianchi (2020); Bauer et al. (2023)). In our analysis, we investigate the impact of the interest rate shocks (Jarociński and Karadi (2020); Altavilla et al. (2019),on the cross-section of corporate bond yields and explicitly examine the role of various intermediaries. Furthermore, our findings shed light on the observed increase in the response of bond yields after the announcement, a phenomenon also noted in other markets such as treasuries and referred to as the post-FOMC announcement drift (Brooks et al. (2018)). While Bretscher et al. (2021) estimate the sensitivity of US mutual funds' demand to interest rates and Fang (2023) study the effects of US bond fund flows on corporate bond spreads at a quarterly frequency, our study focuses on the effects of corporate bond spreads around announcement days in the Euro area. Utilizing higher-frequency data enables us to comprehend the dynamic response of bond spreads around announcements and investigate the differential response of bonds in a segmented market. Zhang et al. (2023) studies the mutual funds flows around monetary policy announcements.

2. The Euro Area Corporate Bond Market

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.[5] 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.[6] Figure 1a shows the rising share of market financing for non-financial corporations. The figure also shows how bond financing is even more relevant during recessions (the shaded area in Figure 1a), when access to bank loans may be impaired.

The leading investors in corporate bonds issued by Euro area non-financial corporations are mutual funds, insurance companies and pension funds (ICPF), banks, and the ECB.[7] 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 1b splits the amount of long-term corporate bonds issued by Euro area non-financial corporations and held by Euro area investors.

2.1 Data

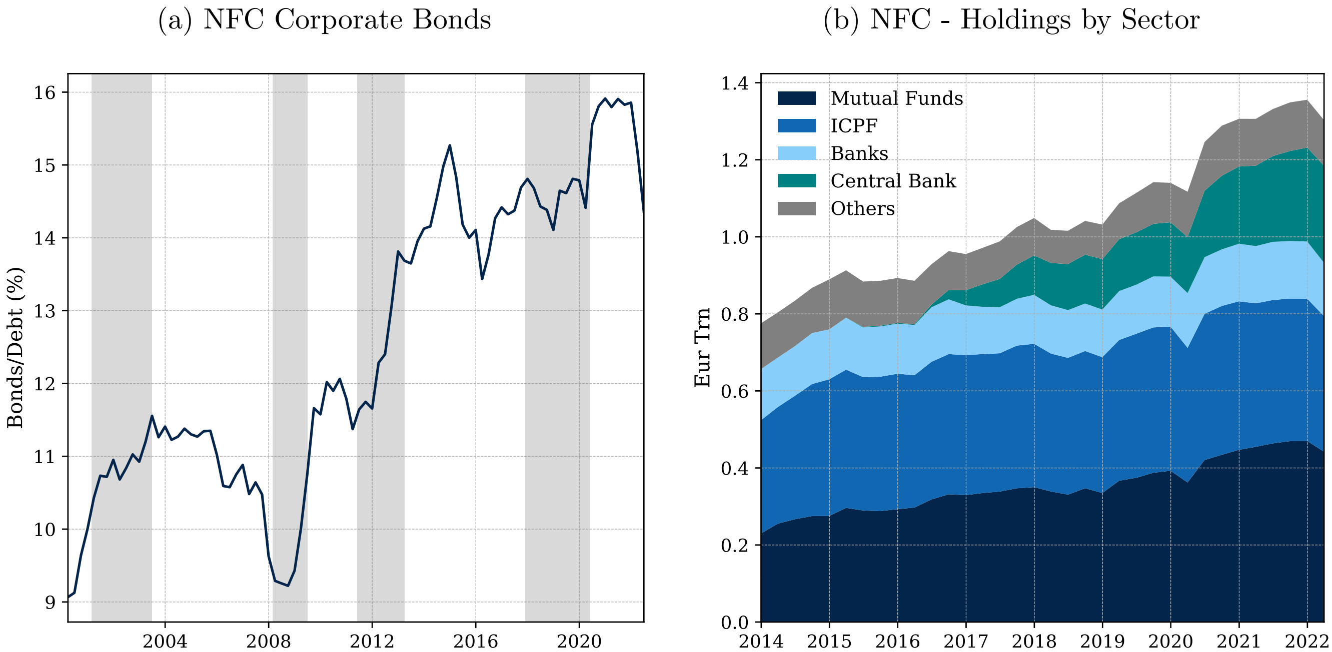
In order to study the effects of monetary policy shocks on corporate bonds and on the balance sheets of financial intermediaries, we combine a number of different data sets.

[5]See Darmouni and Papoutsi (2022) for a discussion on the rise of bond financing in Europe.

[6]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.

[7]Note that throughout the paper, we use the term ECB to represent the whole Eurosystem. Large parts of the central bank asset portfolio in the Euro area are held by the National Central Banks that form the Eurosystem along with the ECB.

Figure 1: Euro area non-financial corporate bonds



Note: Figure 1a shows the total amount of bonds issued by Euro area non-financial corporations as a share of total non-financial corporations' debt. Figure 1b 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.

2.1.1 Bond Holdings

We calculate the proportions of bonds held by various intermediaries using detailed data from the ECB Securities Holding Statistics (SHS). SHS provides a comprehensive overview of security-level 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. The sectors we focus on are monetary financial institutions (referred to as banks), insurance companies and pension funds (ICPF), and mutual funds.

2.1.2 Information on Financial Assets

We collect data 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 bonds' bid price, ask price, accrued interest, yield to maturity, oas spread, duration, and ratings. We compute a measure of illiquidity using the bid-ask spread. We use the ECB CSDB (Central Securities Database) to collect ratings by three agencies: Fitch Ratings, Moody's and Standard & Poor's (S&P).

We use data from the Euro Area Monetary Policy Event-Study Database (EA-MPD), developed by Altavilla et al. (2019), to measure the high-frequency intraday movement in OIS rates around ECB announcements. We use monetary policy shocks based on the methodology of Jarociński and Karadi (2020).

3. Heterogenous Investors and Monetary Policy: A Simple Model

We present a stylized model as the foundation for our empirical analysis. The initial step involves deriving equilibrium expected returns within a frictionless equilibrium framework. Subsequently, we introduce market segmentation by imposing constraints on the investment in certain securities by particular investors. Finally, we employ comparative statics to delineate the effects of ECB asset purchases and monetary policy. The model serves as a tool for comprehending the repercussions of segmentations on expected returns and our comparative statics.

Assets and Investors Consider a two-period economy with N assets, denoted as $i = 1, \ldots, N$, each having returns at time 1 represented by $R_i \sim N(\mu_i, \sigma_i^2)$, where μ_i is an equilibrium object and σ_i^2 is a parameter. The risk-free rate is denoted by R. We assume uncorrelated returns for the assets and unit supply. There are two investor types: $k = M$ for mutual funds and $k = O$ for other investors. For each investor type, there is a continuum of investors, with a total mass of one. Each investor has assets A^k under management. Note that all investors within a group are identical, and hence we only index investors by their type. The size of the assets under management is determined before the investors are able to trade, and it is determined by the following equation:

$$\log A^k = \log \bar{A}^k + \boldsymbol{\beta_k}'\boldsymbol{\nu} \tag{1}$$

In this context, $\boldsymbol{\nu}$ represents a vector encompassing macroeconomic shocks, such as those stemming from productivity or monetary policy. Simultaneously, $\boldsymbol{\beta_k}$ constitutes a vector of loadings. For simplicity, we narrow our focus to a monetary policy shock, condensing the vector of macroeconomic shocks to the scalar ν and the loadings to β_k. Additionally, we posit that investor types have different risk aversions denoted by γ_k.

In addition to the two types of investors there is a central bank with an exogenous allocation denoted as X_i^{CB}.

Investors' Demand Investors allocate their portfolio across risky assets and the risk free rate. $X_{i,k}$ is the portfolio share allocated to asset i. Investors solve a mean-variance portfolio problem:

$$\max_{\{X_{i,k}\}_{i=1}^{n}} \quad E\left[\sum_i X_{i,k}R_i + \left(1 - \sum_i X_{i,k}\right) R\right] - \frac{\gamma_k}{2} Var\left(\sum_i X_{i,k}R_i\right), \tag{2}$$

where γ_k is the investor-specific risk aversion. The equation characterizing the investor's portfolio allocation is given by the standard equation:

$$X_{i,k} = \frac{1}{\gamma_k}\frac{E\left[R_i - R\right]}{\sigma_i^2}. \tag{3}$$

In this context, we can also think of the coefficient $\gamma_k\sigma_i^2$ representing the elasticity of the investor's allocation to asset i based on its expected excess return. This is naturally related to the concept of investors' demand elasticity.

Frictionless Equilibrium Market clearing for each asset i is expressed as:

$$\int_0^1 A_M X_{i,M}\ dj + \int_0^1 A_O X_{i,O}\ dj + X_i^{CB} = 1.$$

Plugging the investors' demand (Equation 3), we can rewrite the market clearing as:

$$\int_0^1 A_M \frac{1}{\gamma_M}\frac{E\left[R_i - R\right]}{\sigma_i^2} dj + \int_0^1 A_O \frac{1}{\gamma_O}\frac{E\left[R_i - R\right]}{\sigma_i^2} dj + X_i^{CB} = 1.$$

We can use the property of having identical investors within each type and solve for the equilibrium excess returns. The equilibrium expected excess returns are governed by the following equation:

$$E\left[R_i - R\right] = \frac{1}{\frac{A_M}{\gamma_M} + \frac{A_O}{\gamma_O}}\sigma_i^2\left(1 - X_i^{CB}\right). \tag{4}$$

The excess returns depend on the risk aversion of the two types of investors scaled by the size of their assets.

Market Segmentation: We incorporate market segmentation by postulating that only a fraction of O investors, denoted as θ_i^O, is eligible to invest in asset i. This parameter, θ_i^O, is asset-specific and may vary based on factors such as the country of the issuer, the rating, or the sector. We represent this segmentation using an indicator function $\mathbb{1}_j^i$, which signals whether investor j of type O has the capability to invest in asset i. The market clearing condition with market segmentation is expressed as:

$$\int_0^1 A_M X_{i,M}\ dj + \int_0^1 \mathbb{1}_j^i A_O X_{i,O}\ dj + X_i^{CB} = 1.$$

It is crucial to emphasize that, without imposing leverage constraints, the portfolio allocation to other assets remains unaffected for investors unable to invest in asset i. Consequently, equation 3 remains valid for the allocation to asset i if the investor can invest in this asset. Otherwise, its portfolio share of asset i is 0. This leads to the following market clearing condition:

$$\int_0^1 A_M \frac{1}{\gamma_M} \frac{E\left[R_i - R\right]}{\sigma_i^2} dj + \int_0^1 \mathbb{1}_j^i A_O \frac{1}{\gamma_O} \frac{E\left[R_i - R\right]}{\sigma i^2} dj = 1 - X_i^{CB}, \tag{5}$$

where $\mathbb{1}_j$ is the indicator function signifying whether investor j can invest in asset i. In this scenario, the equilibrium expected excess returns are determined by:

$$E\left[R_i - R\right] = \frac{1}{\frac{A_M}{\gamma_M} + \frac{\theta_i^O A_O}{\gamma_O}} \sigma_i^2 \left(1 - X_i^{CB}\right). \tag{6}$$

It's important to highlight that the assets of other investors are now scaled down by the parameter θ_i^O, inducing a higher equilibrium risk premium for asset i all else being equal.

Asset Purchases: Central banks' asset purchases are quantified through the variable X^{CB}. An increase in X^{CB} reduces the supply investors need to hold in equilibrium. In the absence of market segmentation (i.e., $\theta_i^O = 1$), the impact of an increase in asset purchases on risk premiums is given by:

$$\frac{\partial E\left[R_i - R\right]}{\partial X_i^{CB}} = -\frac{\sigma_i^2}{\frac{A_M}{\gamma_M} + \frac{A_O}{\gamma_O}}. \tag{7}$$

These effects are contingent on the total assets intermediated by mutual funds and other investors, their risk aversion (or elasticity), and the riskiness of the assets. Furthermore, this model suggests that for two assets, i and j, with similar risk $\sigma_i^2 \sim \sigma_j^2$, the effects of asset purchases on risk premia are also similar.

Market segmentation significantly alters the effects of asset purchases on risk premia. The expressions are now modified to:

$$\frac{\partial E\left[R_i - R\right]}{\partial X_i^{CB}} = -\frac{\sigma_i^2}{\frac{A_M}{\gamma_M} + \frac{\theta_i^O A_O}{\gamma_O}}. \tag{8}$$

In this scenario, the parameter θ_i^O introduces a wedge. The model suggests that for two assets, i and j, with similar risk ($\sigma_i^2 \sim \sigma_j^2$), they may display significantly different responses in risk premia depending on θ_i^O compared to θ_j^O.

Monetary Policy In this simple framework, monetary policy can exert an influence on risk premiums by altering investor demand. Substituting A^M and A^O using Equation 1 allows us to derive the risk premium for asset i:

$$E\left[R_i - R\right] = \frac{1}{\frac{\bar{A}_M exp(\beta_M \nu)}{\gamma_M} + \frac{\theta_i^O \bar{A}_O exp(\beta_O \nu)}{\gamma_O}} \sigma_i^2 \left(1 - X_i^{CB}\right).$$

The impact of a monetary policy shock on risk premiums is expressed as follows:

$$\frac{\partial E\left[R_i - R\right]}{\partial \nu} = -\frac{\sigma_i^2\left(1 - X_i^{CB}\right)}{\left(\frac{A_M}{\gamma_M} + \frac{\theta_i^O A_O}{\gamma_O}\right)^2}\left(\frac{A_M \beta_M}{\gamma_M} + \frac{\theta_i A_O \beta_O}{\gamma_O}\right). \tag{9}$$

Segmentation influences the monetary policy effects on risk premiums by diminishing the effects through $\theta_i^O A_0 \beta_O$ and altering the denominator capturing elasticity. Consider a scenario where a positive monetary policy shock (tightening) diminishes the size of the mutual fund sector (i.e., $\beta_M < 0$), while the other sector remains unaffected (i.e., $\beta_O = 0$). In this case, the overall demand from mutual funds contracts, leading to an increase in risk premiums. The rise in risk premiums stimulates increased demand from other investors, thereby mitigating the overall effects. However, this second-round effect becomes less relevant if markets are segmented and θ_i^O is large.

3.1 Discussion

Central Bank Corporate Bond Purchases The framework presented in Section 3 indicates that, without market segmentation, the cross-sectional effects on risk premiums due to asset purchases depend on the overall market elasticity and the riskiness of the bonds. If we consider two bonds with similar riskiness of returns, denoted by σ_i, we can anticipate similar effects. However, the presence of market segmentation can introduce significant variations in the cross-section of corporate bonds.

The market segmentation parameter θ_i^O signifies that specific investors, such as insurance companies or banks, refrain from investing in certain bonds. The most extensively studied form of market segmentation centers on the differentiation between investment-grade and high-yield bonds. Market segmentation may also extend to other factors, such as the country of the issuer firms. Insurance companies and banks demonstrate a notable degree of home bias, predominantly investing in bonds issued by firms from their own country.

The role of market segmentation for the corporate bond market has been demonstrated for the different pricing of similar bonds. This difference emerges from Equation 6, which shows how market segmentation can drive a wedge in asset pricing between similar bonds. Market segmentations, however, also affect, transmission of asset purchases and monetary policy to the cross-section of corporate bonds.

Equation 8 emphasizes that when the central bank acquires bonds in a market with high segmentation, the impact on risk premiums is more pronounced, even after conditioning for the same level of risk. As certain investors refrain from buying certain bonds, the remaining investors (such as mutual funds) demand a higher risk premium to hold these bonds. The central bank's purchases, by diminishing the net supply of these assets, wield a substantial influence on their risk premia. At the same time, if the ECB sells those assets, these bonds may experience a significant increase in their spreads. Mutual funds, tasked with absorbing the sales from the ECB, will charge higher risk premia to do so.

The mechanism is intricately connected to the asset pricing literature on demand (Koijen and Yogo (2019); Koijen et al. (2021); Bretscher et al. (2021)), emphasizing the distinction between aggregate effects and cross-sectional effects. Notably, insurance companies demonstrate lower elasticities compared to mutual funds. This implies that in a market without segmentation, the overall impact of asset purchases on risk premia is greater when the share of assets held by insurance companies is higher relative to that of mutual funds. However, in the cross-section, a higher share held by mutual funds may indicate a greater degree of market segmentation and, consequently, a heightened sensitivity to asset purchases.

Monetary Policy Following a tightening in monetary policy, the overall demand from mutual funds contracts, leading to an increase in risk premiums. The rise in risk premiums stimulates increased demand from other investors, thereby mitigating the overall effects. However, this second-round effect becomes less relevant if markets are segmented. In market segments where insurance companies or banks abstain from investing, mutual funds encounter challenges in offloading the bonds they wish to sell. Consequently, risk premia must adjust more significantly to facilitate market clearing. The prediction are that bonds with higher mutual funds ownership are more sensitive to conventional monetary policy shocks.

4. Corporate Sector Purchase Programme (CSPP)

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. The CSPP is a non-standard monetary policy measure that involves the purchase of corporate bonds by the ECB. Under the CSPP, the ECB buys investment-grade bonds issued by non-bank corporations within the eurozone. The CSPP operates alongside other measures within the Asset Purchase Programme (APP).

The ECB considers investment-grade bonds with the first-best rating and a minimum credit assessment of BBB-/Baa3. There is no prescribed minimum issuance volume for corporate bonds to be eligible for purchase under the CSPP. Eligibility extends to debt instruments issued by issuers incorporated in the euro area, meaning they must be residents of the euro area. Notably, the location of incorporation of the issuer's ultimate parent is not a factor in this eligibility criterion. Consequently, corporate debt instruments issued by entities incorporated in the euro area remain eligible for purchase, even if their ultimate parent is located outside the euro area, as long as they meet all other eligibility criteria.

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.

The distribution of CSPP holdings by country of risk closely aligns with that of 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.

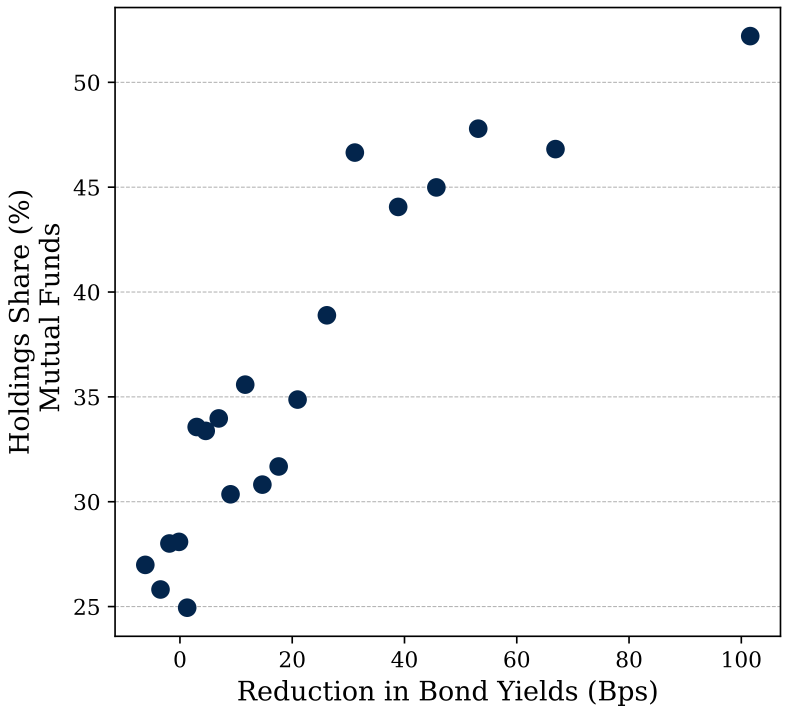
Bond Yield Response and Mutual Funds Holdings We quantify the response to the ECB policy announcement of all the bonds comprising the Markit iBoxx Euro-denominated corporate bond indexes and subsequently match the bonds to the intermediaries holding them. This sorting reveals a discernible pattern: bonds held by mutual funds displayed a more pronounced reduction in bond yields compared to other intermediaries. Figure 2 illustrates the correlation between the shares of bonds held by mutual funds and the reduction in bond yields following the announcements. To mitigate noise, we rank bonds into percentiles based on their response and group them into 20 bins.

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, with some showing a decline of up to 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.

To comprehend the factors influencing the correlation between the response in bond yields and the shares held by mutual funds, we initiate our analysis by (i) examining the aggregate impact of the CSPP announcement. Subsequently, we delve into (ii) a discussion on the allocation strategies of mutual funds and other investors, emphasizing the significance of the selection mechanism. Finally, (iii) we explore the role of market segmentation in shaping the observed patterns. This three-pronged approach aims to provide a comprehensive understanding of the driving forces behind the observed correlation.

Equation 3 indicates that this phenomenon can naturally result from a higher risk aversion parameter γ_k. Simultaneously, Equation 7 asserts that bonds with higher credit risk are inherently more responsive to central bank purchases simply because σ_i is higher. The two equations suggest that, even in the absence of market segmentations, we would observe a positive correlation between mutual funds shares and bond responsiveness to CSPP, as visually displayed in Figure 2. This correlation arises because the CSPP predominantly impacted credit risk premiums (as shown in Figure 3b), and mutual funds *select* bonds with higher credit risk.

Figure 2: Mutual Funds Holdings and Bond Yield Response to CSPP



Note: The figure depicts the correlation between the shares of bonds held by mutual funds and the reduction in bond yields following the announcements. To enhance clarity and reduce noise, we rank bonds into percentiles based on their response and organize them into 20 bins. On the x-axis, the figure portrays the reduction in bond yields (in basis points) during the week following the announcement, while the y-axis represents the holdings of mutual funds as a share of Euro area investors.

Aggregate Response We examine the overall reaction of corporate bond yields to the ECB announcement by utilizing 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:

$$\underbrace{Y_t}_{\substack{\text{Market Corporate}\\ \text{Yield}}} = \sum_i w_{i,t} \times y_{i,t} = \underbrace{\sum_i w_{i,t} \times \iota_{i,t}}_{\substack{\text{Interest Rate}\\ \text{Component}}} + \underbrace{\sum_i w_{i,t} \times ys_{i,t}}_{\substack{\text{Credit Spread}\\ \text{Component}}}. \tag{10}$$

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.

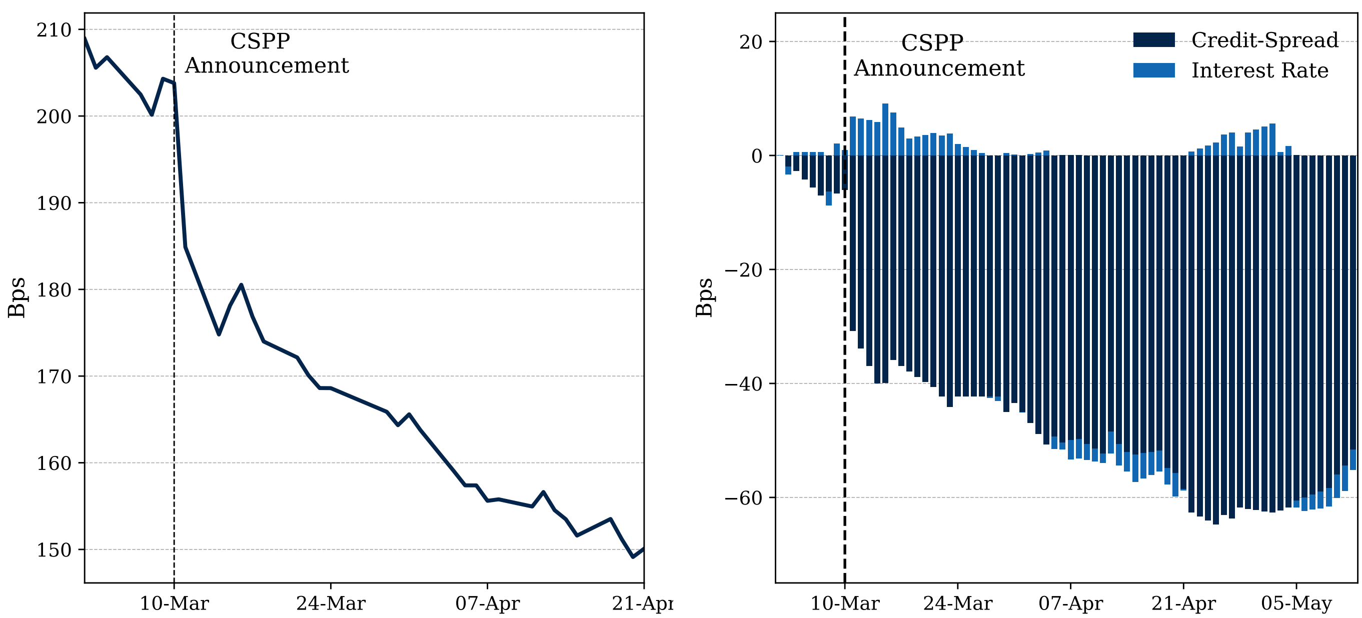
Figure 3a illustrates the progression of the aggregate index, showcasing the impact of the CSPP announcement in effectively reducing corporate bond yields. A significant drop in bond yields occurred on the day of the announcement, followed by a more gradual decrease in the subsequent weeks. Notably, the decline was predominantly driven by a reduction in the spread component, as evidenced by Figure 3b. 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)).

Figure 3: CSPP Announcement

(a) CSPP Announcement

(b) Decomposition: CSPP Announcement



Note: The figure shows the evolution of the value-weighted Euro area non-financial corporations bond yields. Panel (a) shows the evolution around the Corporate Sector Purchase Programme (CSPP) announcement on March 10, 2016. Panel (b) shows the decomposition of bond yields around ECB CSPP announcement. We decompose the market corporate bond yield into an interest rate component and a credit spread component. The figure plots the individual contribution of the two components to the observed variation the overall corporate bond market yields. Source: Markit iBoxx.

4.1 Allocations of Intermediaries in the Corporate Bond Market

In Figure 3, we illustrate how the CSPP led to lower bond yields primarily by reducing credit spreads. It is crucial, therefore, to delve into a discussion on the allocation strategies of mutual funds compared to other investors. In this section, we utilize the universe of corporate bonds based on holdings data from the ECB SHSS and bond prices from the ECB CSDB database. Figure 4a displays the distribution of bonds held by mutual funds and other investors (including insurance companies, pension funds, and banks). The bonds are further categorized into investment-grade and high-yield, with the holdings expressed as shares of the total held by Euro area investors. In terms of the amount outstanding, high-yield bonds constitute 22% of the total.

This segmentation provides a detailed analysis of the allocation patterns among different investor types across the risk spectrum. Notably, mutual funds hold lower shares of investment-grade corporate bonds, ranging between 30% and 40%, while they have a 60% stake in high-yield bonds. The observed distribution of allocation is likely influenced by regulatory costs imposed on insurance companies and banks. The substantial capital requirements associated with holding high-yield bonds make it a costly endeavor. Consequently, a significant portion of insurance companies or banks may choose to avoid holding any of these bonds, resulting in a lower aggregate amount of holdings in this category. The regulatory framework plays a pivotal role in shaping the investment decisions of these institutions, ultimately impacting the overall composition of their portfolios.

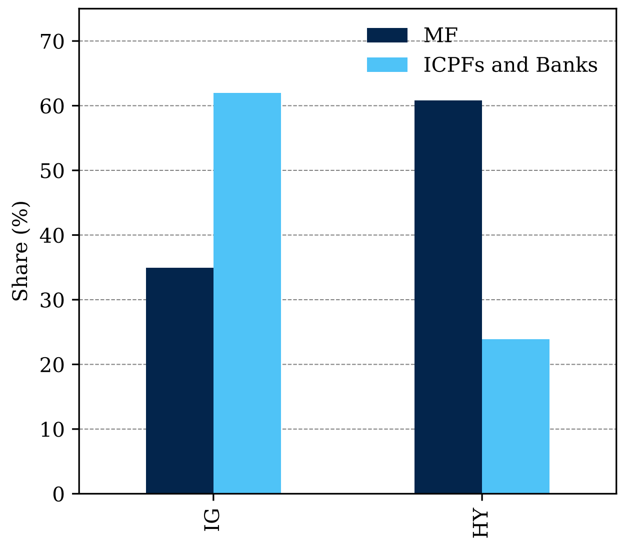
Moving forward, we delve into the distribution of bonds within the investment-grade group, further stratified by their worst rating among the three rating agencies. Figure 4b illustrates the holdings by mutual funds, revealing lower shares of AA and A-rated bonds, approximately 30%. There is a noticeable increase in their share when it comes to BBB-rated bonds. Additionally, significant dispersion is observed within the BBB-rated bonds, with the share of BBB+ or BBB around 40%, while the share of BBB- exceeds 50%. This underscores a substantial degree of heterogeneity within the BBB-rated bonds. In 2015, BBB-rated bonds collectively constituted 53% of investment-grade bonds, and over subsequent years, this proportion continued to rise, reaching 63% by 2022. Within this rating category, there is also considerable dispersion in credit spreads. Consequently, the majority of the variation in the response to CSPP occurs within this specific category.

The notable divergence in the allocation between BBB/BBB+ and BBB- bonds can be ascribed to the investment strategies employed by insurance companies and banks. The fundamental rationale behind this approach is that, in the event of a downgrade, holding BBB- bonds becomes significantly more costly due to increased regulatory expenses associated with high-yield bonds. Consequently, a segment of insurance companies and banks refrains from allocating any capital to BBB- or, equivalently, to the riskier tranches of investment-grade bonds.

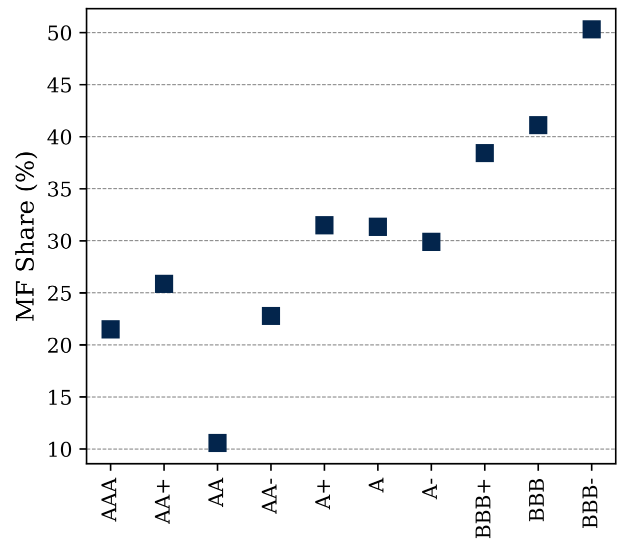
We further classify investment-grade bonds based on their spreads relative to OIS rates, organizing them into ten groups ranging from safer to riskier (refer to Figure 5a). The figure illustrates

Figure 4: Allocation by Ratings

(a) Investment Grade and High-Yield Holdings



(b) Mutual Funds Allocation by Rating



Note: In Panel (a), the figure illustrates the distribution of bonds held by mutual funds and other investors (total held by insurance companies, pension funds, and banks). Bonds are categorized into investment-grade and high-yield, with holdings computed as a percentage of the total held by Euro area investors. In Panel (b), the figure depicts the distribution of bonds within the investment-grade group, further split by their worst rating among the three rating agencies. The data are as of 2015-Q4, representing the last quarter before the CSPP announcement.

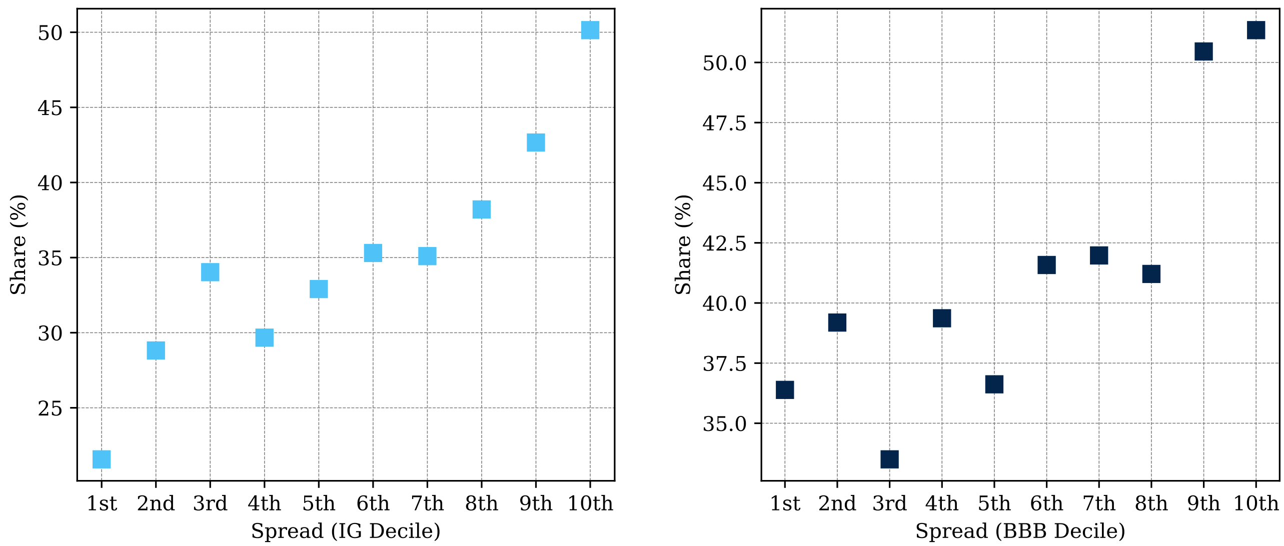
an increasing allocation by mutual funds toward bonds with higher credit spreads. Particularly noteworthy is the surge in the holdings of riskier investment-grade bonds. This trend is even more pronounced for BBB-rated bonds, where mutual funds maintain significantly higher shares of the riskier bonds. Figure 5b demonstrates a discernible increase in the shares held as we transition to the two riskier deciles of BBB bonds. Mutual funds shares range from 35% to 42.5% of the bonds in deciles one to eight. We observe a notable increase in the holdings to above 50% in the riskier 9th and 10th deciles. This pattern diverges from the findings of Becker and Ivashina (2015) but underscores that insurance companies and banks predominantly invest in safer bonds, steering clear of exposure to the riskier tranches of BBB bonds.

4.2 The Cross-Section of Response

We now delve into the cross-sectional effects of corporate bonds following the CSPP announcement. As highlighted by Todorov (2020), BBB-rated bonds witnessed a more significant reduction in bond yields due to the policy. However, our observations reveal a substantial dispersion within the various rating categories. In Figure 6, we visually present the reduction in spreads of corporate bonds across

Figure 5: Allocation by Spreads (2015)

(a) Mutual Funds Share by Spread Decile (IG) (b) Mutual Funds Share by Spread Decile (BBB)



Note: The figure plots the average shares of insurance corporations with respect to the total held by insurance companies and mutual funds in 2015-Q4. The spread deciles in panel (a) are based on the full sample of Investment Grade (IG) corporate bonds issued by nonfinancial corporations. The spread deciles in panel (b) are based on the full sample of BBB corporate bonds issued by Nonfinancial corporations.

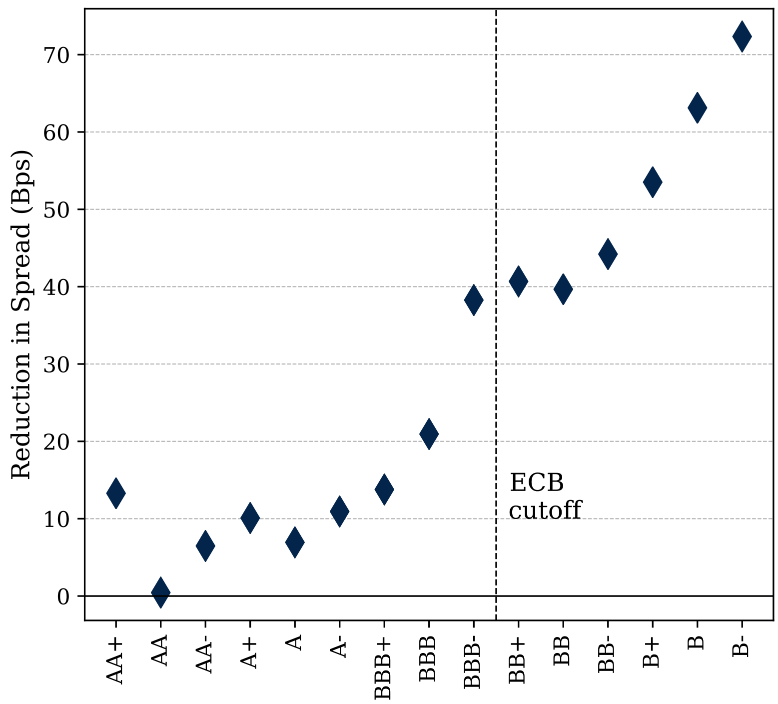
different ratings. We calculate the spread change in the week following the announcement for the subset of bonds constituting the Markit iBoxx corporate bond index.

Bond spreads decreased across all corporate bonds, with the impact being more pronounced for lower-rated bonds. Additionally, it is evident that the spread of BBB- bonds experienced a more substantial decline compared to BBB bonds. The bond yields of BBB- saw a reduction of 40 basis points, double the magnitude of BBB. Notably, the difference between BBB- and BBB is three times greater than the spread in response between BBB and BBB+.

Remarkably, the significant increase in the bond response precisely aligns with the rating bucket (BBB-), where we observe a substantial surge in the allocation of mutual funds. Bonds rated BBB- are, in fact, notably different from BBB bonds, as they pose a high risk of migration into high-yield. Due to this risk, a considerable number of insurance companies and banks refrain from investing in these bonds, resulting in market segmentation.

The model detailed in Section 3 predicts that these bonds present a higher equilibrium risk premium compared to bonds of similar risk but different ratings and higher sensitivity to ECB corporate bond purchases. As insurance companies and banks refrain from absorbing the supply of high-yield bonds or those close to high-yield status (BBB-), mutual funds are compelled to hold a relatively larger amount, demanding a higher risk premium to do so. The ECB's purchase of these

Figure 6: Change in Spread Around CSPP Announcement



Note: The figure plots the reduction in bond yields in the week of the announcement of the CSPP policy on March 10, 2016. We compute the change in spread for the subset of bonds constituting Markit iBoxx. Bonds are organized according to the worst rating among the three rating agencies.

bonds leads to a sharp reduction in risk premiums. In terms of elasticity, the rationale is that, while mutual funds have higher elasticity compared to insurance companies or banks, they need to absorb or sell all the variation in the net supply of these assets, resulting in higher sensitivity to ECB actions.

While we clearly observe market segmentation for BBB- bonds and a more pronounced response for these bonds, segmentation within the corporate bond market can stem from various factors. Notably, insurance companies and banks tend to exhibit a significant degree of home bias. Consequently, bonds issued by firms based in countries with a smaller insurance sector may be less likely to be held by insurance companies. Additionally, insurance companies typically engage in primary market purchases and adopt a buy-and-hold investment strategy. This approach means that, even for companies issuing different bonds at different times, insurance companies may hold a significantly higher share of one bond compared to others.

At the same time, Equation 8 demonstrates that market segmentation may also be a significant factor shaping the cross-sectional response. The heightened response of BBB- bonds may therefore indicate that market segmentation is influencing the bond response. We will now proceed to test the relevance of market segmentation in the response of bond yields to the CSPP announcement.

4.3 Market Segmentation and the CSPP Announcement

To examine the relevance of market segmentation, we conduct a regression analysis, regressing the change in bond yields around the CSPP announcements on mutual funds holdings and a set of fixed effects, following the approach proposed by Coppola (2021). For our analysis, we utilize the OAS yield spread and narrow down the sample to Euro-denominated bonds. Additionally, we focus on bonds rated as investment-grade and issued by nonfinancial corporations.

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 exogenous characteristics of the bonds, namely the duration group (0y-1y, 1y-3y, 3y-5y, 5y-8y, 8y+), issuer country, average rating, worst rating, issuer sector, issuer company, and callability of the bonds. Additionally, we control for bond liquidity using the bid-ask spread before the announcement. Controlling for bid-ask spread helps address concerns about the differential effects due to bond liquidity. However, it's important to note that liquidity is endogenous and depends on the intermediaries holding the bonds. This implies that we are controlling for a factor that, in turn, depends on the shares of mutual funds, potentially influencing the results.

Hypothesis Our regression framework is guided by Equation 8. By controlling for characteristics such as rating, sector, issuer country, etc., we aim to account for the riskiness of the bond (σ_i) in the model. If market segmentations are relevant, Equation 8 suggests that bonds with similar risk profiles will respond differently to the announcement. Specifically, bonds with higher mutual funds holdings would exhibit greater responsiveness, resulting in a more pronounced reduction in bond yields.

Regression Model We run the following cross-sectional regression:

$$\Delta ys_i^n = \beta_n^{MF}\theta_i^{MF} + \text{Interacted Fixed Effects} + \eta_n^{MF}\theta_i^{MF} + \varepsilon_i^n, \tag{11}$$

where Δys_i^n is the n-days change in OAS spread of bond i around the announcement of CSPP, $\theta_{MF,i}$ 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.

Results The results are presented in Table I. The tables showcase the coefficient β^{MF} for various specifications of controls, each interacted with others. In Panel (a), the coefficients represent the effects of a 5-days 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 spread of 28 bps (half the coefficient reported in the table). However, as expected, when controlling for the rating, this number drops to 20 bps. Furthermore, when accounting for the sector, the coefficient decreases to 10 bps.[8]

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 12. Additionally, we explore a 10-days lag, and the coefficients remain remarkably stable. This consistency at the 5 and 10-days and 20-days lag indicates that the effects are not solely attributable to noise in the first few days following the announcement. While the coefficient estimates are somewhat less precise, resulting in slightly larger standard errors, the overall pattern remains robust.

Additionally, we examine the bond basis, represented by the disparity between the bond yields (OAS spread) and the corresponding CDS of the bond. Our findings indicate that the bond basis of bonds held by mutual funds experiences a more significant decline compared to those held by other intermediaries. Further details and results can be found in Appendix B.

The findings underscore the significance of both *selection* and market segmentations in influencing the response of bond yields to CSPP. The results suggest that in segmented markets, where banks or insurance companies are less inclined to invest in specific bonds, the equilibrium risk premia and sensitivity to corporate bond purchases are more pronounced for those particular bonds.

5. 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 inadequate to address the magnitude of the shocks.

Following the scheduled governing council meeting on March 12, 2020, 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 7a denote the dates of these pivotal events. The figure visually depicts the surge in yields observed in March

[8] It is worth noting that we adhere to the definition of sector or industry provided by Markit iBoxx. The industries include, but are not limited to: Industrials, Chemicals, Utilities, Telecommunications, Consumers, Food & beverage, Industrial goods & services, Automobiles & parts, Retail, Construction & materials, Media, Personal & household goods, TMT, Basic resources, Technology, Travel & leisure, Health care, Energy, Oil & gas, Real estate, Consumer services, Basic materials, Consumer goods, Renewable energy.

Table I: Mutual Funds Holdings and CSPP Announcement

	Panel (A): 5-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-55.690***	-46.192***	-50.943***	-40.276***	-49.979***	-31.120***	-20.202**	-11.586**
	(6.16)	(6.95)	(10.69)	(9.17)	(14.11)	(8.75)	(9.79)	(4.48)
Observations	472	466	452	429	399	328	343	435
Adj. R-squared	0.146	0.170	0.231	0.304	0.344	0.570	0.520	0.864
	Panel (B): 10-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-55.511***	-45.265***	-46.297***	-37.732***	-47.013***	-30.854***	-16.748*	-10.929
	(7.16)	(8.40)	(9.75)	(8.66)	(13.66)	(8.67)	(9.92)	(6.60)
Observations	472	466	452	429	399	328	343	435
Adj. R-squared	0.112	0.143	0.261	0.348	0.426	0.585	0.586	0.772
	Panel (C): 20-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-56.007***	-39.698***	-41.945***	-33.066***	-38.163***	-29.255***	-14.352	-14.364*
	(7.32)	(8.05)	(8.70)	(9.31)	(12.12)	(7.18)	(10.25)	(8.54)
Observations	467	461	449	426	397	324	338	432
Adj. R-squared	0.110	0.186	0.317	0.377	0.427	0.611	0.537	0.629
Duration	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Rating	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Country	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Rating Worst	No	No	No	Yes	Yes	Yes	Yes	Yes
Callable	No	No	No	No	Yes	No	No	No
Liquidity	No	No	No	No	No	Yes	No	No
Sector	No	No	No	No	No	No	Yes	No
Issuer	No	No	No	No	No	No	No	Yes

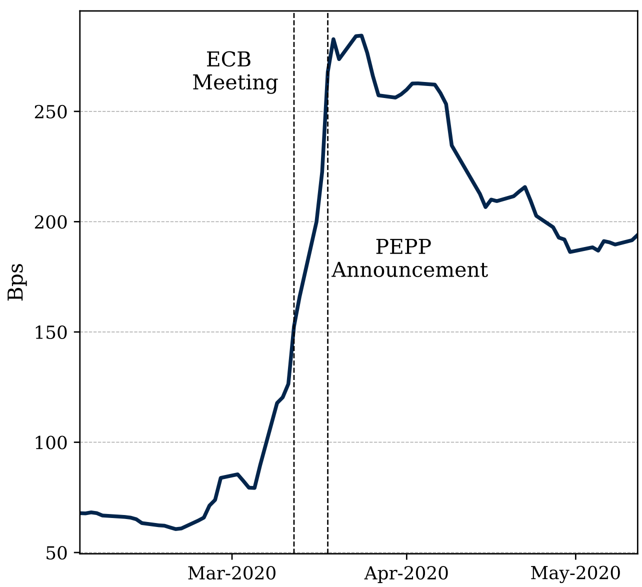
Note: The table shows the estimated coefficients and standard errors from Equation 11. Standard errors are double clustered by time and bond groups.

2020, notably intensified by the ECB meeting. However, with the introduction of the PEPP, the sharp increase in bond yields was curtailed, leading to a sudden reversal and a subsequent reduction in funding costs. In summary, Figure 7a underscores the potent impact of ECB corporate purchases on corporate bond yields.

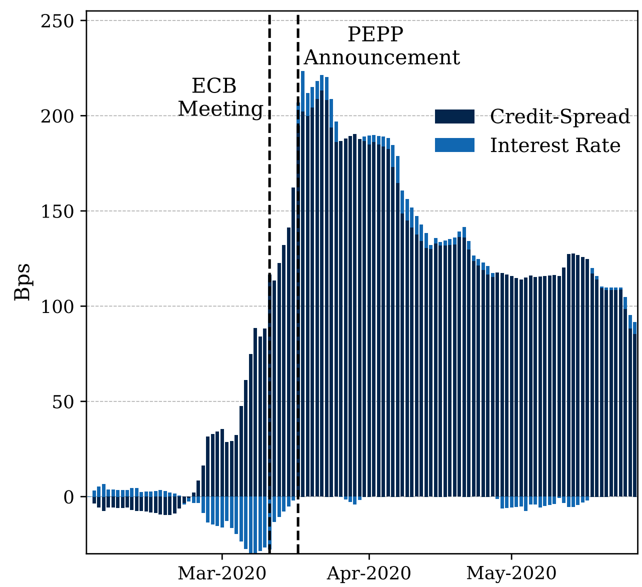
Figure 7b also shows that the relative contribution of the credit risk component dwarfed the interest rate component at the launch of the PEPP programme. As expected, the rise in bond yields at the onset of the Covid crisis was entirely driven by a surge in credit spread. The timely interventions of the ECB halted the spike in credit spread and led to a gradual reduction in yields.

Figure 7: PEPP Announcement

(a) PEPP Announcement



(b) Decomposition: PEPP Announcement



Note: Figure 7a shows the evolution around the Pandemic Emergency Purchase Programme (PEPP) announcement on March 20, 2020. Panel (b) shows the decomposition of bond yields around ECB PEPP announcement. We decompose the market corporate bond yield into an interest rate component and a credit spread component. The figure plots the individual contribution of the two components to the observed variation the overall corporate bond market yields. Source: Markit iBoxx.

We explore the effects of the PEPP announcement on bond yields by employing the regression from Equation 11. In this case, we utilize the change in OAS spread in the week following the PEPP announcement. It is noteworthy that the announcement occurred on March 18, and we assess the response from the Monday following the announcement (March 23) for 5 business days (one week), 10 business days (two weeks), and 20 business days (approximately one month). The findings reveal a more pronounced reduction in bond spreads for bonds with higher mutual fund shares. This holds true even for bonds from the same issuer. However, it is important to note that the coefficient, once we control for liquidity, loses statistical significance. This result is not surprising.

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.

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

Table II: Mutual Funds Holdings and PEPP Announcement

				Panel (A): 5-days lag				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-22.004***	-28.294**	-34.446**	-37.099**	-47.842***	-15.507	-31.392**	-8.757***
	(6.95)	(10.84)	(15.73)	(14.44)	(17.15)	(12.38)	(14.70)	(2.61)
Observations	1134	1134	1123	1094	1046	963	945	779
Adj. R-squared	0.008	0.011	0.023	0.050	0.182	0.411	0.356	0.955
				Panel (B): 10-days lag				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-27.833**	-39.012**	-50.154**	-51.844**	-70.218***	-31.061	-49.148**	-8.268**
	(11.27)	(15.66)	(22.61)	(22.85)	(23.83)	(18.83)	(22.14)	(3.95)
Observations	1134	1134	1123	1094	1046	963	945	779
Adj. R-squared	0.004	-0.001	0.050	0.104	0.228	0.388	0.462	0.958
				Panel (C): 20-days lag				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
θ_i^{MF}	-61.092***	-69.902***	-81.507***	-66.401***	-86.780***	-42.919**	-75.854***	-12.950***
	(12.75)	(18.35)	(22.43)	(21.98)	(22.99)	(16.60)	(20.58)	(4.82)
Observations	1134	1134	1123	1094	1046	963	945	779
Adj. R-squared	0.019	0.013	0.113	0.197	0.288	0.450	0.524	0.950
Duration	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Country	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Rating Worst	No	No	No	Yes	Yes	Yes	Yes	Yes
Callable	No	No	No	No	Yes	No	No	No
Liquidity	No	No	No	No	No	Yes	No	No
Sector	No	No	No	No	No	No	Yes	No
Issuer	No	No	No	No	No	No	No	Yes

Note: The table shows the estimated coefficients and standard errors from Equation 11. Standard errors are double clustered by time and bond groups.

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.

6. Interest Rate Shocks

Central banks also play a role in influencing corporate bond spreads by steering interest rates. In this paper, we utilize a proxy for conventional monetary policy in the form of monetary policy shocks developed by 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 8a 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, coinciding with the onset of the sovereign debt crisis, and extended until 2020, marked by the pandemic crisis. Throughout this period, there is minimal variability in monetary policy shocks, particularly after 2016. 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 expectations, leading to an upward shift in the OIS interest rate curve.

At the conclusion of 2021, the ECB initiated a tightening of its monetary policy. The surge in post-pandemic inflation compelled the ECB to increase its policy rates, transitioning from 0% to 4.5%. This period was characterized by a notable incidence of monetary policy shocks, as illustrated in Figure 8b. Throughout 2022, the shocks were predominantly positive, but significant negative shocks were also observed, particularly in 2023.

Before delving into the examination of intermediaries' roles in the transmission of monetary policy to corporate bonds, we first estimate the aggregate effects on the Markit iBoxx index. To achieve this, we employ a regression analysis using the change in the Markit iBoxx corporate bond OAS index and regress it on the monetary policy shock. The employed regression model is expressed as follows:

$$\Delta YS_t^n = \alpha^n + \beta^{MP,n} MP_t + \varepsilon_t^n. \tag{12}$$

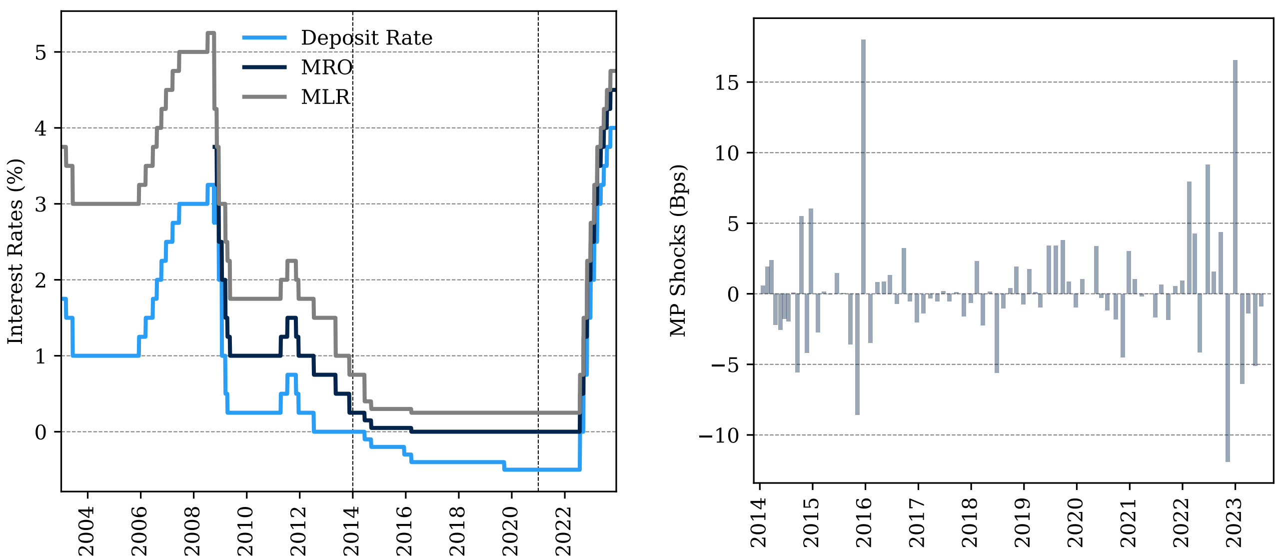
Here, ΔYS_t^d denotes the change in OAS spreads from the day before the announcements to $n-$days after the announcements, and MP_t represents the conventional interest rate shock by Jarociński and Karadi (2020). We employ the 2-year OIS rate as a measure of interest rate, a standard tenor commonly used in the monetary policy literature (e.g., Hanson and Stein (2015)). We partition the sample into two distinct periods: 2014-2020 and 2020-2023.[9] Figure 9 illustrates the estimated $\beta^{MP,n}$ at various lags ($n = 0, \ldots, 30$). 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,

[9] The 2014-2020 period corresponds to the sample utilized in the previously circulated draft.

Figure 8: ECB Policy Rates and Interest Rate Shocks

(a) ECB Interest Rates

(b) Monetary Policy Shocks



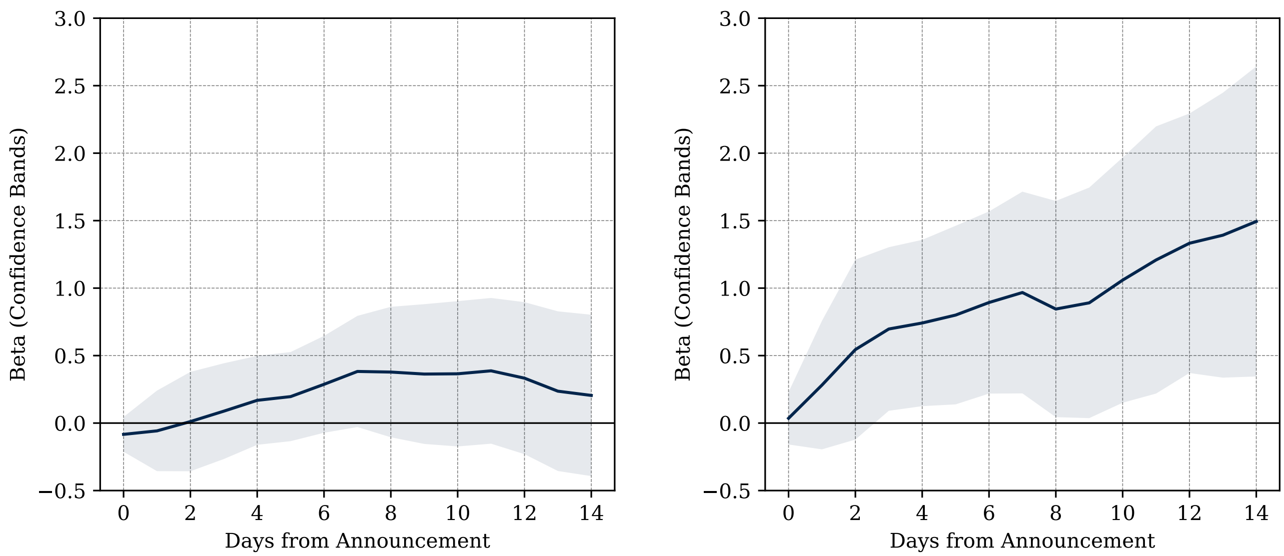
Note: Panel (a) displays the ECB policy rates: the interest rate on deposit, the ECB Main Refinancing Operations Rate (MRO) and Marginal Lending Facility Rate (MLR). The two vertical lines correspond to the beginning of 2014 and the end of 2020. Panel (b) displays the interest rate shocks by Jarociński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

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)).

We observe that in the 2014-2020 sample, monetary policy shocks exert significantly lower effects on corporate bond spreads (Figure 9a). During this period, short-term interest rates in the Euro area remained close to the zero 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 9b), characterized by the recent ECB monetary policy tightening. In this period, we find that a 100bps monetary policy shock leads to a 100bps reduction in spreads 6 days from the announcement and a 150bps reduction 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 intermediary's 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

Figure 9: Corporate Bond Spread Response to Monetary Policy Shocks



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 spreads 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.

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 9 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 abrupt and decisive tightening measures, exhibit significantly different effects compared to the impact of a gradual monetary policy easing cycle, as observed in the 2014-2020 sample.

6.1 Mutual Funds Holdings and Interest Rate Shocks

Hypothesis The model posits that a larger mutual fund sector would amplify the sensitivity of corporate bonds' risk premia to monetary policy. Cross-sectionally, the impact of monetary policy is expected to be more pronounced for bonds held by mutual funds. A monetary policy tightening triggers a reduction in the assets under the management of mutual funds. Consequently, mutual funds are compelled to sell their bonds. While they might attempt to sell these bonds to insurance companies or banks, the equilibrium necessitates greater price adjustments in market segments with relatively lower shares of these investors, given similar risk conditions.

Regression Model To test the predictions of our stylized model and investigate the involvement of mutual funds in the transmission of conventional monetary policy to spreads, we concentrate on a specific set of bonds included in the Euro-denominated Markit iBoxx indexes. This subset is chosen based on criteria related to investability and liquidity, ensuring their eligibility for inclusion in the index. Our analysis encompasses bonds issued by both nonfinancial corporations and financial corporations. We evaluated the potential role of mutual funds by running the following regression model:

$$\begin{aligned}\Delta ys^n_{i,t} = \alpha + \beta^{MP}_n MP_t + \beta^{MF}_n \theta_{MF,i,t} \times MP_t + \text{Interacted Fixed Effects} \\ + \eta^{MF}_n \theta_{MF,i,t} + \varepsilon^n_{i,t},\end{aligned} \tag{13}$$

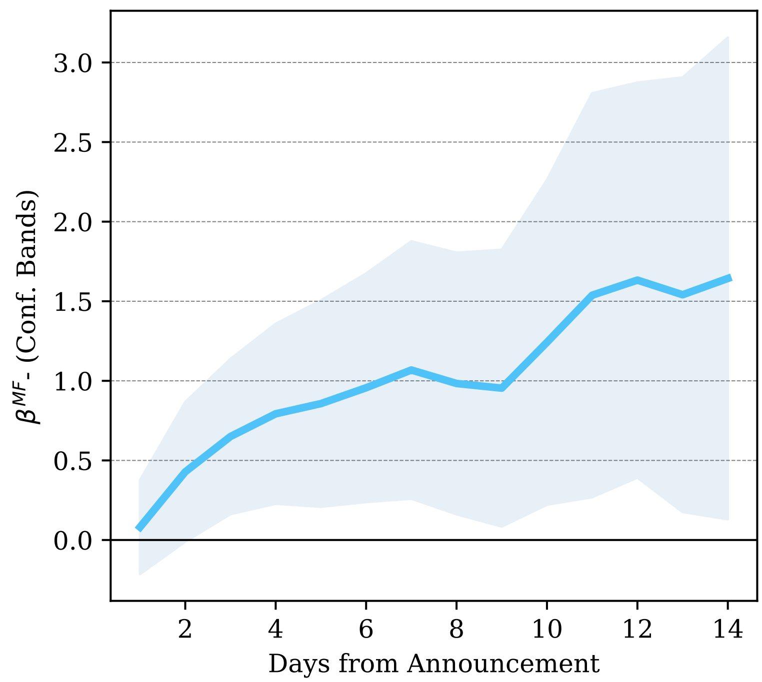
where $\Delta ys^n_{i,t}$ is the n-day change in the OAS spread of bond i around announcement t, and $\theta^{MF,i,t}$ represents the shares of bond i held by mutual funds at time t. Different sets of fixed effects are interacted with, with a designated set of fixed effects considered as a group.

The model incorporates various fixed effects, each interacting with a time-fixed effect. These include the duration of the bond, average ratings from Standards&Poor's, Fitch, and Moody's, the worst rating among the three agencies, the country of the issuer, a dummy variable for bond callable status, the bid-ask spread prior to the announcement, the sector or industry of the bond, and the identity of the issuer. The rationale behind including a variety of fixed effects is to investigate the effects on bonds with similar risk profiles. This approach allows for a focused examination of the impact within comparable risk categories.

Results We estimate Equation 13 across different lags and with various sets of interacted fixed effects (or groups). The coefficients, as illustrated in Figure 10, are visually presented with fixed effects for the country, rating, the worst rating, and the duration. 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 50% ownership by mutual funds experiences an additional 50 basis points shock in response to a 100 basis points shock induced by monetary policy.

Another intriguing dynamic is that bonds with higher mutual fund ownership display a more noticeable post-announcement drift. As demonstrated by Brooks et al. (2018), the post-announcement drift is relevant in the treasury market, and it is discussed in relation to mutual funds' investment. Our use of mutual funds' holdings indicates that this pattern is indeed more pronounced for bonds held by mutual funds.

Figure 10: Marginal Effects of Mutual Fund Shares



Note: The figure shows the estimated β^{MF} coefficient from Equation 13, 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.

Ultimately, Figure 10 suggests that ownership does not appear to be relevant immediately on impact or in the first few days after the announcement. This phenomenon is likely attributed to the fact that not all mutual funds react on announcement days, and the variation in bonds' demand by mutual funds influences bonds with lags.

Tables III present a concise overview of the outcomes for distinct sets of fixed effects when evaluating the effects at 5 days, 10 days and 20 days subsequent to the announcements. The coefficient is approximately 0.8 with a 5-day lag and 1 at a 10-day lag for the fixed effects set depicted in Figure 10. The inclusion of the callability dummy and liquidity (bid-ask) minimally influences the coefficient but enhances precision by reducing standard errors. Noteworthy is the observation that, even for bonds issued by the same company, the coefficient remains statistically significant at the 10-day lag. However, when we go beyond day 15, while the coefficient is still large (and even larger), the precision of the estimates deteriorates. The coefficients are not statistically significant beyond 20 business days.

Table III: Mutual Funds Holdings and Interest Rate Shocks

	Panel (A): 5-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5	Δys^5
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
MP x θ_i^{MF}	1.065*	0.912*	0.911*	0.841**	0.854**	0.670**	0.459**	0.386
	(0.55)	(0.49)	(0.52)	(0.42)	(0.39)	(0.30)	(0.22)	(0.28)
Levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116083	116002	115006	111454	98150	99294	96776	74087
Adj. R-squared	0.124	0.129	0.133	0.166	0.563	0.121	0.431	0.362
	Panel (B): 10-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}	Δys^{10}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
MP x θ_i^{MF}	1.600*	1.381*	1.319*	1.185*	1.240**	0.962**	0.558*	0.226**
	(0.90)	(0.78)	(0.79)	(0.63)	(0.62)	(0.40)	(0.31)	(0.09)
Levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112429	112342	111391	107970	94764	96139	93685	71661
Adj. R-squared	0.338	0.362	0.403	0.473	0.478	0.622	0.764	0.931
	Panel (C): 20-days lag							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}	Δys^{20}
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
MP x θ_i^{MF}	3.632	2.924	2.003	1.637	1.940	1.344	1.592	1.792
	(2.45)	(1.89)	(1.39)	(1.17)	(1.27)	(0.84)	(1.29)	(1.74)
Levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	114566	114506	113630	110156	97775	98149	95660	73217
Adj. R-squared	0.059	0.053	0.138	0.204	0.600	0.596	0.863	0.858
Duration	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Country	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Rating Worst	No	No	No	Yes	Yes	Yes	Yes	Yes
Callable	No	No	No	No	Yes	No	No	No
Liquidity	No	No	No	No	No	Yes	No	No
Sector	No	No	No	No	No	No	Yes	No
Issuer	No	No	No	No	No	No	No	Yes

Note: The table shows the estimated coefficients and standard errors from Equation 13. The sample runs from 2014 to 2023. Standard errors are double clustered by time and groups (the set of interacted fixed-effects).

7. Conclusion

In summary, our study delves into the nuanced dynamics of the corporate bond market in response to monetary policy, shedding light on the roles of selection and market segmentation. The empirical evidence presented highlights the intricate relationship between central bank actions and the behavior of various investor categories, particularly mutual funds, insurance companies, and banks.

Our findings reveal that corporate bonds with higher mutual fund shares exhibit a more pronounced response to ECB corporate bond purchase announcements. This heightened sensitivity is attributed to both selection effects, where mutual funds tend to hold riskier bonds, and market segmentations, where certain investors avoid specific securities, leaving mutual funds as primary intermediaries.

The theoretical framework introduced in our study provides a conceptual basis for understanding these empirical observations. The model underscores the importance of market segmentations in shaping the impact of asset purchases on risk premia, with mutual funds playing a pivotal role in mediating the supply of certain bonds.

We study the initial announcement of corporate bond sector purchases (CSPP) and extend our analysis to the Pandemic Emergency Purchase Program (PEPP), demonstrating a similar pattern of mutual fund-dominated responses to bond yield reductions.

In exploring the effects of conventional monetary policy, our study indicates that corporate bond spreads exhibit increased sensitivity to interest rate shocks, with bonds held by mutual funds displaying stronger reactions. This observation aligns with the notion that the size of the mutual fund sector influences the overall sensitivity of risk premia to monetary policy, particularly in the presence of market segmentations.

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A. CSPP Policy

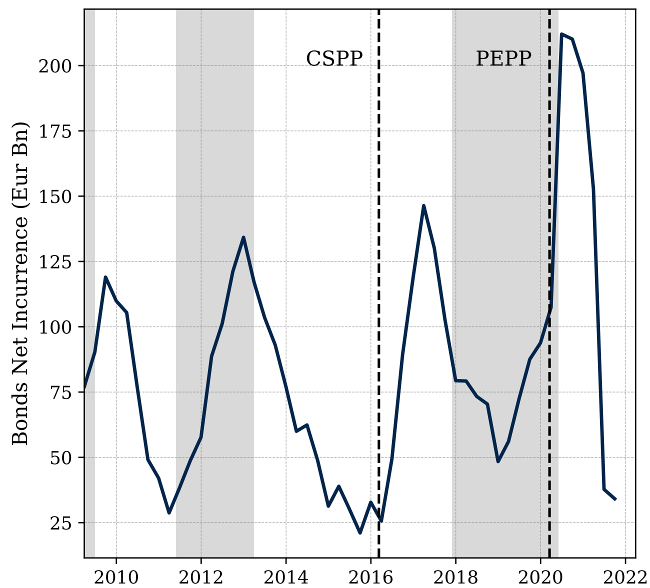
The Corporate Sector Purchase Programme (CSPP) was announced on March 10, 2016. Net purchases of corporate sector bonds under the CSPP were conducted by the Eurosystem between June 8, 2016, and December 19, 2018, with an average monthly net purchase amount of 5.7 billion euros. From January to October 2019, the Eurosystem focused on reinvesting the principal payments from maturing securities held in the CSPP portfolio. Purchases of securities under the CSPP resumed on November 1, 2019, and continued until the end of June 2022, with an average monthly net purchase amount of 5.2 billion euros. Starting July 2022, the Eurosystem shifted its approach to only reinvesting the principal payments from maturing securities.

The implementation of the private sector asset purchase programmes has adhered to the market neutrality principle. This principle guides the ECB in purchasing securities in proportion to their relative market capitalization.

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.

The impact of the policy was not limited to corporate bond prices but also extended to bond issuances. Figure 11 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 11: Corporate Bond Volumes, CSPP and PSPP



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

B. CSPP. Additional Results

We also look at the effects on the bond basis, the difference between the bond yields and the bond CDS. Table IV shows the results. We find a negative and statistically significant effect at the short-term horizon. The coefficient is still negative when we look at 10 days horizon but the standard errors are larger. Note that we have a limited number of bonds that both have a corresponding CDS and are part of the Markit iBoxx index.

Table IV: CSPP and Mutual Funds. Bonds Basis

	(1) Δys^2 b/se	(2) Δys^5 b/se	(3) Δys^{10} b/se
Tot MF	-59.882**	-23.280*	-11.209
	(23.75)	(11.79)	(15.35)
Observations	48	48	48
Adj. R-squared	0.339	-0.072	0.294
Duration	Yes	Yes	Yes
Rating	Yes	Yes	Yes

C. Interest Rate Shocks. Additional Results

Section 6 delves into the effects of mutual fund holdings on the transmission of monetary policy to corporate bonds. In this section, we present additional results. Table V displays the estimated coefficients from Equation 13 using a 2-day lag. The table indicates that none of the coefficients are statistically significant. This suggests that the effects on spreads on announcement days are not driven by the intermediaries that hold the bond.

Table V: Mutual Funds Holdings and Interest Rate Shocks Lag=2

	(1) Δys^2 b/se	(2) Δys^2 b/se	(3) Δys^2 b/se	(4) Δys^2 b/se	(5) Δys^2 b/se	(6) Δys^2 b/se	(7) Δys^2 b/se	(8) Δys^2 b/se
MP x Tot MF	0.432	0.433	0.452	0.418	0.425	0.366	0.058	-0.001
	(0.33)	(0.32)	(0.34)	(0.30)	(0.26)	(0.25)	(0.12)	(0.07)
Levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	114941	114860	113875	110353	97091	98333	95837	73385
Adj. R-squared	0.457	0.499	0.531	0.594	0.660	0.693	0.786	0.923
Duration	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Country	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Rating Worst	No	No	No	Yes	Yes	Yes	Yes	Yes
Callable	No	No	No	No	Yes	No	No	No
Liquidity	No	No	No	No	No	Yes	No	No
Sector	No	No	No	No	No	No	Yes	No
Issuer	No	No	No	No	No	No	No	Yes

Note: The table shows the estimated coefficients and standard errors from Equation 13. The sample runs from 2014 to 2023. Standard errors are double clustered by time and groups (the set of interacted fixed-effects). We use a two days lags.