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ETFs, Creation and Redemption Processes, and Bond Liquidity

John D. Finnerty
Fordham University Gabelli School of Business
finnerty@fordham.edu (corresponding author)

Natalia Reisel
Fordham University Gabelli School of Business
nreisel@fordham.edu

Xun Zhong
Fordham University Gabelli School of Business
xzhong21@fordham.edu

Abstract

We examine a link between bond exchange-traded fund (ETF) creation and redemption processes and the underlying bond market liquidity. Using daily creation and redemption data, we find that including a bond in a creation or redemption basket has a favorable impact on the bond's liquidity for both high-yield and investment-grade markets. The improvement in liquidity persists during times of market stress with this impact being stronger for redemptions than creations. Our results suggest that ETF mispricing arbitrage explains the improvement in bond liquidity. However, we also find evidence that transaction costs and bond inventory management limit the ETF arbitrage.

I. Introduction

There is concern among bond market participants and regulators that the growing popularity of fixed income exchange-traded funds (ETFs) adversely affects the liquidity of the bond market.[1] Concerned parties suggest that the liquidity mismatch between fixed income ETFs and the underlying corporate bonds encourages trading activity to move from the illiquid bond market to highly liquid bond ETFs, thus causing the underlying bond markets to become even more illiquid. Dannhauser (2017) provides some support for this view. A counterargument to this centers on the unique ETF creation and redemption processes whereby ETF authorized participants (APs) can exchange a basket of bonds for newly created ETF shares (creation) or can exchange outstanding ETF shares for a basket of the underlying bonds (redemption). These processes allow arbitrageurs to trade simultaneously in both markets to maintain the intuitive relationship between the

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[1]In 2017, the SEC formed the Fixed Income Market Structure Advisory Committee (FIMSAC), which, among other mandates, is studying the impact of fixed income ETF growth on corporate bond liquidity and pricing.

ETF price and the ETF's net asset value (NAV), thus providing a new rationale for trading illiquid bonds.

In this paper, we study the impact that ETF creation and redemption processes have on the liquidity of corporate bonds and investigate the drivers of the creation and redemption activities on both stress and nonstress days. We find significant improvements in bond market liquidity resulting from the creation and redemption processes, which are driven by APs taking advantage of mispricing arbitrage opportunities even on stress days. We also find, however, that creation and redemption activities cannot be fully explained by the arbitrage.

This paper uses a unique combination of ETF holdings from BlackRock and ETF Global data sets that facilitate a granular analysis at the bond level over a relatively long period, from 2009 until 2022. The analysis incorporates information provided by both reported creation and redemption baskets and realized baskets to generate a comprehensive set of results. The reported ETF baskets are obtained from BlackRock, and the analysis based on reported baskets is performed on BlackRock's bond ETFs.[2] We separately analyze investment-grade and high-yield bonds to investigate potential differential effects between these two major bond market sectors.

ETF portfolio managers use the creation and redemption processes to manage portfolio tracking error. As part of these processes, a subset of bonds that the ETF is willing to accept to create an ETF share (creation basket) and a subset of bonds that the ETF will deliver for redemptions (redemption basket) are reported to APs after the close of trading on day $t-1$ for ETF redemptions and creations on day t. This suggests that the reported baskets provide a demand signal for individual bonds that are available prior to the start of trading. Bonds in the creation basket are demanded by the ETF and are more likely to be bought in the bond market, whereas bonds in the redemption basket have negative demand by the ETF and are more likely to be sold in the bond market. Consistent with this intuition, using daily data on ETF bond holdings, we show that the quantity of bonds in the ETF significantly increased for bonds included in the creation basket and significantly decreased for bonds included in the redemption basket by the end of trading day t. Hence, the reported creation and redemption baskets provide a credible demand signal for individual bonds.

APs may negotiate with ETF portfolio managers to use variations of the reported baskets when exchanging ETF shares for bonds or exchanging bonds for ETF shares. We rely on the approach developed by Shim and Todorov (2023) to proxy the composition of the realized creation and redemption baskets.[3] Regular daily data on the composition of creation and redemption baskets enable us to investigate the differential impact of creations and redemptions on underlying bond liquidity and, in particular, to conduct a focused study of the economic drivers of creation and redemption activity.

The paper is organized into two main parts. We begin by first investigating the impact of redemption and creation processes on underlying bond liquidity.

[2]DTCC has data on reported baskets for all ETFs, but these data are not publicly available.

[3]Different APs may negotiate different baskets. Our estimated realized baskets capture combined activity by all APs holding a particular bond.

These processes facilitate new demand for illiquid bonds, and thus may result in increased liquidity of the underlying bonds. Using two different measures of daily bond liquidity, the bid–ask spread and trading volume, we indeed find increased liquidity following the inclusion of ETF bonds in the creation or redemption baskets. Results are robust for both reported and realized baskets. To mitigate the concern that ETF managers select the most liquid bonds for the baskets, we i) explore within-bond variation in the basket membership and ii) employ an instrumental variable estimation that exploits monthly rebalancing in the benchmark indexes that the ETFs track. We find improvements in liquidity in the markets for both high-yield and investment-grade bonds.

The positive impact of the creation and redemption processes on bond liquidity persists during times of stress in bond markets, although the magnitude of the impact varies across baskets and bond market sectors. While inclusion in the creation baskets generally has a weaker or similar impact on bond liquidity on stress days than on nonstress days, we find some evidence that inclusion in the redemption baskets further increases bond liquidity on stress days.

The second part of this paper investigates the drivers of ETF creation and redemption activities to provide further insights into mechanisms that may affect underlying markets. A primary motive for engaging in such activity is to capture arbitrage profits from the over- or underpricing of the ETF shares relative to the NAV of the underlying bond portfolio. As an additional and sometimes conflicting motive, Pan and Zeng (2019) propose that APs utilize the creation and redemption processes to manage their corporate bond inventories. For example, an AP stuck holding large quantities of illiquid bonds when the bond market becomes stressed may use the creation process, even if it conflicts with mispricing arbitrage, as a means of decreasing its illiquid bond inventory and freeing up capacity to hold other assets on its balance sheet. In this scenario, ETF redemptions should slow down during times of bond market stress.

For all creation baskets, our empirical results provide evidence consistent with the mispricing arbitrage motive. The intensity of creation activity increases as the ETF price rises above the NAV. After controlling for mispricing, creation activity tends to increase on stress days, suggesting that factors beyond mispricing might drive such activity. Further, sensitivity to mispricing decreases somewhat during times of stress consistent with the inventory management motive. It is in times of stress that APs seek to replace illiquid bonds on their balance sheet with liquid ETF shares, resulting in lower sensitivity to ETF mispricing. Nevertheless, certain APs still continue to take advantage of the mispricing on stress days. Discussions with ETF market participants suggest that other APs, which are not bond dealers, may step in to take advantage of the mispricing arbitrage opportunities. Last, we find that creation activity decreases when bond liquidity is low since the increased transaction costs render the arbitrage opportunity less profitable or even unprofitable.

ETF mispricing is also an important factor in explaining redemption activity. The intensity of redemption activity increases as the ETF price drops below the NAV, and APs continue to take advantage of relative mispricing even on stress days. Overall, we find evidence that APs continue to take advantage of relative mispricing on stress days for both creations and redemptions. The literature has expressed concerns that introducing an ETF might lead to market instability (Bhattacharya

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and O'Hara (2018)): While there is more information at the ETF level, there can be persistent distortion from fundamental value in the pricing of the underlying assets.[4] Our finding of persistent arbitrage, even during periods of market stress, at least partially mitigates this concern and highlights an important role that ETF APs play in addressing relative mispricing and counteracting bond market fragility.

Interestingly, after controlling for mispricing, redemption activity increases on stress days. Both creation and redemption activities increase on stress days, while the inventory management motive predicts an asymmetric impact. Thus, APs' activities are more nuanced than predicted by Pan and Zeng's model, and divergent market beliefs may be at play in influencing these processes, for example, APs responding to client demand for bonds (Todorov (2021)). As with creations, we find that a decrease in bond liquidity adversely affects redemption activity due to the higher cost of arbitrage. Overall, our evidence is consistent with limits to arbitrage.

The paper continues as follows: Section II provides a brief overview of bond ETFs. We discuss related literature and testable predictions in Section III. The data and the methodology are described in Section IV. Results are discussed in Sections V and VI, and Section VII concludes.

II. Overview of Fixed Income Exchange-Traded Funds

We begin by describing corporate bond ETFs and explaining the institutional linkage between a corporate bond ETF and the underlying corporate bonds. We refer interested readers to Madhavan (2016), Ben-David, Franzoni, and Moussawi (2018), and Lettau and Madhavan (2018) for more detailed descriptions of ETFs.

Corporate bond ETFs belong to the broader class of fixed income ETFs, which include ETFs that hold government bonds, investment-grade corporate bonds, high-yield corporate bonds, municipal bonds, and money market instruments. Barclays Global Investors iShares introduced the first fixed income ETFs into the U.S. market in 2002, and iShares-sponsored fixed income ETFs still represent about 42.4% of the corporate bond ETF market. iShares is now owned by BlackRock, the largest asset management firm in the world. Fixed income ETFs have grown rapidly in popularity since their inception by providing an attractive alternative to investing directly in the underlying bonds. For example, for May 2022, U.S. corporate bond ETF aggregate trading volume ($207.4B) comprised about 24.9% of the total volume traded by the underlying corporate bond market ($832.2B) (BlackRock (2023)).

ETFs are basket securities, which are traded on an exchange with a single class of common stock. Each ETF has a sponsor, who at the time it creates the ETF specifies the fund's investment objective, the benchmark market index whose returns the ETF will seek to replicate, and the tracking methodology the fund's manager will employ in managing the ETF's bond portfolio. For example, the High Yield Corporate Bond (HYG) ETF, which we analyze, is designed to track the Markit iBoxx USD Liquid High Yield Index, which is comprised of

[4]These distortions occur because market makers for the underlying bonds cannot perfectly distinguish between price changes caused by factors pertinent to their assets and other factors irrelevant to them when learning from ETF price changes.

U.S. dollar-denominated high-yield corporate bonds (BlackRock, iShares iBoxx $ High Yield Corporate Bond ETF Fact Sheet as of Mar. 31, 2021, https://www.ishares.com/us/literature/fact-sheet/hyg-ishares-iboxx-high-yield-corporate-bond-etf-fund-fact-sheet-en-us.pdf, last accessed Dec. 2022). Bond ETFs commonly include a cash component resulting from accrued interest or from principal payment at maturity or at the time of a bond call.

The bond ETF's sponsor appoints APs, who consist of broker-dealers, specialist market makers, and institutional investors. APs engage in large in-kind transactions in the ETF shares and the underlying bonds in connection with the creation and redemption of ETF shares: buying bonds in the open market, depositing the specified basket with the fund sponsor in exchange for creation units, and selling those shares in the ETF market to effect ETF creation, and buying ETF shares, depositing them with the ETF sponsor in exchange for the specified basket, and selling those bonds in the open market in connection with ETF redemption. Redemption simply reverses the creation process. Non-APs can only create and redeem ETF shares by acting through APs.

ETF managers report creation and redemption baskets to APs on a daily basis. These baskets typically include a subset of ETF bonds and a cash component, which is relatively small and has cash in place of fractional shares used to match the basket NAV to the ETF NAV. APs could negotiate baskets that deviate from the reported ones.

III. Related Literature and Testable Predictions

A. Related Literature

While ETFs have been available in the market since 1993 (State Street Global Advisors' SPDR), the academic literature describing their impact on markets is still in its infancy. The first most notable papers related to corporate bond ETFs, and the ones that motivated our research, are Dannhauser (2017) and Pan and Zeng (2019).

Dannhauser (2017) focuses on the financial innovation of bond ETFs and their impact on the bond market. By comparing ETF bonds to non-ETF bonds, the author finds a significant valuation effect whereby a 1-standard-deviation increase in the proportion of bonds held by the ETF lowers the yield spread for both investment-grade and high-yield bonds. More relevant to this study, Dannhauser (2017) finds that ETF ownership has no impact on the liquidity of high-yield bonds and provides some evidence, although limited, of a negative impact on the liquidity of investment-grade bonds. Dannhauser (2017) suggests that ETFs attract liquidity traders away from the bonds leaving a larger proportion of informed traders participating in the bond market.

Pan and Zeng (2019) construct a model that yields testable hypotheses describing how APs of bond ETFs, who also tend to be bond dealers, utilize the ETF share creation and redemption processes to take advantage of arbitrage opportunities resulting from relative ETF mispricing when the ETF price diverges from the NAV of the constituent bonds as well as to manage their bond inventories. Bridging the gap between Dannhauser (2017) and Pan and Zeng (2019), this paper focuses on the daily ETF creation and redemption processes and their impact on the underlying bond liquidity.

Closely related to our work are also Marta (2022) and Holden and Nam (2021), who further study how the introduction of bond ETFs impacts underlying liquidity by comparing ETF and non-ETF bonds. Instead, we study ETF creation and redemption processes and provide a granular analysis of the factors that may explain the liquidity impact. In a subsequent paper to ours, Koont, Ma, Pástor, and Zeng (2023) also study ETF creation and redemption processes. They focus on what ETF portfolio managers do. The authors model how an ETF portfolio manager chooses daily creation and redemption baskets by trading off index tracking error against liquidity transformation. Like us, they provide empirical evidence that basket membership impacts the liquidity of the underlying bonds. We differ from Koont et al. in that we focus on what APs do and present a different set of empirical results. We analyze drivers of actual creation and redemption activities by APs and provide novel insights into mechanisms that affect underlying bond markets across both investment-grade and high-yield sectors on stress and nonstress days. We show that a combination of inventory management and mispricing arbitrage explains much of the creation and redemption activities by APs. Importantly, our findings show that APs continue to take advantage of arbitrage opportunities even on stress days, which explains the improvement in bond liquidity we find.

B. Testable Predictions

One of the important roles of the AP is to help keep an ETF's share price in line with its NAV. As active bond market participants, the APs are expected to determine when the ETF's share price deviates significantly from the NAV and then help to correct the relative mispricing via arbitrage. APs use the ETF creation and redemption processes to bridge the two markets, trading both the ETF shares and the constituent bonds in order to capture arbitrage profits and mitigate the relative mispricing. This arbitrage activity entails buying bonds in the creation basket in the bond market, exchanging them for ETF shares, and selling the ETF shares when the ETF's share price exceeds the ETF's NAV. It also involves buying ETF shares, exchanging them for the redemption basket, and selling the bonds in the bond market when the ETF's NAV exceeds its share price.

Thus, acting on mispricing arbitrage opportunities provides an additional rationale for trading illiquid bonds and predicts that creation and redemption processes increase the liquidity of the underlying bonds. Furthermore, APs acting on arbitrage opportunities is consistent with the relative mispricing driving their creation and redemption activities.

Pan and Zeng (2019), however, propose limits to such arbitrage, which might manifest on stress days.[5] Specifically, they suggest that APs may use the creation and redemption processes to manage their corporate bond inventories instead of taking advantage of the mispricing arbitrage opportunities. APs are often large dealer banks with bond trading desks that are separate from the ETF trading desk.

[5]See also Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018), who argue that the most notable changes in the secondary market for corporate bonds do not manifest during normal trading but emerge when the market is stressed.

A conflict between APs' dual roles as ETF arbitrageurs and as bond dealers may arise because both roles require using APs' overall balance sheet to hold bonds. Pan and Zeng's model predicts that APs will generally take advantage of arbitrage opportunities via the creation and redemption processes under normal (nonstress) market conditions. However, on stress days, when APs experience a shock from other trading activities affecting their desired inventory levels, they may instead use the creation or redemption processes to restore their own bond inventory to optimal levels. If there is a significant liquidity mismatch between the two markets, an AP (e.g., might offload unwanted bond inventory through ETF creation even when the ETF is trading at a discount relative to the NAV). Thus, on stress days, the creation and redemption activities are less sensitive to mispricing.

In the Pan and Zeng (2019) model, transaction costs affect creation and redemption activities. Interestingly, this effect is asymmetric between stress and nonstress days. Under normal conditions, creation and redemption activities are negatively related to transaction costs. This is because such costs reduce the profitability of mispricing arbitrage. On stress days, however, creation and redemption activities are positively related to transaction costs. This is because APs are more likely to manage their own bond inventories when the bonds are less liquid and transaction costs are high.

The inventory management framework has implications not only for mispricing arbitrage but also for underlying bond liquidity.[6] Specifically, following a positive inventory shock, instead of buying the bonds in the creation basket in the bond market, the APs use bonds already on their balance sheet and exchange them for ETF shares. Further, AP redemption activity slows down, and overall, bond trading by APs to take advantage of the mispricing arbitrage opportunities slows down, ceteris paribus.

Similarly, following a negative shock to the inventory, APs exchange ETF shares for the redemption basket without selling the bonds in the bond market to restore their bond inventories to the optimal level. Creation activity by APs slows down. Thus, the inventory management framework predicts that the impact of creation and redemption activities on bond trading and liquidity is limited, especially on stress days. While there is bond trading to take advantage of the mispricing arbitrage opportunities on nonstress days that enhance the liquidity of the underlying bonds, there is limited or no such trading on stress days. Hence, the liquidity impact of creation and redemption processes differs between stress and nonstress days.

Todorov (2021), however, points out that each ETF has multiple APs with different bond inventories and furthermore with different client relationships. An AP may use the creation or redemption process not only to close the arbitrage gap or manage its own bond inventory but also to accommodate client demand. Thus, the drivers of creation and redemption processes are likely to be more nuanced than predicted by Pan and Zeng's model, and divergent market beliefs could be at play in influencing these processes.

In this paper, we first investigate the impact of the redemption and creation processes on underlying bond market liquidity and then investigate the role of

[6]Pan and Zeng's (2019) model is silent concerning the impact of creations and redemptions on underlying bond market liquidity.

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relative mispricing, inventory management, and transaction costs in motivating ETF creation and redemption activities by APs on both stress and nonstress days. To identify stress days, we use the Bank of America/Merrill Lynch corporate bond spread indexes as described in the next section.

IV. Data and Variables

This study utilizes two data sources of ETF holdings: BlackRock ETF data for two prominent bond ETFs, the HYG high-yield and LQD investment-grade bond ETFs, and ETF Global data. We also rely on TRACE, IHS Markit iBoxx Indices, CRSP, and St. Louis Fed data to perform our tests. This section describes how these data are used for sample construction and defines the key variables.

A. Sample Construction

We start our sample construction with the BlackRock ETF data. This comprehensive data set includes the daily lists of all ETF bond constituents, the number of bonds, and NAVs from Jan. 2009 through Dec. 2016. For each day, the data also include a description of the creation and redemption baskets, which provides the identity of the bonds along with the number of bonds required. The advantages of using BlackRock data are its accuracy, the earlier time coverage with the data going back to 2009, and the availability of the reported baskets that allow for a richer analysis of how ETFs' creation and redemption processes impact the underlying bond markets. BlackRock historical data did not report the composition of the creation and redemption baskets prior to 2009. Further, after 2016, BlackRock changed its practice with respect to listing creation and redemption baskets and began including all the bonds in the HYG ETF portfolio and in the LQD ETF portfolio in their respective daily creation and redemption baskets. Although the nature of these lists is now different, our data set offers a rare opportunity to test the impact of creation and redemption processes on underlying bond market liquidity.[7]

Thus, our final BlackRock data set spans the period from 2009 until 2016. Our analysis that relies on reported creation and redemption baskets is performed over this time period. BlackRock's share of the U.S. bond ETF market was 71% in 2009 and 49% in 2016 (BlackRock (2023)).

We complement the data on ETF holdings we obtained from BlackRock with ETF Global data sets. ETF Global started providing coverage of ETF holdings in 2017. The advantage of using ETF Global data is that it covers ETFs managed by more than one sponsor. The disadvantages are that the exact dates of the holdings are unknown, and the reported baskets are unavailable.[8] The date of holdings provided in ETF Global is based on the date when an ETF manager reports the fund's holdings. We use the approach Shim and Todorov (2023) developed to approximate holding dates and estimate realized creation and redemption baskets based on the changes in the ETF holdings. A shortcoming of this approach is that it may capture activities unrelated to creations or redemptions by APs. Appendix A

[7]ETF portfolio managers furnish daily creation and redemption baskets to APs but generally not to any other market participants.

[8]DTCC has data on reported baskets, but these data are not publicly available.

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provides details. Our ETF Global data set spans the period from 2017 until 2022, and the analysis that uses this sample relies on the realized baskets. Note that the ETF Global sample includes BlackRock ETFs.

We also use the approach Shim and Todorov (2023) developed to estimate realized creation and redemption baskets for the BlackRock data set. We perform our main analysis using the reported baskets and use estimated realized baskets in additional tests reported in Appendix B. We note that reported baskets represent bond demand by ETF managers while realized baskets capture creation and redemption activities by APs based on this demand.

We merge the ETF holdings data sets with TRACE using 9-digit bond CUSIPs. TRACE includes important information needed to calculate our liquidity measures, such as bond price, buy/sell indicator, and bond quantity traded. Additionally, we obtained share prices for the ETFs in our samples from CRSP, and we downloaded the Bank of America/Merrill Lynch corporate bond spread indexes we use to calculate the market stress indicators from the St. Louis Fed website. Finally, we acquired a set of benchmark bond indexes from IHS Markit. We use these indexes to address potential endogeneity concerns in our analysis.

B. Main Variables

We use two common liquidity measures to investigate the impact of creation and redemption processes associated with ETF constituent bonds. These measures are computed for each constituent bond on each day.

1. Bid–Ask Spread: TRACE includes a buy(B)/sell(S) indicator that distinguishes between trades when the dealer buys or sells from a customer. For constituent bond b on day t, the bid–ask spread is computed using the indicator as follows:

$$(Bid - Ask)_{bt} = \sum_{i=1}^{N} A_i w_i^A - \sum_{j=1}^{M} B_j w_j^B \tag{1}$$

This measure is interpreted as the dollar-weighted average bid–ask spread where the i^{th} trade is at the ask price $A_i$and the j^{th} trade is at the bid price B_j. This calculation requires at least one buy and one sell trade per day. If the current bid–ask spread is missing, then we use the previous day's measure to avoid substantially reducing the sample size.

2. Trading Volume: For constituent bond b on day t, the daily trading volume is computed as the sum of the number of bonds traded across all reported transactions within the day. This calculation uses the variable *entrd_vol_qt* available in TRACE, and we apply a log transformation.

We selected these two measures of bond liquidity because they are very intuitive and do not rely on any model assumptions and are thus well-suited to measuring the liquidity of the markets for individual bonds on a daily basis.

Table 1 provides descriptive statistics for our liquidity measures and other main variables for both BlackRock and ETF Global samples. The average high-yield bid–ask spread in the Blackrock sample is 0.641, and the average investment-grade bid–ask spread is 0.605. These numbers are lower in the ETF Global sample, with average spreads at 0.48 and 0.35, respectively. The average

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TABLE 1

Summary Statistics

Table 1 provides summary statistics for the main variables used in our analysis. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. Bid–Ask Spread and Trading Volume are liquidity measures described in the text. *Stress* is equal to 1 on days when the Bank of America/Merrill Lynch high-yield or investment-grade spread index experiences a 1.96 standard deviation or greater increase, and is 0 otherwise. *dCreate* equals 1 on days when the bond is in the creation basket, and *dRedeem* equals 1 on days when the bond is in the redemption basket. *#Create* is the number of ETFs that include the bond in their creation baskets. *#Redeem* is the number of ETFs that include the bond in their redemption baskets. Δq is the change in the quantity of bonds in the ETF from day $t-1$ to day t.

Panel A. BlackRock Sample

	High Yield			Investment Grade		
	Mean	Median	*N*	Mean	Median	*N*
Bid–Ask_Spread	0.641	0.352	437,757	0.605	0.384	1,048,359
Log(Trad.Vol)	7.249	7.597	713,231	7.066	7.178	1,617,021
Stress	0.025	0.000	1,231,914	0.023	0.000	1,879,976
d(Redeem) (reported)	0.191	0.000	1,107,634	0.114	0.000	1,883,429
dCreate (reported)	0.207	0.000	1,107,634	0.098	0.000	1,883,429
dRedeem (realized)	0.258	0.000	1,234,185	0.027	0.000	1,883,429
dCreate (realized)	0.178	0.000	1,234,185	0.032	0.000	1,883,429
Δq (thousands)	0.003	0.000	1,231,001	0.005	0.000	1,880,316
ETF Share Price	88.14	89.85	1,834	113.73	115.29	2,012
Fund NAV	87.65	89.53	1,833	113.34	115.11	2,013

Panel B. ETF Global Sample

	High Yield			Investment Grade		
	Mean	Median	*N*	Mean	Median	*N*
Bid–Ask_Spread	0.480	0.270	1,336,324	0.351	0.188	5,290,507
Log(Trad.Vol)	5.779	6.522	1,991,289	4.668	5.442	10,529,557
Stress	0.026	0.000	2,093,897	0.011	0.000	11,065,215
#Create	0.261	0.000	2,122,754	0.185	0.000	11,239,514
#Redeem	0.297	0.000	2,122,754	0.134	0.000	11,239,514
Δq* (thousands)	−0.001	0.000	10,357,566	0.0005	0.000	60,468,252
ETF Share Price	40.46	35.46	44,020	38.20	26.41	68,629
Fund NAV	40.15	32.85	44,877	37.97	26.55	70,390

* This variable is at the bond-ETF level.

log of daily trading volume varies between 4.67 and 7.25 across our samples. For the BlackRock sample, about 21% of the high-yield bonds are in the reported creation baskets and 18% are in the realized baskets. For the redemption baskets, the numbers are 19% and 26%, respectively. The average percentages of the bonds in the reported and realized baskets are lower for the investment-grade sample, with 9.85% (3.2%) in the reported (realized) creation baskets and 11.4% (2.7%) in the reported (realized) redemption baskets. For the ETF Global sample, on average, a bond is included in 26.1% of the high-yield ETF realized creation baskets, and a bond is included in 29.7% of the realized redemption baskets; these percentages for investment-grade ETFs are 18.5% and 13.4%, respectively.

In our analysis, we employ a stress indicator for the corporate bond markets. This stress indicator, $Stress_t$, is equal to 1 on days when the Bank of America/ Merrill Lynch high-yield or investment-grade corporate bond spread index experiences a 1.96 standard deviation or greater increase from the mean, and is 0 otherwise. We use the high-yield spread stress indicator when analyzing high-yield bonds and the investment-grade spread stress indicator when analyzing investment-grade bonds. The construction of our stress indicator is similar to the one adopted by Bessembinder et al. (2018). Stress days represent less than 3% of the days covered by our samples on average.

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V. Empirical Tests and Results

We begin by first confirming the credibility of the demand signal from bonds being listed in the reported creation and redemption baskets. We then discuss the empirical results that reveal the impact on liquidity from ETF creation and redemption processes. This is followed by an investigation of different rationales for ETF creation and redemption activities.

A. Creation/Redemption Demand Signal

In this subsection, we test the credibility of the demand signal from bonds being listed in the reported creation and redemption baskets using our BlackRock sample. As a part of the creation and redemption processes, after the close of trading during the sample period, BlackRock, the ETF sponsor, disseminated to the APs a subset of bonds that the ETF manager was willing to take to create an ETF share on the following trading day, the reported creation basket. It is therefore expected that the quantity of those bonds included in the creation basket should be more likely to increase in the ETF's portfolio than those bond issues that are not in the creation basket. Likewise, the ETF manager also disseminated a subset of bonds, the reported redemption basket, that the manager would deliver upon request by an AP to redeem an ETF share. Hence, it should be expected that the quantity of the redemption basket constituents held by the ETF should decrease more than bonds that are in the ETF but not in the redemption basket. Thus, we can treat creation or redemption basket constituency as a demand signal. This demand signal allows us to disentangle the impact of creations and redemptions, which in turn enables us to investigate the differential impact of the creation and redemption processes on underlying bond liquidity and to perform a focused study of the economic drivers of the creation and redemption activities.

However, even though the baskets were published, there was no guarantee that APs would create or redeem any shares the following day. Therefore, we first test the reliability of the demand signal by testing whether listing in the creation or redemption basket is indeed followed by actual changes in the numbers of those bonds held in the ETF's bond portfolio.

To do this, we consider the simple specification where we regress time $t-1$ to time t changes in the quantity of each bond, Δq_{bt}, on the dummy variables *dCreate* and *dRedeem*, which are equal to 1 if the bond is in the respective basket on day t, and are 0 otherwise:

$$\Delta q_{bt} = a + d_c \times dCreate_{bt} + d_r \times dRedeem_{bt} + b_b + \epsilon_{bt}. \tag{2}$$

If the creation and redemption basket demand signals are informative, then we should expect $d_c > 0$ and $d_r < 0$ indicating an increase in the quantity of bonds in the creation basket and a decrease in the quantity of bonds in the redemption basket, respectively.

Table 2 provides the results of applying this test. Consistent with our expectations, we find that the coefficient on the *dCreate* indicator is positive and statistically significant for both high-yield and investment-grade bond ETFs, and the coefficient on the *dRedeem* indicator variable is negative and statistically

TABLE 2

Change in the Quantity of Bonds

Table 2 presents the results of regression analysis on the change in the quantity of bonds in the ETF after a bond appears in the HYG or LQD ETF reported creation or redemption basket. The dependent variable is Δq, the change in the quantity of bonds in the ETF from day $t-1$ to day t. The sample covers the time period from 2009 through 2016 and includes bonds in the BlackRock HYG or LQD ETFs. *dCreate* equals 1 on days when the bond is in the creation basket, and *dRedeem* equals 1 on days when the bond is in the redemption basket. Daily data are used. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	High Yield	Investment Grade
	1	2
dCreate	0.070***	0.212***
	(0.001)	(0.002)
dRedeem	−0.084***	−0.329***
	(0.001)	(0.002)
Bond FE	Yes	Yes
N	1,105,055	1,880,316
R^2	0.017	0.021

significant for both specifications. Hence, on days when bonds are included in the reported creation basket, there is a subsequent increase in the number of bonds held by the ETF, and on days when bonds are included in the reported redemption basket, there is a subsequent decrease in the number of bonds held by the ETF.

B. Impact on Bond Liquidity

Next, we investigate whether the processes of creation and redemption affect the liquidity of the markets for the underlying bonds. It is important to note that not all bonds in the ETF are impacted by the creation or redemption processes because only a subset of the ETF bond portfolio is included in the baskets. Therefore, any bond liquidity impact should primarily affect those bonds belonging to the creation or redemption baskets.

We fitted the following regression model:

$$Liquidity_{bt} = a + d_c \times Create_{bt} + d_r \times Redeem_{bt} + b_b + \epsilon_{bt}. \quad (3)$$

This empirical specification tests the relationship between being in the creation or redemption basket on day t and the bond's liquidity measured on that day. The dependent variable, $Liquidity_{bt}$, is estimated using the previously described liquidity measures—bid–ask spread and daily trading volume. $Create_{bt}$ and $Redeem_{bt}$ are measures of basket inclusion. In the BlackRock sample, we measure basket inclusion using indicator variables that take the value of 1 on days when the bond is in the reported creation or redemption basket, $dCreate_t$ or $dRedeem_t$. In the ETF Global sample, we use two measures of basket inclusion. First, we measure basket inclusion by the number of ETFs that include the bond in their realized creation or redemption baskets, $\#Create_{bt}$ or $\#Redeem_{bt}$. Second, similar to the BlackRock sample, we use indicator variables that take the value of 1 on days when the bond is in the realized creation or redemption basket of the ETF. We perform the latter analysis at the bond-ETF level and include the fund-by-day fixed effects.

Results presented in Table 3 for the two liquidity measures consistently show that basket inclusion is associated with higher liquidity for both creations and

TABLE 3

Impact on Bond Liquidity

Table 3 presents the results of regression analysis of the impact on liquidity measures of listing in the ETF creation or redemption basket. The dependent variables are Bid–Ask Spread and Trading Volume, described in the text. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. *dCreate* equals 1 on days when the bond is in the creation basket, and *dRedeem* equals 1 on days when the bond is in the redemption basket. *#Create* is the number of ETFs that include the bond in their creation baskets. *#Redeem* is the number of ETFs that include the bond in their redemption baskets. Daily data are used. All specifications include day fixed effects, except, in Panel B, where specifications 3, 6, 9, and 12 include fund-by-day fixed effects. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. BlackRock Sample

	Bid–Ask Spread				Trading Volume			
	High Yield		Investment Grade		High Yield		Investment Grade	
	1	2	3	4	5	6	7	8
dCreate	−0.072***	−0.028***	−0.150***	−0.061***	0.544***	0.159***	0.818***	0.376***
	(0.012)	(0.007)	(0.010)	(0.006)	(0.034)	(0.021)	(0.042)	(0.021)
dRedeem	−0.101***	−0.029***	−0.090***	−0.029***	0.532***	0.197***	0.474***	0.201***
	(0.010)	(0.004)	(0.009)	(0.004)	(0.025)	(0.012)	(0.025)	(0.012)
Bond FE	No	Yes	No	Yes	No	Yes	No	Yes
N	397,946	397,938	1,048,359	1,048,340	640,015	640,011	1,617,021	1,616,993
R^2	0.032	0.238	0.049	0.254	0.057	0.213	0.053	0.274

Panel B. ETF Global Sample

	Bid–Ask Spread						Trading Volume					
	High Yield			Investment Grade			High Yield			Investment Grade		
	1	2	3	4	5	6	7	8	9	10	11	12
#Create	−0.038***	−0.015***		−0.062***	−0.009***		0.775***	0.309***		1.269***	0.208***	
	(0.001)	(0.001)		(0.000)	(0.000)		(0.003)	(0.003)		(0.002)	(0.002)	
#Redeem	−0.069***	−0.012***		−0.069***	−0.006***		0.822***	0.269***		1.583***	0.182***	
	(0.001)	(0.001)		(0.001)	(0.001)		(0.003)	(0.003)		(0.003)	(0.003)	
dCreate			−0.015***			−0.012***			0.311***			0.266***
			(0.001)			(0.001)			(0.010)			(0.006)
dRedeem			−0.010***			−0.009***			0.274***			0.209***
			(0.002)			(0.001)			(0.014)			(0.007)
Bond FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
N	1,336,324	1,336,207	7,524,283	5,290,507	5,290,467	33,459,136	1,991,289	1,991,162	9,802,554	10,529,557	10,529,531	56,481,797
R^2	0.051	0.267	0.217	0.055	0.251	0.234	0.116	0.389	0.354	0.083	0.415	0.410

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redemptions. Panel A reports the results for the BlackRock sample. In specifications (1)–(4), where the dependent variable is bid–ask spread, we observe that the coefficients on the basket inclusion variables are negative and statistically significant at conventional levels for all specifications, including when controlling for bond fixed effects. These results indicate that the bid–ask spread decreases on days when the bond is included in either the creation or redemption basket. This decrease occurs for high-yield and investment-grade bonds. For example, specification (2) in Panel A shows that including a bond in the reported creation basket reduces the high-yield bid–ask spread on average by 0.028. Given that the median bid–ask spread is 0.35, this represents an 8% reduction in the spread. Inclusion in the redemption basket has a similar impact. For the investment-grade bonds, specification (4) in Panel A shows that including a bond in the reported creation basket reduces the bid–ask spread on average by 0.061. Given that the median investment-grade bid–ask spread is 0.38, this represents a 16% reduction. For bonds in the redemption basket, the impact associated with a reduction in the bid–ask spread is 0.03, which represents an 8% reduction.

Specifications (5)–(8) report the impact on daily trading volume for bonds included in the creation or redemption basket. The coefficients on the basket inclusion variables are positive and statistically significant at conventional levels for all specifications. Consistent with the bid–ask spread results, we find evidence that being included in the creation or redemption basket increases bond liquidity.

Panel B reports the results for the ETF Global sample. We continue to find that being included in the creation or redemption basket increases bond liquidity. In specifications (1)–(6), where the dependent variable is bid–ask spread, the coefficients on the basket inclusion variables are negative and statistically significant at conventional levels for all specifications. In specifications (7)–(12), where the dependent variable is trading volume, the coefficients on the basket inclusion variables are positive and statistically significant at conventional levels for all specifications.

The evidence presented here supports the hypothesis that the ETF creation and redemption processes increase liquidity for the underlying bonds across investment-grade and high-yield sectors. The results hold for both reported and realized baskets.

C. Bond Liquidity on Stress Days

So far, our results suggest that the ETF creation and redemption processes increase bond liquidity. We explore this further by testing the relationship between ETF creation and redemption processes and bond liquidity on stress days. Bessembinder et al. (2018) argue that the most notable changes in the secondary market for corporate bonds do not manifest during normal trading but emerge when the market is stressed. This argument is consistent with the Pan and Zeng (2019) model, which predicts that APs are less likely to take advantage of mispricing arbitrage opportunities on stress days, which implies that the creation and redemption processes are less likely to have a positive impact on bond liquidity on stress days.

To test the impact of stress in the high-yield market and the investment-grade market on bond liquidity, we augment the regression model (3) by including a stress indicator variable and interaction variables:

$$(4) \quad Liquidity_{bt} = a + d_c \times Create_t + d_{cs} \times Create_t \times Stress_t + d_r \times Redeem_t + d_{rs} \times Redeem_t \times Stress_t + Stress_t + b_b + \epsilon_{bt}.$$

The stress indicator, $Stress_t$, is equal to 1 on days when the Bank of America/Merrill Lynch high-yield or investment-grade corporate bond spread index experiences a 1.96 standard deviation or greater increase from the mean, and is 0 otherwise. The dependent variable, $Liquidity_{bt}$, is estimated using the previously described liquidity measures—bid–ask spread and daily trading volume. $Create_{bt}$ and $Redeem_t$ are measures of basket inclusion. In the BlackRock sample, we measure basket inclusion using indicator variables that take the value of 1 on days when the bond is in the reported creation or redemption basket, $dCreate_t$ or $dRedeem_t$. In the ETF Global sample, we use two measures of basket inclusion. First, we measure basket inclusion by the number of ETFs that include the bond in their realized creation or redemption baskets, $\#Create_{bt}$ or $\#Redeem_{bt}$. Second, similar to the BlackRock sample, we use indicator variables that take the value of 1 on days when the bond is in the realized creation or redemption basket of the ETF. We perform the latter analysis at the bond-ETF level and include the fund-by-day fixed effects.

Table 4 provides the results. The coefficients on *Create* and *Redeem* are consistently negative for the bid–ask spread variable and consistently positive for the trading volume variable in both Panel A and Panel B suggesting increased bond liquidity due to the creation and redemption processes on nonstress days, which is consistent with our previously reported results.

Interestingly, Panel A of Table 4 shows that membership in reported creation or redemption baskets has an asymmetric impact on bond liquidity on days of heightened stress for high-yield bonds. Specifications (1)–(2) show that the coefficient on the interaction term between *dCreate* and *Stress* is consistently positive but statistically insignificant, indicating that creations have a similar impact on bid–ask spread on stress days as on nonstress days for high-yield bonds. However, for redemptions, we find that the bid–ask spreads narrow even more due to the redemption process, indicating that the bonds become more liquid on stress days than on nonstress days. This can be seen in the negative and statistically significant coefficients on all the $dRedeem \times Stress$ interaction terms.

Specifications (5)–(6) of Panel A provide a similar analysis but use daily trading volume as the dependent variable. Similar to the bid–ask spread, we again see the asymmetric impact of the creation and redemption processes on bond liquidity on stress versus nonstress days for high-yield bonds. While the coefficients on the $dCreate \times Stress$ interaction term are negative, the coefficients on the $dRedeem \times Stress$ interaction term are consistently positive and statistically significant at the 1% level, suggesting even greater liquidity for bonds in the reported redemption basket on stress days. We note that the negative coefficient on $dCreate \times Stress$ in specification (6) is statistically significant at the 10% level.

TABLE 4

Bond Liquidity and Stress Days

Table 4 presents the results of regression analysis of the impact on liquidity measures of listing in the ETF creation or redemption basket on stress days. The dependent variables are Bid–Ask Spread and Trading Volume, described in the text. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. *dCreate* equals 1 on days when the bond is in the creation basket, and *dRedeem* equals 1 on days when the bond is in the redemption basket. *#Create* is the number of ETFs that include the bond in their creation baskets. *#Redeem* is the number of ETFs that include the bond in their redemption baskets. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield or investment-grade spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. All specifications include day fixed effects, except, in Panel B, where specifications 3, 6, 9, and 12 include fund-by-day fixed effects. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. BlackRock Sample

	Bid–Ask Spread				Trading Volume			
	High Yield		Investment Grade		High Yield		Investment Grade	
	1	2	3	4	5	6	7	8
dCreate	−0.058***	−0.025***	−0.146***	−0.056***	0.545***	0.161***	0.816***	0.373***
	(0.012)	(0.008)	(0.010)	(0.007)	(0.034)	(0.021)	(0.042)	(0.021)
dCreate×Stress	0.031	0.039	−0.049*	−0.033	−0.027	−0.097*	0.060	0.133**
	(0.034)	(0.031)	(0.035)	(0.028)	(0.074)	(0.060)	(0.096)	(0.065)
dRedeem	−0.085***	−0.025***	−0.091***	−0.030***	0.522***	0.187***	0.469***	0.196***
	(0.009)	(0.004)	(0.008)	(0.004)	(0.025)	(0.012)	(0.025)	(0.012)
dRedeem×Stress	−0.073***	−0.065***	−0.041*	−0.021	0.347***	0.358***	0.219***	0.222***
	(0.021)	(0.018)	(0.024)	(0.021)	(0.043)	(0.039)	(0.048)	(0.037)
Bond FE	No	Yes	No	Yes	No	Yes	No	Yes
N	534,137	534,125	1,344,692	1,344,680	639,098	639,094	1,615,064	1,615,036
R^2	0.025	0.226	0.044	0.242	0.057	0.213	0.053	0.274

Panel B. ETF Global Sample

	Bid–Ask Spread						Trading Volume					
	High Yield			Investment Grade			High Yield			Investment Grade		
	1	2	3	4	5	6	7	8	9	10	11	12
#Create	−0.039***	−0.015***		−0.062***	−0.009***		0.779***	0.310***		1.268***	0.209***	
	(0.001)	(0.001)		(0.000)	(0.000)		(0.003)	(0.003)		(0.002)	(0.002)	
#Create×Stress	0.012*	0.016**		0.036***	0.033***		−0.191***	−0.031*		0.107***	−0.015	
	(0.007)	(0.007)		(0.007)	(0.007)		(0.020)	(0.017)		(0.022)	(0.017)	

(continued on next page)

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TABLE 4 (continued)

Bond Liquidity and Stress Days

Panel B. ETF Global Sample (continued)

	Bid–Ask Spread						Trading Volume					
	High Yield			Investment Grade			High Yield			Investment Grade		
	1	2	3	4	5	6	7	8	9	10	11	12
#Redeem	−0.069***	−0.012***		−0.070***	−0.007***		0.821***	0.261***		1.581***	0.178***	
	(0.001)	(0.001)		(0.001)	(0.001)		(0.003)	(0.003)		(0.003)	(0.003)	
#Redeem ×Stress	0.014***	0.001		0.074***	0.071***		0.029**	0.158***		0.107***	0.235***	
	(0.005)	(0.005)		(0.009)	(0.009)		(0.014)	(0.012)		(0.024)	(0.019)	
dCreate			−0.015***			−0.013***			0.312***			0.267***
			(0.001)			(0.001)			(0.010)			(0.006)
dCreate ×Stress			0.006			0.015			−0.052			−0.054
			(0.018)			(0.009)			(0.041)			(0.054)
dRedeem			−0.010***			−0.010***			0.269***			0.208***
			(0.002)			(0.001)			(0.015)			(0.007)
dRedeem ×Stress			0.0001			0.024**			0.088***			0.060*
			(0.008)			(0.012)			(0.034)			(0.035)
Bond FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
N	1,336,324	1,336,207	7,524,283	5,290,507	5,290,467	33,459,136	1,991,289	1,991,162	9,802,554	10,529,557	10,529,531	56,481,797
R^2	0.051	0.267	0.217	0.055	0.251	0.234	0.116	0.389	0.354	0.083	0.415	0.410

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The magnitude, however, is not high enough to reverse the positive impact of creation processes on liquidity on stress days, which is 0.064 (0.161–0.097).

We do not find evidence in Panel A of Table 4 that membership in reported creation or redemption baskets has an asymmetric impact on bond liquidity on days of heightened stress for investment-grade bonds. We see some improvement in liquidity on stress days for both creation and redemption baskets. In specification (3), the coefficients on $dCreate \times Stress$ and $dRedeem \times Stress$ are negative and statistically significant at the 10% level, indicating a reduction in the bid–ask spread on stress days. In specification (8), the coefficients on $dCreate \times Stress$ and $dRedeem \times Stress$ are positive and statistically significant at conventional levels, indicating an increase in the trading volume on stress days.

In additional analysis, we created realized baskets for our BlackRock sample using the Shim and Todorov (2023) approximation, which we also use for constructing our ETF Global sample. While the reported baskets we use clearly indicate bond demand by ETF managers, the realized baskets attempt to capture creation and redemption activities by APs based on the ETF managers' revealed demand. The data on actual realized baskets are not publicly available, which is why we have to rely on the approximation procedure. One concern with such an approximation is that it may capture ETF activities unrelated to creations and redemptions by APs. Results of this analysis are presented in Appendix B. First, we note a stronger positive impact on bond liquidity of inclusion in the realized baskets than in the reported baskets. For example, specification (1) shows that including a bond in the realized creation basket reduces the high-yield bid–ask spread on average by 0.104. Given that the median bid–ask spread is 0.35, this represents about a 30% reduction in the spread. Recall that the reduction is 8% for inclusion in the reported basket. Further, we find that the improvement in liquidity persists across all specifications on stress days for both creation and redemption baskets.

Going back to Table 4, Panel B provides results based on ETF Global realized baskets. Specifications (1)–(6) use the bid–ask spread as the dependent variable. While creation and redemption processes result in increased bond liquidity on nonstress days, the positive and generally statistically significant coefficients on the interaction terms in these specifications suggest a reduction in the positive impact on liquidity for bonds in the creation and redemption baskets on stress days and in some cases even the reversal of the positive impact. The results in specifications (7)–(12) show an increase in the trading volume for the bonds in the redemption basket for both high-yield and investment-grade bonds on stress days, consistent with liquidity improvement.

The concern with the liquidity effects reported so far centers on the bond selection preferences of the ETF managers. ETF portfolio managers use the creation and redemption processes to manage portfolio tracking errors. However, Koont et al. (2023) suggest that ETF portfolio managers might also use the creation and redemption processes to facilitate liquidity transformation. This, in turn, would result in an ETF manager selecting the most liquid bonds for these baskets. On the other hand, some market participants have argued that during times of market stress, ETF portfolio managers may deliberately adjust their redemption baskets to include less liquid, less desirable bonds to discourage ETF redemptions (Todorov (2021) and Cohen, Laipply, Madhavan, and Mauro (2022)).

The specifications with bond fixed effects partially address this concern regarding the selection bias. In these specifications, we explore within-bond variations in basket membership and investigate the bond liquidity impact after a bond is added to a basket. In Section V.D, we further investigate how the bond liquidity impact of the creation and redemption processes might be affected by the selection bias and employ an instrumental variable approach to address the potential endogeneity that could result from this bias.

D. Bond Liquidity: Instrumental Variable Approach

In this subsection, we address the endogeneity of the bond's basket inclusion by employing an instrumental variable approach. Each ETF has a sponsor, who, at the time it creates the ETF, specifies the benchmark market index whose returns the ETF will seek to track. An ETF holding a bond that is overweight relative to the index may respond by removing it from the creation basket and adding it to the redemption basket and vice versa.

We construct an instrument by recognizing that fixed income indexes rebalance at month ends. Koont et al. (2023) argue that shocks to bond over- or underweighting on index rebalancing days should affect ETF basket inclusion without being confounded by changes in unobservable bond characteristics that also influence bond liquidity. Thus, we use shocks to bond over- or underweighting on index rebalancing days as an instrument in a 2-stage least-squares estimation (2SLS). In this analysis, we use a subset of ETFs that track benchmark indexes created by IHS Markit. Notably, fixed income ETFs using the Markit benchmark indexes represent about 42.4% of the corporate bond ETF market. Appendix C provides details and results of the first stage of the 2-stage least-squares estimation.

Table 5 provides the results of the second stage, where we re-estimate equations 3 and 4 using the predicted values for basket inclusion from the first stage. We consistently find that a bond's inclusion in the creation or redemption basket improves liquidity for both high-yield and investment-grade bonds on nonstress days. The coefficients on *Create* and *Redeem* are always negative and statistically significant at conventional levels for specifications (1)–(4), for both reported (Panel A) and realized (Panel B) baskets, indicating a reduction in the bid–ask spread. The coefficients on *Create* and *Redeem* are always positive and statistically significant at conventional levels for specifications (5)–(8) for both reported (Panel A) and realized (Panel B) baskets, indicating an increase in the trading volume.

In Panel A of Table 5, we continue to find that membership in reported creation or redemption baskets has an asymmetric impact on bond liquidity on days of heightened stress for high-yield bonds. The bid–ask spread narrows even more and trading volume increases more for the bonds in the redemption baskets, indicating that the bonds become more liquid on stress than on nonstress days. This can be seen in the negative and statistically significant coefficient on $dRedeem \times Stress$ in specification (2) and the positive and statistically significant coefficient on $dRedeem \times Stress$ in specification (6). For creations, however, the impact of stress on liquidity is either insignificant or negative.

In Panel A of Table 5, we also find that membership in reported creation or redemption baskets has an asymmetric impact on bond liquidity on days of

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TABLE 5

Bond Liquidity: Instrumental Variable Approach

Table 5 presents the results of the second stage of the 2-stage IV estimation described in the text. The dependent variables are Bid–Ask Spread and Trading Volume. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. In this analysis, we use a subset of ETFs that track benchmark indexes created by IHS Markit. *p_dCreate* equals 1 on days when the bond is in the creation basket, and *p_dRedeem* equals 1 on days when the bond is in the redemption basket. All basket inclusion variables are predicted values from stage 1. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield or investment-grade spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. All specifications in Panel A include day fixed effects. All specifications in Panel B include fund-by-day fixed effects. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	Bid–Ask Spread				Trading Volume			
	High Yield		Investment Grade		High Yield		Investment Grade	
	1	2	3	4	5	6	7	8
Panel A. BlackRock Sample								
p_dCreate	−0.012**	−0.013***	−0.047***	−0.047***	0.093***	0.097***	0.299***	0.298***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.013)	(0.013)	(0.014)	(0.014)
p_dCreate × Stress		0.062		−0.011		−0.152**		0.086
		(0.039)		(0.038)		(0.078)		(0.098)
p_dRedeem	−0.024***	−0.022***	−0.047***	−0.045***	0.200***	0.191***	0.315***	0.307***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.009)	(0.010)	(0.007)	(0.007)
p_dRedeem × Stress		−0.075***		−0.081***		0.389***		0.497***
		(0.028)		(0.020)		(0.058)		(0.050)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	365,401	365,143	764,674	762,656	448,360	448,052	943,186	941,312
R^2	0.231	0.231	0.235	0.235	0.209	0.209	0.257	0.257
Panel B. ETF Global Sample								
p_dCreate	−0.727***	−0.724***	−4.027***	−4.031***	16.09***	16.10***	33.65***	33.61***
	(0.080)	(0.080)	(0.056)	(0.055)	(0.511)	(0.512)	(0.338)	(0.339)
p_dCreate × Stress		−0.098		−0.314**		−0.384		5.036*
		(0.112)		(0.149)		(0.704)		(2.987)
p_dRedeem	−2.580***	−2.571***	−8.511***	−8.526***	37.73***	37.72***	60.02***	59.91***
	(0.245)	(0.245)	(0.113)	(0.113)	(0.908)	(0.910)	(0.777)	(0.781)
p_dRedeem × Stress		−0.236		0.343*		0.150		9.788***
		(0.188)		(0.191)		(0.882)		(3.521)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	988,360	988,360	3,487,247	3,487,247	1,286,704	1,286,704	5,007,368	5,007,368
R^2	0.185	0.185	0.236	0.236	0.328	0.328	0.335	0.335

heightened stress for investment-grade bonds. Similar to high-yield bonds, bonds in the redemption basket become more liquid on stress than on nonstress days. This can be seen in the negative and statistically significant coefficient on $dRedeem \times Stress$ in specification (4) and the positive and statistically significant coefficient on $dRedeem \times Stress$ in specification (8). The interaction term $dCreate \times Stress$ is insignificant in specifications (4) and (8), indicating that the creation process has a similar impact on liquidity on stress days as on nonstress days.

Within the mispricing arbitrage framework, the increase in liquidity caused by redemptions on stress days makes sense if the mispricing on stress days is such that the ETF is cheap relative to the price of the underlying constituent bonds (i.e., the ETF's NAV). In such a case, an arbitrageur would buy the low-priced ETF shares in the ETF market, redeem them for the redemption basket of individual bonds, and then sell the higher-priced basket of bonds in the bond market. To test this possibility, we regress the *Stress* indicator variable on $Misprice_t$, the price differential between the ETF share price and the ETF's NAV,

$$Misprice_t = \frac{Price_{ETFt}}{NAV_t} - 1. \quad (5)$$

Panel A of Appendix D provides the results of this test for the BlackRock sample that covers the years from 2009 to 2016. Indeed, we find evidence that the mispricing is generally negative on stress days, although the magnitude seems to change over time. For example, for the high-yield bonds, the average mispricing on stress days over the sample period is −0.003 (0.006–0.009). Thus, the increase in liquidity caused by redemptions on stress days, at least partially, could be explained by mispricing.

Panel B of Table 5 provides results for the ETF Global realized baskets. The positive impact of the creation and redemption processes on bond liquidity persists on stress days, as evident in all specifications. However, we find no evidence of improvement in liquidity for high-yield bonds on stress days. For investment-grade bonds, specification (6) shows a decrease in the bid–ask spread for the creation baskets, and specification (8) shows an increase in the trading volume for the creation and redemption baskets for the investment-grade bonds, consistent with liquidity improvement.

Regarding mispricing, Panel B of Appendix D presents the results for the ETF Global sample that covers the years from 2017 to 2022. Similar to the earlier time period, we find that mispricing for the high-yield bonds is, on average, negative on stress days by −0.003 (0.001–0.004). It is also negative on stress days for investment-grade bonds, on average, by −0.007 (0.001–0.008). This, however, did not result generally in improved liquidity for the bonds in the redemption baskets, which suggests that factors other than mispricing might be at play in driving creation and redemption activities. Section VI looks closely at the relationship between creation and redemption activities and ETF mispricing.

Overall, our results show that the creation and redemption processes improve the liquidity of the underlying bonds consistent with the mispricing arbitrage motive. After correction for endogeneity, there is little evidence to suggest that the positive impact on liquidity reverses on stress days, such as a potential reversal for high-yield bonds in the BlackRock creation basket. The creation and redemption processes seem to improve the underlying bond liquidity even on stress days.

VI. Dynamics of ETF Creation and Redemption Activity

As part of the ETF creation and redemption processes, ETF managers provide a list of bonds demanded by ETFs to APs daily. We refer to these lists as reported baskets. APs, however, may not always act on this demand; they engage in ETF creation and redemption activities only so long as it is the preferred alternative. In this section, we study drivers of the ETF creation and redemption activities by APs to provide further insights into mechanisms that may affect the underlying bond markets. We closely examine the interplay between mispricing arbitrage and inventory management, focusing on stress days and transaction costs.

A. Relative Mispricing and the Dynamics of Creations and Redemptions

The impact of relative mispricing on ETF creation and redemption activities is presented in Table 6. Panel A presents the results for the BlackRock sample, where we have data on the lists of bonds demanded by the ETFs. These are the reported baskets. To capture creation and redemption activities by APs, we calculate the change in the quantity of each bond in the reported creation basket from end of day $t-1$ to end of day t and do the same for bonds in the redemption basket. We separately analyze creation and redemption activities by APs.

We begin by investigating the impact of mispricing and stress on creation activities for high-yield bonds, specifications (1)–(3). Specification (1) regresses changes in the quantity of each bond held in the ETF creation basket on the mispricing variable and the stress indicator. It is first noted that the constant term in the regression is positive and statistically significant indicating that the quantity of each bond held in the ETF tends to increase conditional on it being in the creation basket. Further, the coefficient on *Misprice* is positive and statistically significant, suggesting greater creation activity (i.e., the quantity of bonds increases more) when the ETF is expensive relative to the NAV (i.e., *Misprice* is positive). This is consistent with arbitrageurs using the creation process to capitalize on the mispricing.

We also note that the coefficient on the stress variable, *Stress*, is positive and statistically significant. After controlling for mispricing, creation activity increases on stress days, suggesting that factors beyond mispricing might drive such activity.

Specification (2) adds an interaction variable between mispricing and stress to the model. The coefficient on the interaction term is negative and statistically significant, suggesting that sensitivity to mispricing decreases during times of stress, consistent with the inventory management framework. It is in times of stress that APs seek to replace illiquid bonds on their balance sheet with liquid ETF shares (Pan and Zeng (2019)). In this circumstance, the inventory management motive outweighs the arbitrage motive resulting in lower sensitivity to mispricing.

Specification (3) takes a closer look at the impact of mispricing by disentangling the sensitivity of the creation activity to positive and negative mispricing. This approach helps to address a concern that the stress indicator also captures the direction of mispricing as seen in Appendix D. Our focus here is on the sensitivity to positive mispricing, $Misprice^{+}$, which is equal to *Misprice* if it is positive, and is 0 otherwise. The coefficient on $Misprice^{+}$ is positive and highly statistically significant, consistent with the arbitrage motive. We continue to find that sensitivity to mispricing decreases during times of stress, as seen by the negative coefficient on $Misprice^{+} \times Stress$. The sensitivity to negative mispricing is insignificant.

The dynamics for high-yield bonds in the redemption basket are presented in specifications (4)–(6). It is first noteworthy that the constant terms are negative and statistically significant, indicating that when bonds are placed in the redemption basket, the quantity held by the ETF decreases. The decrease is significantly slower when the ETF price rises above the NAV of the constituent basket, as indicated by the positive and statistically significant coefficient on *Misprice* observed in specification (4). When the NAV is greater than the ETF price and the mispricing is negative, arbitrageurs buy the relatively cheap ETF shares in the ETF market,

TABLE 6

Mispricing and Dynamics of Creation and Redemption

Table 6 presents the results of regression analysis of the impact of ETF mispricing and bond market stress on the change in the quantity of bonds in the creation and redemption baskets. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. We exclude bonds that are in both the creation and redemption baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. *Misprice* is a ratio of the ETF share price to the Fund NAV minus one. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. BlackRock Sample

	High-Yield Creations			High-Yield Redemptions			Investment-Grade Creations			Investment-Grade Redemptions		
	1	2	3	4	5	6	7	8	9	10	11	12
Misprice	10.56***	11.24***		6.975***	6.286***		60.18***	61.62***		66.91***	63.55***	
	(0.506)	(0.524)		(0.467)	(0.486)		(4.844)	(5.144)		(2.377)	(2.562)	
Stress	0.055***	0.022**	0.027*	−0.09***	−0.06***	−0.08***	0.14***	0.15***	0.20***	−0.51***	−0.52***	−0.94***
	(0.009)	(0.010)	(0.014)	(0.012)	(0.010)	(0.014)	(0.036)	(0.035)	(0.041)	(0.031)	(0.031)	(0.046)
Misprice×Stress		−13.80***			9.67***			−20.9***			34.49***	
		(1.505)			(1.529)			(7.189)			(5.937)	
$Misprice^+$			13.35***			0.74			71.59***			39.43***
			(0.656)			(0.577)			(6.132)			(1.761)
$Misprice^+Stress$			−12.2***			12.84***			−33.13**			158.8***
			(2.978)			(2.572)			(11.99)			(9.107)
$Misprice^-$			−1.41			37.58***			−8.486			177.5***
			(1.361)			(1.705)			(15.12)			(12.349)
$Misprice^-Stress$			−2.534			−19.8***			51.27***			−148.6***
			(2.579)			(2.530)			(16.18)			(14.437)
Constant	0.04***	0.04***	0.03***	−0.11***	−0.10***	−0.07***	0.04***	0.04***	0.008	−0.46***	−0.45***	−0.37***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.009)	(0.009)	(0.012)	(0.004)	(0.004)	(0.006)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	139,082	139,082	139,082	121,831	121,831	121,831	89,249	89,249	89,249	119,076	119,076	119,076
R^2	0.057	0.057	0.058	0.041	0.042	0.048	0.069	0.070	0.070	0.093	0.093	0.100

(continued on next page)

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TABLE 6 (continued)

Mispricing and Dynamics of Creation and Redemption

Panel B. ETF Global Sample

	High-Yield Creations			High-Yield Redemptions			Investment-Grade Creations			Investment-Grade Redemptions		
	1	2	3	4	5	6	7	8	9)	10	11	12
Misprice	0.633***	0.639***		0.769***	0.773***		0.272***	0.278***		0.300***	0.301***	
	(0.003)	(0.003)		(0.004)	(0.004)		(0.001)	(0.001)		(0.001)	(0.001)	
Stress	0.001***	0.0003***	−0.001***	−0.004***	−0.004***	−0.005***	0.002***	0.001***	0.001***	−0.0004***	0.0004***	−0.0004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Misprice × Stress		−0.109***			−0.064***			−0.097***			−0.011**	
		(0.015)			(0.017)			(0.005)			(0.005)	
Misprice^+			0.983***			0.861***			0.350***			0.372***
			(0.006)			(0.005)			(0.002)			(0.001)
$\text{Misprice}^+\text{Stress}$			0.652***			0.458***			−0.217***			−0.050***
			(0.042)			(0.036)			(0.012)			(0.015)
Misprice^-			0.156***			0.649***			0.098***			0.122***
			(0.005)			(0.008)			(0.002)			(0.003)
$\text{Misprice}^-\text{Stress}$			−0.191***			−0.253***			0.102***			0.157***
			(0.018)			(0.030)			(0.007)			(0.009)
Constant	0.006***	0.006***	0.005***	−0.009***	−0.009***	−0.009***	0.002***	0.002***	0.002***	−0.003***	−0.003***	−0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ETF FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9,676,430	9,676,430	9,676,430	9,676,430	9,676,430	9,676,430	57,184,736	57,184,736	57,184,736	57,184,736	57,184,736	57,184,736
R^2	0.090	0.090	0.091	0.157	0.157	0.157	0.060	0.060	0.060	0.079	0.079	0.079

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redeem them for the redemption basket, and sell the bonds in the bond market. Our results show that redemption activity slows down when the ETF price rises above the NAV, consistent with the arbitrage motive. ETF mispricing is an important factor in explaining both creation and redemption activities.

Interestingly, after controlling for mispricing, redemption activity increases on stress days; the coefficient on *Stress* is negative and statistically significant. Both creation and redemption activities seem to increase on stress days, while the bond inventory management motive predicts an asymmetric impact. Thus, APs' activities are more nuanced than predicted by Pan and Zeng's model, and divergent market beliefs could be at play.

Each ETF has multiple APs with different bond inventories and furthermore with different client relationships (Todorov (2021)). An AP may use the creation or redemption process not only to close the arbitrage gap or manage its own bond inventory but also to accommodate client demand. During times of stress, when there may be panic selling of ETF shares (ETF runs), the client demand may explain the increase in redemption activity we find. Specifically, a large client may prefer to hold underlying bonds over ETF shares if it is concerned that the ETF liquidity could evaporate during stress days. The AP could accommodate such demand by redeeming the client's ETF shares (rather than selling them in the market) and avoiding further downward pressure on the ETF share price. In effect, the APs could use the creation and redemption processes to enhance their market-making activities (Todorov (2021)). One of an ETF's APs may manage its bond inventory during stress days and create ETF shares, while another AP may accommodate client demand by redeeming ETF shares for bonds even on days with no ETF mispricing.

Next, we consider the sensitivity to mispricing on stress days. Specification (5) shows that the sensitivity of redemption activity to mispricing for high-yield bonds increases on stress days; the coefficient on the interaction term is positive and statistically significant. To see the dynamics better, specification (6) reports the sensitivity to positive and negative mispricing. Our focus here is on the sensitivity to negative mispricing. The coefficient on the variable $Misprice^{-}$, which is equal to *Misprice* if it is negative, and is 0 otherwise, is positive and highly statistically significant, consistent with the mispricing arbitrage motive. The sensitivity to negative mispricing reduces from 37.58 to 17.83 (37.58–19.75) on stress days but remains positive. APs continue to take advantage of relative mispricing even on stress days. The sensitivity to positive mispricing is insignificant.

The dynamics of the creation and redemption activities in our BlackRock sample are similar for the investment-grade bonds, specifications (7)–(12). We continue to find that mispricing is important in explaining creation and redemption activities. There is evidence that the sensitivity to mispricing decreases on stress days. Nevertheless, APs continue to take advantage of relative mispricing even on stress days for both creations and redemptions. For example, specification (9) shows that the sensitivity to positive mispricing for creations decreases from 71.59 to 38.46 (71.59–33.13) on stress days but remains positive. Similarly, the sensitivity to negative mispricing for redemptions decreases from 177.5 to 28.9 (177.5–148.6) on stress days but remains positive in specification (12).

Panel B of Table 6 presents the results for the ETF Global sample. Recall that ETF Global covers more than one ETF, and the analysis in Panel B is at the bond-

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ETF level as the mispricing varies across ETFs. We again separately analyze creation and redemption activities. To capture these activities on creation or redemption days, we include all bonds in the ETF, not only the ones that experienced the change in holdings, in our analysis. This helps to ensure that we do not overestimate the impact of mispricing by excluding bonds with no changes in holdings.[9]

We continue to find that ETF mispricing is an important factor in explaining creation and redemption activities. The coefficient on *Misprice* is positive and statistically significant across all specifications. Further, after controlling for mispricing, both creation and redemption activities increase on stress days, consistent with our earlier findings. We document some new dynamics on stress days. Notably, different from the BlackRock sample, specification (3) shows that the sensitivity to positive mispricing increases for high-yield creations on stress days as indicated by the positive and significant coefficient on $Misprice^{+} \times Stress$. Specification (12) in turn shows that the sensitivity to negative mispricing increases for investment-grade redemptions on stress days as indicated by the positive and significant coefficient on $Misprice^{-} \times Stress$.

Overall, we find evidence that APs continue to take advantage of relative mispricing opportunities even on stress days for both creations and redemptions.

B. Liquidity and the Dynamics of Creations and Redemptions

In this subsection, we investigate the role that transaction costs play in explaining ETF creation and redemption activities. Pen and Zeng's model predicts that creation and redemption activities are negatively related to transaction costs under normal conditions because such costs limit mispricing arbitrage, and APs are less likely to select illiquid bonds. In contrast, on stress days, creation and redemption activities are positively related to transaction costs. This is because APs are more likely to manage their bond inventories when the bonds are less liquid and transaction costs are high.

Results of the analysis are presented in Table 7. We first look into those high-yield bonds included in the BlackRock-reported creation baskets, specifications (1)–(2) of Panel A. The increase in the quantity of bonds is statistically significantly related to both liquidity measures, the bid–ask spread and the trading volume. With a negative and statistically significant coefficient on the bid–ask spread variable, we find that as the bid–ask spread narrows, the quantities of individual bonds used in creation activity increase. A similar result is seen for trading volume. As the trading volume variable has a positive and statistically significant coefficient, the quantities of those bonds used in the creation activity increase as liquidity rises. Interestingly, market stress does not have any impact on the intensity of creation activity for high-yield bonds.

Specifications (3)–(4) present similar analyses for high-yield bonds in the redemption basket. Recall that the average change in bond quantity is negative for

[9]We might underestimate the impact of mispricing with this approach as some bonds might not be demanded by the ETF and thus be unavailable for creation or redemption activity.

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TABLE 7

Liquidity and Dynamics of Creation and Redemption

Table 7 presents the results of regression analysis of the impact of bond liquidity and bond market stress on the change in the quantity of bonds in the creation and redemption baskets. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. We exclude bonds that are in both the creation and redemption baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022. The analysis is conditional on the bonds included in the realized baskets. Bid–Ask Spread and Trading Volume are bond liquidity measures, described in the text. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	High-Yield Creations		High-Yield Redemptions		Investment-Grade Creations		Investment-Grade Redemptions	
	1	2	3	4	5	6	7	(8)
Panel A. BlackRock Sample								
Bid–Ask_Spread	−0.012***		0.010***		−0.048***		0.086***	
	(0.003)		(0.003)		(0.011)		(0.006)	
Bid–Ask_Spread×Stress	0.012		−0.004		−0.030		0.107***	
	(0.012)		(0.027)		(0.053)		(0.037)	
log(Trad.Vol.)		0.013***		−0.012***		0.056***		−0.101***
		(0.001)		(0.001)		(0.003)		(0.003)
log(Trad.Vol.)×Stress		−0.006		−0.063***		−0.022		−0.152***
		(0.005)		(0.010)		(0.017)		(0.015)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	61,684	73,956	67,792	78,571	63,070	75,515	98,658	110,022
R^2	0.059	0.057	0.038	0.038	0.072	0.075	0.077	0.101
Panel B. ETF Global Sample								
Bid–Ask_Spread	−0.039***		0.018***		−0.010***		0.006***	
	(0.002)		(0.001)		(0.001)		(0.001)	
Bid–Ask_Spread×Stress	0.024***		0.015***		0.009		0.003	
	(0.007)		(0.005)		(0.006)		(0.003)	
log(Trad.Vol.)		0.030***		−0.015***		0.008***		−0.005***
		(0.000)		(0.000)		(0.000)		(0.000)
log(Trad.Vol.)×Stress		−0.006***		−0.026***		0.013***		−0.005***
		(0.002)		(0.002)		(0.001)		(0.001)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	320,686	391,885	357,896	439,622	1,123,044	1,580,463	890,259	1,279,840
R^2	0.256	0.266	0.387	0.387	0.175	0.184	0.380	0.383

redemption baskets. With a positive and statistically significant coefficient on the bid–ask spread variable, we find that as the bid–ask spread widens, the quantities of individual bonds used in redemption activity decrease. Results are consistent across liquidity measures. As bonds become more illiquid, bid–ask spreads widen or trading volume falls, and the intensity of redemption activity decreases. The impact is even greater on stress days when the trading volume is used to capture liquidity, as indicated in specification (4).

The results are similar for the investment-grade bonds, specifications (5)–(8) of Panel A. As bonds become more illiquid, the intensity of creation and redemption activities decreases. Moreover, we now find that the liquidity impact on redemption activity is greater on stress days using both measures, bid–ask spread and trading volume, as seen in specifications (7) and (8). The stress results so far provide no evidence to support the inventory management motive. They are, however, consistent with the argument that transaction costs present limits to arbitrage, and APs shy away from less liquid bonds for creation and redemption activities.

Panel B of Table 7 presents the results of the analysis for the ETF Global sample. We first consider bonds included in the high-yield realized creation baskets, specifications (1) and (2). The increase in the quantity of bonds is statistically significantly related to both liquidity measures. We continue to find that as the bid–ask spread narrows and the trading volume increases, the quantities of individual bonds used in creation activity increase. Interestingly, the results in these specifications now show that the sensitivity of creation activity to transaction costs decreases on stress days. This is indicated by the positive and significant coefficient on the interaction term in specification (1) and by the negative and significant coefficient on the interaction term in specification (2), suggesting that the inventory management motive might be at play. The results for the redemption baskets on stress days, however, are different: The sensitivity of redemption activity to transaction costs increases on stress days as indicated by the positive and significant coefficient on the interaction term in specification (3) and by the negative and significant coefficient on the interaction term in specification (4).

Specifications (5)–(8) in Panel B present results for the investment-grade bonds. As bonds become more illiquid, we continue to find that the intensity of creation and redemption activities decreases under normal conditions. On stress days, the sensitivity of creation and redemption activities to transaction costs does not change when the bid–ask spread is used but increases when the trading volume is used.

Overall, the results in this section show that transaction costs play an important role in explaining creation and redemption activities. While arbitrageurs take advantage of the creation and redemption processes to profit from mispricing arbitrage opportunities and thereby maintain a close relationship between an ETF's price and its NAV, these processes are hindered by decreases in bond liquidity. As this effect seems stronger for bonds in the redemption basket, our results suggest that APs are reluctant to accept a basket of illiquid bonds to add to their balance sheet or to accommodate client demand via the ETF redemption process when the markets for the underlying bonds are stressed. We also find evidence, although limited, that inventory management might explain at least some of the ETF share creation activity during stressful periods.

VII. Conclusions

We investigated the impact of bond ETF creation and redemption processes on the markets for the underlying high-yield and investment-grade corporate bonds. We use the information provided by both reported and realized baskets. Reported baskets represent bond demand by ETF managers while realized baskets capture creation and redemption activities by APs acting on this demand. We find that ETF creation and redemption processes predominantly have a favorable impact on bond liquidity.

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We also find that the bond liquidity effects are complex and sometimes might be subject to reversal during market stress periods. We do find consistent evidence that APs take advantage of mispricing arbitrage opportunities even on stress days, which explains the improvement in liquidity we document. However, not all activities by APs are fully explained by ETF arbitrage. The impact on bond liquidity also depends on how the trading and risk management decisions of APs, market makers, broker-dealers, and institutional investors interact with the full panoply of economic factors that affect the quality of these markets and on how that interaction plays out as bond market conditions change.

Appendix A. ETF Global Sample Construction

Our construction of the ETF Global sample begins by considering all the fixed income ETFs listed in the ETF Global database spanning the period from May 2017 to Dec. 2022. Following Koont et al. (2023), we exclude ETFs that employ active strategies and total bond market ETFs. Furthermore, we remove ETFs that allocate less than 90% of their holdings to U.S. corporate bonds and those that do not regularly update their holding data. For each ETF that meets our selection criteria, we collect daily data on shares, funds flow, and portfolio holdings from the ETF Global database.

To measure an ETF's realized creation and redemption baskets, we employ the approach developed by Shim and Todorov (2023). We identify the creation or redemption activity days as those days on which the ETF records a nonzero funds flow. On these specific days, the realized creation (redemption) basket comprises bonds that exhibit a positive (negative) change in the number of bonds held by the ETF.

The daily holdings for certain ETFs are recorded with a time shift in the ETF Global database, which causes a misalignment between their portfolio change and the corresponding change in ETF fund flows. This misalignment introduces potential leads or lags of up to 2 days. We identify such instances and apply adjustments following Shim and Todorov (2023) to eliminate the leads or lags. We begin by computing the implied funds flows based on holdings and bond prices, and we identify creation and redemption baskets using the approach described previously. Next, we calculate the correlation between the reported funds flows on day t with the implied funds flows on day $t-2$ through day $t+2$. The number of days by which the recorded holdings are shifted is then determined by identifying when this correlation is maximized. For instance, if an ETF's reported flows on day t exhibit the highest correlation with the implied flows on day $t+1$, we conclude that the holdings are erroneously reported with a 1-day delay. In such a case, we adjust the dates backward by 1 day for that particular ETF. Consistent with Shim and Todorov (2023), we find that these shifts are consistent for all ETFs that have the same ETF sponsor.

Figure A1 contains a histogram illustrating the distribution of the correlation coefficients between implied and reported funds flows for all ETFs after correcting for the time shifts in holdings. The median correlation is 0.90, the average is 0.82, and the 75th percentile is 0.96. We filter out ETFs below a threshold of 0.5, resulting in a final sample of 108 ETFs.

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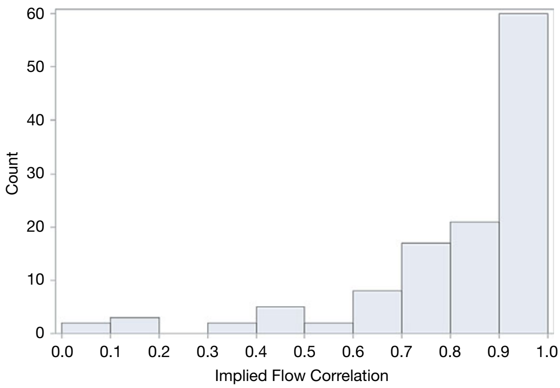
FIGURE A1

Correlation of Implied and Reported Funds Flows

Figure A1 shows the distribution of correlation coefficients between the implied and reported funds flows for all the corporate bond ETFs. Time shifts are applied to align the holding changes and the corresponding changes in ETF fund flows.



Appendix B. Realized Baskets for BlackRock Sample

TABLE B1

Realized Baskets for BlackRock Sample

Table B1 presents the results of regression analysis of the impact on liquidity measures of being included in the realized creation or redemption basket on stress days using the BlackRock sample. The dependent variables are Bid–Ask Spread and Trading Volume, described in Section IV.B. Bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 are included. *dCreate* equals 1 on days when the bond is in the realized creation basket, and *dRedeem* equals 1 on days when the bond is in the realized redemption basket. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield or investment-grade spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. All specifications include day fixed effects. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	Bid–Ask Spread				Trading Volume			
	High Yield		Investment Grade		High Yield		Investment Grade	
	1	2	3	4	5	6	7	8
dCreate	−0.104***	−0.102***	−0.071***	−0.072***	0.686***	0.677***	0.716***	0.719***
	(0.012)	(0.012)	(0.003)	(0.003)	(0.027)	(0.028)	(0.008)	(0.008)
dCreate×Stress		0.071		0.039		−0.262**		−0.120**
		(0.067)		(0.024)		(0.124)		(0.053)
dRedeem	−0.114***	−0.109***	−0.065***	−0.064***	0.723***	0.697***	0.631***	0.621***
	(0.012)	(0.013)	(0.003)	(0.003)	(0.028)	(0.029)	(0.007)	(0.007)
dRedeem×Stress		−0.057		−0.035*		0.342***		0.329***
		(0.064)		(0.021)		(0.113)		(0.041)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	591,305	590,397	1,346,841	1,344,680	713,215	712,298	1,616,993	1,615,036
R^2	0.218	0.218	0.242	0.242	0.200	0.200	0.278	0.278

Appendix C. Instrumental Variable Approach: First Stage

This appendix presents the first stage of the 2SLS estimation. We use shocks to bond over- or underweighting on index rebalancing days as an instrument. These shocks should affect original basket selection by ETF managers as the ETF's index-tracking objective constrains the liquidity transformation. To instrument for the baskets' readjustment, we use an approach similar to Koont et al. (2023) and construct two variables for our BlackRock and ETF Global samples.

For the BlackRock sample, the instrumental variables are constructed as follows using reported baskets:

$$Create\_\mathrm{Instr}_{bt} = dCreate_{bt-1} \times \Delta \mathrm{Deviation}_{bh}$$
$$Redeem\_Instr_{bt} = dRedeem_{bt-1} \times \Delta Deviation_{bh}$$

where $\Delta\mathrm{DEVIATION}_{bh}$ is each bond's overweighting in excess of its average overweighting over the previous week on the index rebalancing day *h.*

For the ETF Global sample, the instrumental variables are constructed as follows using realized baskets:

$$Create\_Instr_{btj} = J^{CR}{}_{tj} \times \Delta Deviation_{bhj}$$
$$Redeem\_Instr_{btj} = J^{RD}{}_{tj} \times \Delta Deviation_{bhj}$$

where $\Delta Deviation_{bhj}$ is each bond's overweighting in ETF *j's* portfolio in excess of its average overweighting over the previous week on the index rebalancing day *h*. $J^{CR}{}_{tj}$ ($J^{RD}{}_{tj}$) is a dummy variable that is equal to 1 if fund *j* has creation (redemption) baskets on day *t*, and 0 otherwise.

We expect $Create\_Instr_{bt}$ to capture adequately exclusion from the creation baskets and $Redeem\_Instr_{bt}$ to capture adequately inclusion in the redemption baskets.

The first-stage regressions are

$$Create_{bt} = \begin{array}{l} dc_1 \times CreateInstr_{bt} + dc_2 \times Redeem\mathrm{m}Inst_{bt} \\ + \; Controls_{bt} + b_b + \epsilon_{bt} \end{array}$$
$$Redeem_{bt} = \begin{array}{l} dr_1 \times CreateInstr_{bt} + dr_2 \times RedeemInstr_{bt} \\ + \; Controls_{bt} + b_b + \epsilon_{bt} \end{array}$$

We expect $dc_1 < 0$ and $dr_2 > 0$.

$Create_{bt}$ and $Redeem_{bt}$ are measures of basket inclusion. We control for each bond's liquidity over the previous week. In the BlackRock sample, we also control for lagged basket inclusion to take into account the possibility that membership in reported baskets may be persistent for some bonds. Table C1 provides the results of the first-stage estimation of the 2SLS estimation.

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TABLE C1

First-Stage Estimation

Table C1 presents the results of the first stage of the 2-stage IV estimation, described in the text. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. In this analysis, we use a subset of ETFs that track benchmark indexes created by IHS Markit. The dependent variable is *dCreate* in odd specifications and *dRedeem* in even specifications. *dCreate* equals 1 on days when the bond is in the creation basket, and *dRedeem* equals 1 on days when the bond is in the redemption basket. *Last Week Liquidity* is the average liquidity over the previous week. Daily data are used. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	Bid–Ask Spread				Trading Volume			
	High Yield		Investment Grade		High Yield		Investment Grade	
	dCreate	dRedeem	dCreate	dRedeem	dCREATE	dRedeem	dCreate	dRedeem
	1	2	3	4	5	6	7	8
Panel A. BlackRock Sample								
CreateInstr	−7.551*	36.826***	−66.902***	35.730***	−8.338**	37.632***	−75.664***	47.931***
	(4.056)	(7.855)	(7.349)	(10.694)	(3.807)	(7.484)	(7.323)	(10.291)
RedeemInstr	−0.170	2.208***	−1.325	62.335***	−0.165	2.348***	−0.519	61.445***
	(0.324)	(0.633)	(3.480)	(5.173)	(0.289)	(0.572)	(3.482)	(5.001)
Last Week Liquidity	0.001***	0.001*	−0.000	0.000	−0.001***	−0.000*	−0.001***	−0.001***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.Create	0.956***		0.962***		0.958***		0.962***	
	(0.000)		(0.000)		(0.000)		(0.000)	
L.Redeem		0.836***		0.924***		0.840***		0.925***
		(0.001)		(0.000)		(0.001)		(0.000)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	457,769	457,769	931,394	931,394	523,253	523,253	1,077,360	1,077,360
R^2	0.933	0.750	0.927	0.862	0.937	0.755	0.925	0.862
Panel B. ETF Global Sample								
CreateInstr	−1.444***	0.167***	−1.010***	0.412***	−1.431***	0.165***	−0.953***	0.408***
	(0.030)	(0.033)	(0.029)	(0.029)	(0.030)	(0.033)	(0.028)	(0.029)
RedeemInstr	0.373***	0.460***	0.056	0.0263	0.370***	0.456***	0.068**	0.016
	(0.035)	(0.039)	(0.035)	(0.035)	(0.035)	(0.038)	(0.034)	(0.035)
Last Week Liquidity	0.003***	−0.003***	−0.002***	−0.033***	0.007***	0.005***	0.006***	0.003***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,229,376	1,229,376	4,569,652	4,569,652	1,286,704	1,286,704	5,007,368	5,007,368
R^2	0.062	0.118	0.065	0.090	0.063	0.118	0.066	0.089

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Appendix D. ETF Mispricing and Stress Days

TABLE D1

ETF Mispricing and Stress Days

Table D1 presents the results of regression analysis of ETF mispricing on stress days. The dependent variable, *Misprice*, is the ratio of the ETF share price to the Fund NAV minus 1. Panel A includes bonds in the BlackRock HYG and LQD ETFs from 2009 until 2016 and relies on the reported baskets. Panel B includes bonds in the ETF Global sample from 2017 until 2022 and relies on the realized baskets. *Stress* is an indicator variable that is equal to 1 when the Bank of America/Merrill Lynch high-yield spread index widens 1.96 standard deviations or more from its mean, and is 0 otherwise. Daily data are used. Robust standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. BlackRock Sample

	High Yield			Investment Grade		
	All	2009–2013	2014–2016	All	2009–2013	2014–2016
	1	2	3	4	5	6
Stress	−0.009***	−0.013***	−0.003***	−0.003***	−0.004***	−0.002***
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.006***	0.008***	0.003***	0.004***	0.005***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	1,831	1,098	733	2,010	1,255	755
R^2	0.027	0.039	0.027	0.006	0.011	0.021

Panel B. ETF Global Sample

	High Yield			Investment Grade		
	All	2017–2019	2020–2022	All	2017–2019	2020–2022
	1	2	3	4	5	6
Stress	−0.004***	−0.003***	−0.004***	−0.008***	NA	−0.008***
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
Constant	0.001***	0.0004***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	43,357	19,042	24,315	67,553	29,389	38,164
R^2	0.030	0.004	0.056	0.103	0.000	0.155

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