ETFs, Illiquid Assets, and Fire Sales

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Major Concern: Significant selling pressure in *liquid* bond ETFs may be transmitted to the *illiquid* bond market and lead to a *fire sale*.

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- Do bond ETFs operate differently from equity ETFs (where the liquidity mismatch is less severe)?
- How do these operational differences affect premiums and discounts?
- Can ETFs actually *prevent* fire sales in the bond market?

Creation/Redemption Primer

- Authorized Participants (APs) can create new or redeem existing ETF shares
- Perform arbitrage to keep ETF price and NAV aligned
  - ETF price $>$ NAV (premium) $\rightarrow$ buy holdings (basket) and sell ETF, create new ETF shares to realize profits
  - ETF price $<$ NAV (discount) $\rightarrow$ sell holdings (basket) and buy ETF, redeem ETF shares to realize profits
- For equity ETFs, premiums are typically close to zero

Preview of Findings

Bond ETF Empirical Facts

- Bond ETFs utilize **“fractional baskets”** (baskets are a small subset of holdings)
- Fractional baskets are associated with more persistent premiums and discounts
- Bond liquidity helps explain magnitude of positive premiums
- Neither liquidity nor fractional baskets help explain magnitude of discounts

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Bond ETF Theory

- Build model of AP redemption with possibility of bond fire sales
- If AP holds inventory in bonds ("skin in the game"), ETF selling (redemption) does not lead to fire sale in underlying bond market
  - AP endogenizes fire sale costs by holding instead of selling redeemed bonds to preserve mark-to-market value of inventory
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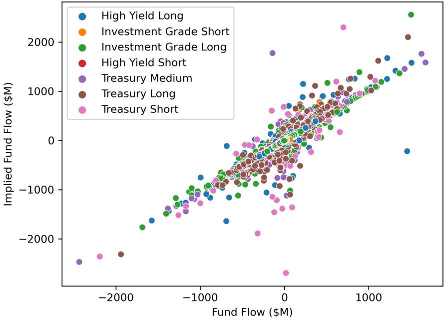
- Model predicts greater inventory $\rightarrow$ greater discounts
- Model helps explain puzzling COVID-19 patterns

Roadmap

1. **New Empirical Facts**
2. Model
3. Conclusion

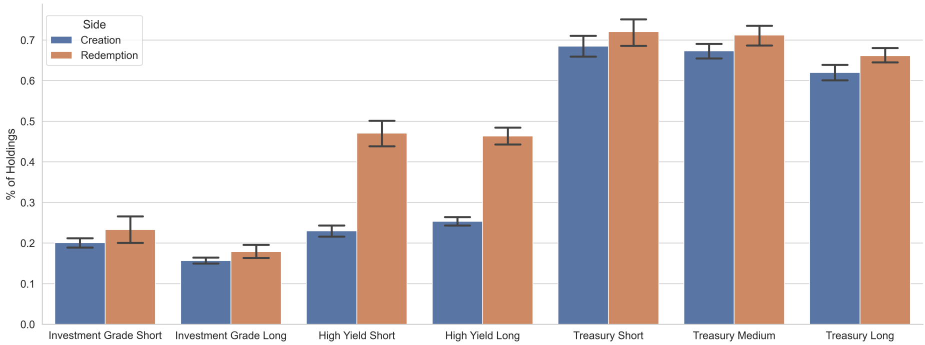
Data and methodology

- We develop a novel methodology to infer realized baskets: use changes in daily holdings on days with reported creation/redemption
  - Main data source is ETF Global, requires precise data cleaning
  - Reported flows and implied flows are in most cases an almost perfect match

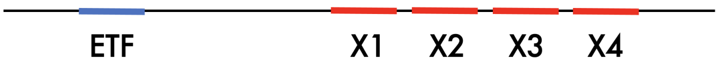


Basket Fractions

Corporate **bond ETF baskets are small fraction of holdings** in contrast to Treasury and equity ETFs with nearly "full" baskets



ETF Arbitrage Mechanics (Equities, Treasuries)



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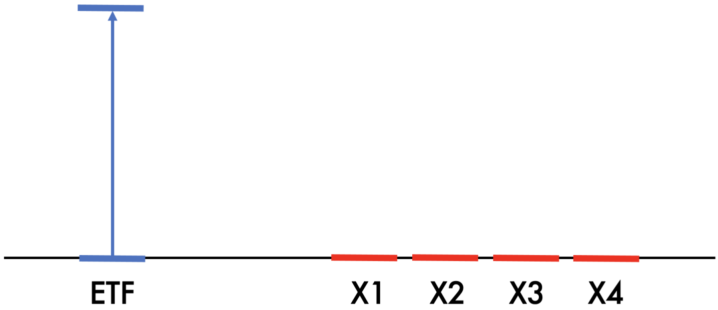

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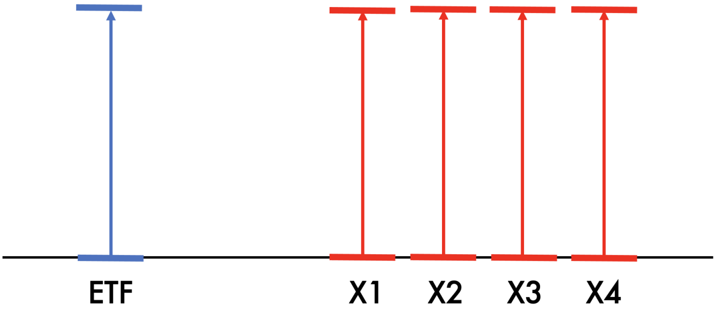

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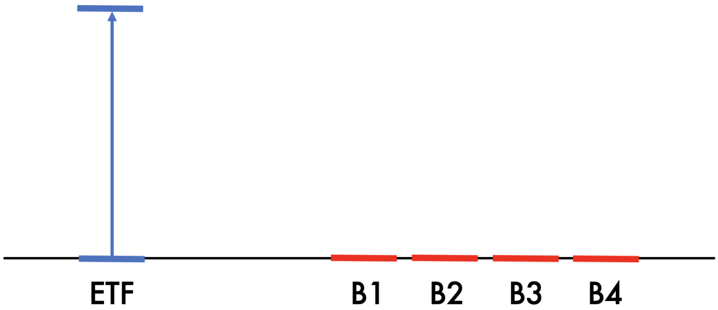

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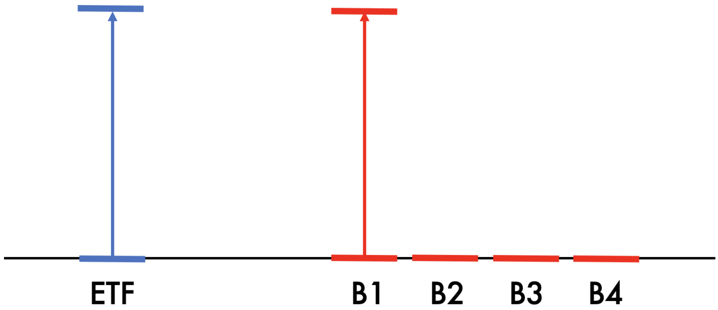

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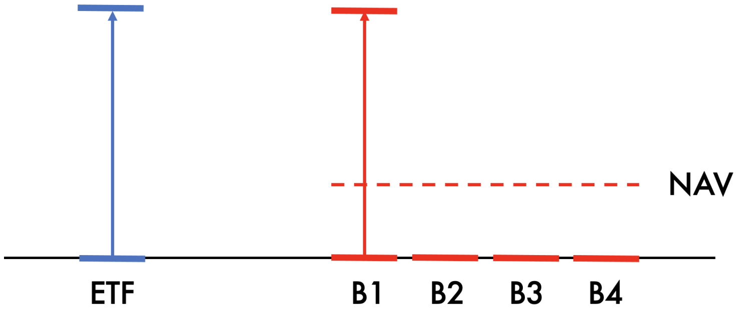

NAV Returns Lag Behind ETF Returns

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ETF Type:		Treasury		Investment Grade		High Yield	
Maturity:	Short	Medium	Long	Short	Long	Short	Long
β_e	0.730	0.938	0.946	0.250	0.516	0.438	0.503
s.e.	(0.010)	(0.005)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
R^2	0.567	0.847	0.916	0.255	0.513	0.451	0.468

As $\pi_{e,t} \approx \pi_{e,t-1} + (r_{e,t} - r_{NAV_e,t})$, $r_{NAV_e,t} < r_{e,t}$ means that the premium $\pi_{e,t}$ is persistent

Premiums are Persistent

AR(1) for premiums: $\pi_{e,t} = \alpha_e + \psi_e \pi_{e,t-1} + u_{e,t}$, $\psi_e > 0$

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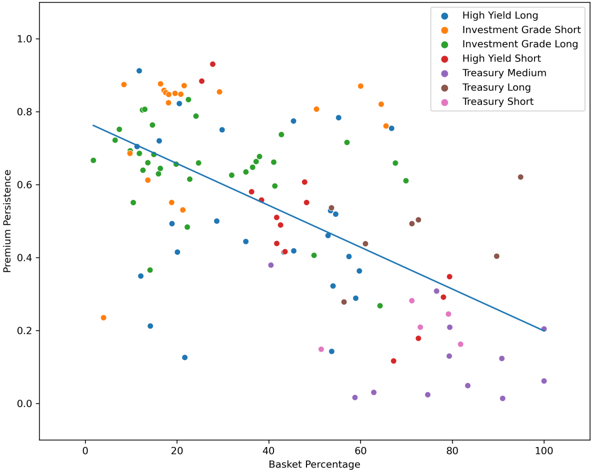
Maturity:	Short	Medium	Long	Short	Long	Short	Long
ψ_e	0.209	0.129	0.468	0.759	0.647	0.493	0.505
s.e.	0.025	0.023	0.015	0.011	0.007	0.012	0.013

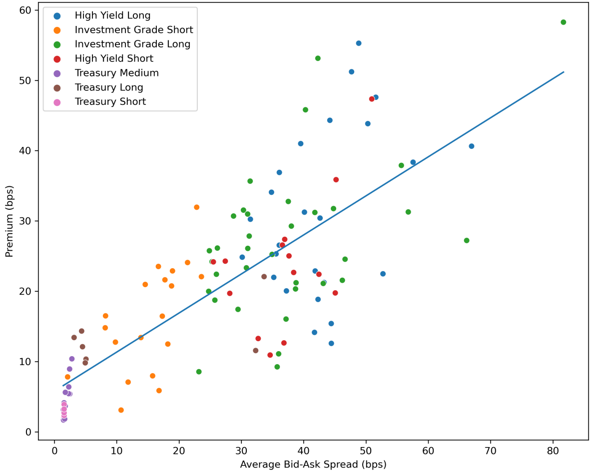
Fractional Baskets and Premium Persistence

Fractional baskets help explain the persistence of premiums



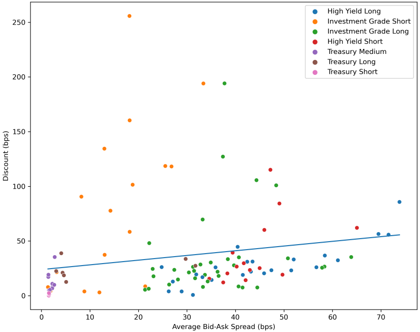
Liquidity and (Positive) Premium Magnitudes

Liquidity helps explain the magnitude of positive premiums

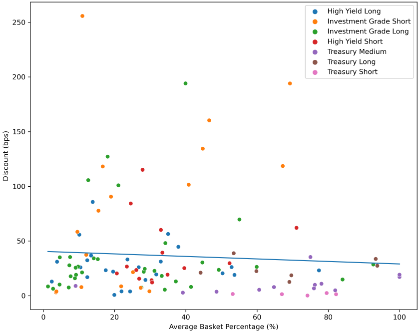


Discount Magnitudes

Neither fractional baskets nor liquidity help explain the magnitude of discounts



Discounts and Bid-Ask Spread



Discounts and Basket Percentage

Premium Regressions

$$y_e = \alpha + \beta_1 \cdot \text{BasketPercentage}_e + \beta_2 \cdot \text{BidAskSpread}_e + \text{controls}_e + \varepsilon_e$$

Dependent Variable (y_e):	ψ_e	$\pi_{e,\pi_e>0}$	$\pi_{e,\pi_e<0}$
Basket Percentage (%)	-0.006***	1.733	5.398
	(-6.365)	(0.441)	(0.304)
Bid-Ask Spread (bps)	0.001	0.545***	0.407
	(0.485)	(7.539)	(1.319)
Controls	✓	✓	✓
Adjusted R^2	0.334	0.575	0.032

Roadmap

1. Empirical Facts
2. **Model**
3. Conclusion

Motivation for the Model

- Aim of model: how do APs respond to significant selling pressure in bond ETFs?
- Model motivated by:
  - Discounts are different from premiums
  - Bond market is relatively illiquid, trading a large quantity could lead to a fire sale (Shleifer and Vishny, 1992)
  - Bond ETF APs are dealers in bond market, hold inventory (Pan and Zeng, 2021)
- Model is related to a growing area of research on ETFs and systemic risks (Bhattacharya and O'Hara, 2020)

Model Setup

- Securities
  - ETF e holds equally-weighted portfolio of two bonds A and B
  - Consistent with fractional baskets, only bond A in basket
  - All prices initially equal to P_0 ($P_0 = P_e = P_A = P_B$)

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- Exogenous liquidity in bond market
  - Price impact of selling x bonds is cx, $c > 0$
  - Selling more than τ leads to fire-sale price impact of fx, $f > c$ (must sell to outsiders)

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AP's payoff:

$$\underbrace{(NAV_{basket} - P_e) \cdot q}_{\text{arbitrage profit}} - \underbrace{\frac{\lambda}{2} \cdot (\gamma q)^2}_{\text{holding costs}} + \underbrace{(z + \gamma q) \cdot \Delta P_A}_{\text{mark-to-market costs}}$$

AP

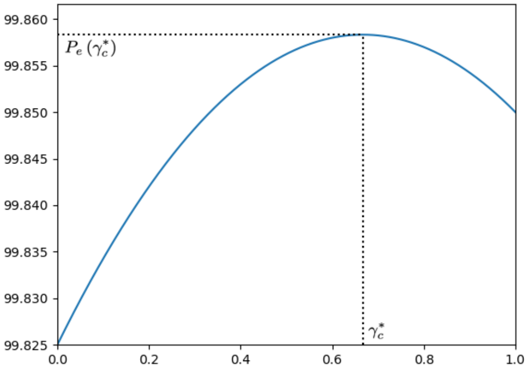
- Representative AP is disciplined by competition
  - Makes zero profits (passes costs to ETF seller through lower ETF price P_e)
  - Competition incentivizes AP to quote highest possible P_e
- AP maximizes P_e as a function of γ (for now, assuming no fire sales):

$$P_e(\gamma) = P_0 - c(q+z) + cz\gamma - \left(\frac{\lambda}{2} - c\right) q\gamma^2$$

No Fire Sales

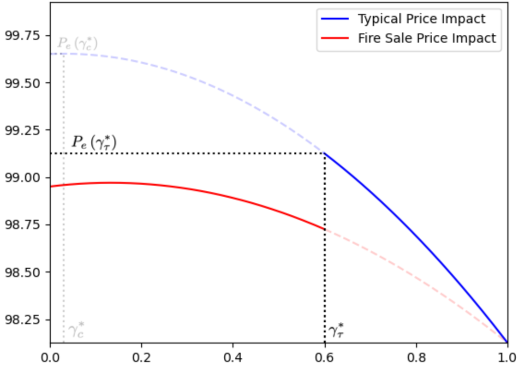
- Without fire sales, equilibrium holding fraction is

$$\gamma_c^* = \frac{cz}{(\lambda - 2c)\, q}$$



Adding Fire Sales

- Allow for the possibility of a fire sale:
  - If $(1-\gamma_c^*)\,q \leq \tau$, then $\gamma^* = \gamma_c^*$
  - If $(1-\gamma_c^*)\,q > \tau$, $\gamma^* = \gamma_\tau^* = 1 - \frac{\tau}{q}$ (sell up to fire-sale threshold τ)



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- With inventory, AP always avoids a fire sale (acts as a buffer between ETF and bond market)
  - Internalizes fire sale cost because it severely reduces value of existing inventory
  - Results in lower ETF price but higher bond prices $\rightarrow$ large discount
  - Discount increasing in inventory

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- Mutual Fund (MF) cannot avoid fire sale because no buffer between redemptions and liquidating assets
  - MF sellers impose cost on remaining MF investors (ETF sellers pay large discounts but remaining investors don't)
  - Outside the model: MF can't avoid these costs, but can use other instruments (cash, pecking order)

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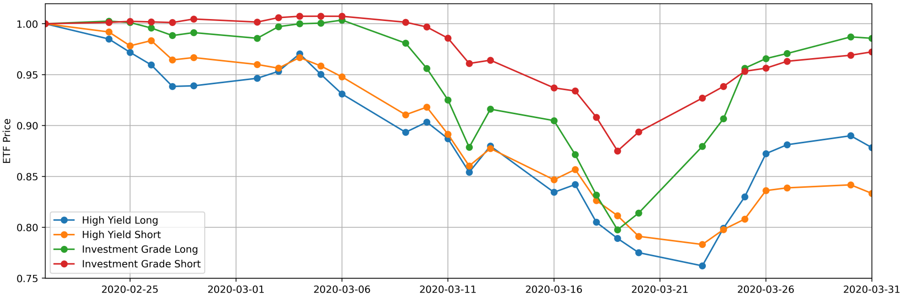
  - Greater inventory $\rightarrow$ greater discounts
- Discounts are also increasing in redemption flow (q)

Empirical Support – Discounts Increasing in Inventories

$$\text{discount}_{e,t} = \alpha_e + \beta_1 z_{e,t} + \beta_2 q_{e,t} + \beta_3 \text{BidAskSpread}_{e,t} + \beta_4 \text{BasketPercentage}_{e,t} + \varepsilon_{e,t}$$

	(1)	(2)
Inventory z (\$B)	1.022***	0.980***
	(2.815)	(2.666)
Redemption Flow q (\$M)		0.013**
		(2.447)
Bid-Ask Spread (bps)		0.118
		(0.983)
Basket Percentage (%)		0.001
		(0.048)
ETF F.E.	✓	✓
R^2	0.359	0.368
Observations	2,477	2,477

Empirical Support – COVID-19 Prices



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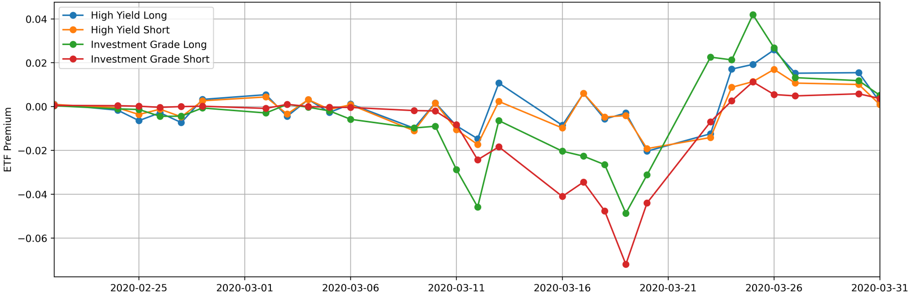
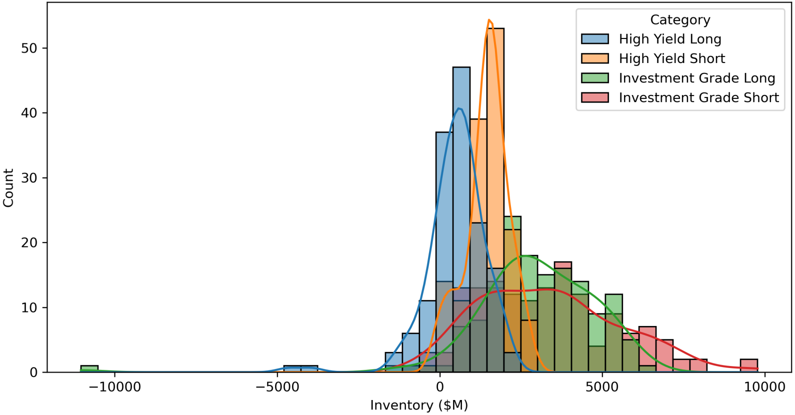


Empirical Support – Dealer Inventories



ETFs investing in bonds in which APs hold the largest *inventory* had the biggest discounts, not ETFs investing in the most illiquid assets

Conclusion

- We show several new facts about bond ETFs
  - They have *fractional baskets*, which leads to imperfect arbitrage
  - Premium persistence is related to fractional baskets, (positive) premium magnitude is related to liquidity
  - Neither explain discount magnitude
- We then build a model to show that APs can prevent fire sales
  - With inventory, AP has "skin in the game," acts as a *buffer* between the ETF market and the bond market
  - Larger AP's costs are passed to redeeming investors in the form of a greater ETF discount
  - Suggests that ETFs have an advantage over mutual funds as custodian of illiquid assets, can prevent fire sales
- Model helps explain the puzzling fact investment grade bond ETFs (not high-yield) saw the largest discounts during the COVID-19 sell-off