True Cost of Immediacy

How large are opportunity costs of not trading?

Does selection bias in OTC trades provide a false impression of liquidity and stability?

Terry Hendershott[1] Dan Li[2] Dmitry Livdan[1] Norman Schürhoff[3]

[1]UC Berkeley [2]Federal Reserve Board

[3]University of Lausanne, Swiss Finance Institute, CEPR

NBER Big Data
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Motivation

- Owner wants to sell an asset and solicits bids $\{B_i\}_{i=1}^N$ from N dealers
- Owner has a reserve price R, would not sell if the highest bid is below R
- If trade is successful the dealer can liquidate the asset for $A >$ winning bid
- Seller's expected profits:

$$\mathbb{E}[\Pi] = \underbrace{(1 - \Pr(\text{Fail})) * \mathbb{E}[B|\text{Trade}]}_{\text{Trade}} + \underbrace{\Pr(\text{Fail}) * R}_{\text{Outside option}}$$

- Cost of immediacy:

$$\textbf{TCI} \equiv \mathbb{E}[A - \Pi] = \underbrace{\mathbb{E}[A - B|\text{Trade}]}_{\text{Observed bid-ask spread}} + \underbrace{\Pr(\text{Fail})}_{\text{Fail rate}} * \underbrace{(\mathbb{E}[B|\text{Trade}] - R)}_{\text{Unobserved cost of trade failure}}$$

This paper:

Estimates the True Cost of Immediacy, **TCI**.

Issues with estimating the cost of immediacy

Firm quotes for all trade sizes enable precise measurement

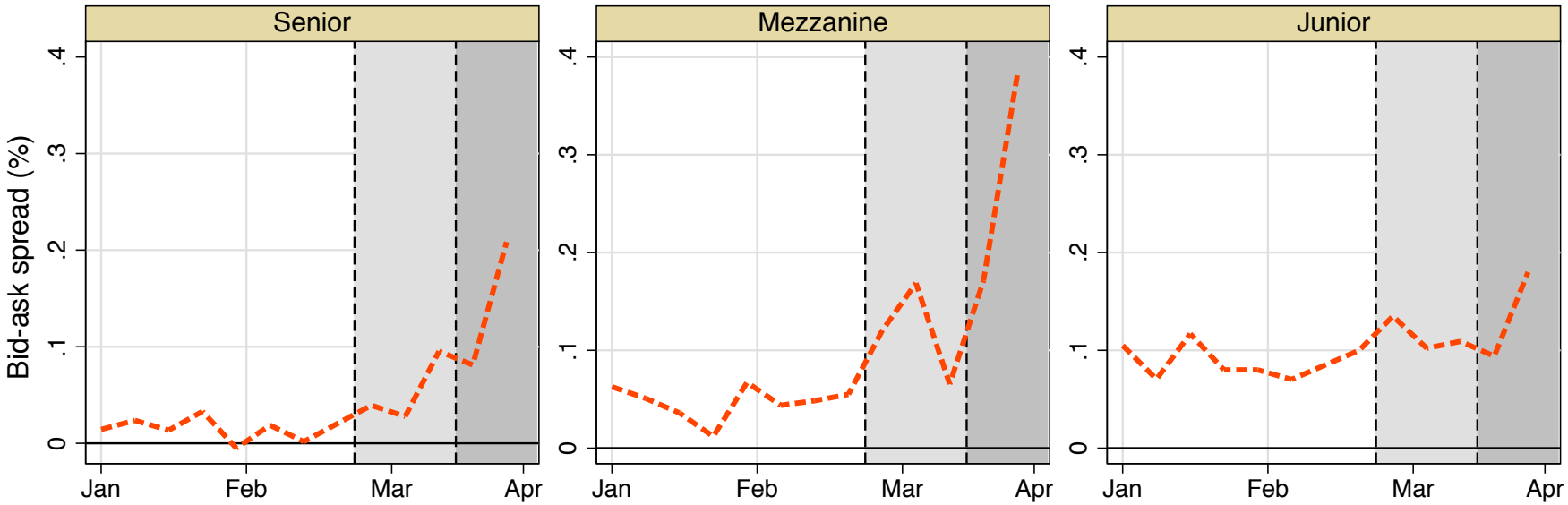
OTC Markets

- No quotes and often sparse trades; data availability?
- 'Roll' models of transaction prices, very noisy

Centralized (Equity) Markets

- Continuous firm quotes, but for small sizes
- Large orders are broken up into small trades over time
- Institutional order data (Ancerno) does not capture unfilled orders
- Optimal trading strategies being price contingent downwardly biases trading costs because larger trades occur when price impact is lower
- Generally, opportunity costs of unfilled orders (Perold (1988))

CLO bid-ask spreads during the 2020 pandemic

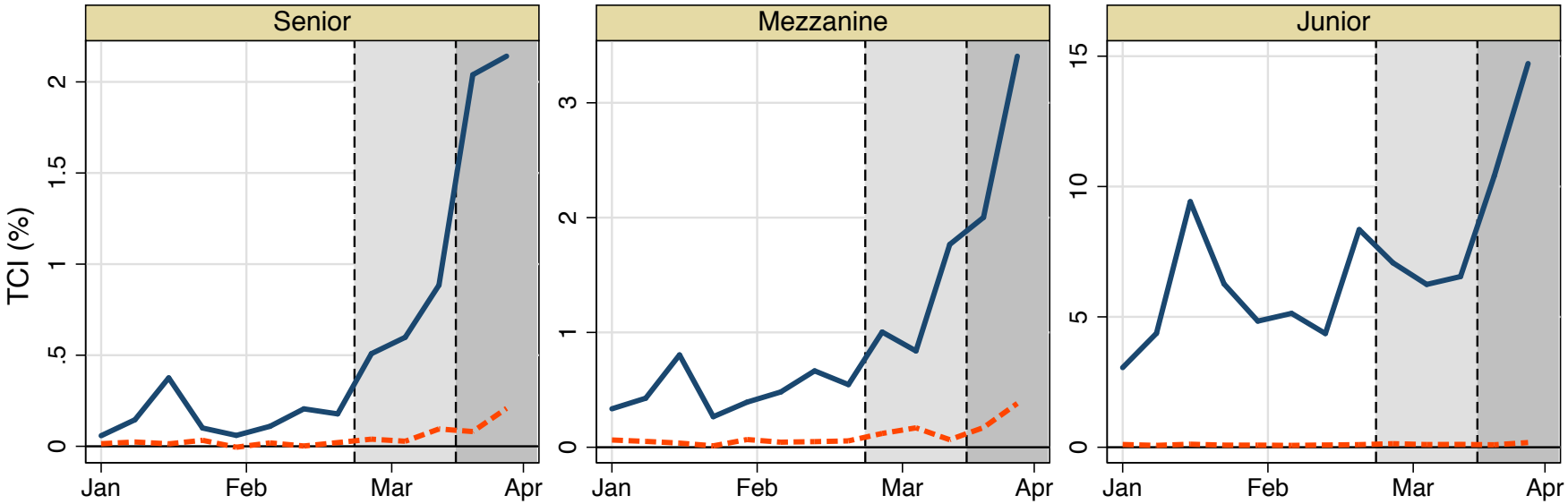


- Bid-ask is dealer buy price minus dealer sell price for roundtrips < 1 day
- Spreads start low (5-10bp of par) then increase noticeably in March
- Spreads remain less than 40bp

Did the CLO market perform well under stress?

CLO TCI and bid-ask spreads during the 2020 pandemic

Bid-ask spreads are in red, TCI is in blue
Note different y-axis scales across tranches



- TCI and bid-ask vary in cross section and time series
- TCI increases to 2% (Senior), 3% (Mezzanine), 15% (Junior)
- Why different? Failures: rise to 60% in Junior

Literature 1

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

- Corporate bond liquidity significantly decreased during 2007-2009

Kargar, Lester, Lindsay, Liu, Weill, and Zuniga (2020) and O'Hara and Zhou (2020) for corporate bonds and Foley-Fisher, Gorton, and Verani (2020) for CLOs

- Bid-ask spreads significantly widened in March 2020

Bessembinder, Jacobsen, Maxwell, & Venkataraman (2018)

- Examine corporate bonds over time: trading costs fairly constant over time, but traditional dealers take on less inventory risk
- Consistent with an decrease in customers' ability to trade and an increase in opportunity costs. However, they are not able to directly measure either of these.

Illiquidity may have been much worse than measured due to failures

Literature 2

Hendershott and Madhavan (2015)

- Study corporate bond trading via request for quote (RFQ) auctions
- RFQs fail often, result in higher costs; CLOs fails likely more costly
  - corporate-bond RFQs are shorter lived (5-10mins)
  - corporate bonds trade significantly more frequently than CLOs
  - the number of corporate-bond dealers is substantially higher
  - do not estimate the costs for attempted trades that fail to ever occur

Riggs, Onur, Reiffen, and Zhu (2020)

- Study index CDS RFQs and bilateral trades
  - Inquiries almost always lead to trades, so cost of failure is less relevant

Harris and Hasbrouck (1996)

- Compare performance of limit versus market orders on NYSE; estimate opportunity cost of limit order as market order after 5min
  - Bessembinder, Panayides, and Venkataraman (2009) extend this by examining opportunity costs for hidden limit orders

CLO Workings

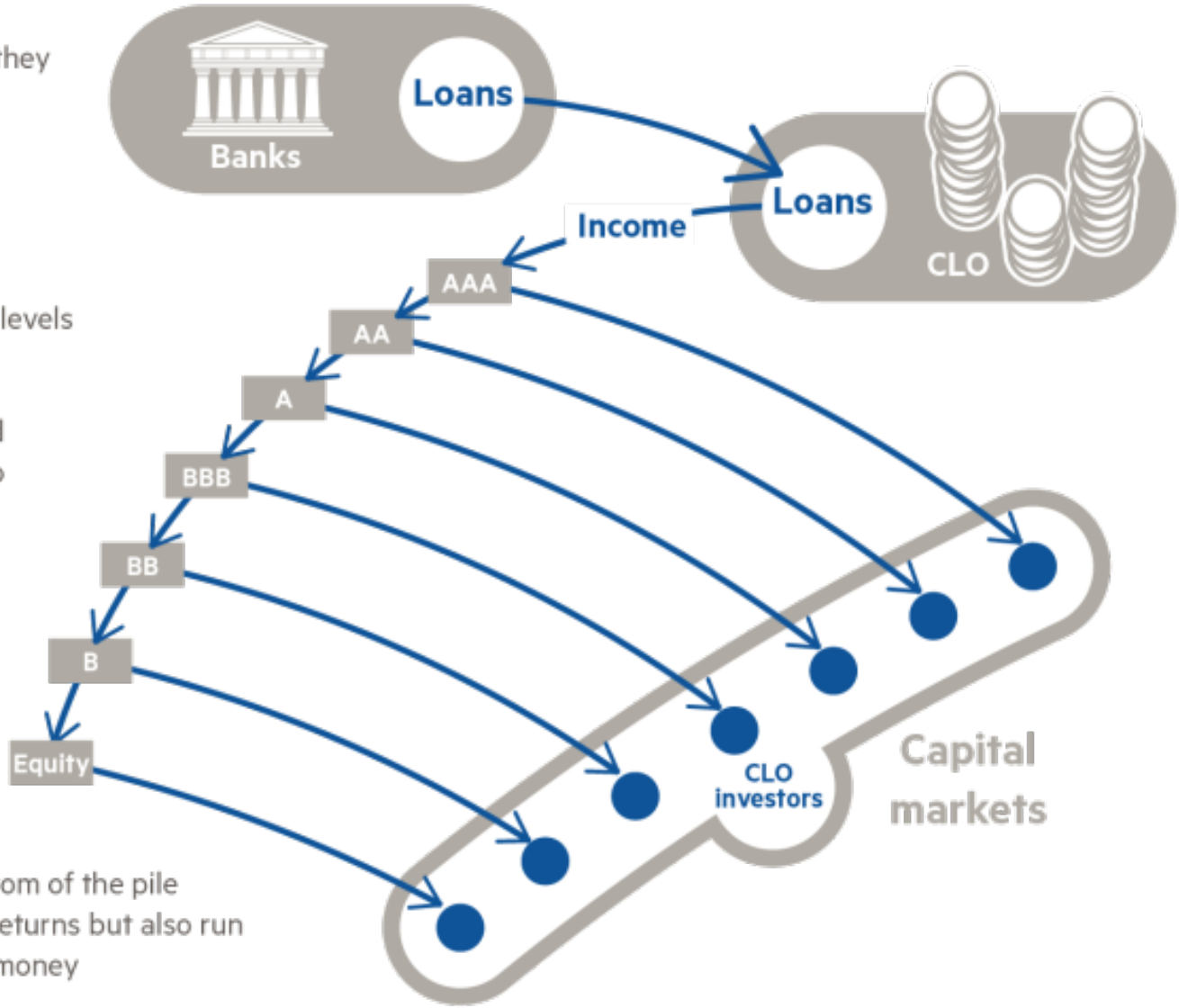
How collateralised loan obligations work

1. Banks sell the loans they have created to a CLO manager

2. The CLO divides the loans' risk into various levels

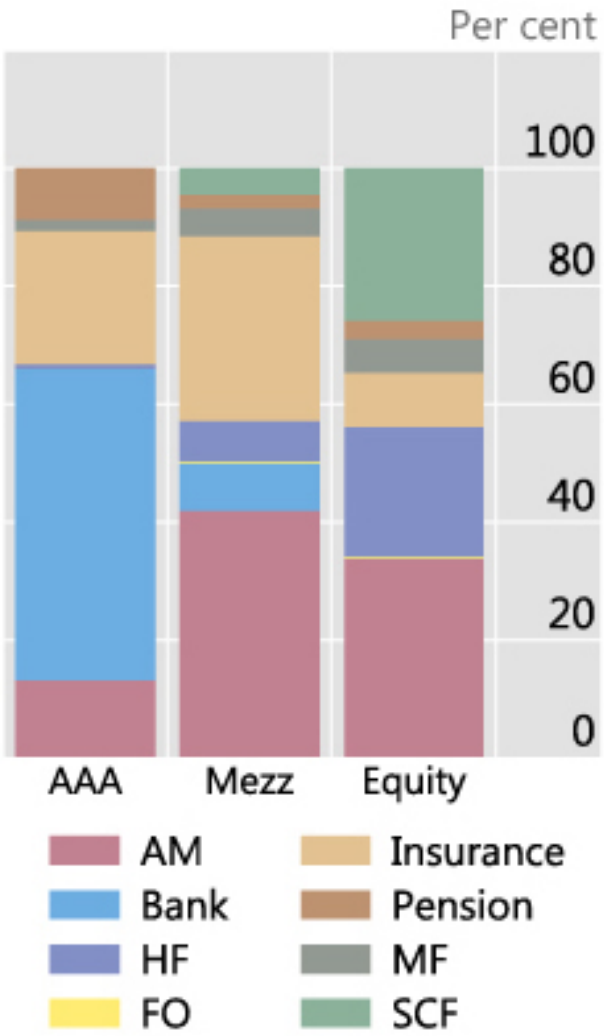
3. As the loans are paid off, the income flows to the buyers of the CLO

4. Investors at the bottom of the pile stand to make higher returns but also run a higher risk of losing money



Who holds CLOs?

CLO investor base as of end-2018[4]



Senior Tranches (Rated AAA and AA)

- Banks
- Institutional asset managers
- Insurance companies
- Pension funds and endowments

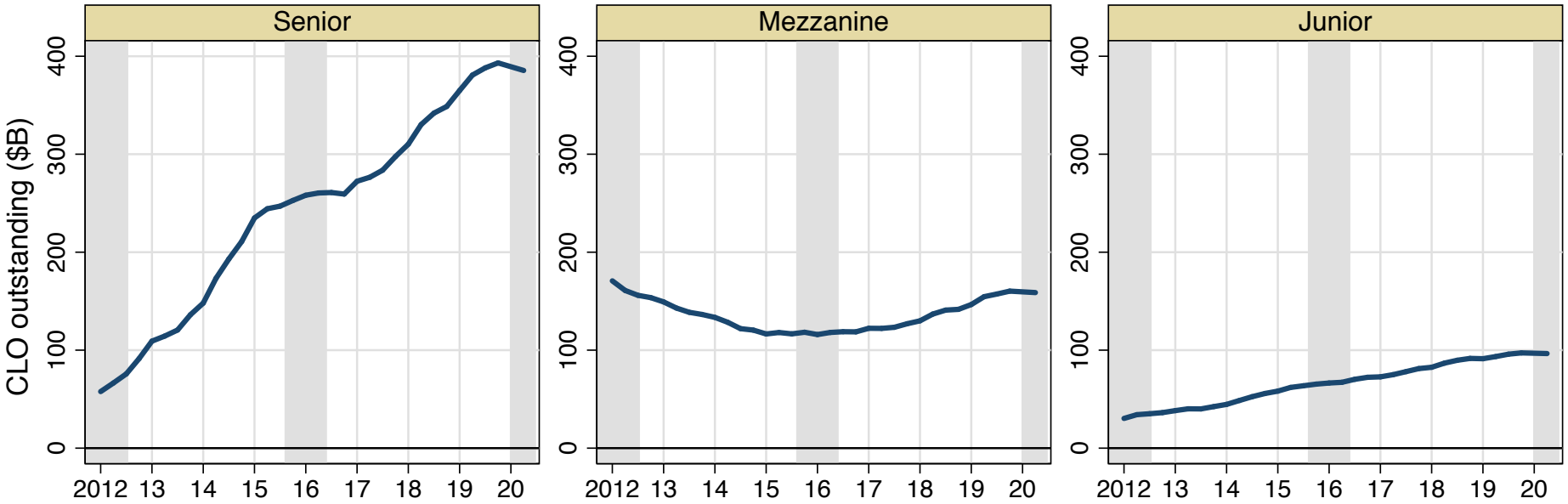
Mezzanine Tranches (Rated A/BBB/BB)

- Banks
- Hedge funds
- Institutional asset managers
- Insurance companies
- Pension funds and endowments
- Permanent-capital vehicles*
- Structured credit funds

Equity Tranches

- Banks
- CLO managers
- Family offices
- Hedge funds
- Institutional asset managers
- Insurance companies
- Pension funds and endowments
- Sovereign wealth funds
- Structured credit funds
- Permanent-capital vehicles*
- Private equity funds

CLO Market Size

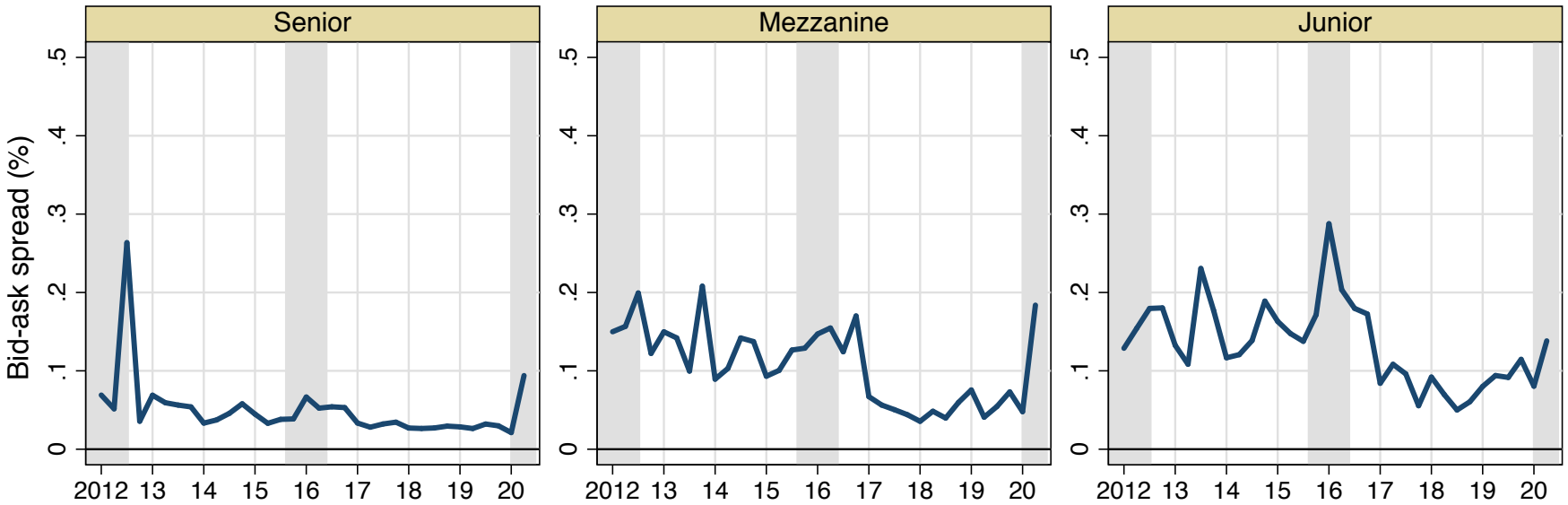


CLO BWICs, 2012 to March 2020, data from Creditflux

- First-price sealed bid auctions
  - Via email (more flexible, less standardized), one day to several days
  - Only seller and winner know high bid (trade price)
  - For trade, information disseminated back to the market or the losing dealers is the "cover", which is the second highest bid in the auction
  - BWIC failure is disclosed as "DNT (Did Not Trade)" (no cover)
- BWIC trade data from non-public TRACE
  - 40% of Customer to Dealer trades can be matched to BWICs
  - Typical CLO trades 11 times in our auction sample
    - Varies some by rating: 15 in senior, 9 in junior
  - Relatively little interdealer trading
    - 0.33 of an interdealer trade for every dealer-buy trade
    - Comparable 2019 numbers are 1.7, 1.8, and 1.4 for munis, IG and HY corporate bonds

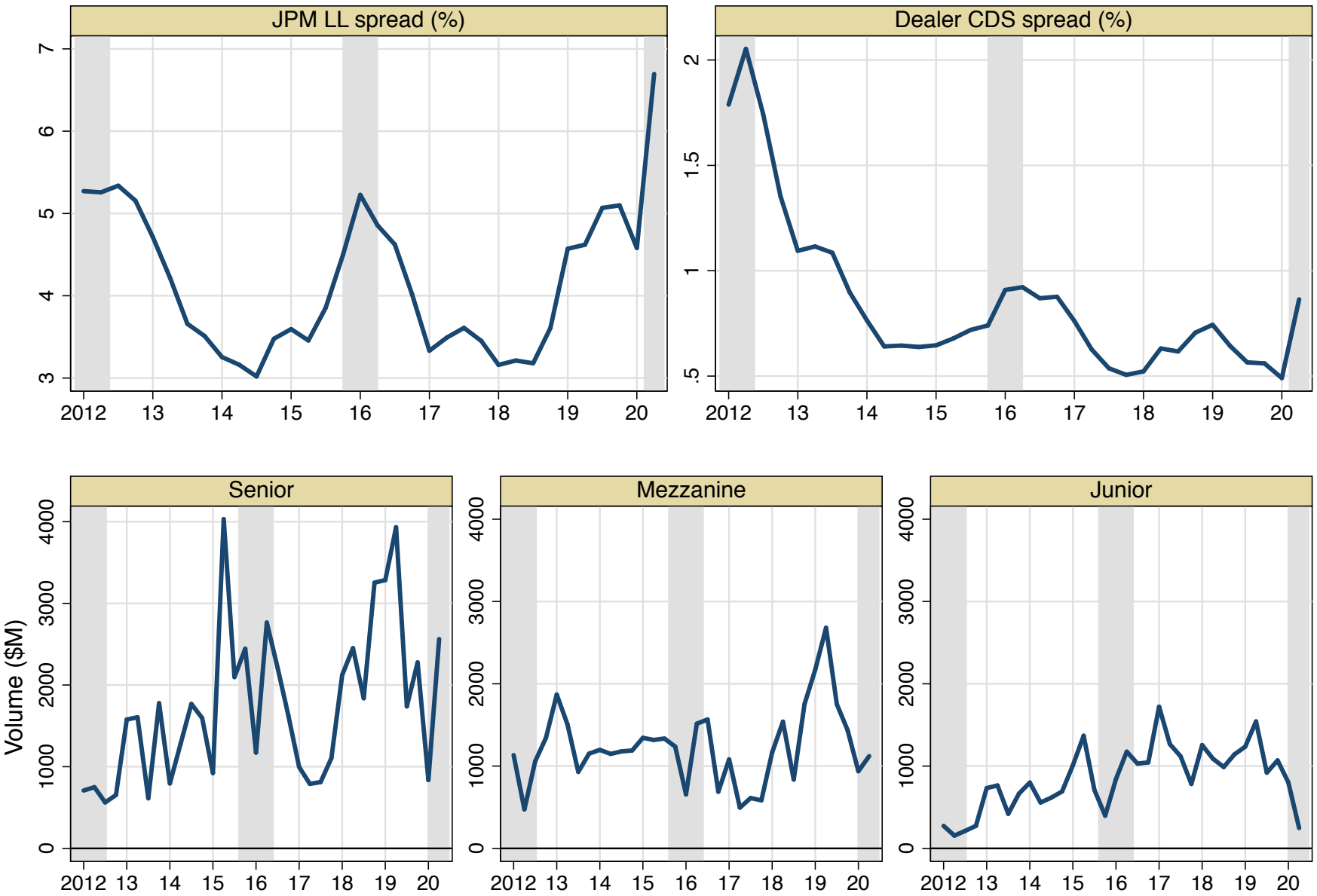
CLO averages and spreads (dealer round trips)

- Senior: Issue size $228M, trade size $2.8M, bid-ask spread 4bp
- Mezzanine: Issue size $34M, trade size $2.5M, bid-ask spread 10bp
- Junior: Issue size $23M, trade size $3.4M, bid-ask spread 12bp

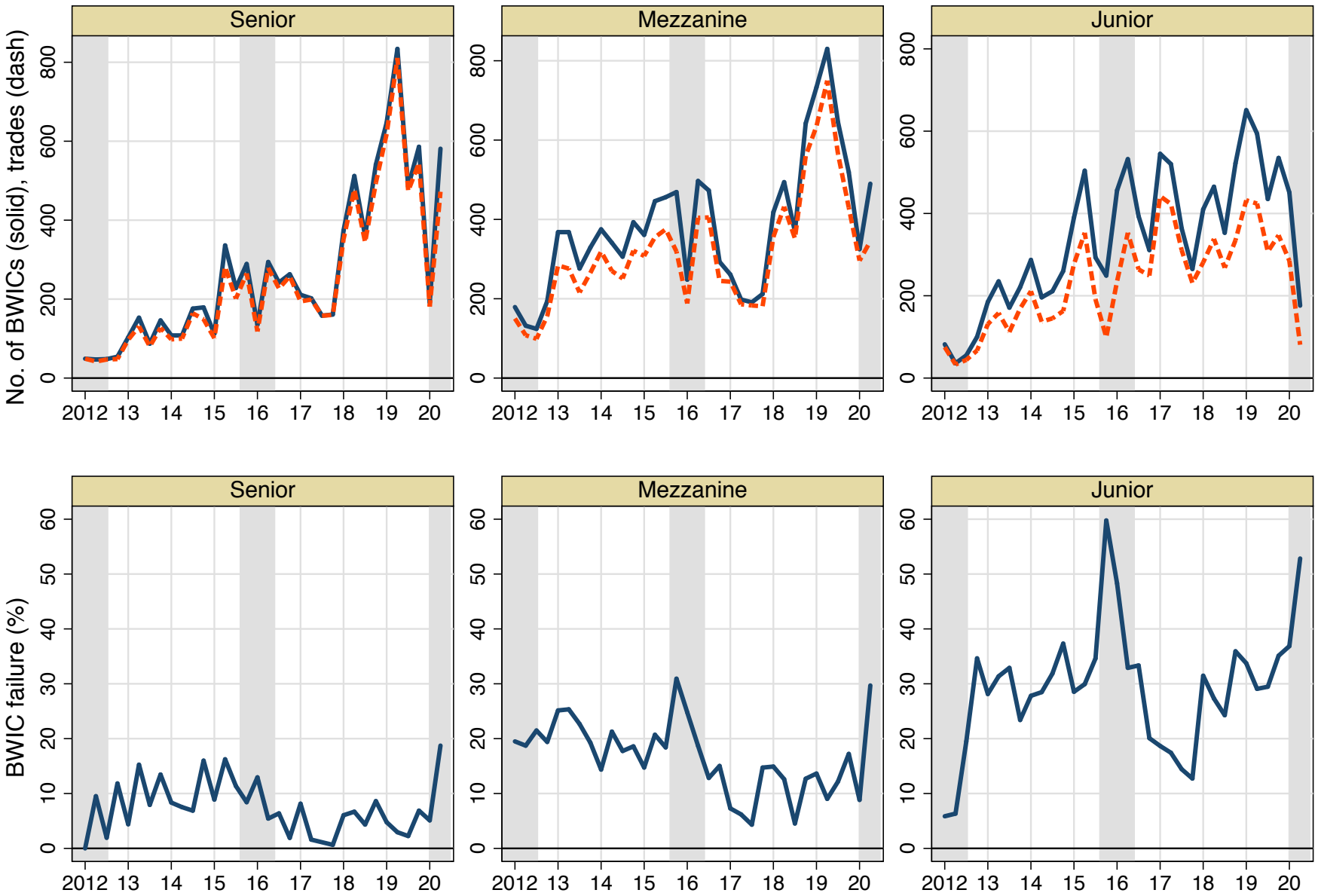


Gray areas are 2012 euro debt, 2015-16 credit stress, 2020
Liquidity improves in second half of sample as market expands

CLO Market Conditions and Trading



CLO BWICs and Failures



TCI estimation strategy

Want to estimate in the data:

$$\textbf{TCI} = \underbrace{\mathbb{E}[A - B|\text{Trade}]}_{\text{Observed bid-ask spread}} + \underbrace{\Pr(\text{Fail})}_{\text{Fail rate}} * \underbrace{(\mathbb{E}[B|\text{Trade}] - R)}_{\text{Unobserved cost of trade failure}}$$

- $\mathbb{E}[A - B|\text{Trade}]$ – observed bid-ask spread
- $\Pr(\text{Fail})$ – observed BWIC failure rate
- $\mathbb{E}[B|\text{Trade}]$ – observed best bid $B = \max\{B_n | n \in \{1, ..., N\}\}$
- R – the lowest accepted bid and an upper bound on outside option:

$$R = \inf_{(B_1, B_2, ..., B_N)} \{B^{1:N} | \text{Trade}\},$$

Reserve value estimation

STEP 1:

Pool BWICs across sellers and parametrize $R(\boldsymbol{X}_i, \varepsilon_{R,i})$ as a function of observable CLO, seller, and market characteristics, $\boldsymbol{X}_i$, and an unobservable noise component, $\varepsilon_{R,i}$, as

$$R(\boldsymbol{X}_i, \varepsilon_{R,i}) = \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i + \varepsilon_{R,i}$$

STEP 2:

Use the "individual rationality" moment restriction:

$$\Pr(B_i^{1:N} < R_i) = \mathbb{E}[\mathbb{1}(B_i^{1:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i + \varepsilon_{R,i}) | \boldsymbol{X}_i] = 0,$$

then relax it to:

$$\mathbb{E}[\tau^* - \mathbb{1}(B_i^{1:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i) | \boldsymbol{X}_i] = 0,$$

where $\tau^* \in [0, 1)$ is the quantile that absorbs $\varepsilon_{R,i}$. This is *quantile* regression.

Manually vary τ^* between 1%, 5%, 10%. Later estimate *optimal* τ^* using GMM.

Empirical Implementation

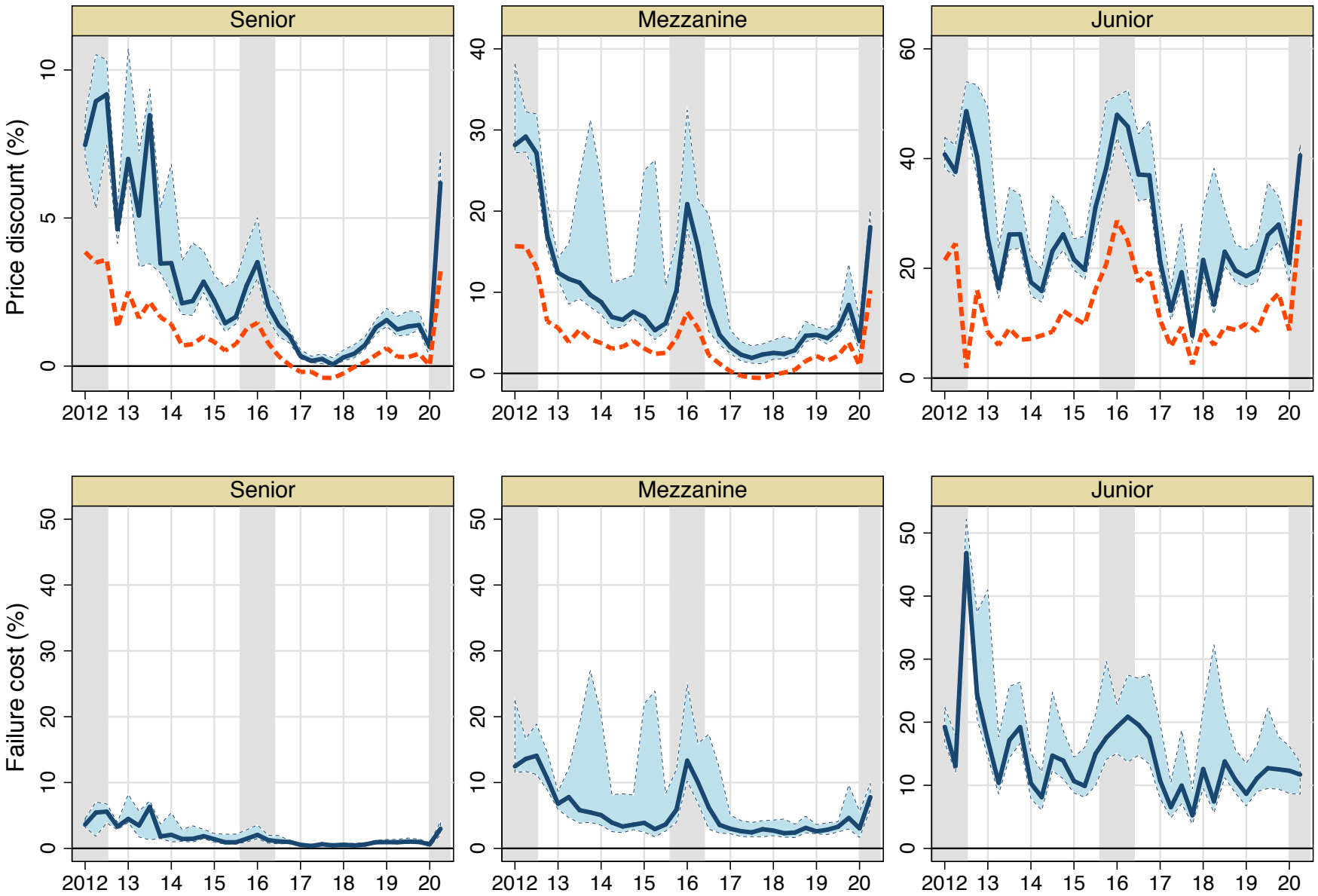
Construct the in-sample average TCI across I BWICs from the perspective of a typical CLO seller

$$\widehat{\text{TCI}} = \frac{1}{I}\sum_{i=1}^{I} \widehat{\text{Bid-ask spread}}_i + \frac{1}{I}\sum_{i=1}^{I}\left(\widehat{\text{BWIC fail rate}}_i * \widehat{\text{Failure cost}}_i\right)$$

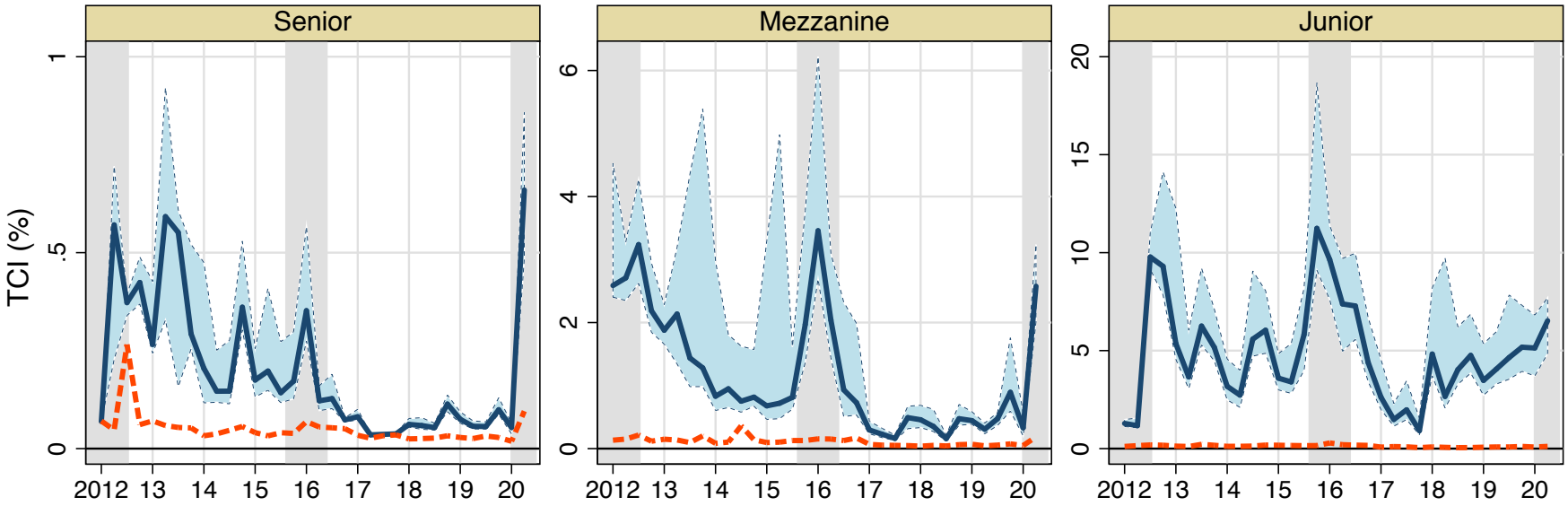
- Linear model for bid-ask spreads: $\text{Bid-Ask spread}_{it} = \alpha + \alpha_t + \boldsymbol{\beta}'\boldsymbol{X}_{it} + \epsilon_{it}$
- Probit for fail rate: $\Pr(\text{BWIC failure}_{it}) = \Phi(\alpha + \alpha_t + \boldsymbol{\beta}'\boldsymbol{X}_{it} + \epsilon_{it})$
- Linear model for expected best bid
- Quantile regression for R

- Similar control variables across these models, quarter fixed effects α_t, characteristics of the trade, the CLO, market and dealer conditions
- Separately estimated for different tranches

Dealers Bids and Failure Costs



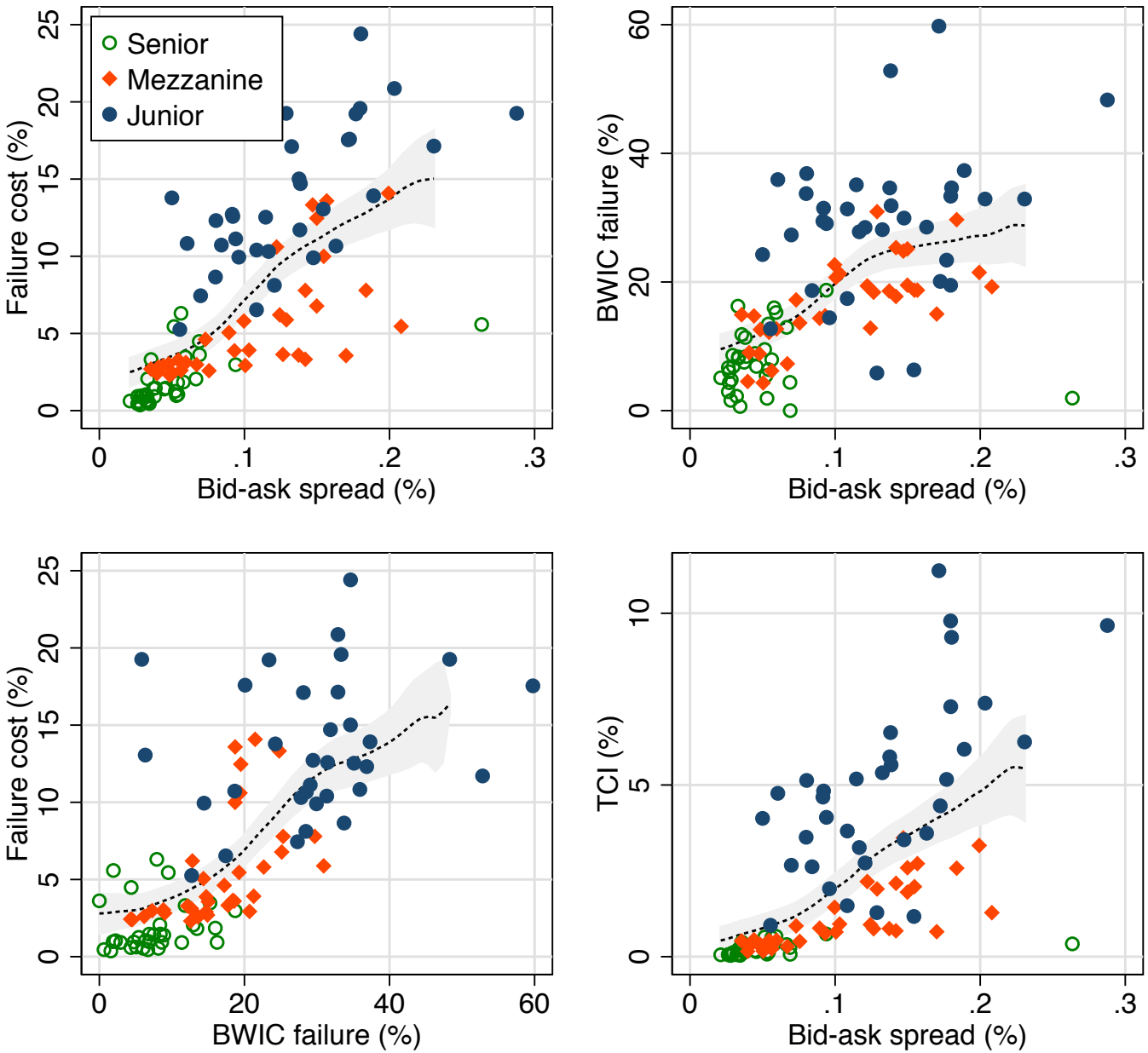
TCI and Bid-Ask Spread



TCI shown for 1%, 5%, and 10% quantiles, dark line is 5%

$$\textbf{TCI} = \mathbb{E}[\text{B-A}|X] + \mathbb{E}[\text{Fail rate}|X] * \mathbb{E}[\text{Fail cost}|X] + \underbrace{Cov(\text{Fail rate}, \text{Fail cost}|X)}_{>0\text{: Amplification}}$$

TCI, Bid-Ask Spread, & Amplification (slopes >> 1)



TCI: "Endogenous" quantile regressions

Additional moments for cover prices, $B^{2:N}$:

Cover prices are reported if they are above the seller's reserve price

$$\Pr(B_i^{2:N} < R_i) = \mathbb{E}[\mathbb{1}(B_i^{2:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i + \varepsilon_{R,i}) | \boldsymbol{X}_i] = 0.$$

ASSUMPTION:

The probability of BWIC success and τ can be parametrized as:

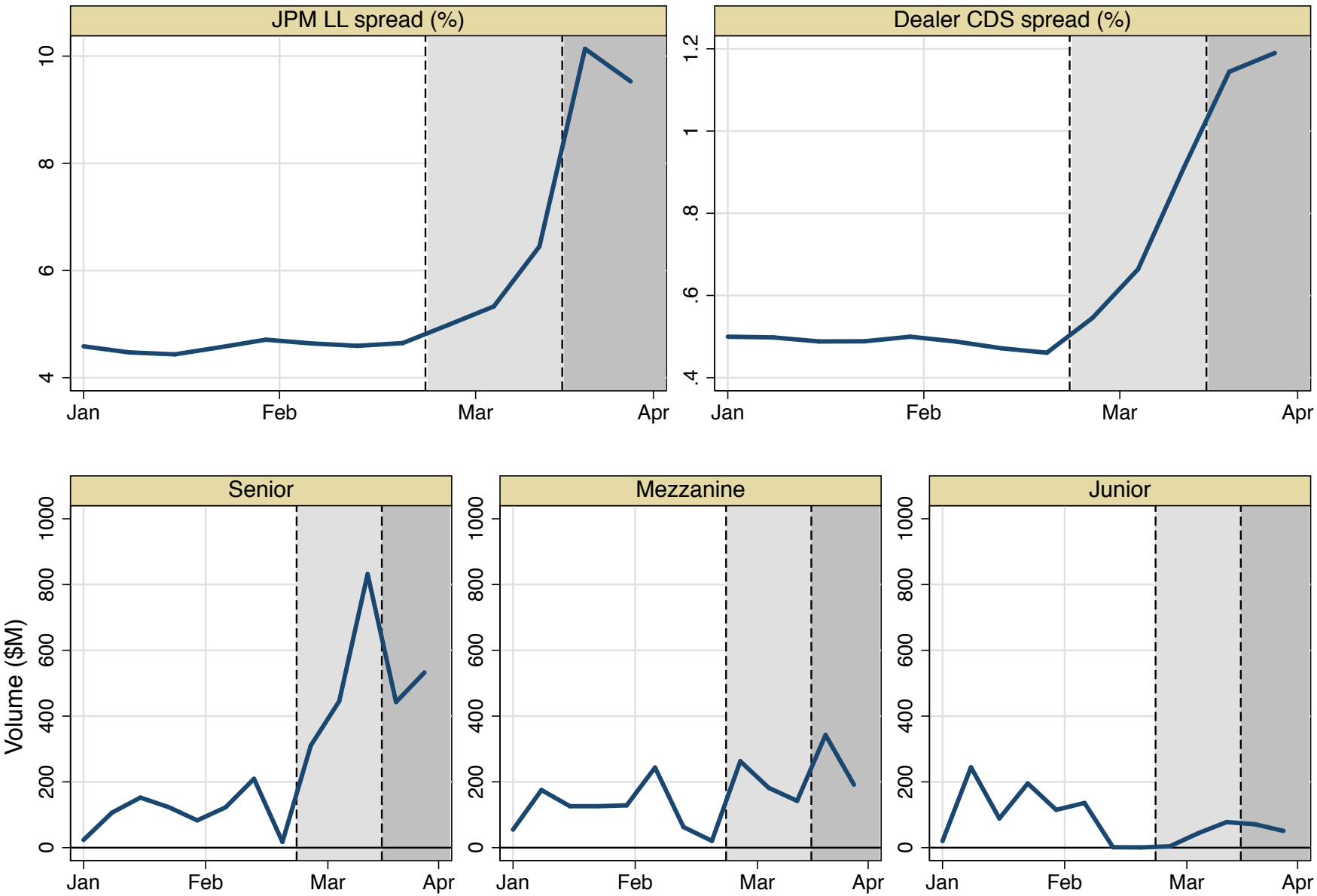
$$\Pr(\text{Trade}_i) = h(S_i) = h(\alpha_S + \boldsymbol{\beta_S}' \boldsymbol{X}_i),$$
$$\tau^j(\widehat{S}_i) = \tau_0^j + \tau_1^j \widehat{S}_i, \qquad j = \{\text{Best Bid,Cover}\}.$$

GMM moment conditions:

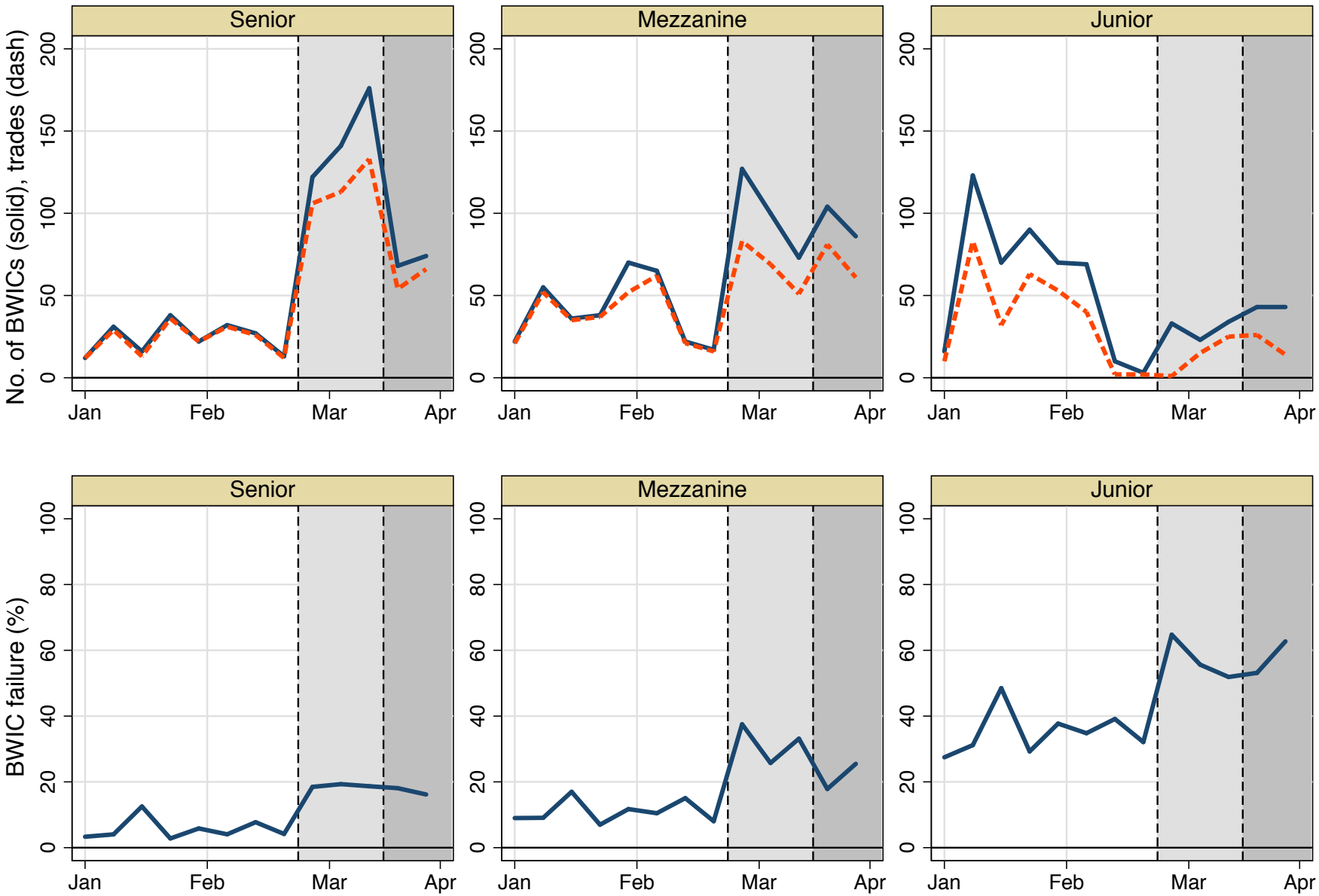
$$\mathbb{E}[\tau_0^j + \tau_1^j \widehat{S}_i - \mathbb{1}(B_i^{j:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i) | \boldsymbol{X}_i] = 0, \qquad j = \{\text{Best Bid,Cover}\}.$$

Estimates for τ^* using above GMM are $< 1\%$ for senior, $1 - 2\%$ for mezzanine, and 2% junior

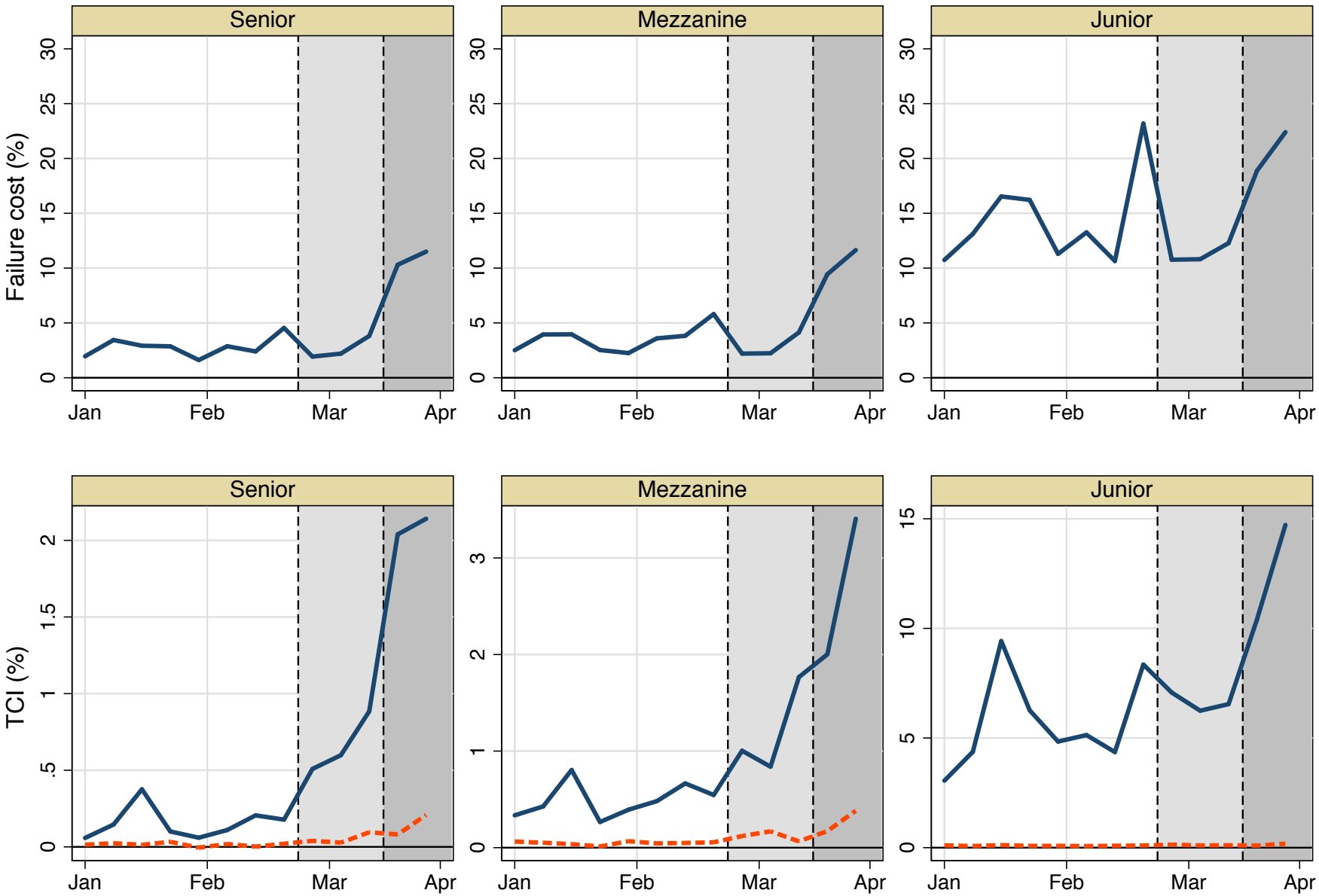
2020 Pandemic: Market Conditions and Volume



2020 Pandemic: BWICs and Failure Rate



2020 Pandemic: Failure Cost, TCI and Bid-Ask Spread



Conclusions

- Challenges of measuring liquidity in OTC markets
  - If traders choose not to sell when bids are low
    - Related issues in centralized markets
- Use "endogenous" quantile regressions to estimate costs of failure to trade in CLOs
- Bid-ask spreads and TCI in CLOs
  - TCI can be $>>>$ spread, gap is higher in lower-rated CLOs and in stressful market conditions when failure rates exceed 50%.
  - Senior CLOs: average observed trade cost is 4 bps, TCI is 13bps
  - Junior tranches: average bid-ask spread is 12bp; 25bps in stressful periods; fail rates double (20-30% to 50-60%): TCI increases from $< 3\%$ to over 15% under stress
  - Co-movement of failure rate and costs amplifies underestimation
- Is illiquidity generally underestimated in illiquid assets? in crises?
- How stable are CLOs?

Discussion of TCI and R

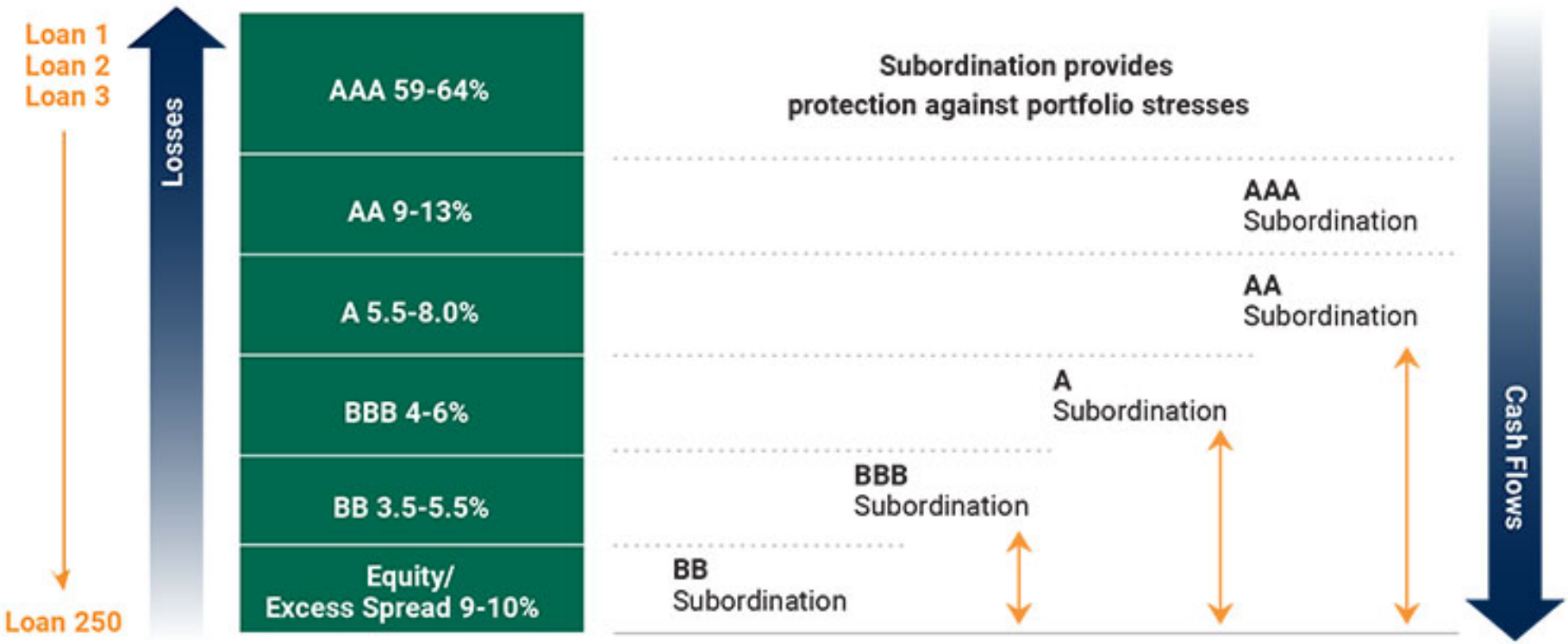
R as the outside option

- If R is above the outside option, TCI is biased down
  - Seller would never set R below their valuation
- In dynamic model
  - Seller would never set R below what they would expect to get if they try to sell again, although evidence is that failed BWICs rarely lead to a subsequent trade
  - Why would bidders bid above R in subsequent auctions?

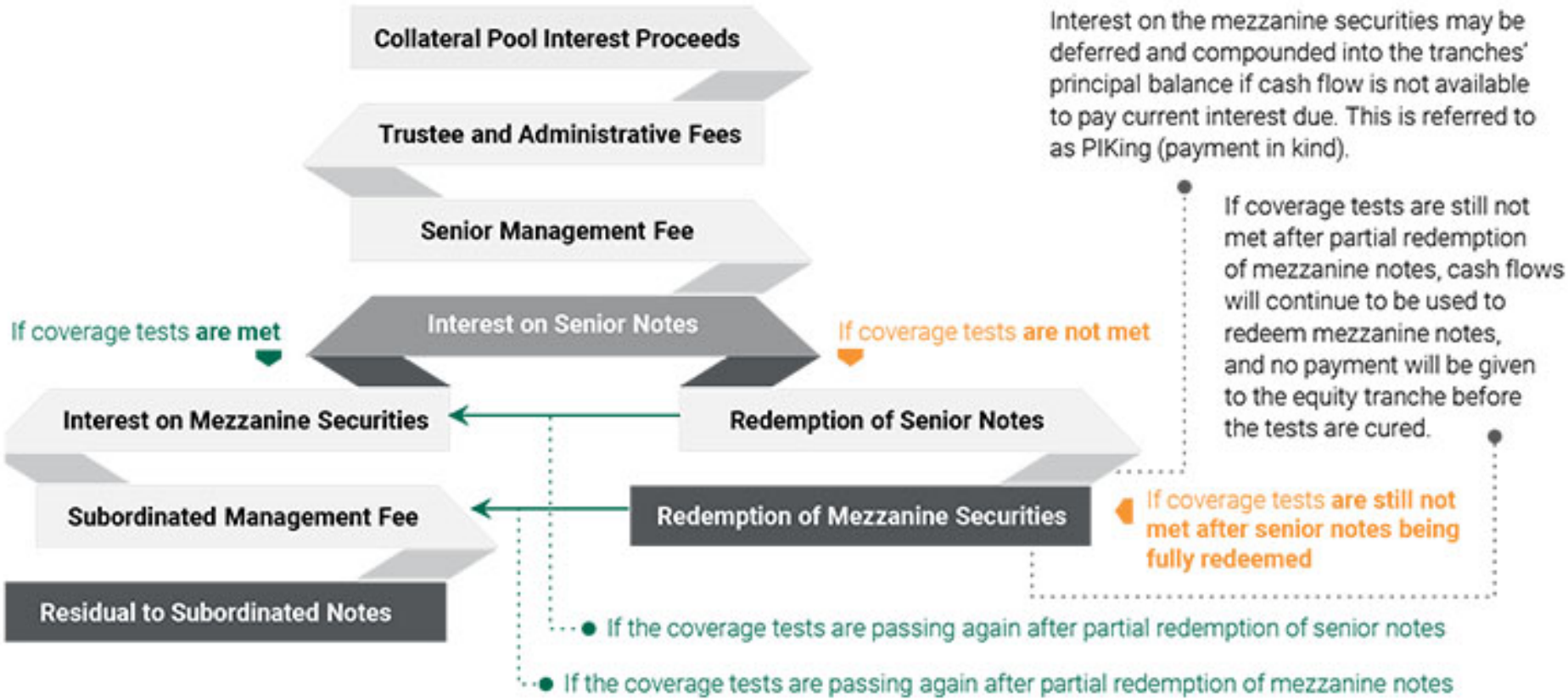
Does using A as benchmark price capture the full spread?

- Buyer likely has more bargaining power with the dealers than seller
- For riskless principle trades, the dealer is only charging a fixed mark up and the compensation for liquidity provision accrues to the final buyer

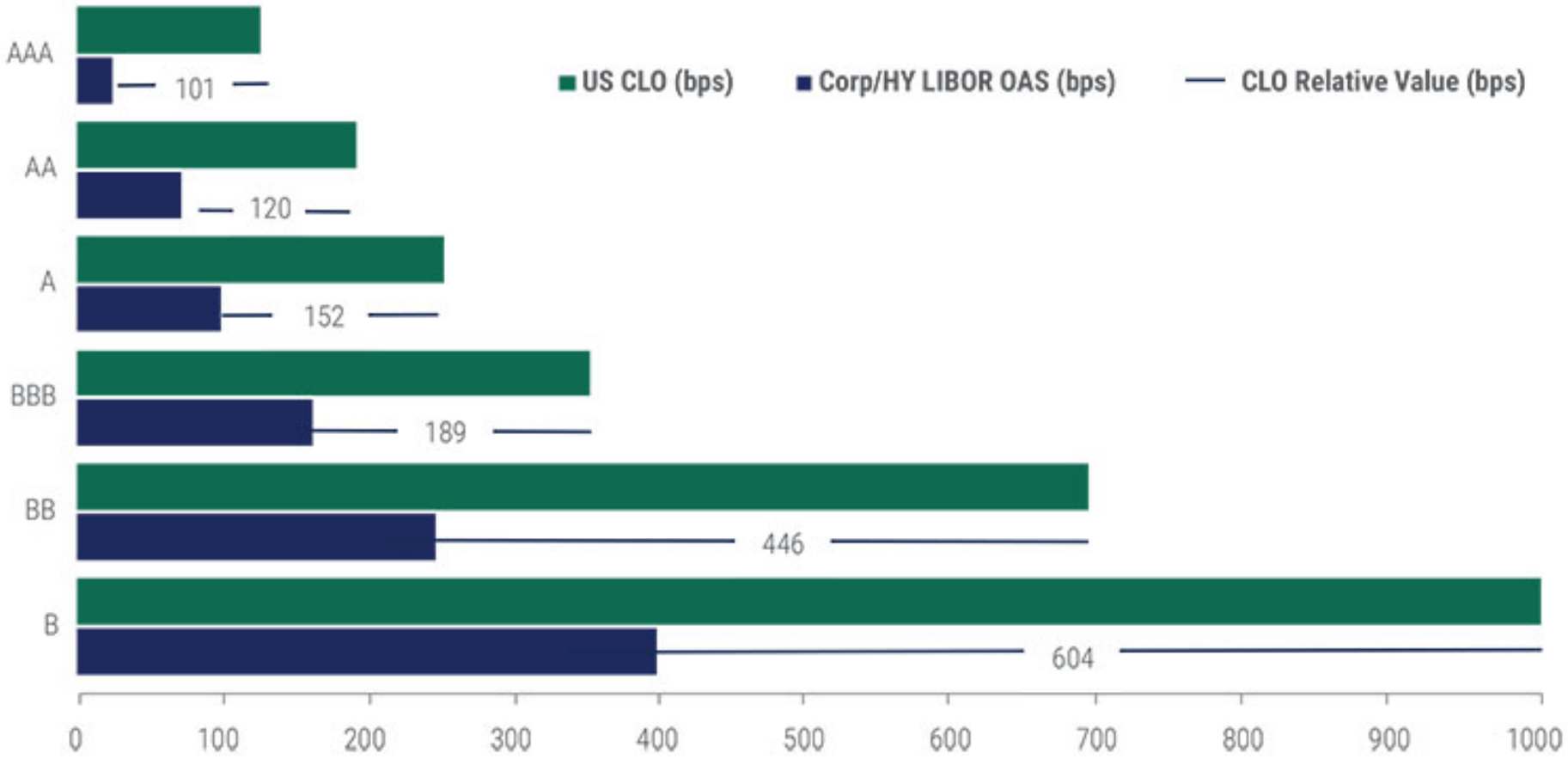
CLO Tranche Structure



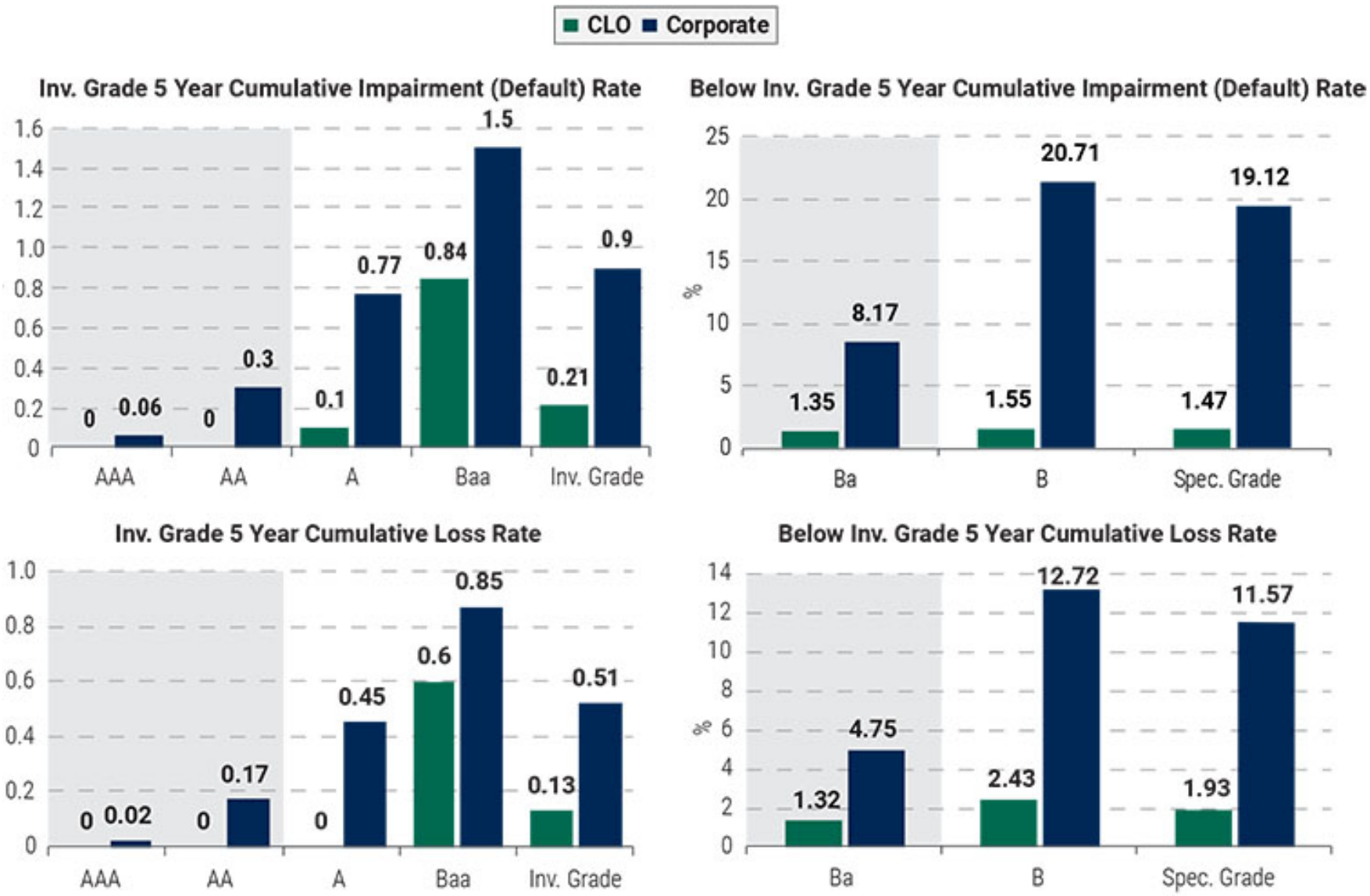
CLO Cash flows



CLO Credit Spreads Versus Comparably Rated Corporate Bonds



CLO Defaults Versus Comparably Rated Corporate Bonds



However, in April 2020 a record 11 leverage loans defaulted