True Cost of Immediacy

How large are opportunity costs? Does selection bias in OTC trades provide a false impression of liquidity and stability?

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Agenda: OTC liquidity with only trades (no quotes)

1. OTC liquidity during the 2020 pandemic

2. Collateralized loan obligations (CLOs) background
   - Most structured products trade like CLOs: start with seller auction

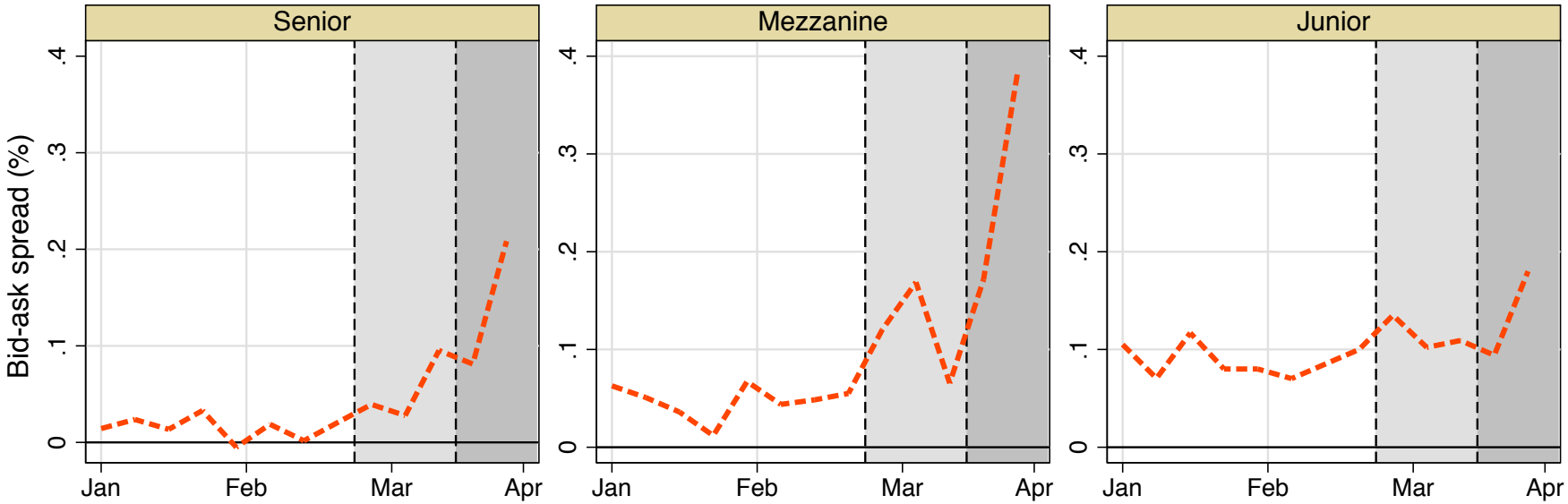
3. Data on bids wanted in competition (BWIC) auctions for CLOs
   - Bid-ask spreads are modest and fairly stable
   - BWICs fail to trade, fail rates spike in "crises" in low-rated CLOs

4. Define true cost of immediacy (TCI) in auction model with failures
   - Auctions fail when bids are low: observed trade prices biased upwards

5. Estimate TCI using auction and transaction data
   - Failure costs and failure rates comove, amplifying spikes in TCI

6. Summary and conclusion

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)

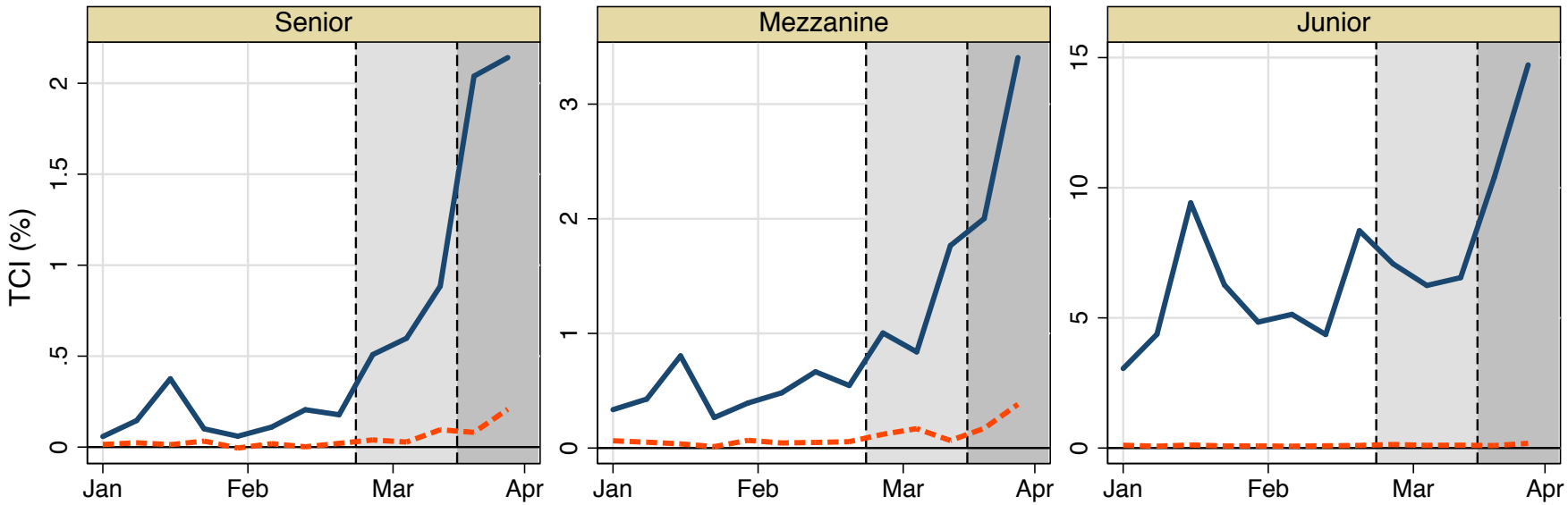
Increase noticeably in March

Remain less than 40bp

Did the CLO market perform well under stress?

TCI and bid-ask spreads during the 2020 pandemic

Bid-ask spreads are dotted line at bottom, TCI in red
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

General 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))

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)

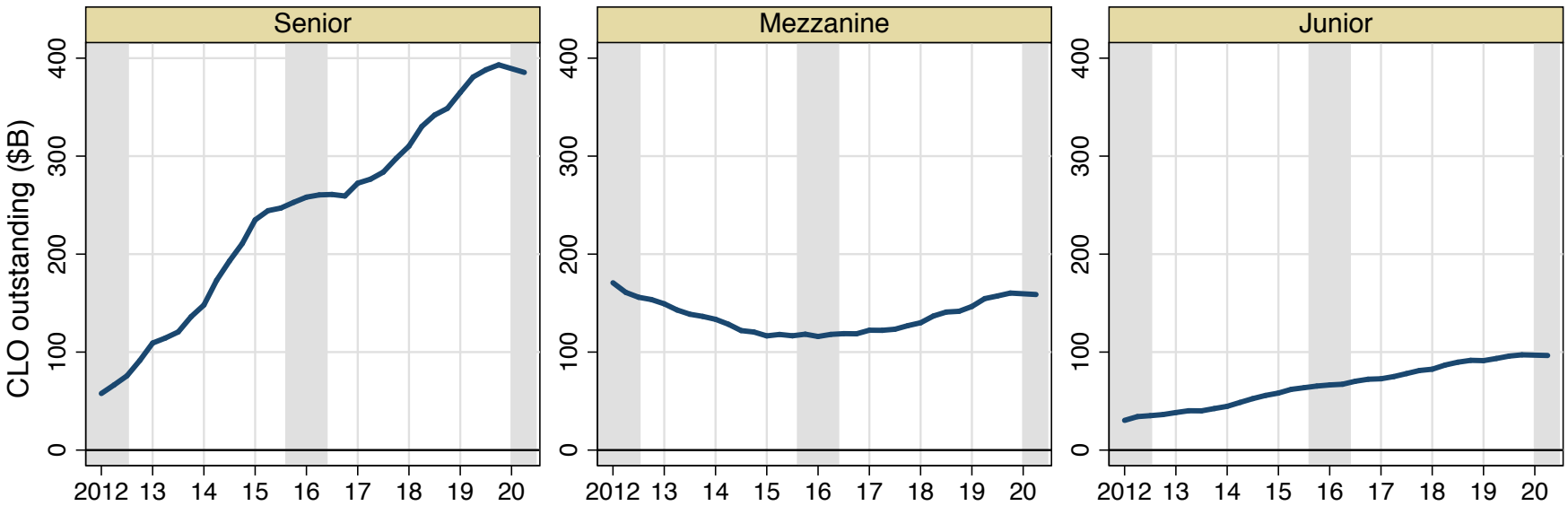
- Study index CDS RFQs and bilateral trades
  - Inquiries almost always lead to trades, so cost of failure is less relevant

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

CLOs

- CLO securities are asset backed securities (ABS), like CDOs
  - special purpose vehicles or trusts issue CLOs on pool of syndicated loans issued by lower-rated, highly indebted corporations
  - finance holdings by issuing different seniorities of debt and equity claims on the cash flow from the collateral
  - significant regulatory concerns, more recently with growth:



Other structured products trade in a similar way to CLOs

CLO Workings

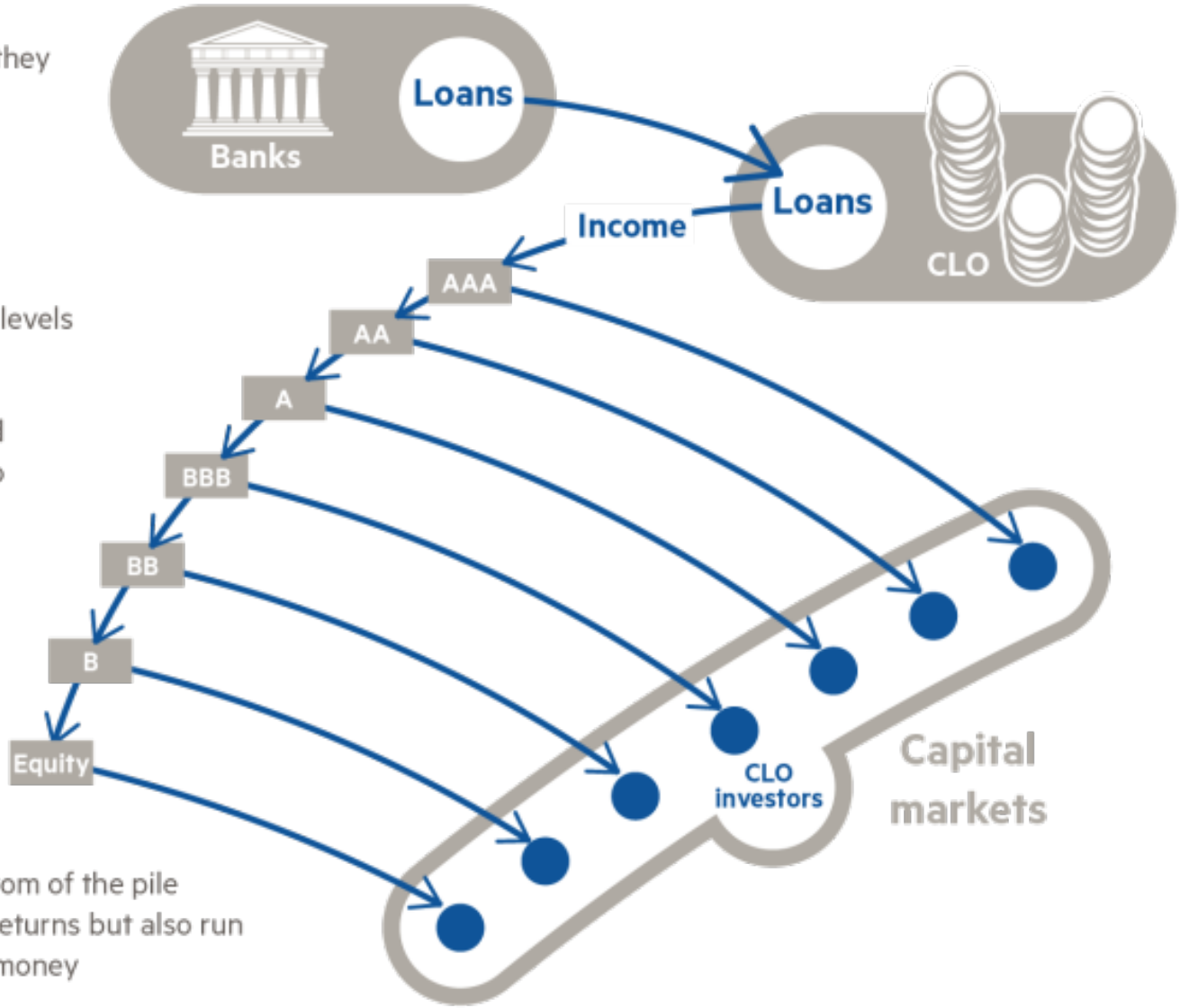
How collateralised loan obligations work

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

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

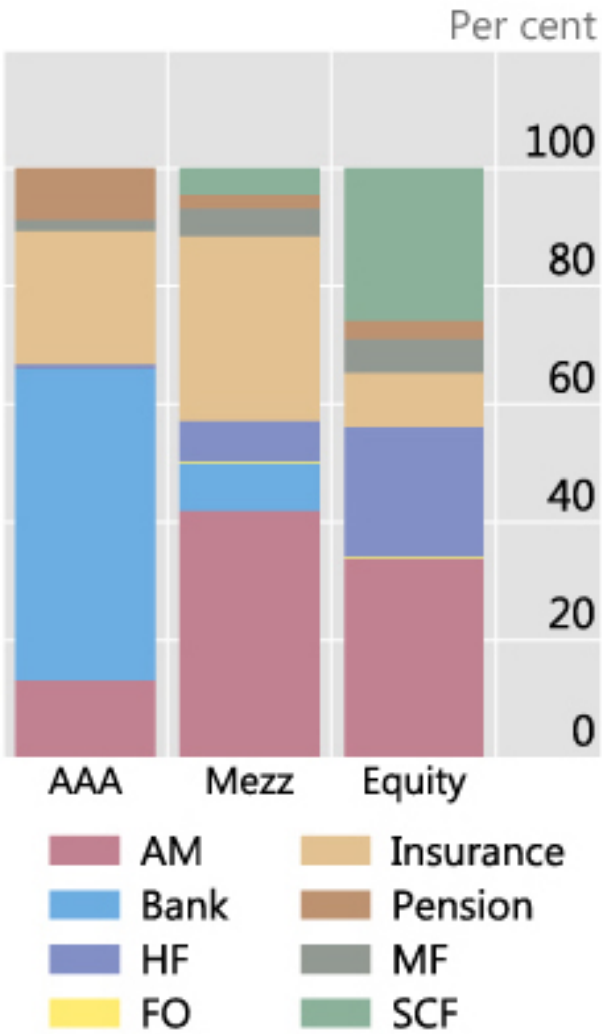
3. As the loans are paid off, the income flows to the buyers of the CLO

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 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)

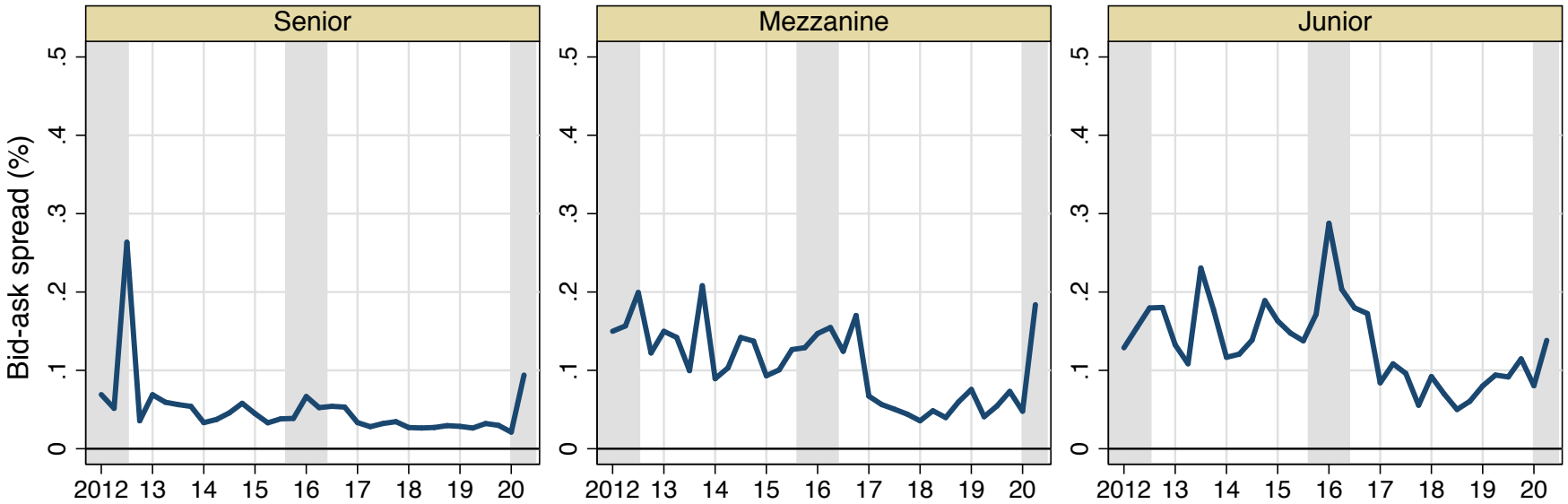
- BWIC trade data from non-public TRACE
  - 40% of Customer to Dealer trades can be matched to BWICs
  - Typical CLO trades 11 times in our auction sample
    - Varies some by rating: 15 in senior, 9 in junior
  - Relatively little interdealer trading
    - 0.33 of an interdealer trade for every dealer-buy trade
    - Comparable 2019 numbers are 1.7, 1.8, and 1.4 for munis, IG and HY corporate bonds

Question Break 1

- Background questions on
  - CLOs
  - BWICs
  - CLOs market structure
- General questions on
  - Opportunity costs
  - Illiquidity
- Specifics of TCI to come

CLO averages and spreads (dealer round trips)

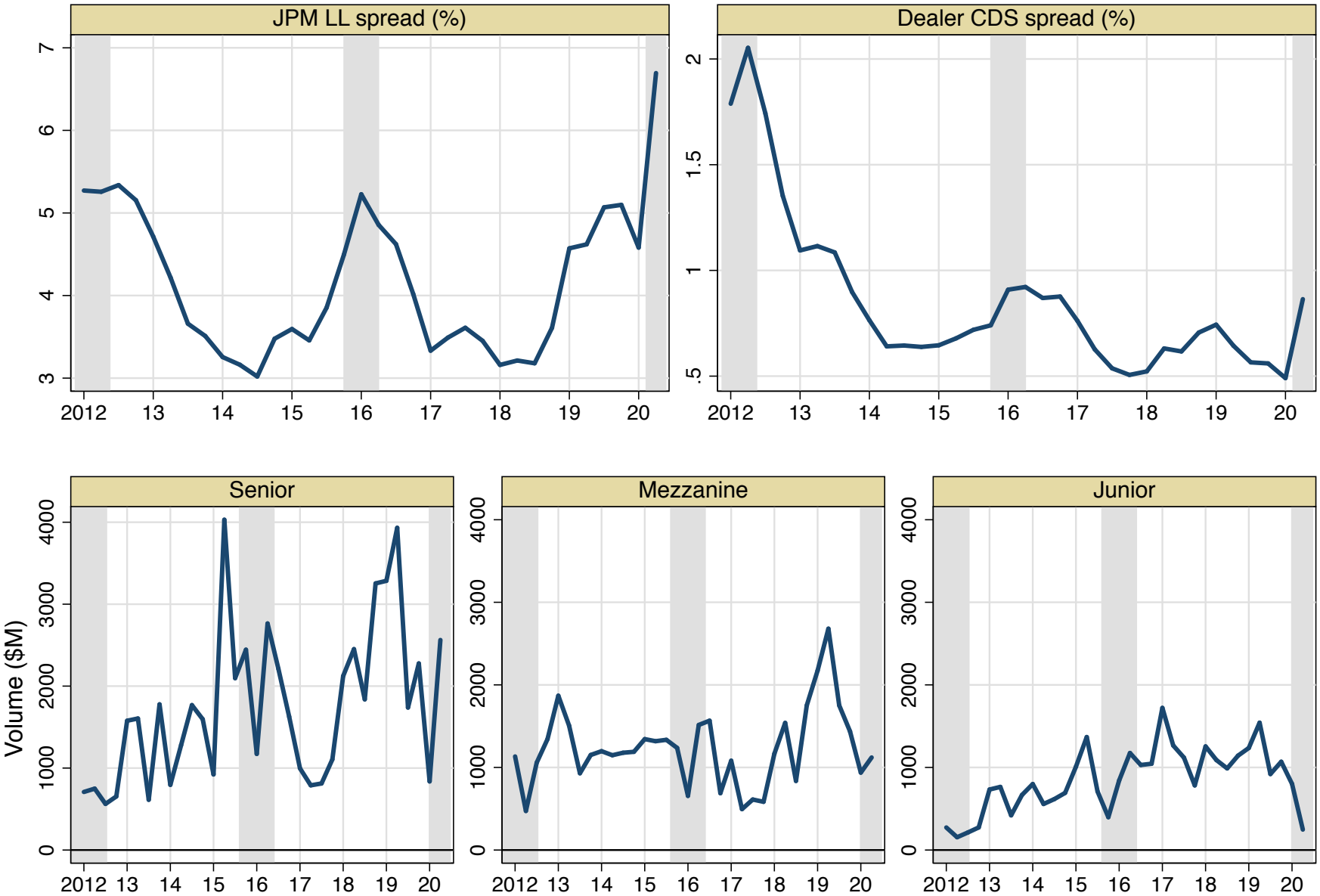
- Senior: Issue size $228M, trade size $2.8M, bid-ask spread 4bp
- Mezzanine: Issue size $34M, trade size $2.5M, bid-ask spread 10bp
- Junior: Issue size $23M, trade size $3.4M, bid-ask spread 12bp



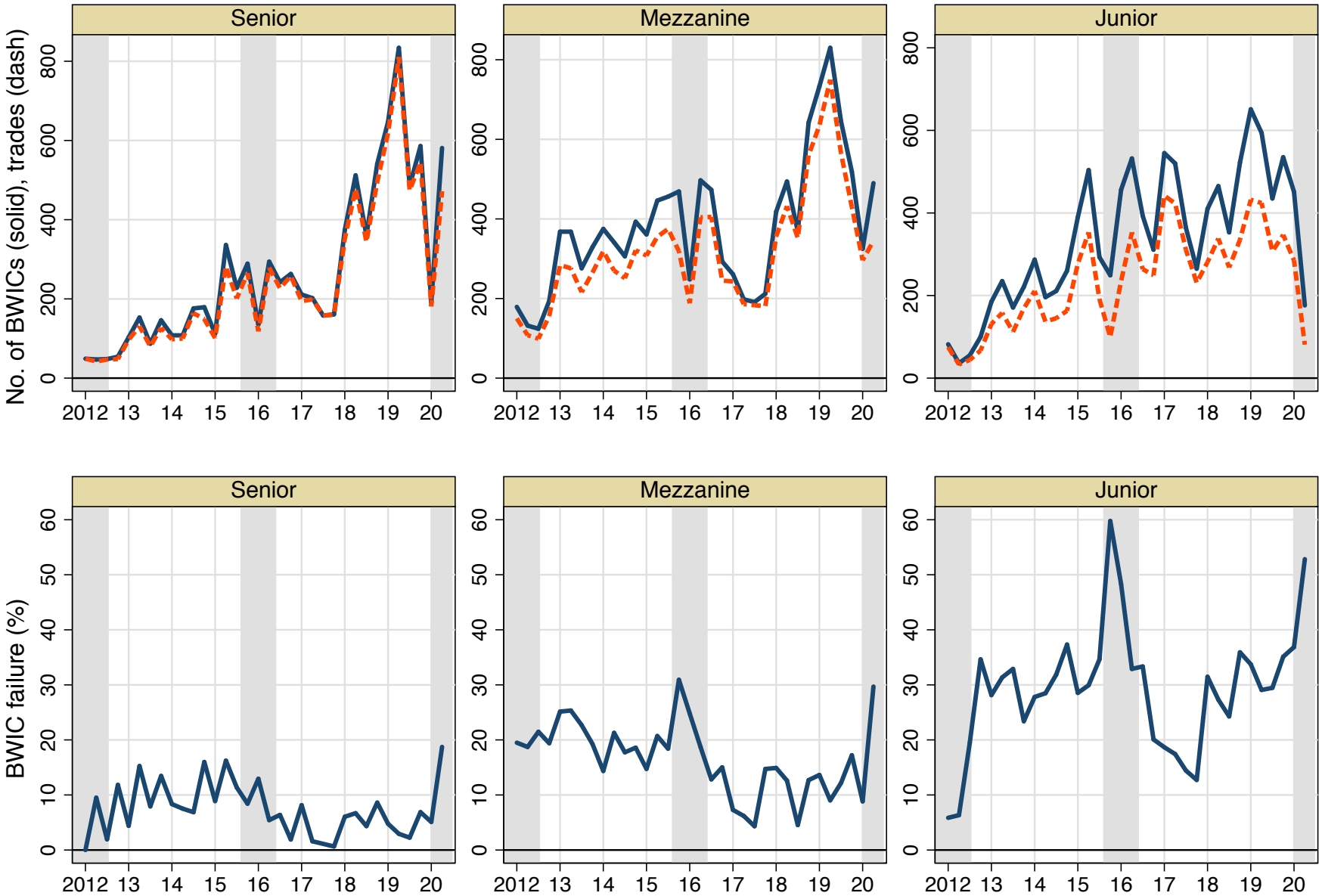
Gray areas are 2012 euro debt, 2015-16 credit stress, 2020

Liquidity improves in second half of sample as market expands

CLO Market Conditions and Trading



CLO BWICs and Failures



Cost of immediacy and Seller's Payoff

Observed cost of immediacy (successful transactions at bid and ask prices B and A):

$$\mathbb{E}[A - B|\text{Trade}].$$

DEFINITION: *True cost of immediacy,* **TCI**, *is Ask minus Proceeds*

$$\textbf{TCI} \equiv \mathbb{E}[A - \Pi].$$

Ask is observed so focus on bids; Π requires valuation to seller when no trade (outside option); Reserve price R is the lowest accepted bid and an upper bound on outside option:

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

Calculating the true cost of immediacy (TCI)

Auctions models with reserve price give:

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

DEFINITION: *The true cost of immediacy, TCI, is equal to*

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

Estimating in the data:

$\mathbb{E}[A - B|\text{Trade}]$ – observed bid-ask spread

$\Pr(\text{Fail})$ – observed BWIC failure rate

$\mathbb{E}[B|\text{Trade}]$ – observed best bid

R – quantile regressions on trade prices, what quantile to choose?

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

Failure Costs

BWIC failure costs are not directly observed (due to seller's reserve price):

$$\text{Failure Cost}_i = \mathbb{E}[B_i^{1:N} - R_i | \text{Trade}_i]$$

Pool BWICs to estimate: $R(\boldsymbol{X}_i, \varepsilon_{R,i}) = \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i + \varepsilon_{R,i}$.

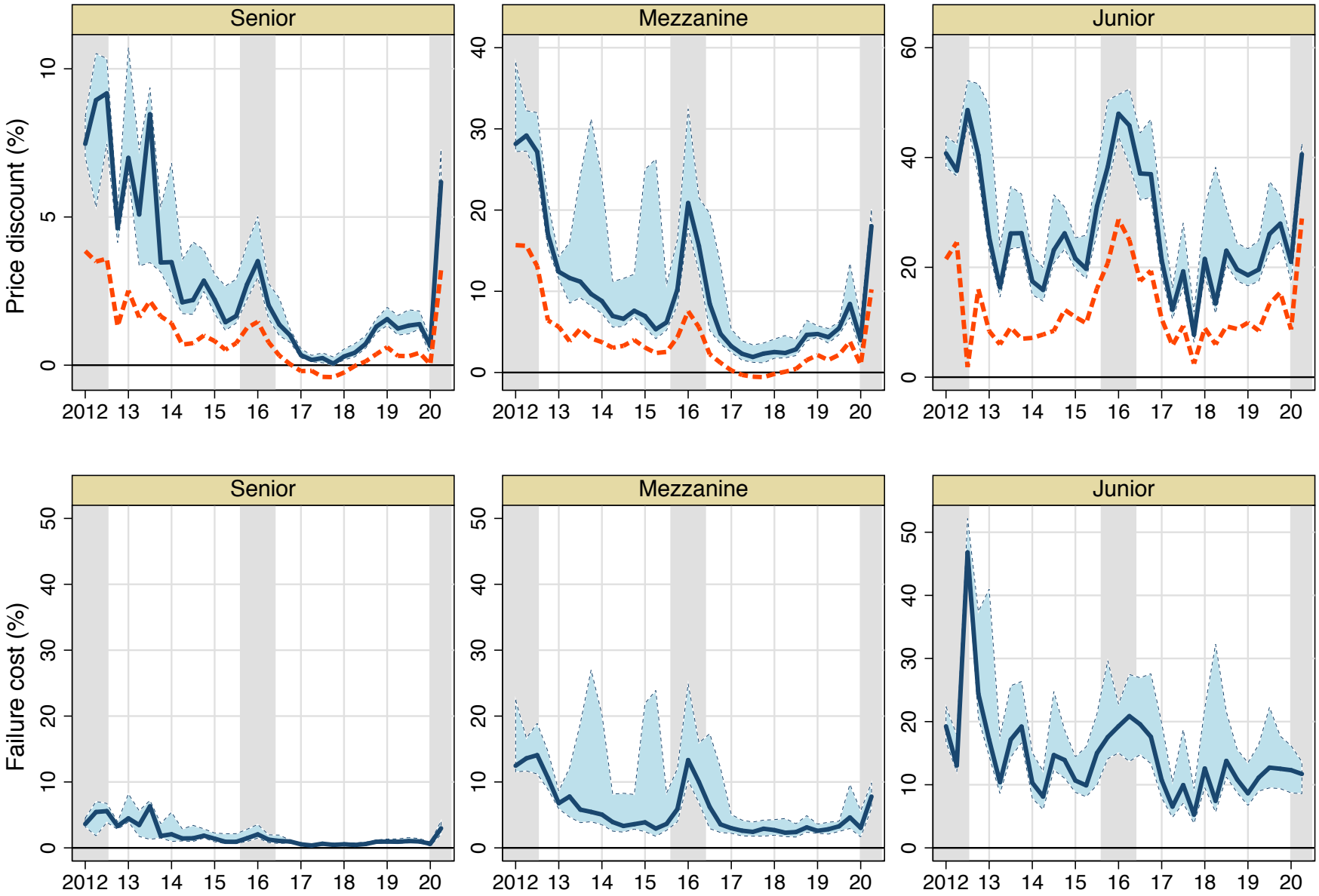
Reserve prices: $\Pr(B_i^{1:N} < R_i) = \mathbb{E}[1(B_i^{1:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i + \varepsilon_{R,i}) | \boldsymbol{X}_i] = 0$.

Want to identify reserve price from variation in bids and lowest accepted bid. Challenge is $\varepsilon_{R,i}$, relax above and require:

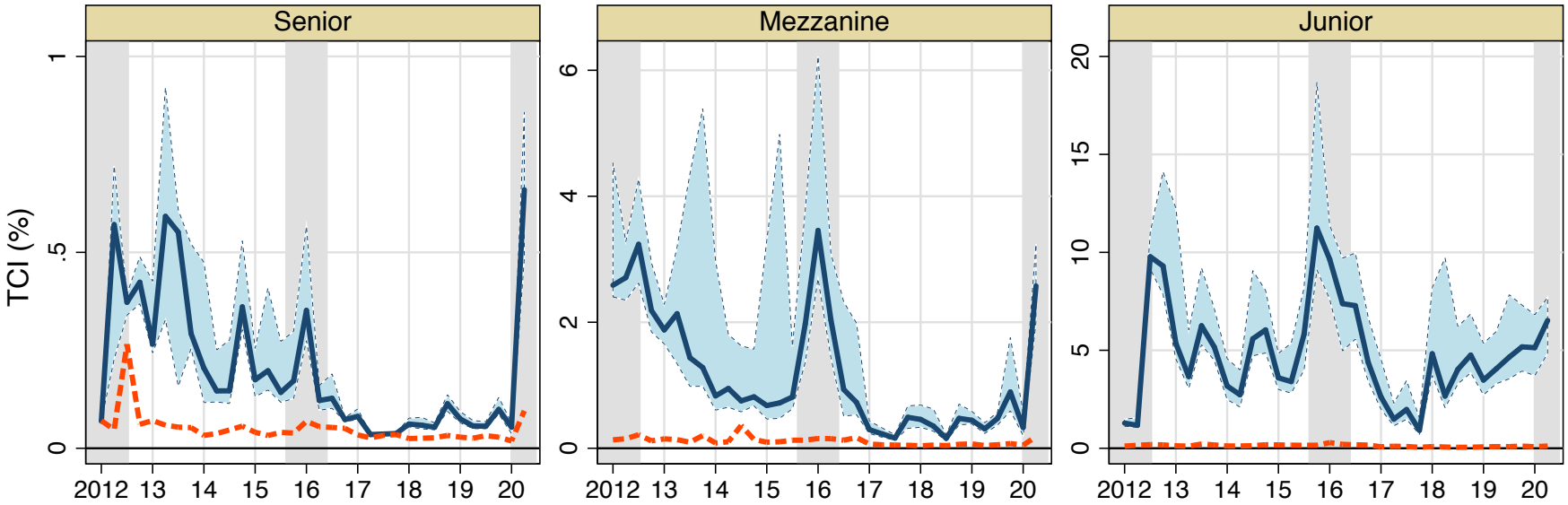
$$\mathbb{E}[\tau^* - 1(B_i^{1:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i) | \boldsymbol{X}_i] = 0,$$

where $\tau^* \in [0, 1]$ is the quantile that absorbs $\varepsilon_{R,i}$. First, manually vary τ^* between 1%, 5%, 10%. Later we estimate τ^* using GMM.

Dealers Bids and Failure Costs



TCI and Bid-Ask Spread



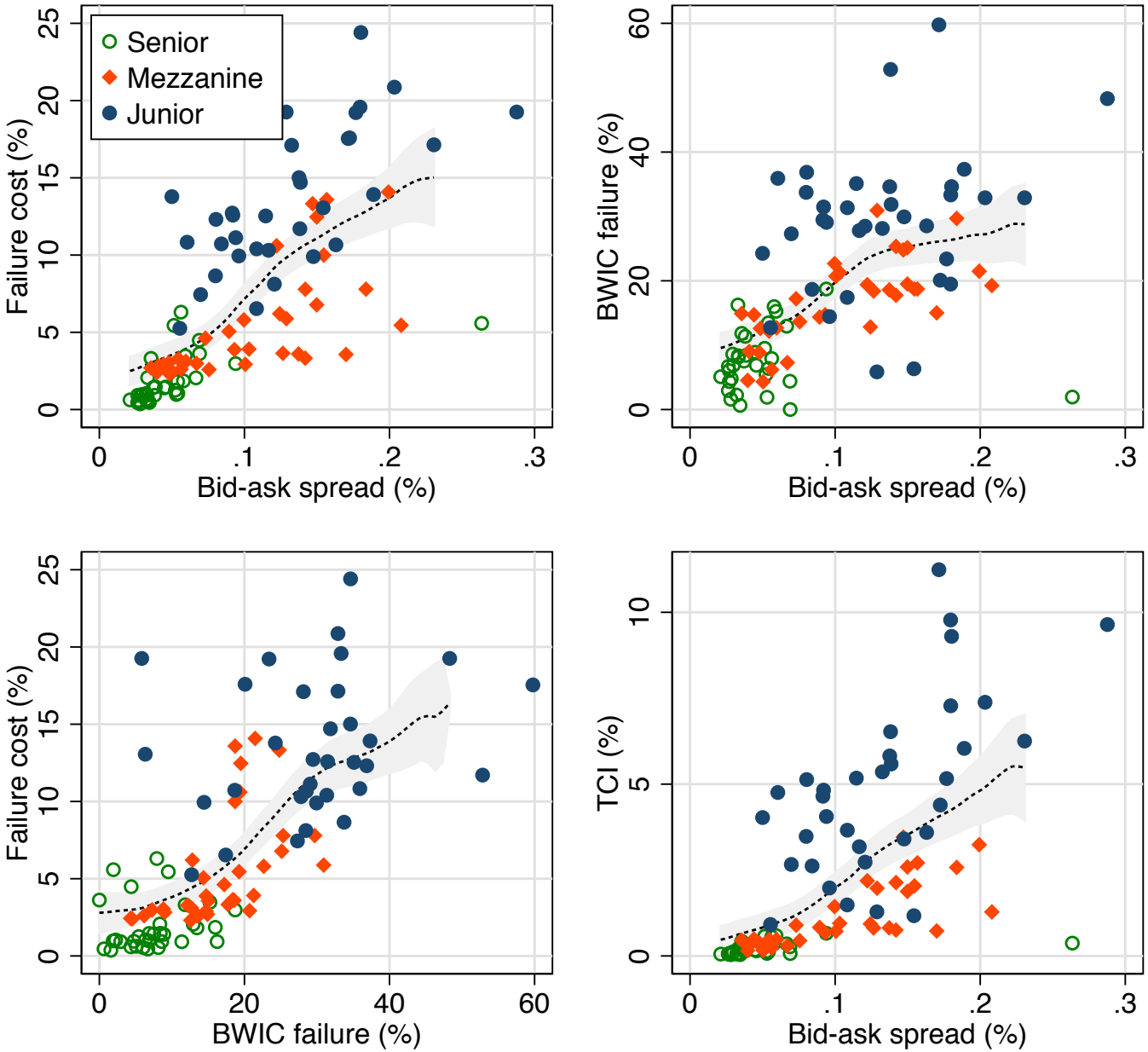
TCI shown for 1%, 5%, and 10% quantiles, dark line is 5%

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

Question Break 2

- TCI definition
- Failure rate
- Failure cost
- TCI estimation

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



TCI: Alternative empirical approaches

BWIC cover prices, $B^{2:N}$, provide more information on bid distribution:

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

Unobserved $\varepsilon_{R,i}$ in moment conditions implies that the rotation τ^* depends on probability of BWIC success (Heckman-like):

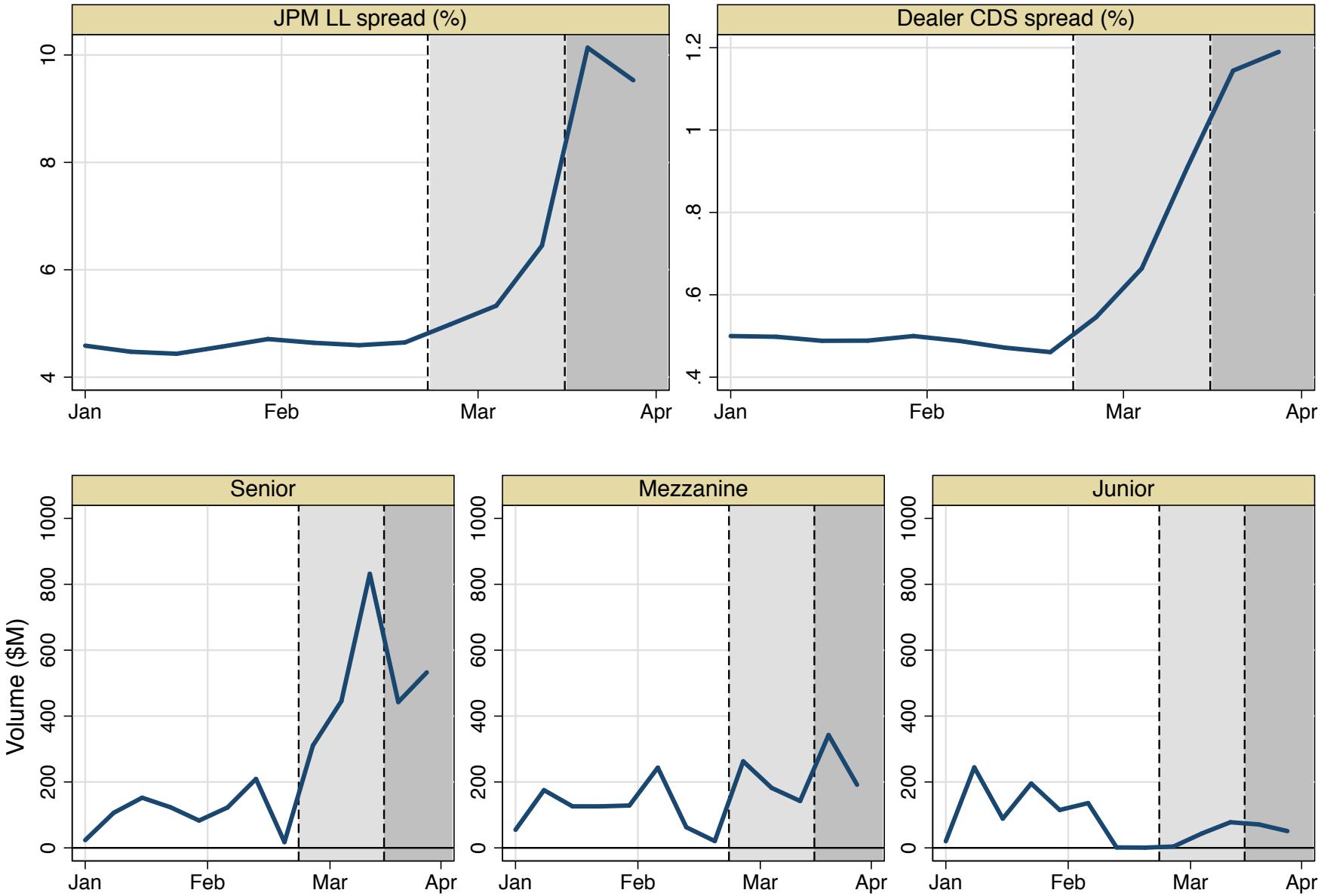
$$\Pr(\text{Trade}_i) = h(S_i) = h(\alpha_S + \boldsymbol{\beta_S}' \boldsymbol{X}_i).$$

Under a linearity assumption, $\tau^j(S_i) = \tau_0^j + \tau_1^j \widehat{S}_i$, with $j = 1$ and 2 indicating best bid and cover, respectively, gives moment conditions:

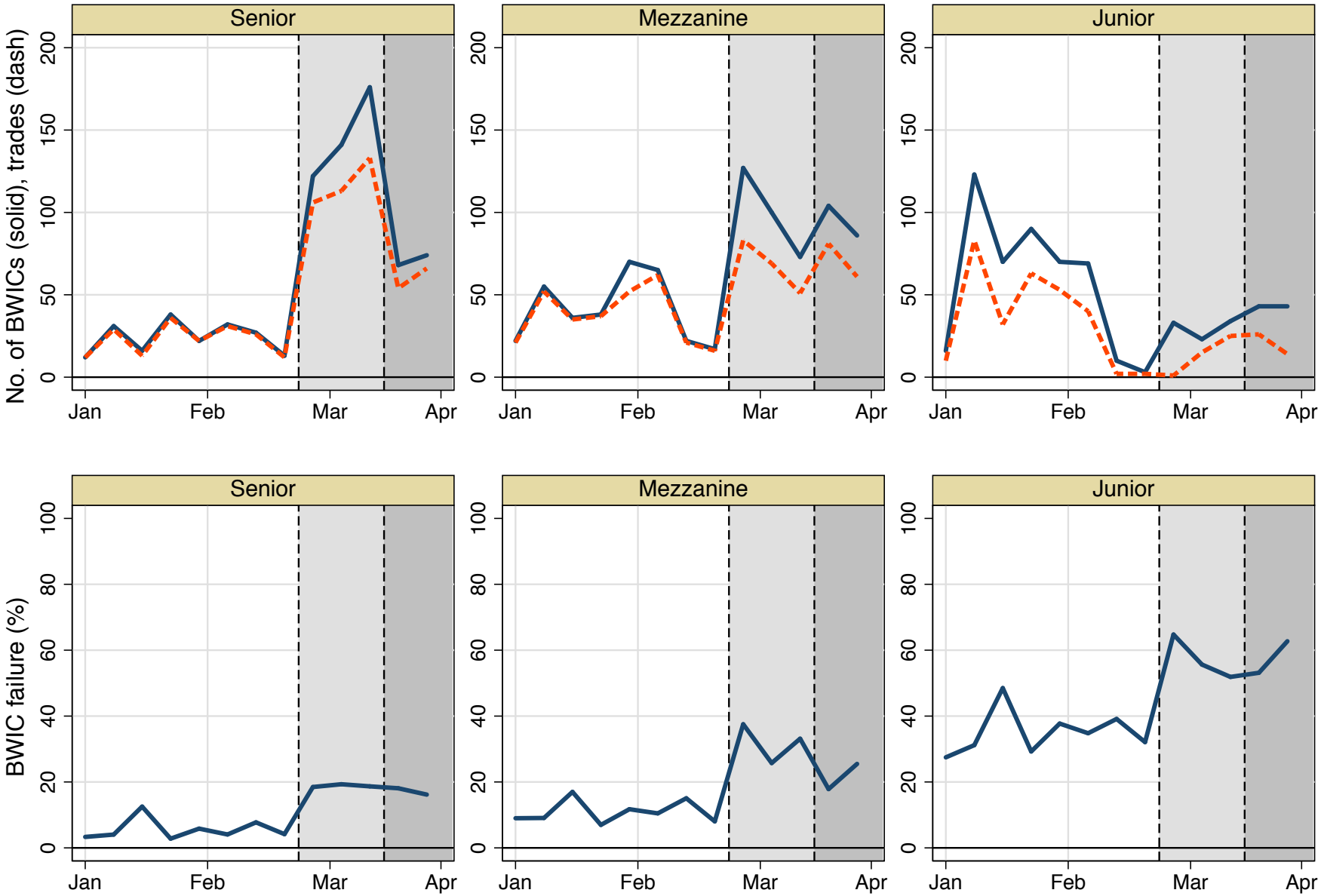
$$\mathbb{E}[\tau_0^j + \tau_1^j \widehat{S}_i - 1(B_i^{j:N} < \alpha_R + \boldsymbol{\beta}_R' \boldsymbol{X}_i) | \boldsymbol{X}_i] = 0, \qquad j = 1, 2.$$

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

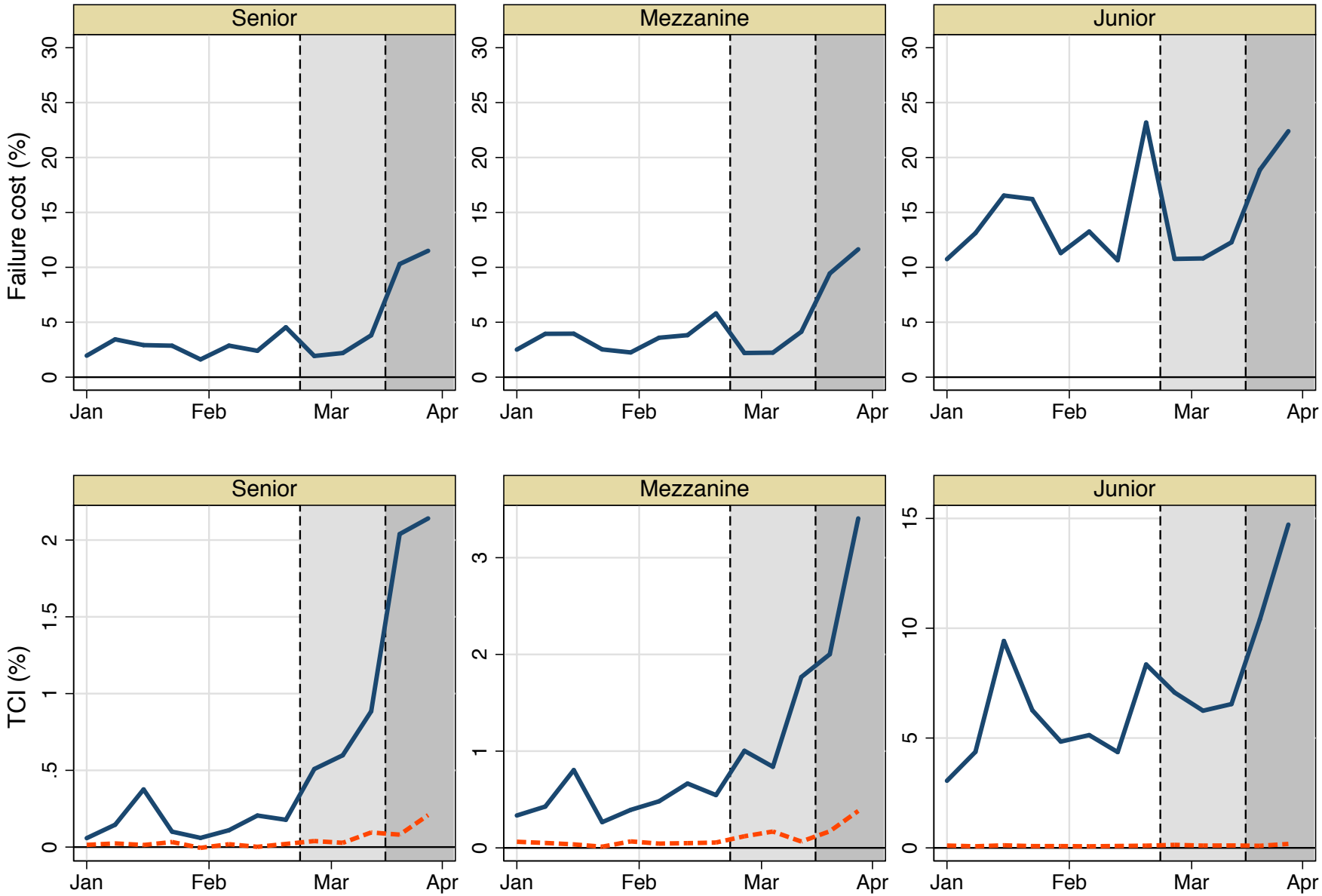
2020 Pandemic: Market Conditions and Volume



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 auction model 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?