Composition Effects in OTC Transaction Costs

Mariano J. Palleja

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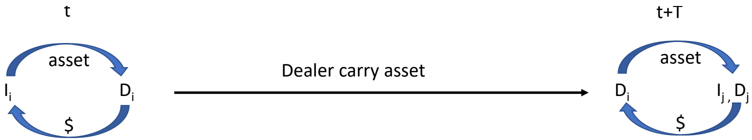
Keywords: OTC markets, transaction costs, composition effect, principal / agency trades

Trading Mechanisms in OTC markets

Consider an investor looking for liquidity in an OTC market

1. Principal trade: fast execution but expensive (inventory costs)



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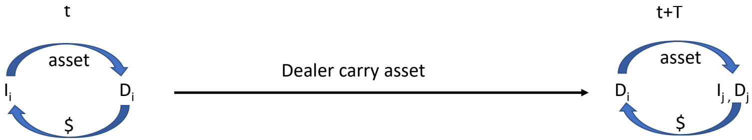
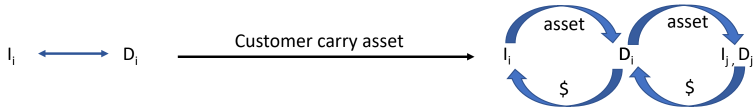


2. Agency trade: slow execution but cheaper (no inventory costs)



Changes in OTC markets

1) Post crisis regulations (Volcker Rule, Basel III)

- $\uparrow$ Inventory costs of principal trading.
- Dick-Nielsen and Rossi (2018), Bao et. al. (2018), Bessembinder et. al. (2018), Choi and Huh (2021)
  - $\downarrow$ dealer's capital commitment & $\downarrow$ principal trades' share
  - $\uparrow$ principal trades' transaction cost.

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2) Electronic platforms' increasing share (Volume: '10: 6%, '17: 13%)

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  - $\downarrow$ overall transaction cost.

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$\rightarrow$ Change in liquidity profile: increasing cost of immediacy & volume shift towards agency.

Volume Evidence Transaction Cost Evidence

Empirical Issue

OTC markets feature bilateral terms of trades:

1. Terms of trade {i,j,t} are determined by
    - investor i characteristics (unobservable)
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→ <u>Composition Effect</u>

Example:

$$\Delta TC^P = g(\Delta TC|\text{on going principal trader} \quad , \underbrace{TC_{post}|\text{new p. trades} \quad , \quad TC_{pre}|\text{old p. trades}}_{\text{Composition Effect}})$$

extensive example

How to isolate the composition effect?

Develop a model with:

- ✓ OTC markets features: bilateral trade and search costs (no networks frictions considered).
- ✓ Two trading mechanisms: Principal and agency.
- ✓ Idiosyncratic speed-cost trade-off defines both the trading mechanism and the transaction cost.

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Characterize trades in each mechanism.

- Principal traders have relatively higher trading needs and hold relatively more extreme preferences.

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Perform counterfactual exercises, controlling for composition effect

- Split trades in trading mechanisms pools before and after a parameter change.
- Compute spread changes within each set of trades.
- Principal transaction costs are partially explained by composition effects
  - Inventory Cost: 34% in principal, 0.7% in agency.
  - Speed of Execution: 99% in principal, -1.5% in agency.

Agenda

Introduction

Literature

Model

Model Outcomes

Quantitative exercises

Contribution

1. Empirical literature OTC market liquidity.
    - Dick-Nielsen and Rossi (2018), Bao et. al. (2018), Bessembinder et. al. (2018), Choi and Huh (2021), O'Hara and Zhou (2021)
    - X Composition effect

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2. Models of dealers' choice of costly principal or agency trading.
   - Tse and Xu (2017); Cimon and Garriot (2019); An (2020); An and Zheng (2020); Saar et. al. (2020).
   - *X* Heterogeneity of fees.
   - *X* Intensive margin (volume traded).

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   - X Intensive margin (volume traded).
3. Models of investors' choice of costly centralized trade or delayed decentralized trade.
   - Miao (2006); Shen (2015).
   - X Centralized = unique price *vs* bargain = Decentralized.

Agenda

Model outline

Lagos and Rocheteau (2009) + 2 trading mechanisms

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- Dealers passively receive orders and execute them in the D-D market:
  1. Principal trade: immediate but costly execution.
  2. Match-making: delayed but non-costly execution.

Investor Value Function

$$V_i(a,t) = \mathbb{E}_i\Bigg[\underbrace{\int_t^{T_\alpha} e^{-r(s-t)} u_{k(s)}(a)ds}_{a_t \text{ utility}} + e^{-r(T_\alpha - t)} \max\Big\{\underbrace{V_k^P(a,T_\alpha)}_{principal}, \underbrace{V_k^A(a,T_\alpha)}_{agency}\Big\}\Bigg] \quad (1)$$

- T_α is the next contact time with a dealer.
- $u_k(a)$ is the utility function of agent with pref. type $\{k,a\}$.
- $u \in C^2$, strictly increasing and strictly concave.
- $\mathbb{E}$ over:
    1. next contact with dealers $\rightarrow$ Poisson rate α.
    2. preference shocks $\rightarrow$ Poisson rate δ.
    3. execution of agency trade $\rightarrow$ Poisson rate β.

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$$V_k^P(a, T_\alpha) = V_{k(T_\alpha)}(a^P_{k(T_\alpha)}, T_\alpha) - p_{(T_\alpha)}[a^P_{k(T_\alpha)} - a] - \phi^P_{k(T_\alpha)}$$

- a_k^P are optimal asset holdings of pref. type k in the principal trade.
- p is the inter-dealer price.
- ϕ_k^P is the fee charged in the principal trade.

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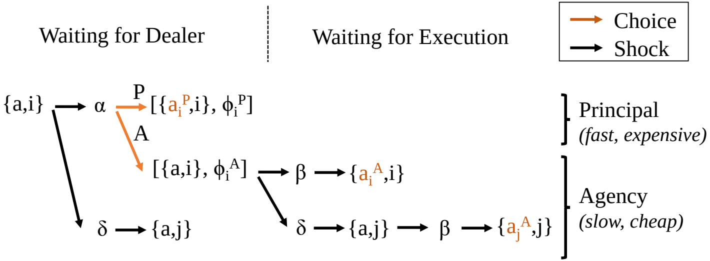
$$V_k^A(a, T_\alpha) = \int_{T_\alpha}^{T_\beta} e^{-r(s-T_\alpha)} u_{k(s)}(a)ds + e^{-r(T_\beta - T_\alpha)}\Big(V_{k(T_\beta)}(a^A_{k(T_\beta)}, T_\beta) - p_{(T_\beta)}[a^A_{k(T_\beta)} - a] - \phi^A_{k(T_\alpha)}\Big)$$

- T_β is the execution time.
- a_k^A are optimal asset holdings of pref. type $k(T_\beta)$ when agency.
- p is the inter-dealer price.
- ϕ_k^A is the fee charged when agency.

Investor's Path



Note: Agency fees ϕ_i^A are set at contact and payed at execution. Agency optimal holdings a_i^A are decided at execution (see specification details here).

Dealers Value Function

$$W(t) = \mathbb{E}\left[e^{-r(T_\alpha - t)} \int_{\mathcal{S}} \Phi_i(a, T_\alpha) dH_{T_\alpha} + W(T_\alpha)\right], \tag{2}$$

$$\Phi_i(a, T_\alpha) = \begin{cases} \phi_i^P - f\left(a^P_{k(T_\alpha)} - a\right) & \text{if principal} \\ e^{-r(T_\beta - T_\alpha)} \phi_i^A & \text{if agency} \end{cases}$$

$f\left(a_k^P - a\right) = \theta p |a_k^P - a|$ is the cost of access to the D-D market.

$\rightarrow \theta \in [0, \frac{r}{r+\beta})$ is the constant marginal cost per dollar traded.

Bilateral Terms of Trade

Protocol: Nash Bargain where dealers hold η power

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- Principal Problem: Immediate and costly execution

$$[a_i^P(a), \phi_i^P(a)] = \arg \max_{(a', \phi')} \Big\{ \underbrace{V_i(a') - p[a' - a] - V_i(a)}_{\text{investor's surplus (IS)}} - \phi' \Big\}^{1-\eta} \Big\{ \phi' - \underbrace{\theta p |a' - a|}_{\text{dealer's cost (DC)}} \Big\}^{\eta}$$

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- Principal Fees and Optimal Asset Holdings

$$\phi_i^P(a) = \eta\, IS + (1-\eta)\, DC \tag{3}$$

$$a_i^P(a) = \arg\max_{a'} \quad V_i(a') - p[a'-a] - \theta p|a'-a| \tag{4}$$

Conditional on gains from trade and trade direction, principal optimal holdings are independent of current holdings

Bilateral Terms of Trade

Protocol: Nash Bargain where dealers hold η power

- Agency Problem: Delayed and non costly execution

$$[a_i^A, \phi_i^A(a)] = \arg \max_{(\{a_k''\}_{k=1}^I, \phi'')} \Big\{ \underbrace{\mathbb{E}_i \Big[\int^{\tau_\beta} e^{-rs} u_{k(s)}(a) ds + e^{-r\tau_\beta} \big(V_{k(T_\beta)}(a''_{k(T_\beta)})}_{\text{investor's surplus (IS)}}$$

$$\underbrace{-p[a''_{k(T_\beta)} - a]}_{\text{IS}} - \phi'' \big) \Big] \underbrace{-V_i(a)}_{\text{IS}} \Big\}^{1-\eta} \Big\{ \mathbb{E}\big[e^{-r\tau_\beta} \phi'' \big] \Big\}^{\eta}$$

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- Agency Fees and Optimal Asset Holdings

$$\mathbb{E}_t[e^{-r\tau_\beta}]\phi_i^A(a) = \eta IS \tag{5}$$

$$a_i^A = \arg\max_{a''} \quad V_{k(T_\beta)}(a'') - pa'' \tag{6}$$

Optimal Trading Mechanism

For each preference i and principal trading direction ρ, find thresholds $\hat{a}_i^\rho$:

Example: Indifference Condition for potential principal buyer

$$\underline{\text{linear}} \rightarrow \quad V_i(a_i^{P,b}) - p(1+\theta)(a_i^{P,b} - \hat{a}_i^b) = \bar{U}_i^\beta(\hat{a}_i^b) + \hat{\beta}[\bar{V}_i - p(\bar{a}_i^A - \hat{a}_i^b)] \quad \leftarrow \underline{\text{concave}}$$

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Trading mechanism decision rule: Rule:

- Investor $\{i, a\}$ chooses principal if $a \leq \hat{a}_i^{1,b}$ or $a \geq \hat{a}_i^{2,b}$
- Investor $\{i, a\}$ chooses agency if $\hat{a}_i^{1,b} < a < \hat{a}_i^{2,b}$

Note: The indifference condition is based on the flow Bellman formulation of the problem. See details here

Steady State Distribution

- Define $n_{[a,i,\omega]}$ as the mass of investors with:
  - $a \in \mathcal{A}^*$: Asset holdings
  - $i \in \{1 : I\}$: Preference shocks
  - $\omega \in \{\omega_1, \omega_2\}$: Waiting for dealer ($\omega_1$) or for execution ($\omega_2$)

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- Flow across states:

$n_{[a,i,\omega]} \rightarrow$	pref. shock δ	$\rightarrow n_{[a,j,\omega]} \forall \{a, \omega\}$	
$n_{[a,i,\omega_1]} \rightarrow$	contact dealer shock α	$\rightarrow n_{[a',i,\omega_1]} \forall \{a, i\}$	if principal
$n_{[a,i,\omega_1]} \rightarrow$	contact dealer shock α	$\rightarrow n_{[a,i,\omega_2]} \forall \{a, i\}$	if agency
$n_{[a,i,\omega_2]} \rightarrow$	execution shock β	$\rightarrow n_{[a',i,\omega_2]} \forall \{i\}$	

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- Flow across states:

$$\begin{array}{llll} n_{[a,i,\omega]} \rightarrow & \text{pref. shock } \delta & \rightarrow n_{[a,j,\omega]} \forall \{a,\omega\} & \\ n_{[a,i,\omega_1]} \rightarrow & \text{contact dealer shock } \alpha & \rightarrow n_{[a',i,\omega_1]} \forall \{a,i\} & \text{if principal} \\ n_{[a,i,\omega_1]} \rightarrow & \text{contact dealer shock } \alpha & \rightarrow n_{[a,i,\omega_2]} \forall \{a,i\} & \text{if agency} \\ n_{[a,i,\omega_2]} \rightarrow & \text{execution shock } \beta & \rightarrow n_{[a',i,\omega_2]} \forall \{i\} & \end{array}$$

- Shocks + Policy Functions $\rightarrow T_{[3I \times I \times 2]}$. (see details here)

$$n = \lim_{k \to \infty} n_0 T^k$$

Steady State Equilibrium

The steady state equilibrium is defined as:

1. Optimal asset holdings $\{a_i^P(a), a_i^A\}_{i=1}^I$.
2. Fees $\{\phi_i^P(a), \phi_i^A(a)\}_{i=1}^I$.
3. Trading mechanism sets $\{\Gamma_i^P, \Gamma_i^A\}_{i=1}^I$ where $\Gamma = \{Buy, Sell, NoT\}$.
4. Stationary distribution $n_{[a,i,\omega]}$.
5. Inter-dealer price p.

Such that

1. Optimal assets satisfies eq. (4) and eq. (6).
2. Fees satisfies eq. (3) and eq. (5).
3. Sets $\{\Gamma_i^P, \Gamma_i^A\}_{i=1}^I$ are defined using thresholds satisfying the indifference conditions.
4. Distribution $n_{[a,i,\omega]}$ satisfies inflow-outflow equations.
5. Price satisfy $\sum_{j=1}^2 \sum_{i=1}^I \sum_{a\in\mathcal{A}^*} a n_{[a,i,\omega_j]} = A$.

Solution Method

Agenda

Baseline Calibration

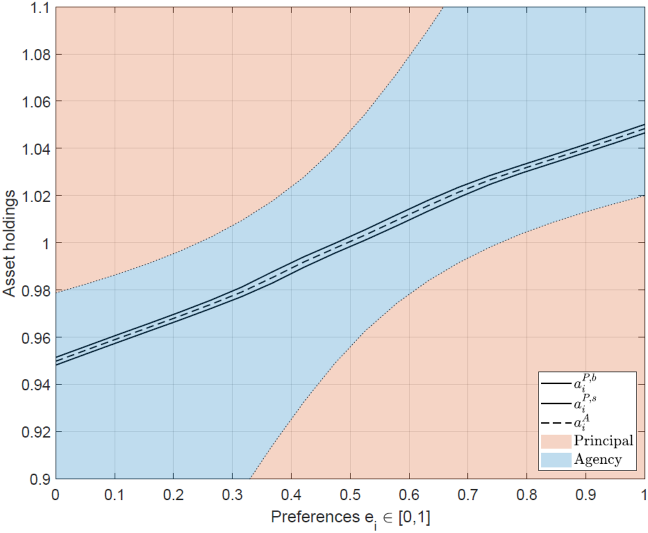
$$\text{Unit of time} = 1 \text{ day} \mid u_i(a) = \epsilon_i \times \frac{a^{1-\sigma}}{1-\sigma}$$

$$\epsilon_i = \left\{\frac{i-1}{I-1}\right\}_{i=1}^{20} \quad \Big| \quad \pi_i = 1/I$$

Parameter	Description	Value	Source / Target
A	Asset supply	1	Normalization
r	Discount	7%	LR09
σ	CRRA coeff	2	LR09
$1/\alpha$	Days to contact dealer	1	LR09
$1/\delta$	Days for preference shock	1	LR09
$1/\beta$	Days for M execution	3	Spreads ratio $=2$
η	Dealer's bargain power	0.9	Hugonnier, Lester, Weill (2020)
θ	Inventory cost	0.1 bp	Mg Lev. Ratio Cost $= 1\%$

θ and β Discussion
Volume-Spreads Trade-off

Trade choice and optimal holdings



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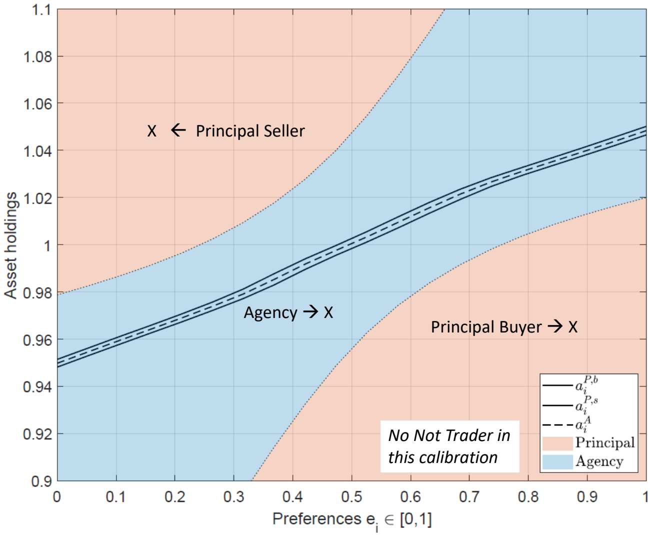

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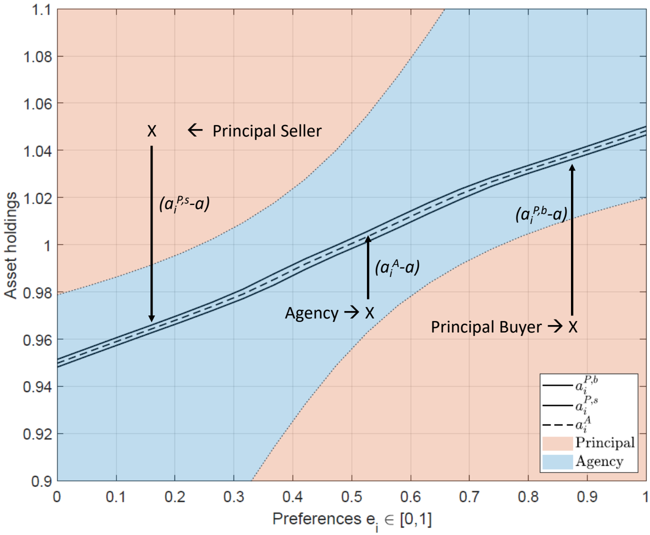
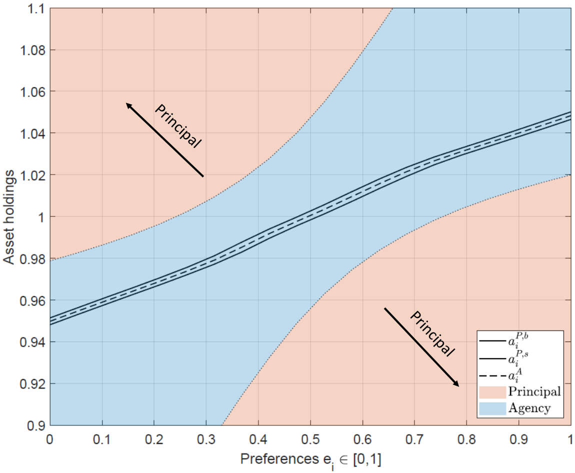
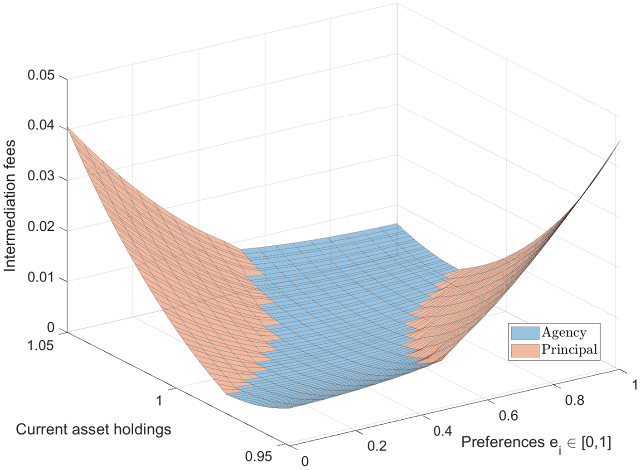


Trade choice and optimal holdings

1) Fix preference, principal is performed by investors with extreme positions
2) Fix trade size, principal is performed by investors with extreme preferences



Spreads: Intermediation fees per trading mechanism.



Spreads per unit traded

Spread Decomposition. Principal Trades

Volume weighted average effective spreads:

$$\mathcal{S}^P = \sum_{i \in \mathcal{I}} \sum_{a \in \Gamma_i^P} \frac{n_{[a,i,\omega_1]} |a_i^P - a|}{\mathcal{T}^P} \frac{\phi_{a,i}^P}{|a_i^P - a| p} \quad , \quad \mathcal{T}^P \quad = \alpha \sum_{i \in \mathcal{I}} \sum_{a \in \Gamma_i^P} n_{[a,i,\omega_1]} |a_i^P - a|$$

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Spread Decomposition: Consider change in parameter $\lambda \in [\lambda_L, \lambda_H]$

$$\mathcal{S}^P(\lambda^L) = \mathcal{S}^{P,L}_{P^L,P^H} \times w^{P,L}_{P^L,P^H} + \mathcal{S}^{P,L}_{P^L,A^H} \times w^{P,L}_{P^L,A^H} + \mathcal{S}^{P,L}_{P^L,NT^H} \times w^{P,L}_{P^L,NT^H}$$

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$$\mathcal{S}^P(\lambda^H) = \mathcal{S}^{P,H}_{P^L,P^H} \times w^{P,H}_{P^L,P^H} + \mathcal{S}^{P,H}_{A^L,P^H} \times w^{P,H}_{A^L,P^H} + \mathcal{S}^{P,H}_{NT^L,P^H} \times w^{P,H}_{NT^L,P^H}$$

$$\begin{aligned}\mathcal{S}^P(\lambda^H) - \mathcal{S}^P(\lambda^L) = & \underbrace{\mathcal{S}^{P,H}_{P^L,P^H} \times w^{P,H}_{P^L,P^H} - \mathcal{S}^{P,L}_{P^L,P^H} \times w^{P,L}_{P^L,P^H}}_{\text{ongoing principals}} \\ & + \underbrace{\mathcal{S}^{P,H}_{A^L,P^H} \times w^{P,H}_{A^L,P^H}}_{\text{agency} \to \text{principal}} + \underbrace{\mathcal{S}^{P,H}_{NT^L,P^H} \times w^{P,H}_{NT^L,P^H}}_{\text{no trader} \to \text{principal}} \\ & - \underbrace{\mathcal{S}^{P,L}_{P^L,A^H} \times w^{P,L}_{P^L,A^H}}_{\text{principal} \to \text{agency}} - \underbrace{\mathcal{S}^{P,L}_{P^L,NT^H} \times w^{P,L}_{P^L,NT^H}}_{\text{principal} \to \text{no trader}}\end{aligned}$$

Spread Decomposition. Agency Trades

Volume weighted average effective spreads:

$$\mathcal{S}^A = \sum_{i \in \mathcal{I}} \sum_{a \in \Gamma_i^A} \frac{n_{[a,i,\omega_1]} rav_{a,i}}{\mathcal{T}^A} \frac{\phi^A_{a,i}}{rav_{[a,i]} p} \quad , \quad \mathcal{T}^A = \beta \sum_{i \in \mathcal{I}} \sum_{a \in \mathcal{A}^*} n_{[a,i,\omega_2]} |a_i^A - a|$$

where $rav_{a,i}$ accounts for realized agency volume:

$$rav_{a,i} = (1 - \hat{\delta})|a_i^A - a| + \hat{\delta} \sum_{j \in \mathcal{I}} \pi_j |a_j^A - a|$$

Spread Decomposition: Consider change in parameter $\lambda \in [\lambda_L, \lambda_H]$

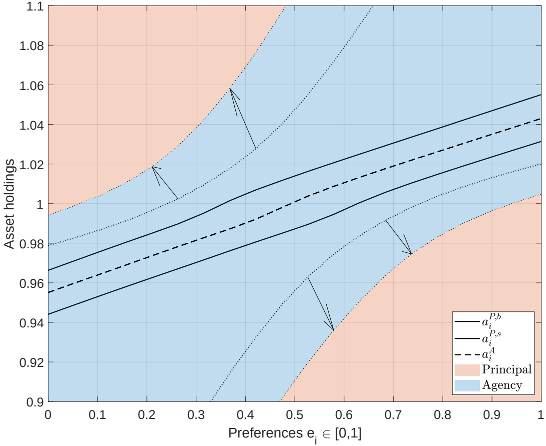
$$\mathcal{S}^A(\lambda^H) - \mathcal{S}^A(\lambda^L) = \underbrace{\mathcal{S}^{A,H}_{A^L,A^H} \times w^{A,H}_{A^L,A^H} - \mathcal{S}^{A,L}_{A^L,A^H} \times w^{A,H}_{A^L,A^H}}_{\text{ongoing agency traders}}$$

$$+ \underbrace{\mathcal{S}^{A,H}_{P^L,A^H} \times w^{A,H}_{P^L,A^H}}_{\text{principal} \to \text{agency}} + \underbrace{\mathcal{S}^{A,H}_{NT^L,A^H} \times w^{A,H}_{NT^L,A^H}}_{\text{no traders} \to \text{agency}}$$

$$- \underbrace{\mathcal{S}^{A,L}_{A^L,P^H} \times w^{A,L}_{A^L,P^H}}_{\text{agency} \to \text{principal}} - \underbrace{\mathcal{S}^{A,L}_{A^L,NT^H} \times w^{A,L}_{A^L,NT^H}}_{\text{agency} \to \text{no traders}}$$

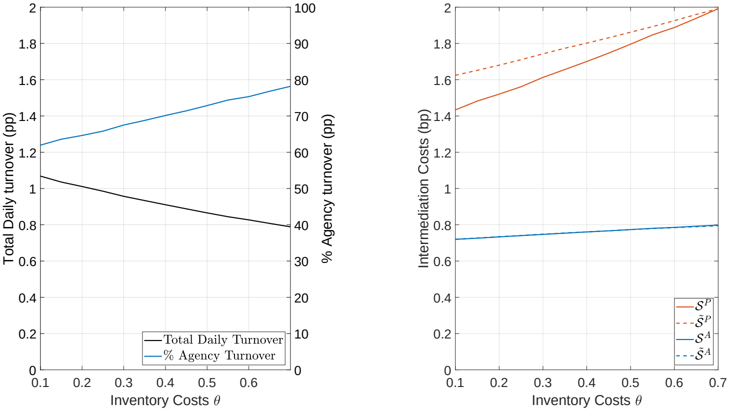
Agenda

Increasing inventory costs $\theta_L = 0.1bp \rightarrow \theta_H = 0.7bp$



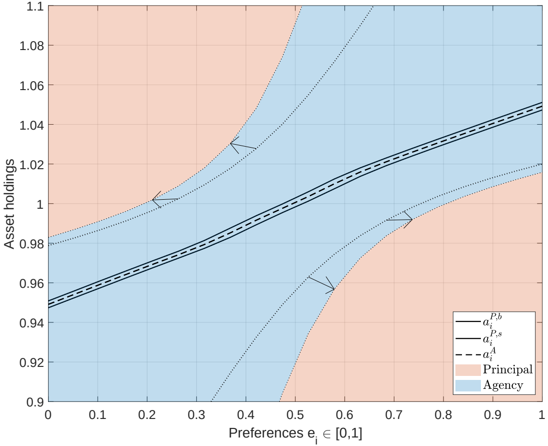
1. Principal trading migrate towards agency.
2. Migrant trades are closer to optimal positions, with centered preferences.

Increasing inventory costs $\theta_L = 0.1bp \to \theta_H = 0.7bp$



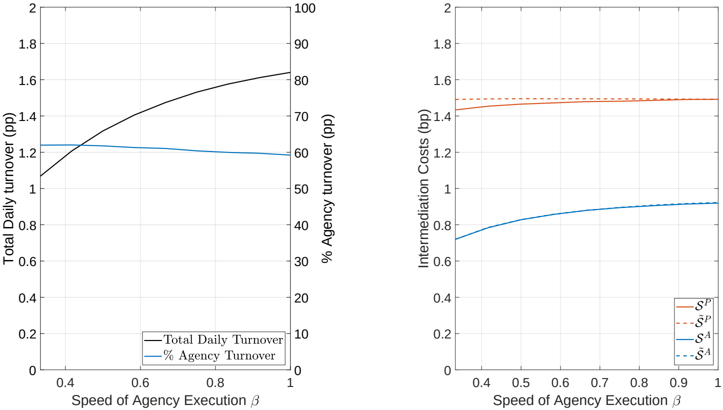
1. Turnover decreases as agency share increases.
2. $\mathcal{S}^P(\lambda^H) - \mathcal{S}^P(\lambda^L) = 55.8bp$, $\mathcal{S}^P(\lambda^H)_{P^L,P^H} - \mathcal{S}^P(\lambda^L)_{P^L,P^H} = 36.7$
3. $\mathcal{S}^A(\lambda^H) - \mathcal{S}^A(\lambda^L) = 7.8bp$, $\mathcal{S}^A(\lambda^H)_{A^L,A^H} - \mathcal{S}^A(\lambda^L)_{A^L,A^H} = 7.5bp$
4. **Composition account for 34.2% in principal and for 4.1% in agency.**

Increasing execution speed $\beta_L = 1/3 \rightarrow \beta_H = 1$



1. Again, principal trades migrate towards agency.
2. Migrant trades are closer to optimal positions, with centered preferences.

Increasing execution speed $\beta_L = 1/3 \to \beta_H = 1$



1. Turnover increases and agency share slightly decreases.
2. $\mathcal{S}^P(\lambda^H) - \mathcal{S}^P(\lambda^L) = 5.8bp$, $\mathcal{S}^P(\lambda^H)_{P^L,P^H} - \mathcal{S}^P(\lambda^L)_{P^L,P^H} = 0.1bp$
3. $\mathcal{S}^A(\lambda^H) - \mathcal{S}^A(\lambda^L) = 20bp$, $\mathcal{S}^A(\lambda^H)_{A^L,A^H} - \mathcal{S}^A(\lambda^L)_{A^L,A^H} = 20.3$
4. **Composition account for 98.7% in principal and for -1.5% in agency.**

Conclusion

- Regulation and technology changes affected ToT in OTC markets.
- Transaction costs may carry a composition effect: trading mechanism type is endogenous.
- This paper develops a model with:
  - ✓ OTC markets features
  - ✓ Two trading mechanism
  - ✓ Speed-cost trade-off defines terms of trade
- This allows to characterize and split trades per trading mechanism
- Transaction costs are partially explained by composition effects:
  - Inventory Cost: 34% in principal, 0.7% in agency.
  - Speed of Execution: 99% in principal, -1.5% in agency.

Composition Effects in OTC Transaction Costs

Mariano J. Palleja

Macro Proseminar
UCLA

February, 2023

-

Keywords: OTC markets, transaction costs, composition effect, principal / agency trades

08 Financial Crisis increased Principal Trading Costs

Basel III (finalized in 2013 in US)

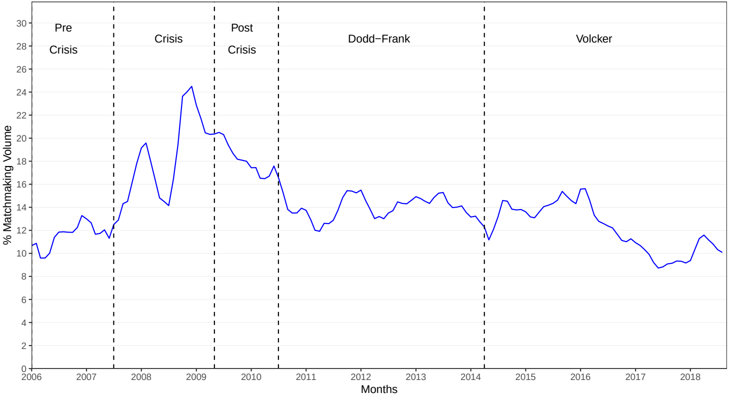
- Liquidity Coverage Ratio (LCR): "high-quality" assets in proportion to any borrowing with term 30 days or less.
- Net Stable Funding Ratio (NSFR): fund assets that mature at various terms less than one year with financing that has at least a matching term.
- Revised Capital Adequacy Ratio (CAR): larger minimum of equity and reserves as a percentage of risk-weighted assets.
- Leverage Ratio (LR), maintain a quantity of stock and cash equal to at least 3% (6% for large banks in U.S) of assets.

Volcker Rule (full compliance by Jul 2015)

- Prohibits banks from engaging in proprietary trading of risky securities.
  - Market making is excepted, but the distinction is blurry.
  - Reports of measures as proxies for the underlying trading motive.

back

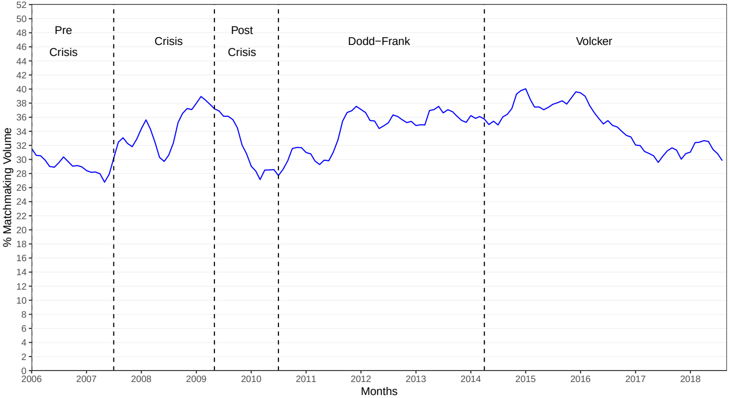
Agency Volume Share - IG



- TRACE: US dealers corp bonds + standard filters + I.G. + D-C trade
- Agency: trades of same dealer-bond offloaded within 15 min.

back

Agency Volume Share - HY



- TRACE: US dealers corp bonds + standard filters + H.Y. + D-C trade
- Agency: trades of same dealer-bond offloaded within 15 min.

back

Volcker Rule Dealers switch towards agency

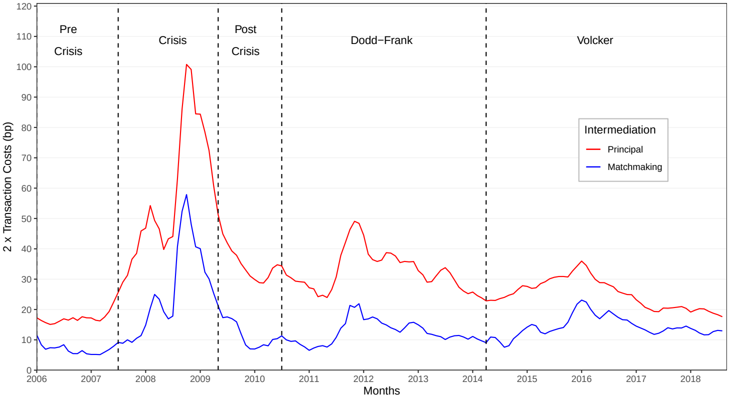
Bao, O'Hara, Zhou (2018)

Panel B: Volcker-affected dealers			
Period	*Percent of volume that is dealer–customer*	*Share of dealer–customer trade*	*Percent of trades that is agency*
Precrisis Period	77.428	93.371	12.104
Crisis Period	83.295	89.117	15.413
Post-crisis Period	75.958	84.569	15.543
Post-Dodd–Frank Period	67.224	79.728	15.965
Post-Volcker Period	75.608	76.297	22.709
Panel C: Non-Volcker dealers			
Period	*Percent of volume that is dealer–customer*	*Share of dealer–customer trade*	*Percent of trades that is agency*
Precrisis Period	22.119	6.629	46.404
Crisis Period	37.803	10.883	45.326
Post-crisis Period	29.192	15.431	35.779
Post-Dodd–Frank Period	33.063	20.272	33.118
Post-Volcker Period	48.722	23.703	29.403

Precrisis Period (January 1, 2006–June 30, 2007), Crisis Period (July 1, 2007–April 30, 2009), Post-crisis Period (May 1, 2009–July 20, 2010), Post-Dodd–Frank Period (July 21, 2010–March 31, 2014), and Post-Volcker Period (April 1, 2014–March 31, 2016). A trade is effectively agent if it is offset by another trade that occurred within one minute with the same trade size by the same dealer but with opposite trade direction.

back

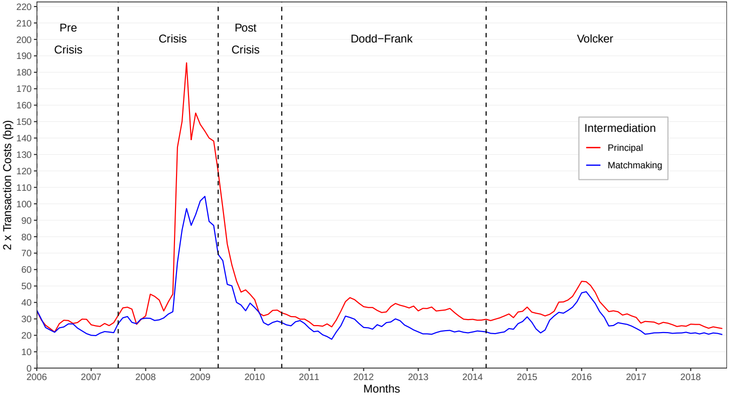
Trading Cost per trading mechanism - IG



- TRACE: US dealers corp bonds + standard filters + I.G. + D-C trades
- Transaction cost: $2 * (\frac{p}{p^{DD}} - 1)$ if dealer sell, $2 * (1 - \frac{p}{p^{DD}})$ if dealer buy
- Agency: trades of same dealer-bond offloaded within 15 min.
- Monthly weighted averages, 1%-99% outliers drop.

back

Trading Cost per trading mechanism - HY



- TRACE: US dealers corp bonds + standard filters + H.Y. + D-C trades
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- Monthly weighted averages, 1%-99% outliers drop.

DC-DC transaction costs increased after new regulations

Choi and Huh (2021)

(b) Spread Regressions for IG Bonds

	Dependent Variables:				
	IRC_C	*IRC*	*same_day*	*invcost*	*liqcost*
	(1)	(2)	(3)	(4)	(5)
crisis	9.007***	8.600***	13.278***	19.153***	19.079***
	(0.692)	(0.521)	(0.700)	(1.236)	(1.227)
post-crisis	0.402	2.403***	4.630***	8.829***	8.615***
	(0.431)	(0.333)	(0.413)	(0.752)	(0.741)
post-regulation	1.328***	2.776***	6.438***	12.940***	12.418***
	(0.328)	(0.253)	(0.312)	(0.552)	(0.542)
Constant	14.641***	13.888***	19.001***	21.061***	21.026***
	(0.343)	(0.258)	(0.322)	(0.569)	(0.560)
$\beta_4 - \beta_3$	0.926***	0.372	1.808***	4.111***	3.803***
Observations	99,501	181,811	421,281	537,117	551,790
R^2	0.251	0.195	0.176	0.062	0.060

(c) Spread Regressions for HY Bonds

	Dependent Variables:				
	IRC_C	*IRC*	*same_day*	*invcost*	*liqcost*
	(1)	(2)	(3)	(4)	(5)
crisis	3.859***	3.727***	5.187***	10.315***	10.381***
	(0.687)	(0.653)	(0.703)	(1.536)	(1.485)
post-crisis	−1.915***	−0.880	−1.726***	3.922***	3.349***
	(0.603)	(0.579)	(0.594)	(1.287)	(1.227)
post-regulation	1.599***	2.583***	3.327***	14.219***	13.073***
	(0.534)	(0.522)	(0.511)	(1.117)	(1.061)
Constant	27.026***	26.084***	28.685***	29.722***	30.418***
	(0.473)	(0.456)	(0.469)	(1.018)	(0.959)
$\beta_4 - \beta_3$	3.515***	3.464***	5.053***	10.297***	9.724***
Observations	133,308	163,712	416,442	298,199	317,046
R^2	0.205	0.192	0.101	0.024	0.022

$$y_{i,t} = \alpha + \sum_{l=2}^{4} \beta_l \mathbb{1}(t \in T_l) + \epsilon_{i,t}$$

where $y_{i,t}$ is one of the following five trading cost measures for bond i on day t: *IRC_C*, *IRC*, *same_day*, *invcost*, or *liqcost*. *invcost* is calculated based on the *Spread* measure using inventory trades only. *liqcost* is calculated by volume-weighting *Spread* for inventory trades and *Spread* for the first legs of DC-DC trades. We include the following set of control variables: the log of the average customer trade size used in calculating $y_{i,t}$; the log of bond amounts outstanding; rating and the log of rating; age and the log of age; time to maturity and the log of time to maturity; the VIX; and bond market volatility.

back

Electronic Trading increases agency trades.

O'Hara and Zhou (2021)

$$RPT^{v}_{i,t,s,d} = \alpha + \beta \times E.Share_{i,t,s,d} + \gamma \times X_{i,t} + \mu_t + \mu_s + \mu_d + \epsilon_{i,t,s,d}$$

Table 4
Electronic trading and riskless principal trades.

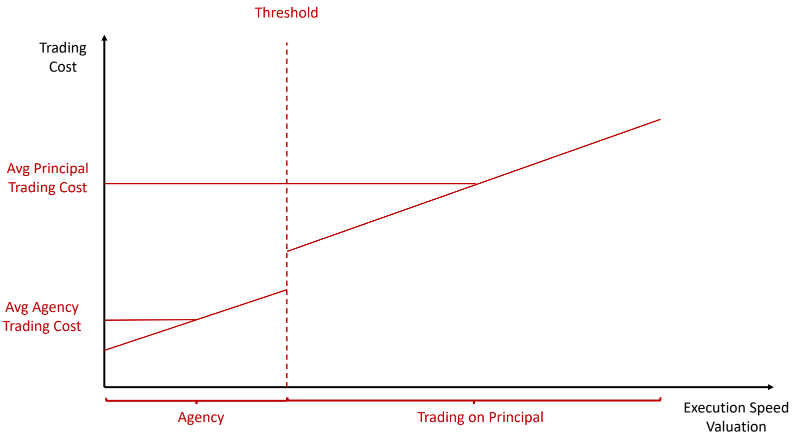
	I Bond level evidence	II Bond level evidence: Controlling for time fixed effects	III Bond-dealer level evidence	IV Bond-dealer level evidence: matched sample
E-Share	0.149***	0.138***	0.234***	0.138***
	(52.11)	(51.25)	(50.77)	(43.84)
Log(Amount Out)	−0.007***	−0.009***	0.002***	
	(−14.35)	(−17.32)	(11.70)	
Time to Maturity	−0.002***	−0.002***	−0.001***	
	(−15.72)	(−15.35)	(−27.75)	
Credit Rating FE	Yes	Yes	Yes	No
Industry FE	Yes	Yes	Yes	No
Size FE	Yes	Yes	Yes	No
Day FE	No	Yes	Yes	No
Dealer FE	No	No	Yes	Yes
Bond-Day-Size FE	No	No	No	Yes
Observations	10,484,065	10,484,065	17,777,860	10,743,569
R^2	0.12	0.12	0.5	0.65

For Columns I and II, the dependent variable is $RPTShare^{v}_{i,t,s}$, which is the share of RPT trade volume out of total voice trade volume, calculated at the bond-day-trade size level. For Columns III and IV, the dependent variable is $RPTShare^{v}_{i,t,s,d}$, which is the share of riskless principal trade (RPT) volume out of total voice trade volume, calculated at the bond-day-trade size-dealer level. *E-Share* is the share of dealer-customer trade volume that occurs on MarketAxess. It is calculated at the same frequency as the dependent variable. Controls include the log of the total par amount outstanding (*Log(Amount*

back

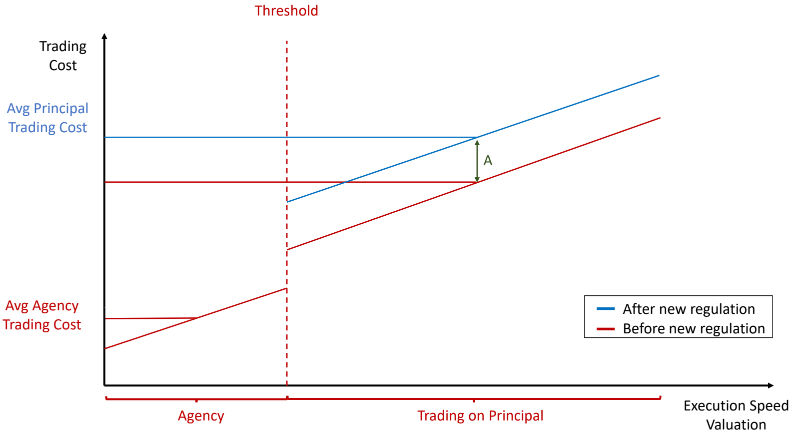
Increase in principal transaction cost example

Initial scenario: trades are split according to execution speed valuation.
Assume execution speed valuation $\sim U[0, 1]$.



Increase in principal transaction cost example

Consider a new costly regulation for principal trading.
If mechanism distributions are held constant:



Increase in principal transaction cost example

Consider a new costly regulation for principal trading.
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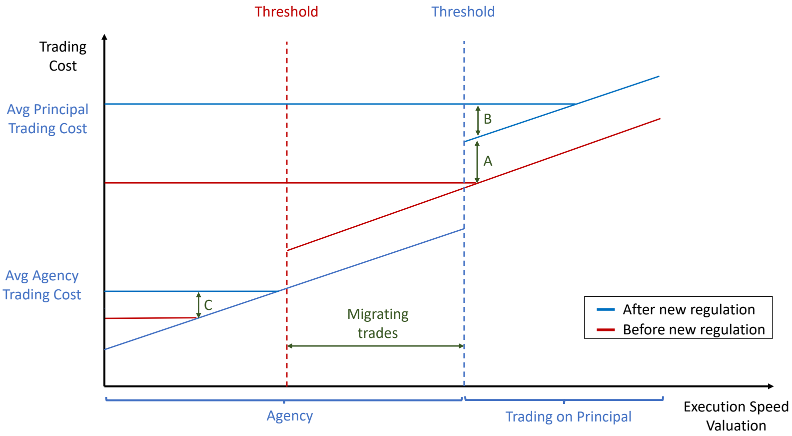

Flow Bellman Equation - Agency Timing

$$V_i(a,t) = \mathbb{E}_i \Big[\underbrace{\int_t^{T_\alpha} e^{-r(s-t)} u_{k(s)}(a) ds}_{a_t \text{ utility}} + e^{-r(T_\alpha - t)} \max \Big\{ \underbrace{V_k^P(a, T_\alpha)}_{principal}, \underbrace{V_k^A(a, T_\alpha)}_{agency} \Big\} \Big]$$

$$V_k^A(a, T_\alpha) = \int_{T_\alpha}^{T_\beta} e^{-r(s-T_\alpha)} u_{k(s)}(a) ds + e^{-r(T_\beta - T_\alpha)} \Big(V_{k(T_\beta)}(a^A_{k(T_\beta)}, T_\beta) - p_{(T_\beta)}[a^A_{k(T_\beta)} - a] - \phi^A_{k(T_\alpha)} \Big)$$

Agency Timing Assumption:

- Fees ϕ^A are set at contact with dealers and payed at execution.
- Optimal holdings a^A are decide at execution.

back

Flow Bellman Equation - Expectations on shocks solved

$$V_i(a,t) = \mathbb{E}_t\Big[\bar{U}_i^{\kappa}(a) + \hat{\kappa}\big[(1-\hat{\delta})\max\Big\{V_i^P(a), V_i^A(a)\Big\} + \hat{\delta}\sum_j \pi_j \max\Big\{V_j^P(a), V_j^A(a)\Big\}\big]\Big]$$

with
$$V_i^P(a) = V_i(a_i^P) - p(a_i^P - a) - \theta p|a_i^P - a| \qquad \leftarrow \text{principal}$$
$$V_i^A(a) = \bar{U}_i^{\beta}(a) + \hat{\beta}[\bar{V}_i^A - p(\bar{a}_i^A - a)] \qquad \leftarrow \text{agency}$$

- $\bar{U}_i^{\nu}(a) = \Big[(1-\hat{\delta}_\nu)u_i(a) + \hat{\delta}_\nu \sum_j \pi_j u_j(a)\Big]\dfrac{1}{r+\nu}, \quad \hat{\delta}_\nu = \dfrac{\delta}{r+\delta+\kappa}, \quad \nu = [\kappa, \beta]$
- $\bar{V}_i^A = (1-\hat{\delta}_\beta)V_i(a_i^A) + \hat{\delta}_\beta \sum_j \pi_j V_j(a_j^A) \quad , \quad \bar{a}_i^A = (1-\hat{\delta}_\beta)a_i^A + \hat{\delta}_\beta \sum_j \pi_j a_j^A$
- $\hat{\kappa} = \dfrac{\kappa}{r+\kappa}, \qquad \hat{\beta} = \dfrac{\beta}{r+\beta}, \qquad \kappa = \alpha(1-\eta)$

Inflow-Outflow Equations

$$n_{[a_i^{P,b},i,\omega_1]} : \quad \delta\pi_i \sum_{j\neq i} n_{[a_i^{P,b},j,\omega_1]} + \alpha \sum_{a\in Buy_i^P} n_{[a,i,\omega_1]} = n_{[a_i^{P,b},i,\omega_1]} \left[\delta[1-\pi_i] + \alpha \mathbf{1}_{[a_i^{P,b}\notin NoT_i^P]}\right]$$

$$n_{[a_i^{P,s},i,\omega_1]} : \quad \delta\pi_i \sum_{j\neq i} n_{[a_i^{P,s},j,\omega_1]} + \alpha \sum_{a\in Sell_i^P} n_{[a,i,\omega_1]} = n_{[a_i^{P,s},i,\omega_1]} \left[\delta[1-\pi_i] + \alpha \mathbf{1}_{[a_i^{P,s}\notin NoT_i^P]}\right]$$

$$n_{[a_i^{A},i,\omega_1]} : \quad \delta\pi_i \sum_{j\neq i} n_{[a_i^{A},j,\omega_1]} + \beta \sum_{a\in \mathcal{A}^*} n_{[a,i,\omega_2]} = n_{[a_i^{A},i,\omega_1]} \left[\delta[1-\pi_i] + \alpha \mathbf{1}_{[a_i^{A}\notin NoT_i^P]}\right]$$

$$n_{[a_j,i,\omega_1]} : \quad \delta\pi_i \sum_{j\neq i} n_{[a_j,j,\omega_1]} = n_{[a_j,i,\omega_1]} \left[\delta[1-\pi_i] + \alpha \mathbf{1}_{[a_j\notin NoT_i^P]}\right], \quad a_j \in \cup_{j\neq i}\{a_j^{P,b}, a_j^{P,s}, a_j^{A}\}$$

$$n_{[a_i,i,\omega_2]} : \quad \delta\pi_i \sum_{j\neq i} n_{[a_i,j,\omega_2]} + \alpha n_{[a_i,i,\omega_1]} \mathbf{1}_{[a_i\in\Gamma_i^A]} = n_{[a_i,i,\omega_2]} \left[\delta[1-\pi_i] + \beta\right], \quad a_i \in \mathcal{A}^*$$

back

Solution Method

1. Set an initial guess for the equilibrium price p.
   1.1 Set an asset holdings grid and an initial guess for $V_i(a)$
   1.2 Compute optimal asset holdings $\{a_i^P(a), a_i^A\}_{i=1}^I$ using eq. (4) and eq. (6).
   1.3 Compute trading mechanism choice for each pair $\{i, a\}$, using indifference condition.
   1.4 Fix $\{a_i^P(a), a_i^A\}_{i=1}^I$, and iterate h times the following steps:
      1.4.1 Update $V_i(a)$ using eq. (1).
      1.4.2 Compute trading mechanism choice for each pair $\{i, a\}$, using indifference condition
   1.5 Update $V_i(a)$ using eq. (1) until convergence with initial guess of step (a).
2. Define trading mechanism sets $\{\Gamma_i^P, \Gamma_i^A\}_{i=1}^I$ using thresholds.
3. Compute transition matrix T using inflow-outflow equations.
4. Set vector n_0 and obtain $n = \lim_{k\to K} n_0 T^k$, with K sufficiently large to reach convergence.
5. Compute total demand and update p until excess demand in market clearing equations converges towards zero.

Note: Our Bellman operator is a contraction mapping with modulus $\hat{\kappa}$ and operates in a complete normed vector space

back

Baseline Calibration

Inventory Costs θ:

- Want to capture the regulations-induced inventory costs.
- Greenwood et. al. (2017), Duffie (2018), Fed stress test (2019): Leverage Ratio Requirement as most important constraint for U.S. banks
  $\rightarrow$ LR: hold extra capital when including assets in inventory: 3% to 5%/
- LR cost $= p[a' - a][e^{zm} - 1]x\%$, where bank face $x\%$ of capital requirement and $z\%$ opportunity costs for such capital, and offload position after m days.
- Model cost $= 2\theta p[a' - a]$. $\implies \theta = [e^{zm} - 1]x\%/2$
- Take $z = r$ as the opportunity cost.
- Goldstein and Hotchkiss (2020), TRACE 02-11, $m = 10.6$ days.
- We consider a baseline $x\% = 1\%$

  $\implies \theta \approx 0.1 b.p.$.

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Execution delay β

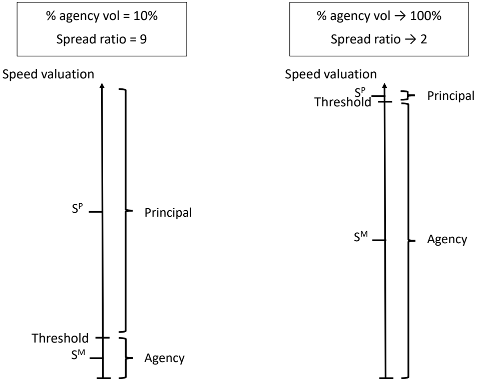
- Targeted=Model: spread ratio $S^P/S^A = 2$.

back

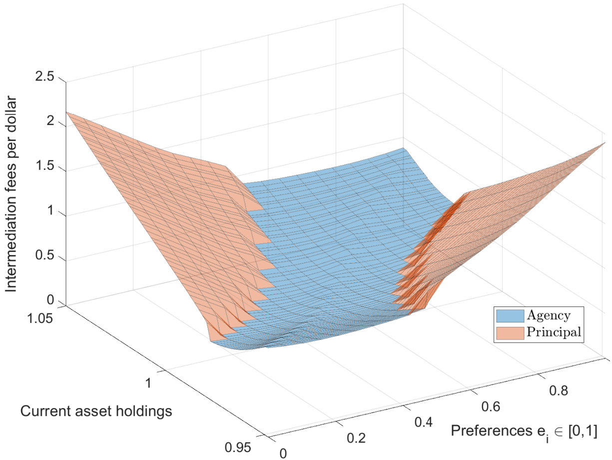
Matching % Agency Volume *vs* Spread ratio

- Assume trading costs are an increasing linear function in speed valuation.
- Assume mass of traders is uniformly distributed across speed valuation line.
- Unique threshold split principal and agency trades.

$\Longrightarrow$ Max spread ratio $=2$, achieved when % agency volume $\rightarrow 100\%$.



Spreads per unit traded: $\dfrac{\phi_i(a)}{|a' - a|} \dfrac{10000}{p}$



Trade choice and optimal holdings - Alternative Calibration