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Priority Rules

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Motivation

- How to design securities markets such that
  - Investors are able to come together in space and time
  - Investor welfare is maximized
- Priority rules are an important element of market design
- Priority rules determine how trades are allocated
  - *within* a venue
  - *across* venues

Priority rules in trading

- Most jurisdictions impose **price priority**
- In the US: “Trade-through prohibition” implies **price priority *within* and *across* trading platforms**
- But what if at the same price: how are trades allocated *within* and *across* platforms?

  - Secondary priority rules are important *within* and *across* platforms

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Priority rules in trading – *within* venue

- Main types: *Price-Time* (PT) and *Price-Broker-Time* (PBT)
  - PT: price priority; within same price, the principle of first come first served (time priority)
  - PBT: price priority; within same price, orders from the same broker execute against each other even if that broker's order was not the first in the queue (broker priority; "queue jumping" may occur)

At 10:10 buyer using broker B buys 100 shares at €22.12

Order book sell side			
price	quantity	seller uses	time
22.12	100	Broker A	10:04
22.12	100	Broker B	10:09

	buyer	seller	QTY	Price
Price time priority (PT) ->	Broker B	Broker A	100	22.12
Price-broker-time priority (PBT) ->	Broker B	Broker B	100	22.12

- *Price-Random Matching* (PRM)

Priority rules in trading – *within* venue (cont'd)

- U.S. financial markets : PT
  - Before 1996 some had PBT
  - Recently, Investors Exchange (IEX) had PBT before becoming a national securities exchange
  - NYSE uses a "parity/priority" model (later arriving orders may jump the queue)

- Canadian Financial markets (PBT)
- Europe: Euronext Internal Matching Service (PBT)
  Nordic countries (PBT)
  MiFID II: frequent batch auctions (FBA) with some having broker-price-time priority

Priority rules in trading – *across* venues

price priority

- But at same price, brokers may have preference for one platform over another
  - Affiliated venues (e.g., ownership, favourable fees) could lead to 'price-platform-time' priority which differs across brokers
- Each broker may prefer another platform due to different affiliated venues.

(e.g., Angel, Harris and Spatt (2011); Spatt (2019))

Research Questions

- Is there a “one size fits all” priority rule that maximizes welfare?
- Do markets endogenously adopt the optimal priority rule, or is regulatory intervention required?
- Exploit role of “relative tick size”, i.e., tick size relative to “dispersion in private values for asset”

Related Literature

- Limit order books:
  - E.g., Foucault (1999); Foucault, Kadan, and Kandel (2005,2013); Goettler, Parlour and Rajan (2005); Parlour (1998)
  - Models have either LOs staying in book for one period, or assume PT
- OTC markets:
  - E.g., Duffie, Gârleanu and Pedersen (2005,2009); Hendershott and Madhavan (2015); Dugast (2018)
  - No queuing, or random allocation assumed
- Trading on multiple platforms:
  - E.g., Parlour and Seppi (2003); Foucault and Menkveld (2008); van Kervel (2015)
  - Priority rules within one venue (or preferencing of platforms)
- Queuing and speed in markets:
  - E.g., Chao, Yao and Ye (2017); Wang and Ye (2017); Yueshen (2014)
  - Role of priority rules

Main takeaways

1. Priority rules determine trading volume and investor welfare
   i. With small ‘relative ticks’ (tick relative to heterogeneity in private values), welfare is higher with PT
   ii. With wide ticks, welfare is higher with PBT

2. Brokers adopt PBT when offered the choice. Regulatory intervention is required with small ticks as PT is then preferred

3. Markets with PT provide incentives for off-exchange reporting

Model – one platform versus ‘multiple platforms’

- We model PT versus PBT within one platform
- Note that our analysis easily converts to a model with two platforms where each broker has a ‘price-platform-time’ priority

1. Set up: Assumptions

- Infinite horizon discrete time model, where a market is modeled as a limit order book

- A single asset is traded having fundamental value V (common knowledge)
  - No innovations (for simplicity)

- Each period a trader arrives; buyers and sellers arrive with the same probability

- They want to trade one unit, and have private valuations for the asset ($b \backsim U$ [0,2]); so their valuation is bV -> max dispersion in private values equals 2V

Set up: Assumptions (cont'd)

- Competition drives ask and bid prices to the tick Δ, i.e., to the most competitive level; A-B= Δ; the tick is symmetric around V (we study heterogeneity in Δ)
  - Dealer-specialists stand ready to provide liquidity at A and B; following market practice, at same price LOB has precedence over dealer-specialist (e.g., Parlour and Rajan, 2003)
  - Dealer-specialists make no rents due to competition – endogenize their number
- Limit orders stay in the book for two periods; If unfilled they expire
- Two brokers; equal market shares of buyers and sellers. Every investor is affiliated to one broker
- Base model: transparency about time order in LOB and about broker affiliation (in extension we consider opacity about broker affiliation)

2. Model: Decision Problem

- Upon arrival a trader can trade via MO, LO or refrain from trading. Her decision is influenced:

i. Her personal valuation (b) and inclination (buyer or seller)

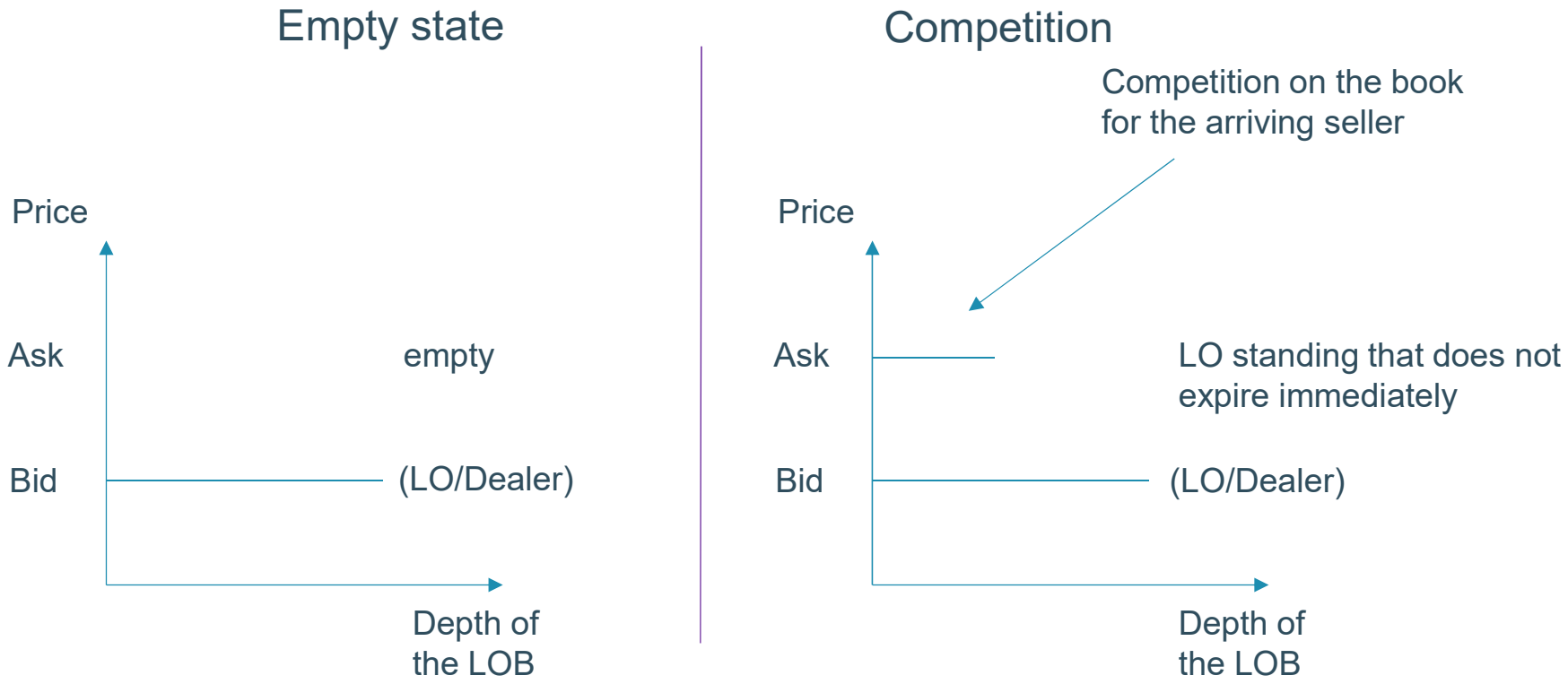
ii. The state of the book upon arrival (anticipating the optimal strategies of future arriving traders)

iii. Her broker affiliation in case of PBT

- We solve for the 'Markov steady state equilibrium'

Model: Relevant States with PT

- Focus on a seller:
- A seller arriving to the market is interested on the ask side. In PT, there are 2 states that determine her behavior. ‘Empty’ and facing ‘competition’ on the ask, i.e., a LO standing



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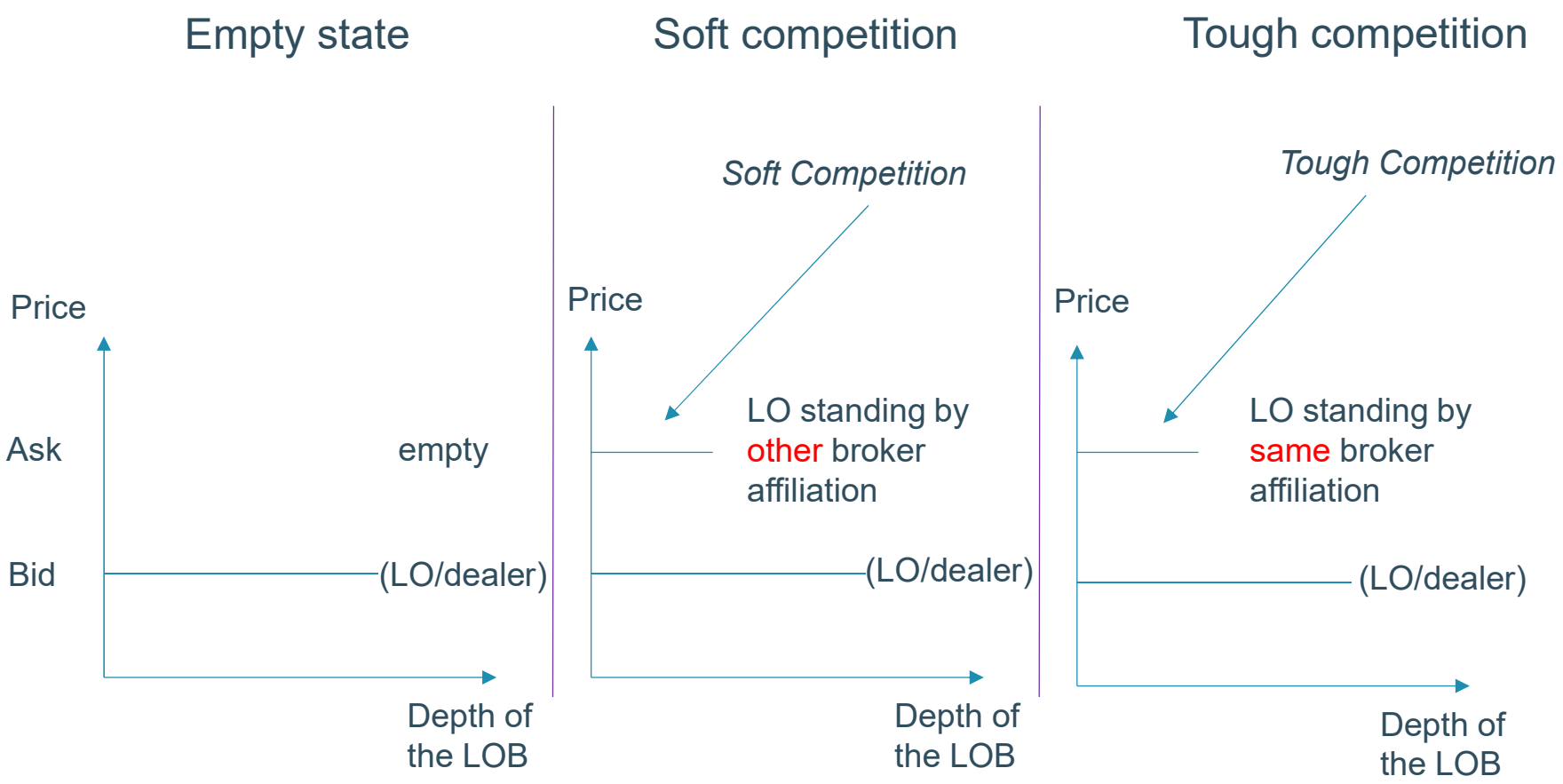
Model: Relevant States with PBT

- In PBT, three states are relevant for an arriving seller



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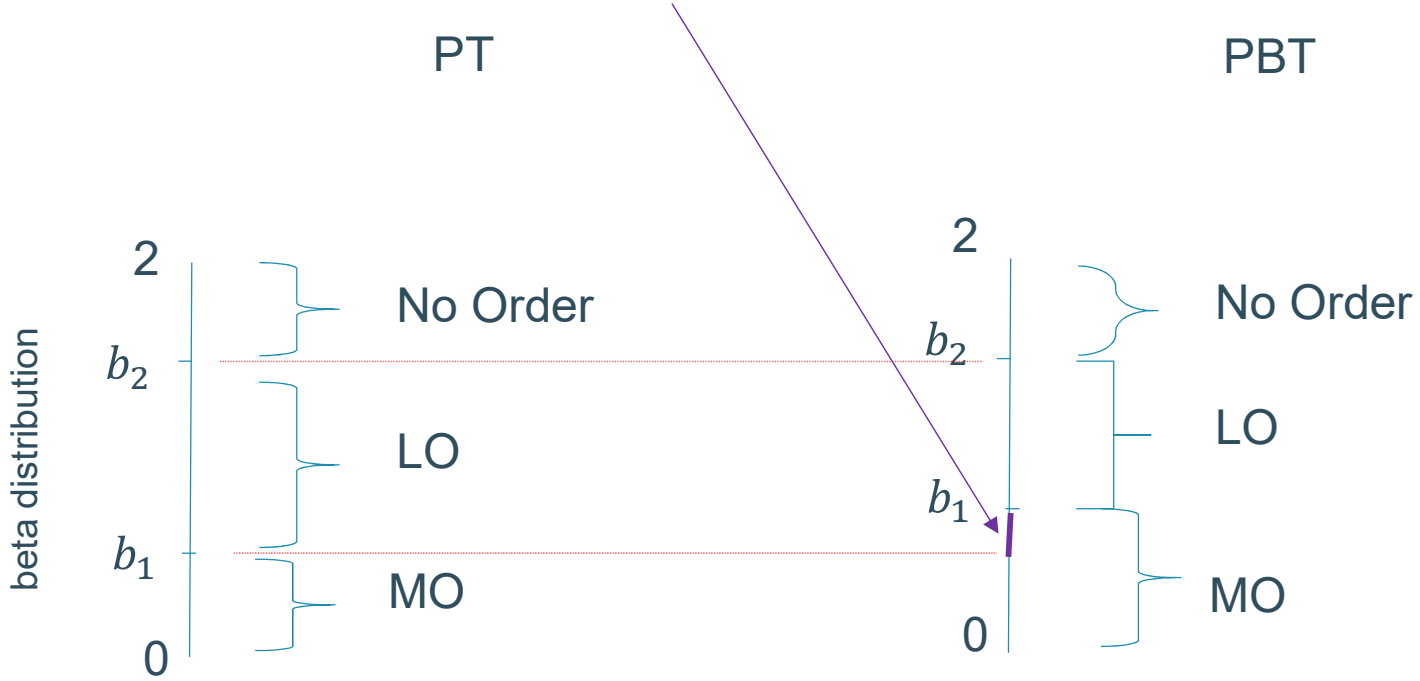
Empty state – comparison PT and PBT

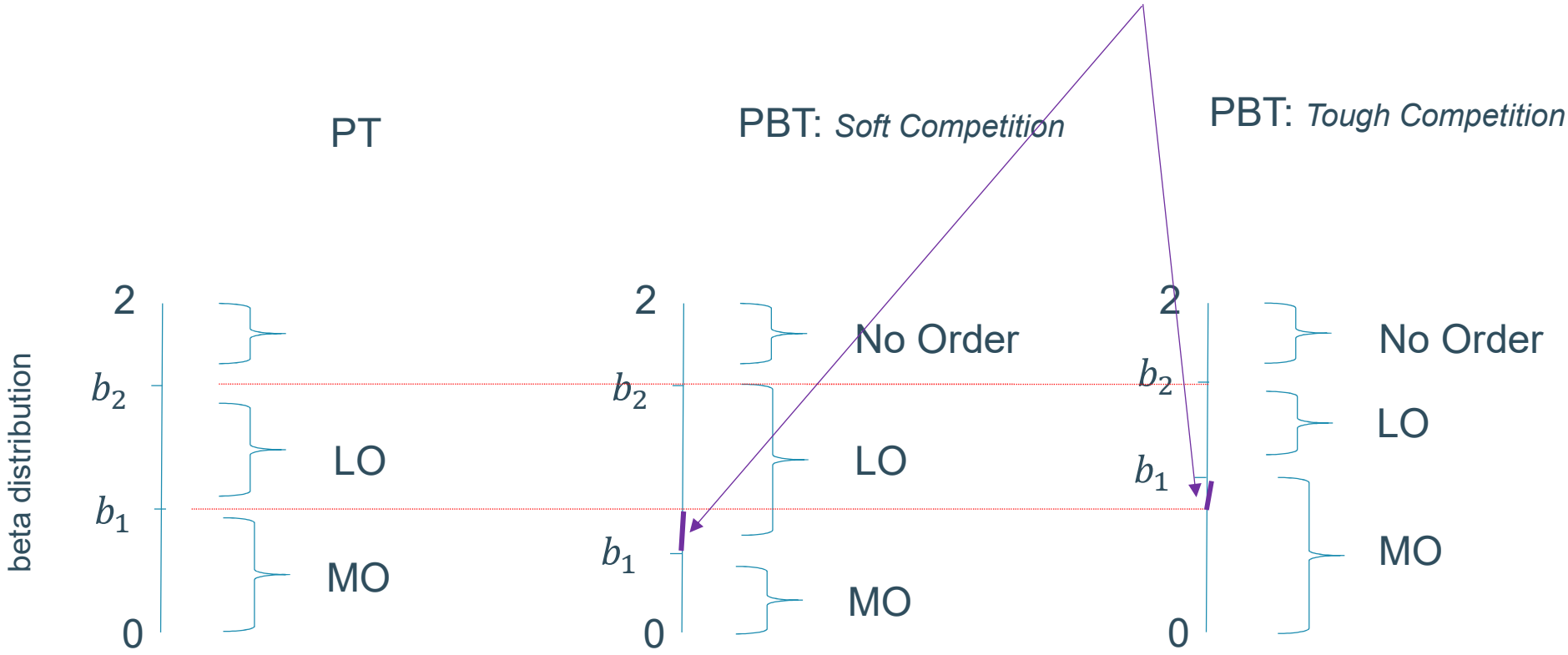
- Assume a seller arriving and sees empty state

Some traders switch from submitting a LO under PT to submitting a MO under PBT: the *anticipation* of queue jumping makes them more "aggressive"



Competition state – comparison PT and PBT

- A seller arriving to the market facing *competition*. Under PBT the decision is affected by the affiliation of the trader who submitted the LO, altering her incentives to join the queue – on average a 'queue-joining' effect



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3. Equilibrium outcomes and empirical predictions

- For any given tick:

➢ When ‘empty state’, LO is less attractive under PBT as trader anticipates she may be queue-jumped.

  ➢ In PBT relative to PT, a MO becomes more attractive given the lower probability of execution of a LO: anticipation effect

➢ With ‘competition’

  ➢ In PT, the trader does not care which broker submitted standing order

  ➢ With PBT, on average there is a queue joining effect

    ➢ also “composition” of queue matters

Empirical predictions: systematic patterns in order flow

- Without informed trading we have systematic patterns in order flow (as in Parlour 1998)

- Systematic patterns differ *between* PT and PBT

Testable Implication 2 *In equilibrium under PBT, limit orders are more likely to be followed by limit orders than in PT.*

Testable Implication 3 *In equilibrium, under PT, market orders are more likely to be followed by limit orders than in PBT.*

Empirical predictions: depth

- The average depth is lower under PBT
  - Anticipation effect leads to less LO in the book
- "More volatile depth" with PBT
  - Traders that face competition join the queue more often; so more often "deep" books
  - From a full depth, we may move to an empty book via 'queue jump' and 'order cancelation'

Testable Implication 5 *In PT, the average depth of the book is higher in comparison to PBT. The likelihood of observing a queue of 'depth of 2' is larger in PBT rather in PT. However, this depth may reverse to an empty book more rapidly in PBT than PT.*

Differences between Small and Wide relative Ticks (relative to dispersion in private values)

PBT relative to PT

"Small" Ticks

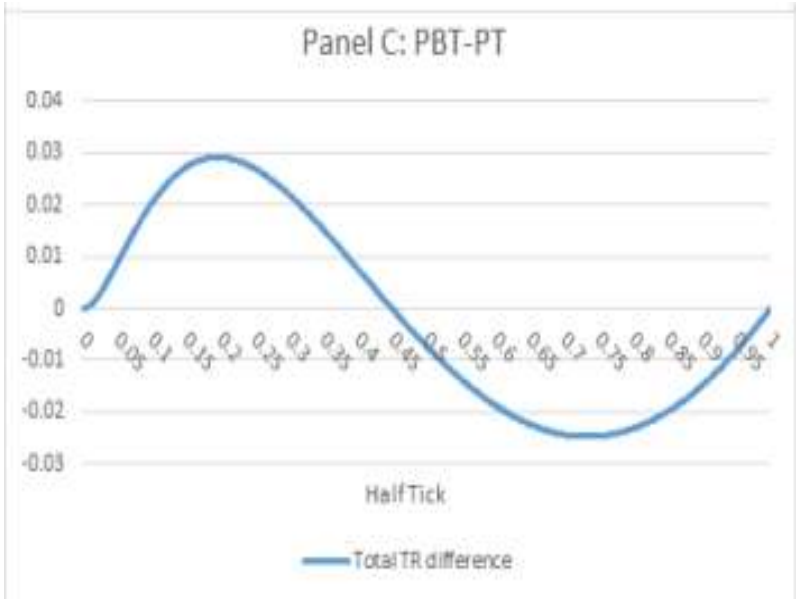
- Anticipation effect is large
  - MOs not so costly
- Higher Trading Rate
  - composition effect: trades mainly with dealers
- Lower generated Investor Welfare

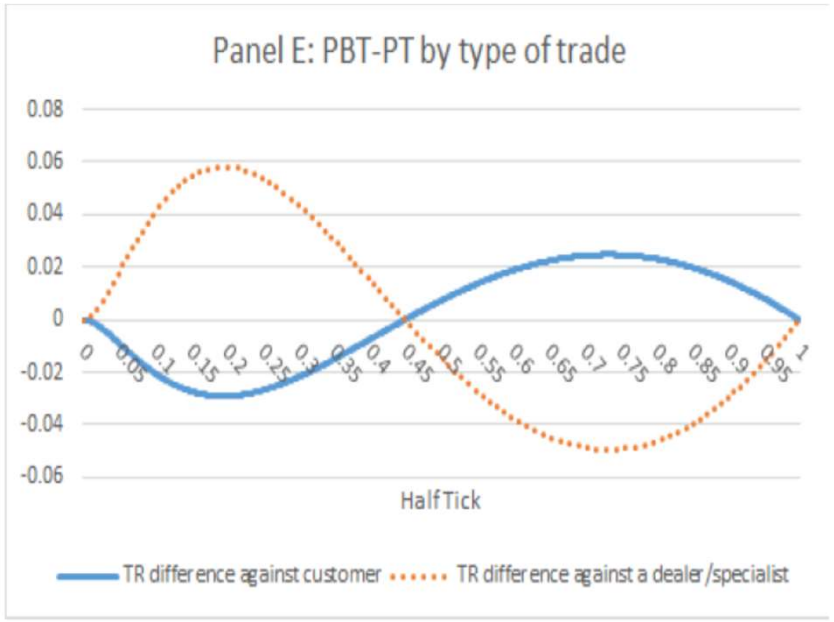
"Wide" Ticks

- Queue joining effect is large
- Lower Trading rate
  - but fill rate of LOs is higher
- Higher generated Investor Welfare

4. Trading Rates (TR) and Investor Welfare

- Difference in trading rates (PBT-PT)
  - Left Panel: Higher TR in PBT in small ticks, opposite in wide
  - Right panel: trade composition – customer/customer and customer/dealer trades





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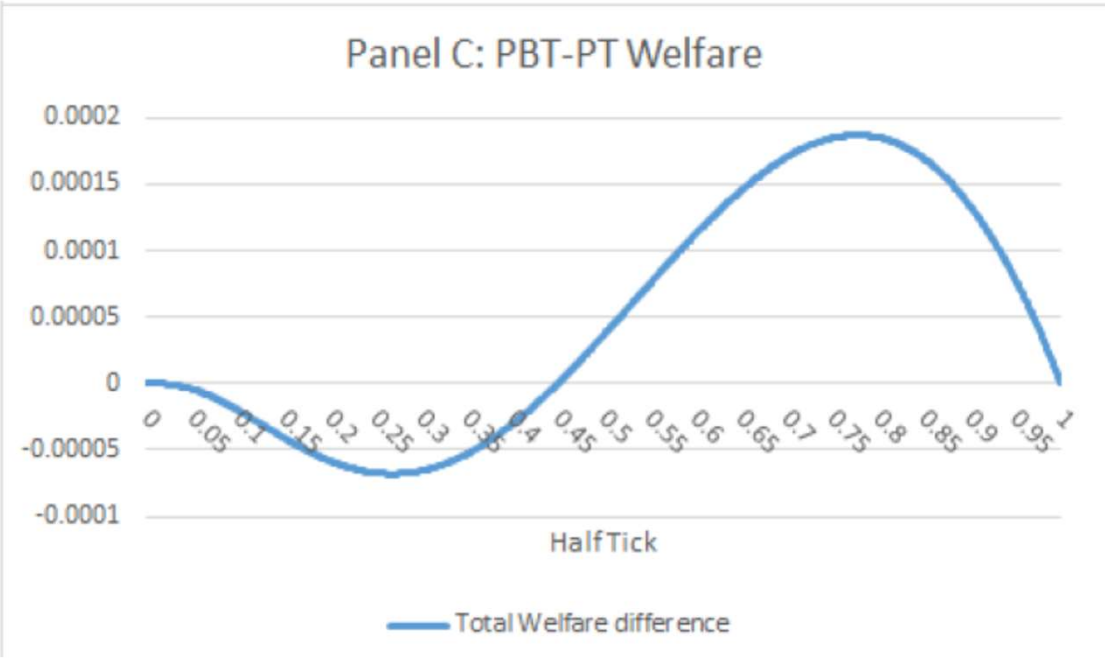
4. Trading rates and Investor Welfare

- Difference in Investor Welfare (PBT-PT)
  - Investor welfare higher with PBT for wide ticks; opposite for small ticks



Testable Implication 6 *Regulators increase investor welfare by prohibiting PBT when the tick is small. For large ticks, regulators increase investor welfare by adopting PBT.*

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5. Endogenous adoption of priority rules and welfare

- Assume that brokers maximize their clients welfare
- Dominant strategy to adopt PBT

Testable Implication 4 *In equilibrium, under the assumption that brokers maximize their investors' welfare, if given the option, then they will adopt PBT over PT.*

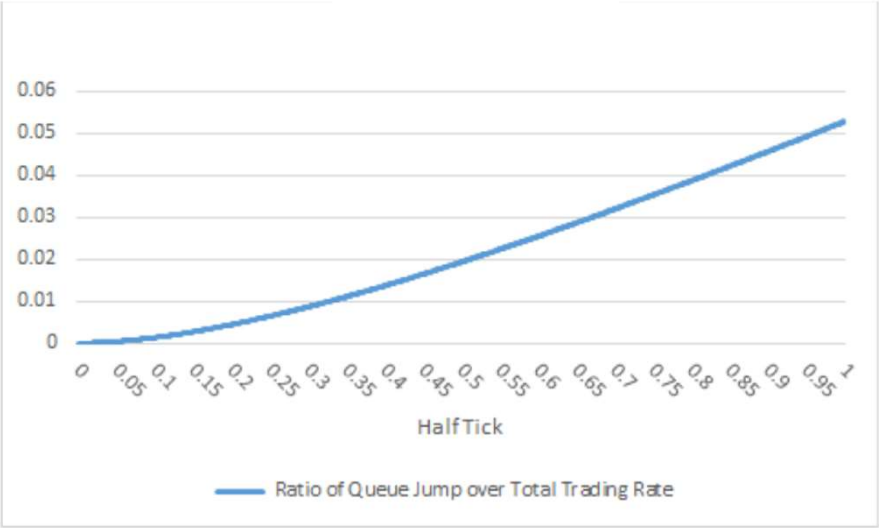
- In small ticks: prisoner's dilemma
- In wide ticks: PBT coincides with social planner's preferred outcome

6. Theoretical model confronted with empirics

- The critical 'relative tick' $\widetilde{\Delta}$ is about 44% of the dispersion in private values
  - PT is optimal when the 'relative tick' is smaller than 44%; PBT optimal otherwise
- Empirical proxy
  - Hendershott and Menkveld (2014) – 697 NYSE stocks from 1994-2005:
    - Dispersion in private values: average of 185 basispoints, with variation from 133 to 307 basispoints depending upon quartile of stocks
    - Effective half-spreads on average 21.62 basispoints (with variation from 8.41 to 46.12 basispoints)
    - 'Relative tick' varies at quartile level between 6% to 15%, with average of 11.7%
    - Suggests PT is preferred but variation *within* quartiles
  - Malinova and Park (2015) – cross-listed Canadian stocks
    - Average spread: 62 to 84 basispoints (cross-listed and non-cross-listed) -- 'relative tick' probably around 20 to 30%;
- Increase in number of brokers decreases the 'critical relative tick'; so PBT may be optimal for at least some stocks.

7. Priority rules and off-exchange reporting

- With PT, brokers can circumvent this priority rule and implement PBT by “off-exchange reporting”
  - If LO of “same broker” is at back of the queue, this broker can take it out of book and match it with a “same broker” trader who wants to submit MO



  - With PT, ‘ratio of off-exchange reported trades to total trades’ increases in tick size

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7. Priority rules and market fragmentation

- Consider PT but with off-exchange reporting

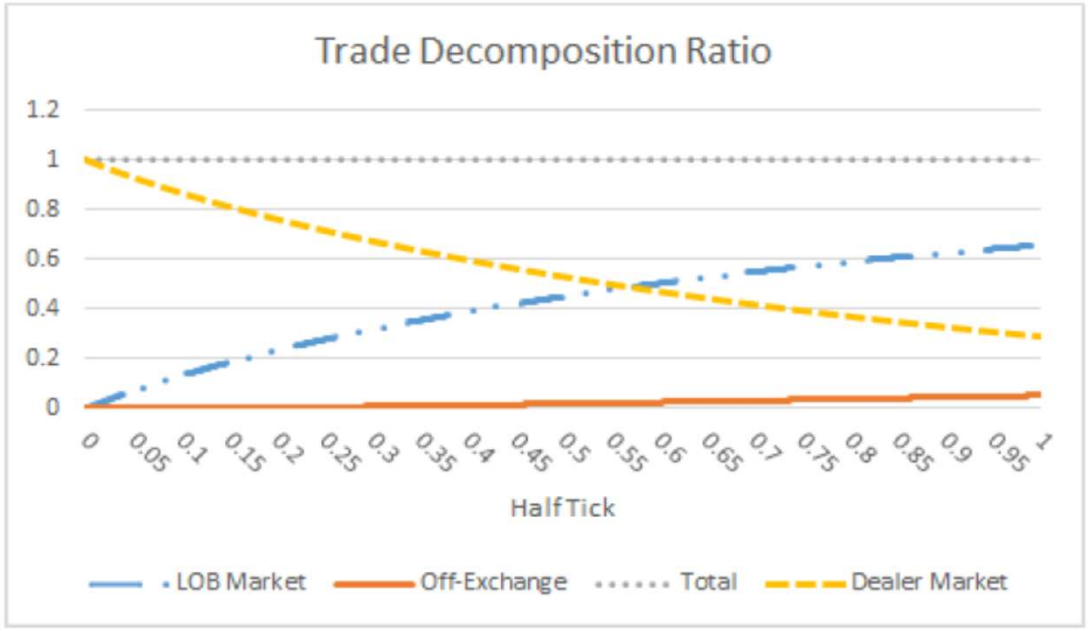


Figure 9: Market fragmentation when off-exchange trading allowed

8. Centralized versus Fragmented Markets

- Priority rules affect traders' choices between MOs or LOs

Testable Implication 7 *In equilibrium, in fragmented markets, limit orders are more likely to be followed by limit orders, than in centralized markets.*

Testable Implication 8 *In equilibrium, in centralized markets, market orders are more likely to be followed by limit orders, than in fragmented markets.*

Testable Implication 9 *In equilibrium, in fragmented markets, limit orders are more likely to be followed by limit orders in different platforms in comparison to the same platform.*

- Incentives for 'platform priority' induce market fragmentation

Testable Implication 10 *Even with price priority, fragmentation across multiple markets endogenously occurs in the absence of time priority across markets, and brokers having as tie-breaking rule a preference for one market.*

9. Robustness and extensions

- N brokers (N>2): impacts of queue jumping diminish; $\tilde{\Delta}$ decreases in N; when N goes to infinity, PBT converges to PT

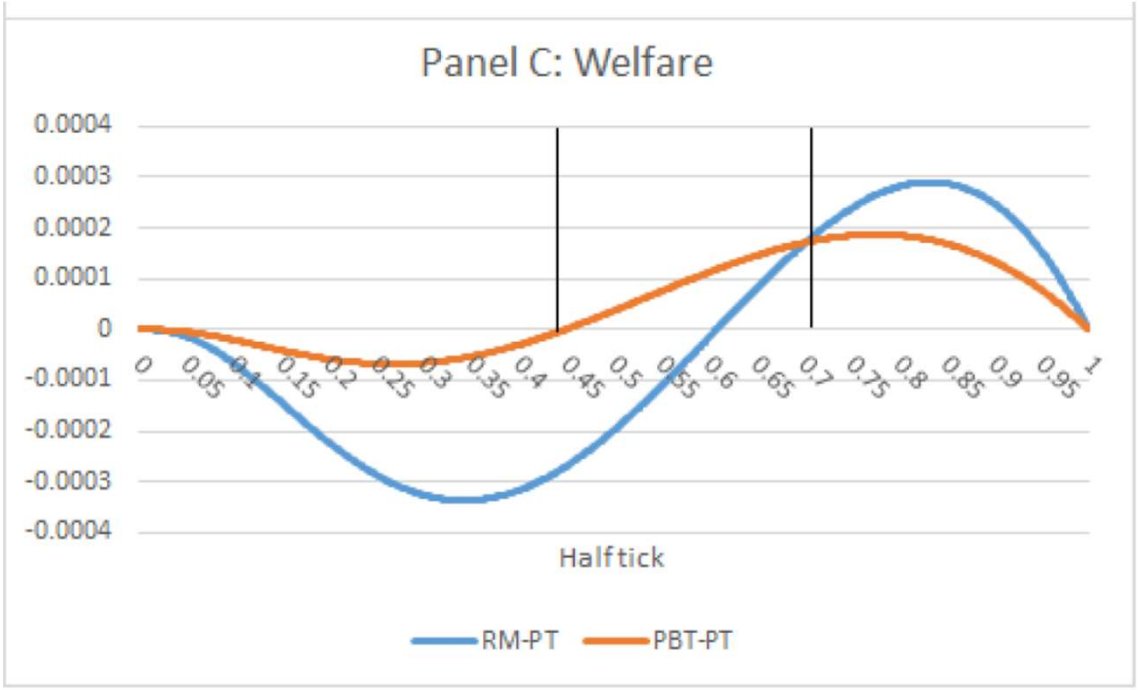
- Endogenize number of dealers

- Opacity about broker affiliations

- No dealer-specialist: more likely to submit LOs but welfare results still holds – positive comovement between trading and welfare

9. Robustness and extensions

- Random Matching (RM)



- Highest welfare:
  - Small ticks: PT; Intermediate ticks: PBT; Large ticks: RM

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Concluding Remarks

- Priority rules affect traders' choices between MOs or LOs.
- In small relative ticks (relative to dispersion in private values), welfare is higher with PT. With wide ticks, PBT yields higher welfare.
- When brokers can individually decide on the priority rule, PBT will be adopted.
- We show that markets fragment differently depending upon priority rules
  - off-exchange reporting is higher in PT and this is more prominent as the tick is wider.
- We contribute to the debate related to priority rules, showing that a "one size fits all" rule may not be optimal.

Thank you

Comments:

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No dealer-specialist

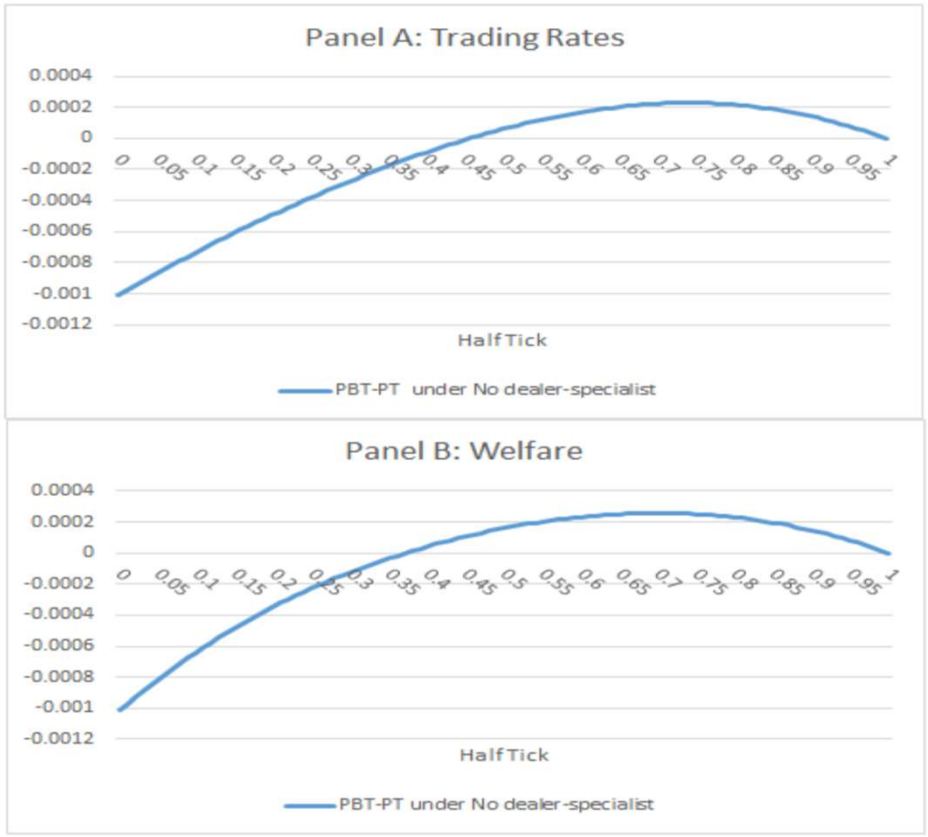
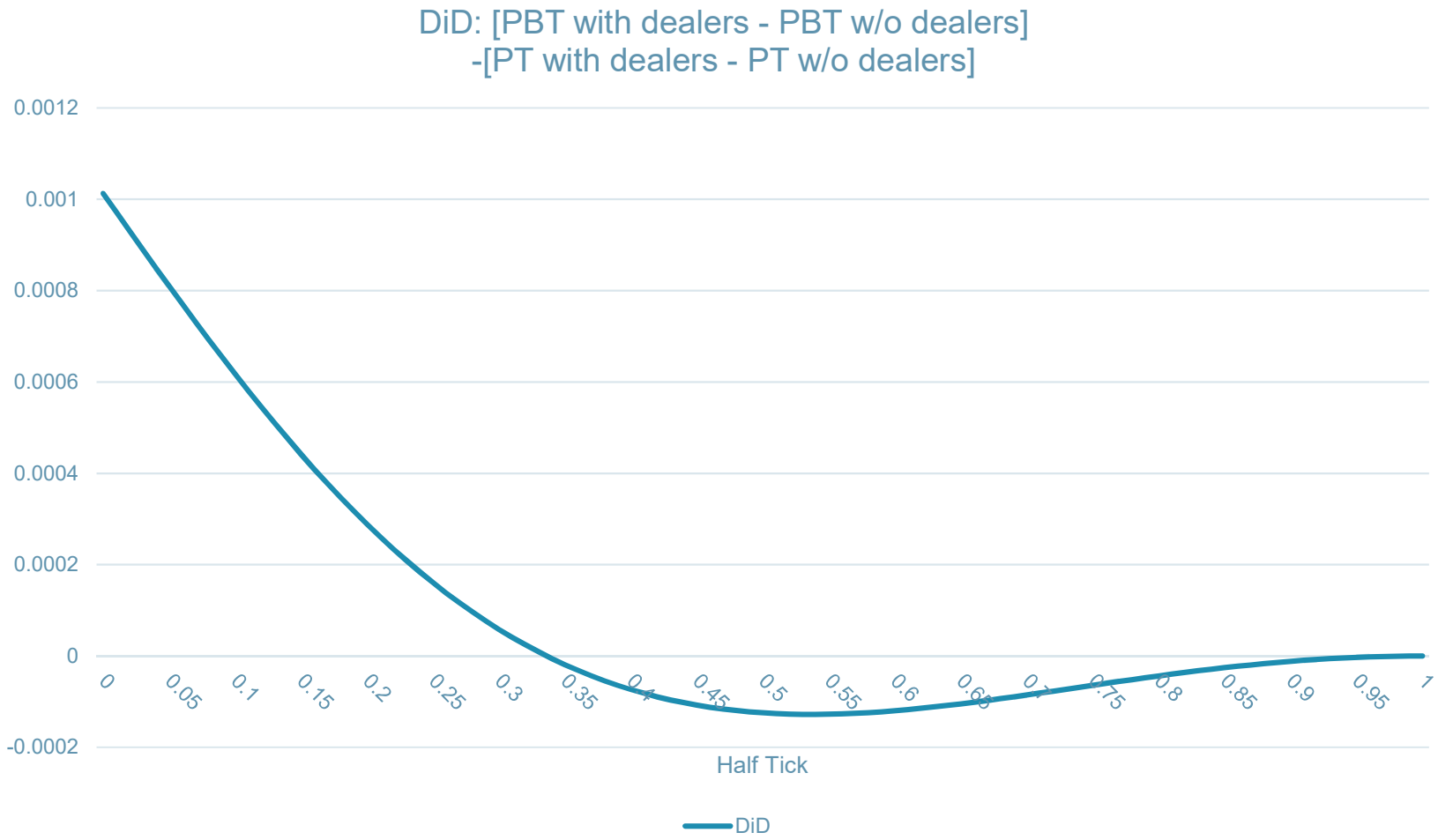


Figure 10: Trading rates and investor welfare in the absence of dealer-specialists

This figure plots trading rates and investor welfare for all tick sizes assuming $V = 1$, in the absence of dealer-specialists. Trading rates and welfare are obtained by a suitable modification of our main model presented in Section A. Panel A charts the difference in trading rates between PBT and PT while in Panel B we plot the difference in welfare as a function of the half-tick.

Dealers ‘indirect’ contribution to welfare



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