Competition for Order Flow and Smart Order routing Systems

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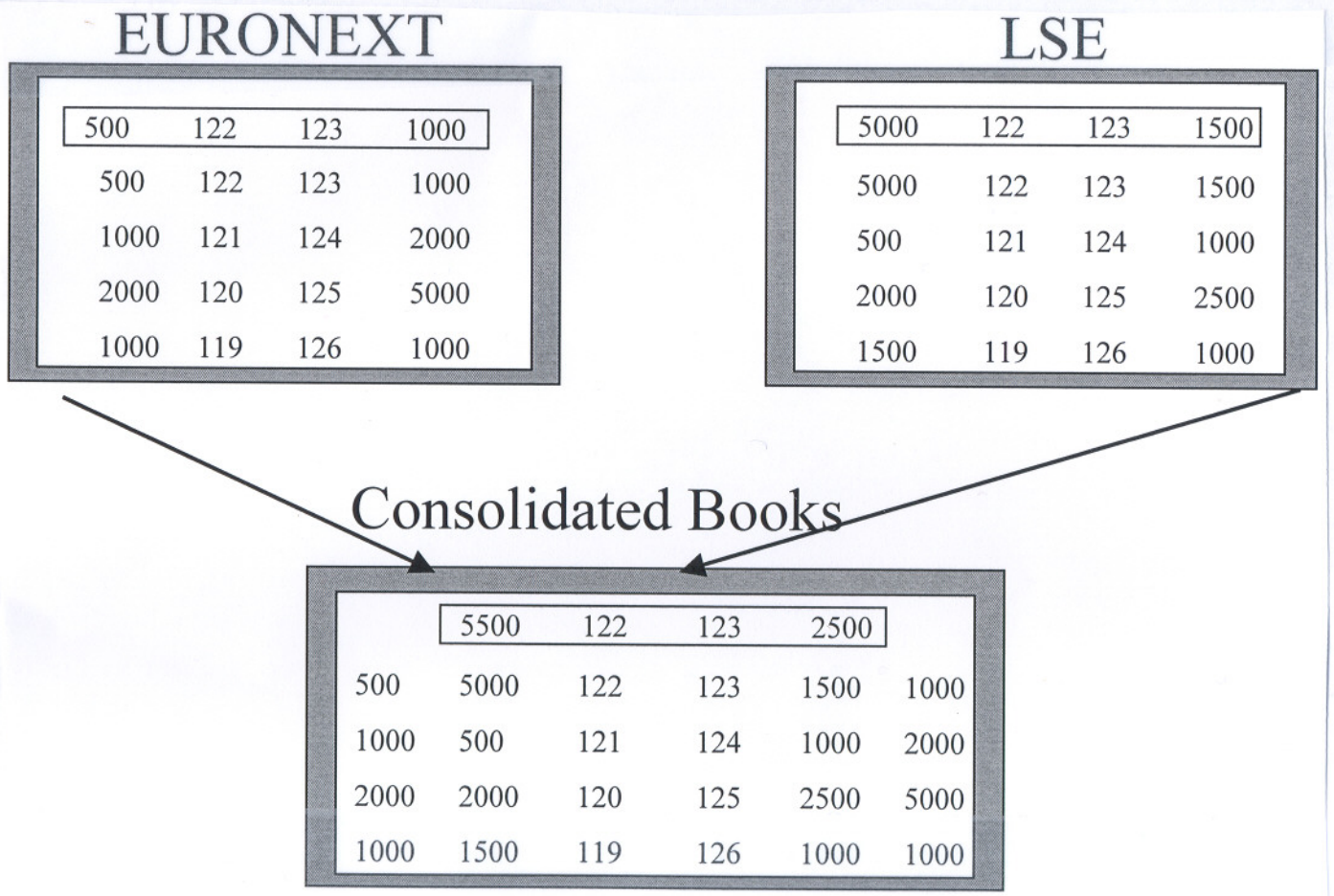
Background and Motivation

- **Automation is changing the industrial organization of financial markets**
  1. It decreases the cost of developing new electronic trading venues
  2. It decreases the cost of searching for best prices across trading venues as traders can use smart order routing systems ("tradebots") to identify optimal routing strategies.
- **$\Longrightarrow$ Proliferation of new marketplaces (ECNs', Bloomberg Tradebook, Tradepoint etc...**
- **Renewed concerns about the effects of market fragmentation + pressure on fees charged by exchanges.**

An interesting case : LSE vs Euronext 1/3

- On may 24, 2004, the LSE launched a new trading platform (EuroSETS) allowing investors to trade dutch stocks listed on Euronext (traded on NSC).
- **Sources of differentiation between the two systems are minimal:**
  1. Identical trading rules : the two markets are organized as electronic limit order markets.
  2. Same location + same pool of potential users
  3. Same clearing and settlement system
- The cost of using both EuroSETS and NSC is essentially the cost of monitoring **both markets**. This cost is minimal **if** the routing decision is automated.

LSE vs Euronext : Smart Order Routing Systems 3/3



LSE vs Euronext 3/3

- **The cost of searching manually for a best offer is not negligible and interacts with competition for order flow:**

  "When I was CEO of Tradepoint (now virt-X), my team and I spent a considerable amount of effort 'selling' the exchange to traders. However, although they all signed up as member, they did not use the market. [...] Even when better bids and offers appeared on our order book, the (momentarily) inferior prices available on the LSE were hit and lifted. Potential users simply could not see, nor easily access the market. If the Tradepoint terminal was at the end of the desk, it was not accessible." (in "Is exchange liquidity contestable?", by Nic Stuchfield, The handbook of World Stock, Derivative and Commodity Exchange.)

- **Brokers' decision to automate the routing decision is a key factor in competition for order flow.**

Questions

- What is the effect of competition between electronic limit order markets on market liquidity?
- Are "thick market" externalities (Pagano (1989), Admati and Pfleiderer (1988)) still important when traders use automated routing systems?
- Is market fragmentation a problem when traders use smart order routing systems which consolidate liquidity pools?
- Have traders sufficient incentives to adopt smart order routing systems?

Regulatory Issues

- **Important questions for the debate on the organization of US and European markets.**
- **Example : SEC release n**$34 - 42450$ **(2000):**
  1. *"To what extent is fragmentation of the buying and selling interest in individual securities among multiple market centers a problem in today's markets? For example, has fragmentation isolated orders [...] reducing liquidity?*
  2. *"Will the greater potential provided by advancing technology for the development of broker order-by-order routing systems [...] address fragmentation problems without the need for Commission action?"*

Literature

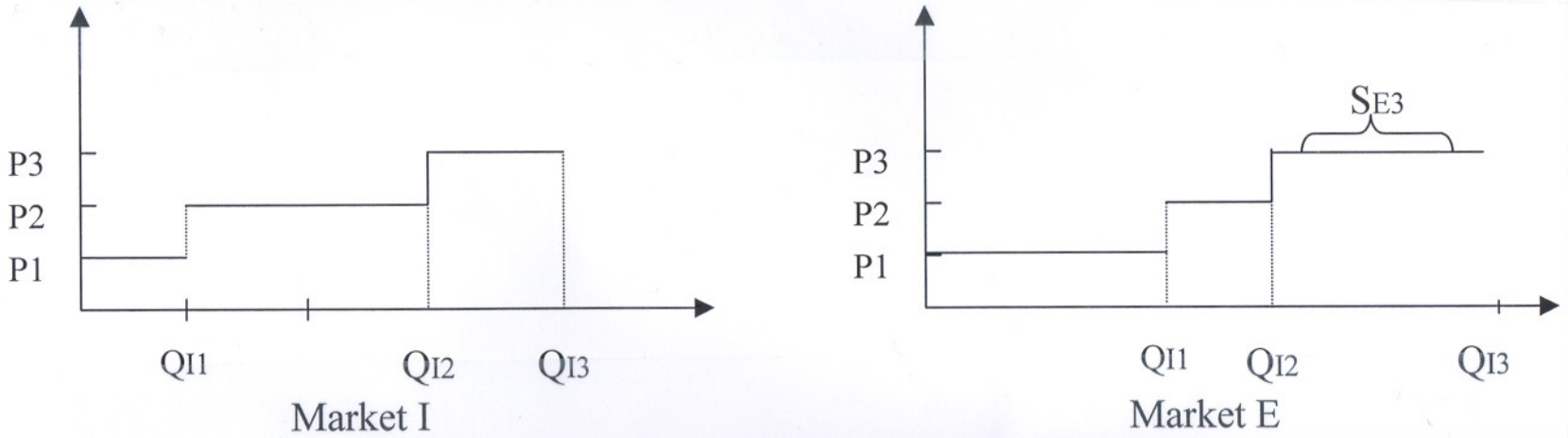
- **Competition between trading mechanisms :** Glosten (1994), Biais, Martimort and Rochet (2000), Parlour and Seppi (2003), Viswanathan and Wang (2002), Sabourin (2004).
  1. Our model builds upon Parlour and Seppi (2003);
  2. However, we focus on competition between 2 pure limit order markets (e.g. EuroSETS and NSC) while they focus on competition between a pure limit order market and an hybrid trading mechanism.
  3. We provide an analysis of the incentives for market participants to automate their routing decision.

The Model

- **A security with final expected value $v_0 = E(\tilde{V})$ trade in two limit order markets : incumbent (I) and entrant (E).**
- **Sequence of Events :**
  1. **Period 1:** Limit order traders post offers in each market.
  2. **Period 2:** A broker seeks to execute an order of size $\tilde{X}$. The order is a buy order with probability α. The routing decision depends both on (i) offers posted in each market and (ii) the routing technology available to the broker.
  3. **Period 3:** Payoffs are realized.

The Limit Order Books

- **Two possible books at the end of period 1 (sell side only) :**



- **Remarks :** The set of possible quotes ($\{p_0, p_1, .., p_n, ..\}$) is discrete. Δ is the *tick size* (identical across exchanges); $p_0 = v_0$;
- Presentation focuses on the ask side; Analysis of the bid side is symmetric.

The Routing Decision

- **Period 2 : Brokers have two possible types.**
  1. **Not equipped with a smart order routing system** (proportion λ). They ignore the offers posted in the entrant market (search costs too high);
  2. **Equipped with a smart order routing system** (proportion $(1-\lambda)$). The system consolidates the offers in both markets and automatically split the broker's order so as to minimize her total payment.
- We first take λ as given and then we endogenize it.

Example

EURONEXT

500	122	123	1000
500	122	123	1000
1000	121	124	2000
2000	120	125	5000
1000	119	126	1000

LSE

5000	122	123	1500
5000	122	123	1500
500	121	124	1000
2000	120	125	2500
1500	119	126	1000

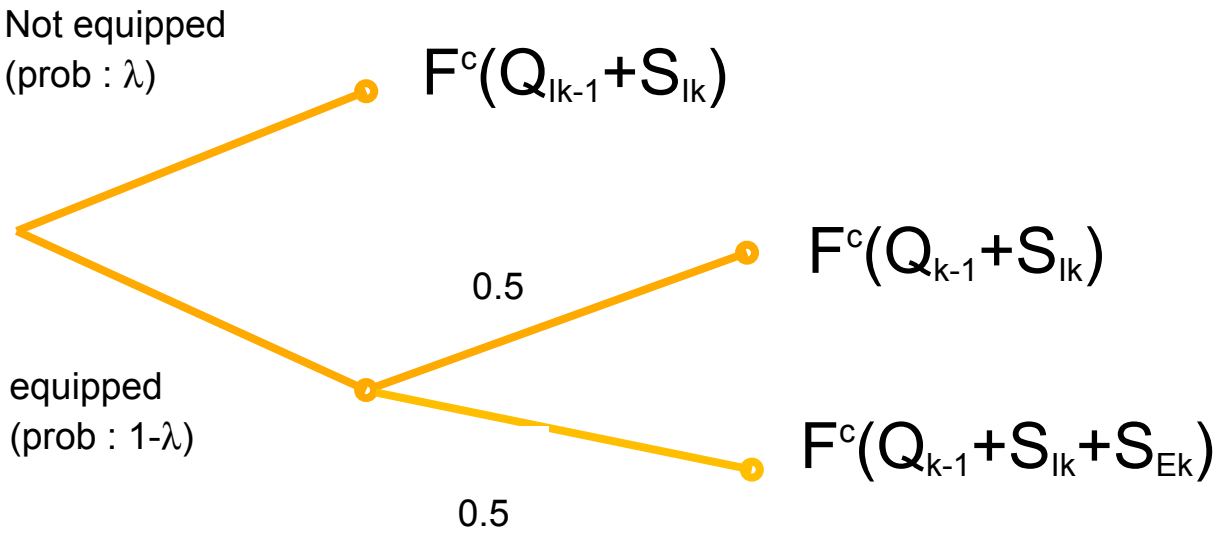
- Consider an order to buy 4000 shares. **Average Price if routing system : 123.375 ¡ Average Price if no routing system : 124**. Indeterminacy for the allocation of 1500 shares.

Limit Order Traders

- **Period 1** : Limit orders are posted by a continuum of limit order traders (as in Seppi (1997) or Parlour and Seppi (2003)).
- They bear an **order entry cost** $c_j > 0$, per share for orders submitted in exchange j (the model can easily be extended to include **execution fees**).
- Time priority is enforced **within** each market but **not across** markets.
- Thus, the expected profit **on the marginal limit order** posted at price p_k in market j is :

$$\Pi^m_{jk}(Q_{jk-1}, Q_{-jk-1}, S_{jk}, S_{-jk}) = P_{jk} * (p_k - v_0) - c_j$$

Execution Probabilities



- Hence $P_I(Q_{Ik-1}, Q_{Ek-1}, S_{Ik}, S_{Ek}) =$

$$\alpha * [\lambda \bar{F}(Q_{Ik-1}+S_{Ik}) + (\frac{1-\lambda}{2})(\bar{F}(Q_{k-1}+S_{Ik}) + \bar{F}(Q_{k-1}+S_{Ek}+S_{Ik})]$$

- It decreases with the (a) the number of shares offered at price p_k in market I and (b) the number of shares offered at better prices in both markets.

- Similarly $P_E(Q_{Ik-1}, Q_{Ek-1}, S_{Ek}, S_{Ik}) =$

$$\alpha * (1 - \lambda) * [\bar{F}(Q_{k-1} + S_{Ek}) + \bar{F}(Q_{k-1} + S_{Ek} + S_{Ik})]$$

- As S_{jk} increases, the execution probability of the "marginal share" offered at price p_k decreases and eventually, the expected profit on expanding the quantity offered at price p_k becomes nil.

Competitive Equilibrium 1/2

- In equilibrium, the book leaves no profit opportunity. That is, the expected profit on the marginal share offered at each price in the book is zero.
- **Definition :** A competitive equilibrium is a set of depths $\{S^*_{I1}, S^*_{I2}, ..., S^*_{Ik}, ...S^*_{E1}, S^*_{E2}, ..\}$ such that the expected profit of the marginal limit order at each price p_k in each limit order book satisfies, $\forall k$:

$$\Pi^m_{jk}(Q^*_{Ik-1}, Q^*_{k-1}, S^*_{Ik}, S^*_{Ek}) = 0 \quad if \quad S^*_{jk} > 0$$

and

$$\Pi^m_{jk}(Q^*_{Ik-1}, Q^*_{Ek-1}, S^*_{Ik}, S^*_{Ek}) \leq 0 \quad if \quad S^*_{jk} = 0$$

where $Q^*_{jk-1} = \sum_{l=1}^{l=k-1} S^*_{jl}$.

Competitive equilibrium 2/2

- **Remark :** If the execution probability of a limit order placed at price p_k in market j is too small then no shares are offered at this price (i.e. $S^*_{jk} = 0$). If this happens at all prices in market j then this market attracts no trading.
- **Thus there are two possible outcomes :**
  1. **The two markets co-exist in equilibrium** (i.e. there exist k and k' such that $S_{Ik} > 0$ and $S_{Ek'} > 0$).
  2. **Or one market dominates.**

An Example

- Suppose that $\tilde{X}$ is uniform on $[0, \bar{Q}]$ and $0 < \hat{c}_E \leq \hat{c}_I < \frac{\Delta}{2}$ where $\hat{c}_j = c_j/\alpha$. Consider two cases : $\lambda = 1$ and $\lambda = 0$.
- **Equilibrium when $\lambda = 1$.** Then exchange I dominates (benchmark) and the cumulative depth offered up to price p_k is :

$$Q^*_{Ik}(1) = \bar{Q}(1 - \frac{\hat{c}_I}{k\Delta})$$

- **Equilibrium when $\lambda = 0$.** Then both exchanges co-exist and the cumulative depths offered up to price p_k in each book is :

$$Q^*_{Ik}(0) = \frac{2\bar{Q}}{3}(1 - \frac{2\hat{c}_I - \hat{c}_E}{\Delta}) \quad \textit{and} \quad Q^*_{Ek}(0) = \frac{2\bar{Q}}{3}(1 - \frac{2\hat{c}_E - \hat{c}_I}{\Delta})$$

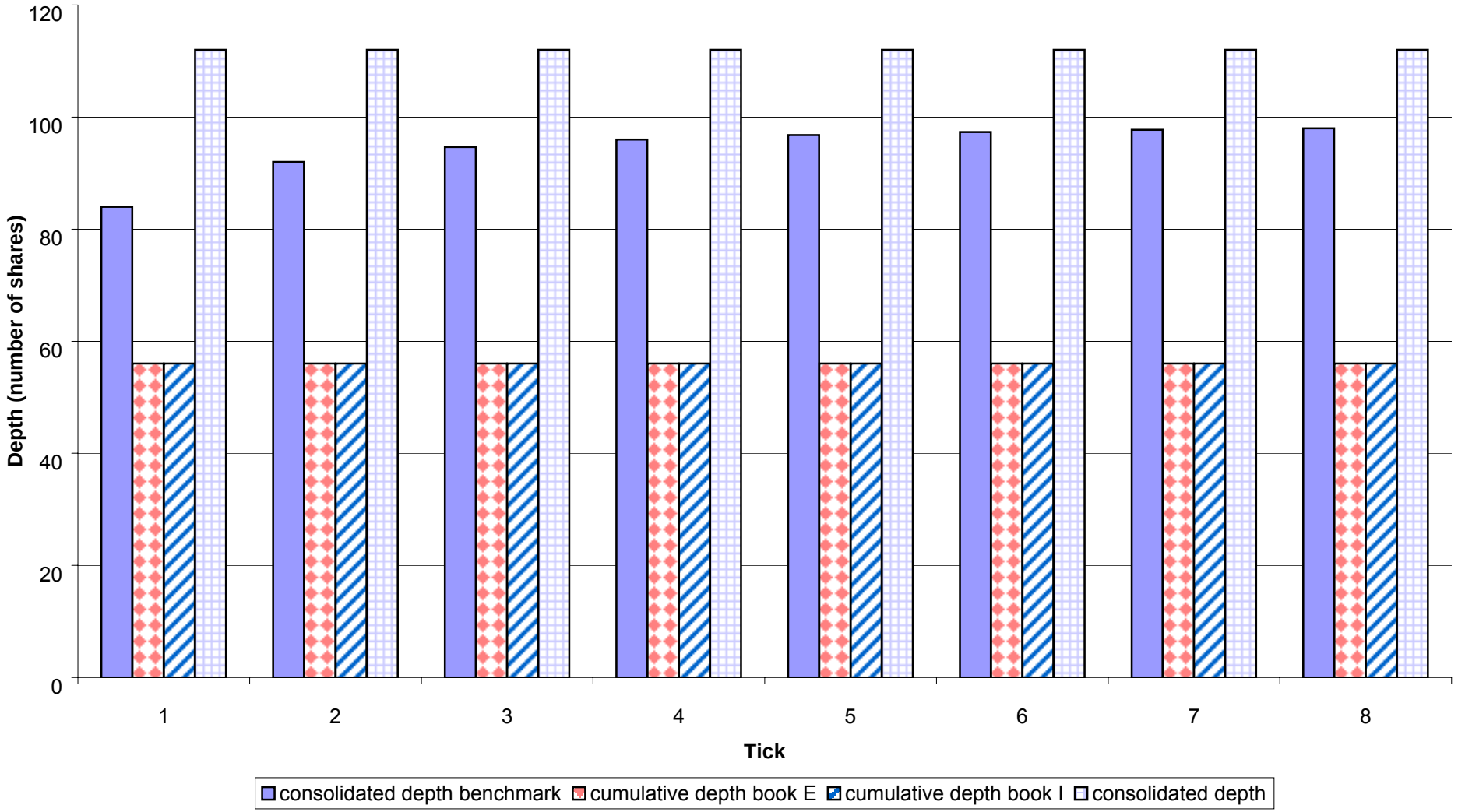
Parameters Values :

Tick =$0.125

$c_I = c_E$ =$0.02

Max size : 100

Figure 1 : depth with and without competition



Observations

1. **Trading does not concentrate in a single trading venu when $\lambda = 0$.**
2. **Cumulative depth in market I, Q_{Ik}, is smaller when both exchanges co-exist**
3. **BUT consolidated depth, $Q_k = Q_{Ik} + Q_{Ek}$ is larger when both exchanges co-exist, at any price.**
4. **An increase in the order entry cost in market j (when $\lambda = 0$):** (i) decreases cumulative depth in this market and (ii) increases cumulative depth in the competing market.
5. Are these properties general? **YES** when the two markets co-exist.

Why can markets co-exist?

- **Absence of time priority across markets is crucial.** It allows traders to use **"Queue-jumping" strategies**
  1. Take a limit order trader who considers posting an offer for an infinitesimal quantity at price p_1 when (a) S_{E1} shares are offered at price p_1 in market E and (b) no shares are yet offered at price p_1 in market I.
  2. **Execution probability in market E :** $P_E = \alpha \bar{F}(S_{E1})$
  3. **Execution probability in market I :** $P_I = \alpha[\frac{1}{2} + \frac{\bar{F}(S_{E1})}{2}]$. Hence, the execution probability is larger in market I.
- $\Longrightarrow$ **Submitting a limit order in market I can be optimal even if the order entry cost is larger in this market.**

Why does fragmentation increase liquidity?

- **Marginal limit orders just break-even BUT infra-marginal limit orders get a strictly positive expected profit**
- The presence of the entrant market allows traders to
  1. **Engage in "Queue-jumping strategies" and compete away the profits on infra-marginal limit orders**
  2. **Expected trading costs for traders using smart order routing systems decrease** $\Longleftrightarrow$ Consolidated depth increases.

Coexistence and Critical Mass

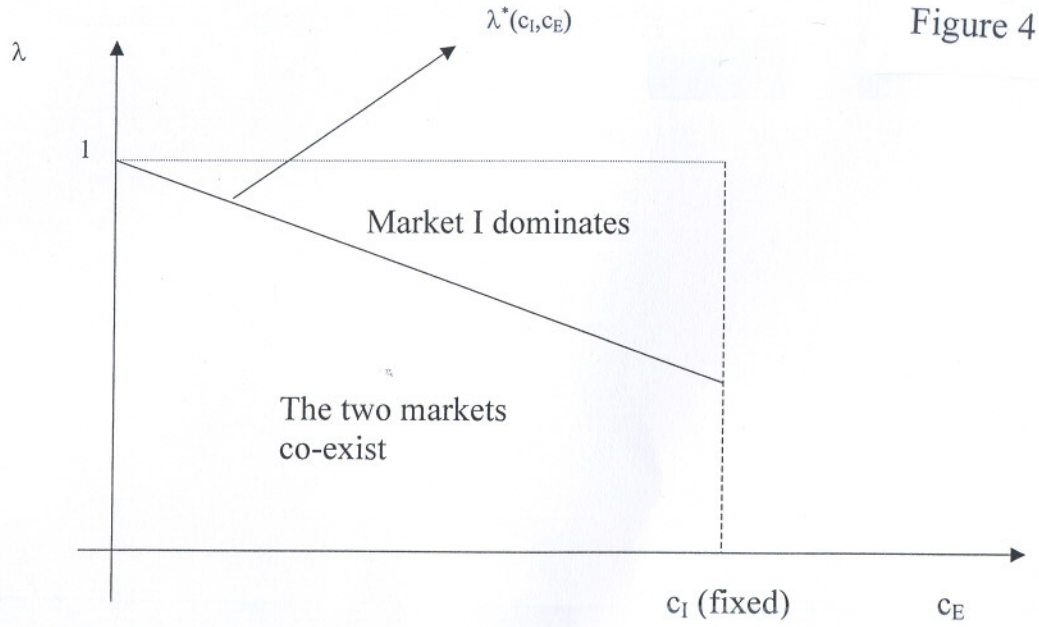


Figure 4

- **Conclusion:** The entrant will attract some trading **iff** the proportion of brokers using smart order routing systems exceeds a *critical mass*. Role of order entry fees.

Parameters Values :

Tick =$0.125

$c_I = c_E$ =$0.02

Max size : 100

Figure 1(a): Effect of a change in λ on cumulative depth in market I

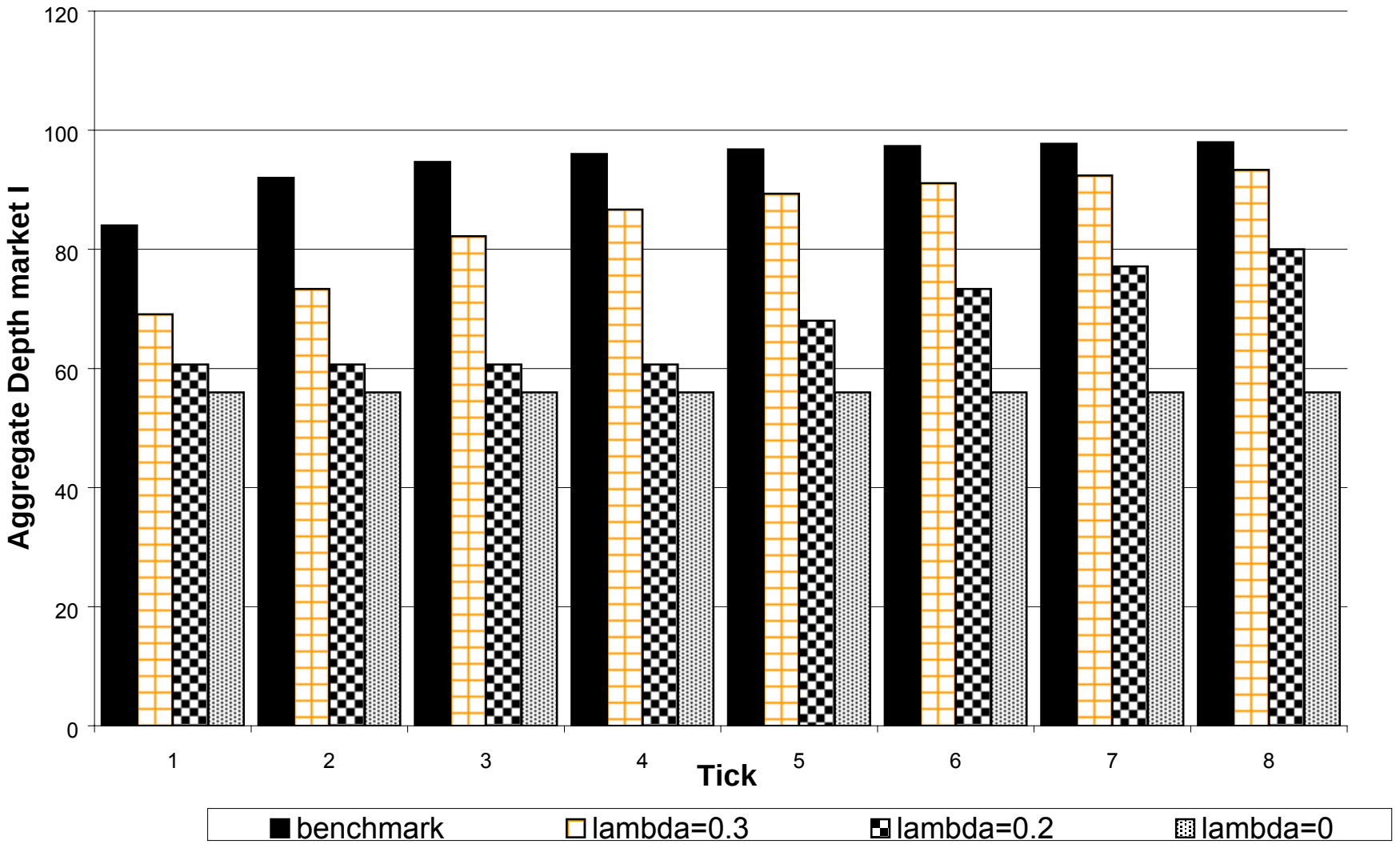


Figure 1(b) : Effect of λ on the cumulative depth in market E

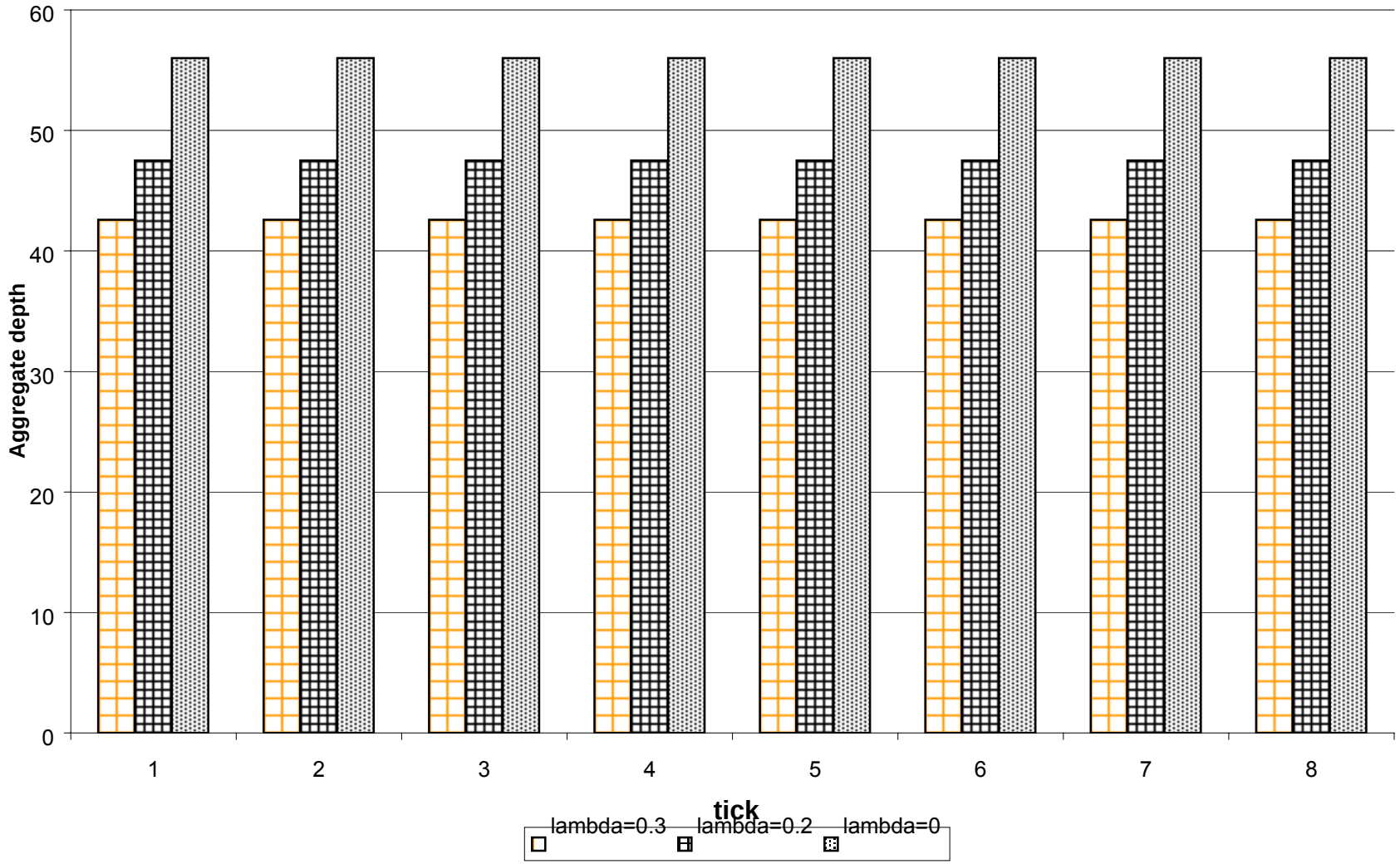
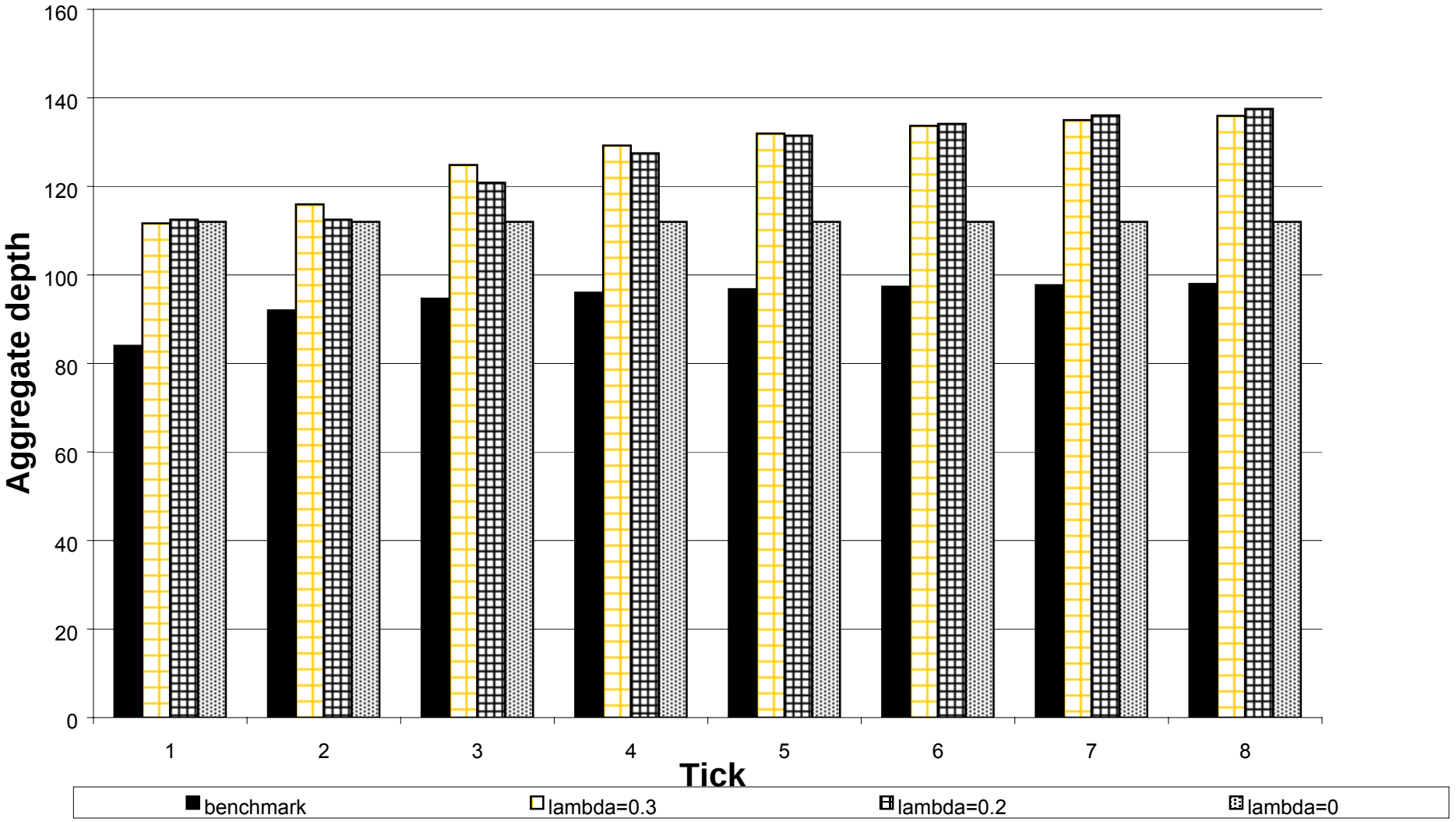


Figure 1(c) : Effect of λ on the consolidated depth



Testable Implications

- **H.1** Entry of a new market should trigger (a) a decrease in the cumulative depth in the incumbent market and (b) an increase in consolidated depth.
- The recent entry of the LSE in the Dutch equity market offers an ideal natural experiment to test this prediction.
- **H.2 :** When the two markets co-exist, cumulative depth in market I increases with λ and cumulative depth in market E decreases with λ.
- This suggests that time-series variations in the depth posted in EuroSETS (LSE) and NSC (Euronext) will be driven by time-series variations in limit order traders' beliefs about the proportion of brokers considering both trading systems ($(1-\lambda)$.

Policy Implications

- Let $T^{er}(\lambda)$ be the expected payment on a buy order for a broker using a smart order routing system. Let $T^{ner}(\lambda)$ be the expected payment on a buy order for a broker not equipped with a smart order routing system.
- **We obtain :**
  1. $T^{er}(\lambda) < T^{enr}(1)$ **iff** $\lambda < \lambda^*$ because market fragmentation improves consolidated depth.
  2. **BUT:** $T^{ner}(\lambda) > T^{enr}(1)$ because market fragmentation reduces cumulative depth in the incumbent market.
- Market fragmentation reduce price impact costs for **all** traders **iff all** traders adopt smart order routing systems. Incentives to adopt routing systems?

The adoption game 1/2

- **Timing:**
  1. **Stage 0 :** A continuum of brokerage firms simultaneously decide to adopt a rounting system or not. The cost, **per trade**, of developing a smart order routing system is $K > 0$.
  2. **Stage 1 : trading** The actions at dates 1 and 2 unfold as described previously.
- Suppose that broker i expects a proportion $\gamma = 1 - \lambda$ of other firms to adopt a routing system. Adoption is optimal **iff**

$$T^{ner}(\lambda) - T^{er}(\lambda) > K$$

- We assume that K is negligible so that $T^{ner}(0) - T^{er}(0) > K$.

The adoption game 2/2

- **Result:** The adoption game features two possible equilibria in pure strategies : (a) all brokers adopt a routing system or (b) no broker adopts a routing system.
- Thus, brokerage firms can fail to adopt smart order routing systems although they are better off in this equilibrium.
- The risk of coordination failure acts as a barrier to entry in the provision of trading services.
- It also suggests that there is room for regulatory intervention (the regulator could force competing markets to display a consolidated view of their books).

Is this risk relevant?

- "When I was CEO of Tradepoint (now virt-X), ...If the Tradepoint terminal was at the end of the desk, it was not accessible. The solution [...] was to get Tradepoint integrated into the main order management systems []This proved to be easier negotiated than implemented [] The traders had many other priorities and we could not demonstrate the required liquidity. Think chicken and egg again!" (in "Is exchange liquidity contestable?", by Nic Stuchfield, The handbook of World Stock, Derivative and Commodity Exchange.)
- **The dutch experiment:** EuroSETS's small market share (despite the presence of competitive offers in LSE book) is in part due to delays in the adoption of smart order routing systems by brokerage firms.

Conclusions and Future Research

- **Competition for the order flow between pure limit order markets enhances market liquidity.**
- **Pure limit order markets can co-exist even if they charge different order submission fees**
- **Market fragmentation reduces trading costs if all market participants adopt smart order routing systems.**
- **BUT ...** Market participants may fail to adopt this technology even if development costs are small.
- **Next Step:** An empirical test of the model predictions. To this end, we have collected snapshots of Euronext and LSE limit order books before and after entry of LSE.