Chapter 1 Fragmentation at any Scale

Fluctuations market share: liquidity

Fragmentation occurs at different levels

- market operators
- trading venues (same operator can operate at multiple)
- order book
- orders (split through time & space to spread order across books)
- tech

Market share of each venue is a convenient way to understand transactions migrate

Market share definition

M: num transactions
t_1, t_2 over N trading venues

trade (numbered ℓ) at price P_ℓ
for volume V_ℓ at time T_ℓ

$\delta_\ell = n$:= trade number ℓ occurred on trading venue n and 0 otherwise

$1_n(\delta_\ell)$:= value 1 when trade occurred on the trading venue n and 0 otherwise

||

Indicator function

$$m^k(n) = \frac{\sum_{t_1 \le \tau_\ell^k \le t_2} p_\ell^k V_\ell^k \cdot 1_n(\delta_\ell^k)}{\sum_{t_1 \le \tau_\ell^k \le t_2} p_\ell^k V_\ell^k}$$

market share in value

[measure frag. by transactions]

⇓

directly linked to revenues

when price is constant (stock does not change alot)

$$m^k(n) \simeq \frac{\sum_{t_1 \le \tau_\ell^k \le t_2} V_\ell^k \cdot 1_n(\delta_\ell^k)}{\sum_{t_1 \le \tau_\ell^k \le t_2} V_\ell^k}$$

$p_\ell^k \simeq p$

market share per trade

$$m_T^k(n) = \frac{\sum_{1 \le \ell \le T} 1_n(\delta_\ell^k)}{T}$$

T:= total number trades

(1.2)

fixed auctions

fixed auctions (venues having monopoly) change market share

Trading venue $T(n)$ has avg. market share of $m(n)$ during fixing auctions

p weight for fixing auctions of overall exchange of the day,

$$m(n; \text{ex-fixing}) \simeq \frac{(1 - m(n)p)\, m(n)\, T}{(1-p)\, T} \simeq \frac{1 - m(n)p}{1-p} \cdot m(n; \text{all included})$$

T: avg daily turnover for stock on whole market

Weight scheming of stock

- natural weighting according to daily turnover of considered stocks

$1 \leq k \leq K$

$$m^{1,\dots,K}(n) = \frac{\sum_{1 \leq k \leq K} T^k m^k(n)}{\sum_{1 \leq k \leq K} T^k}$$

T_k avg daily turnover

$T_k = p^k v^k$

daily turnover

$$m^J(n) = \sum_{k \in J} w_k \cdot m^k(n)$$

weight w_k according to J

($\propto$ Free float / market cap)

$$m_u^{1,\dots,K}(n) = \frac{1}{K} \sum_{1 \leq k \leq K} m^k(n)$$

uniform weight

fragmentation increases with liquidity

Measuring metric adequacy

- Analyzing positioning & revenue of venue: market share (in terms of vev or not)

- probability trade occurs for security k on venue T(n):

2 indicators:

fixing

ex-fixing

natural market share is per trade (1.2)

- probability of unit of currency traded on security K on trading venue T(n)

one measurement during fixed auction
one measurement for intra day

1.1.2 Phase 1: First attempts of fragmentation

European niche market liquidity

natural liquidity: direct from investors buying/selling for medium to long term held positions

opportunistic liquidity: offered by new HFT & MM

lemon & cherry liquidity

- clients receptive to siloed offers,

ex: LSE group maintains trading on Turquoise on stocks already listed on the LSE

↳ Turquoise more lemons
LSE more cherries

- market participant creates own mix of liquidity

creates:
- mid point dark pools
- buy side only pools
- size priority books
- random auctions

resource allocation

↑ df ↑ better resource allocation

↑ pools ↑ positive evolution of microstructure

Fragmentation definition

- guided by operational use

→ indicative of reverse of trading venues

→ estimate probability of trade occurs one one venue

→ monitor entropic dispersion of market shares

Complexity mechanisms

MiFID opened up fragmentation complexity with 3 mechanisms

1. best execution
2. 3 statuses trading venues
3. pre-trade transparency rules

Best execution

US & european commission did not provide a consolidated tape (consolidated competative priced limit orders available at exchanges)

LD could cause inversion of best prices

meta competition

- two layered competition
  1. best execution policy

2. competition between trading venues

→ puts pressure on venues & intermediaries for improving PFP

Types of trading venues

Constrained transactions:

- RM (regulated market), matching engine public order book
- MTF (multilateral trading facility)
- SIs (systematic Internalizers)
- OTC (over the counter)

disturbed planned organization of markets:

- size of OTC, bad organization of post-trade transparency pushed most of actors to reduce OTC deals
- few participants for SIs, pre/post transparency too attached

Pre-trade transparency

- pre-trade transparency: disclosure of state of orderbook to traders

⇒ more info to decision-makers, more rational actions will be more efficient PFP

price formation

price can be formed by executing a liquidity demanding order against a resting order in orderbook

large in scale waiver: large orders can rest in orderbooks w/o transparency. Possible for fully hidden orders provided large enough

reference price waiver: allows for hidden orders of any size provided they don't form a price via confrontation of offer and demand

↳ transparency delegated to reference trading venue

Post-trade transparency

- essential for PFP ⟹ post trade publication of any transaction as soon as possible

Phase 2: convergence toward european offer

Entropy of market microstructure

Entropy: measure of randomness

Consolidated market considered system ⟹ disorder increases with fragmentation

Entropy

$$\text{Entropy} = -\sum_{n=1}^{N} m_n \cdot \log m_n$$

m_n market share of n^{th} value

Fragmentation Efficiency index

normalized entropy

$$H = -\frac{1}{\log N} \sum_{n=1}^{N} m_n \log m_n$$

FEI
frag. eff. index

- scores relative to given number of available venues

70/20/10 ≠ 70/20/60/0

Different definitions of fragmentation summary

fragmentation: order split to find liquidity to be fulfilled as soon as possible. Dispersion of means to access liquidity

FEI: measures how traded euro split between different venues

fragmentation of tech

Application protocols
Network protocols
Compression protocols

1.1.4 Phase 3: Apparition of broker crossing networks and dark pools

MFT: second hand liquidity
Historical pools: first hand liquidity

Executing brokers created 100% first hand liquidity
First BCN (broker crossing networks)

MFT launch dark pools (double capped)

Note: MFT multilateral trading facilities

last phase MiFID:

- Stabalization of tech means in few hands
- rise of BCNs
- conversion into MFT dark pools

small / medium / large market caps

1. asymmetry liquidity of stock

liquidity for ask (sell orders):

→ borrow shares

→ borrow fees ↓ liquidity ↑ (free float)

liquidity for bid: (buying)

→ essentially 'free'

HFTs provide naked liquidity on ask

no hedging

2. unbalanced inventory

HFT & MM buy/sell corr financial instruments

→ Hedge positive inventory on cash components of index

→ selling future contracts on same index

⇓ easier to sustain inventory imbalance

if indices have underlying future contracts

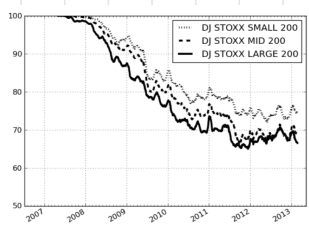


Figure 1.9. Market share of the primary market on the three capitalization segments of the EuroStoxx 600.

daily traded amount v. Market share

→ indexes seperate from another

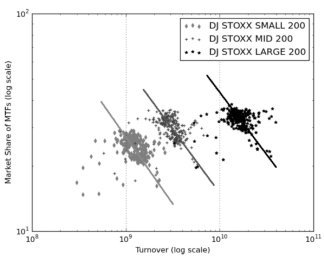


Figure 1.10. Market share on MTFs with respect to turnover for three EuroStoxx indexes; one point is one day of 2011. The scale is log-log, disclosing multiplicative relationships.

larger cap, larger Market share

→ by indv. indices, ↑ turnover ↓ Market share

Turnover v. Market share

Market share of MFTs

$$\text{Market share MFTs} = \frac{b_i}{\text{Turnover}^{\gamma}} + \varepsilon$$

b_i intercept specific to index

γ universal slope (indep. from index / stock)

ε noise

↑ volume ↑ capture by historical venues

1. historical markets more stable for liquidity
2. investors present during high vol have less mature tracking processes

Fragmentation summary

→ frag ↑ as cap ↑

→ frag ↓ volume ↑ (for one given stock)

1.2 SOR (smart order routing)
Structural comp. european PFP

1.2 route orders in fragmented market

Atomic orders

large orders split

→ market impact has to be estimated
→ market risk consideration

risk adverse → reduce price fluctuations
→ execute quickly

↑ risk aversion ↑ market impact

↓ risk aversion ↑ market risk

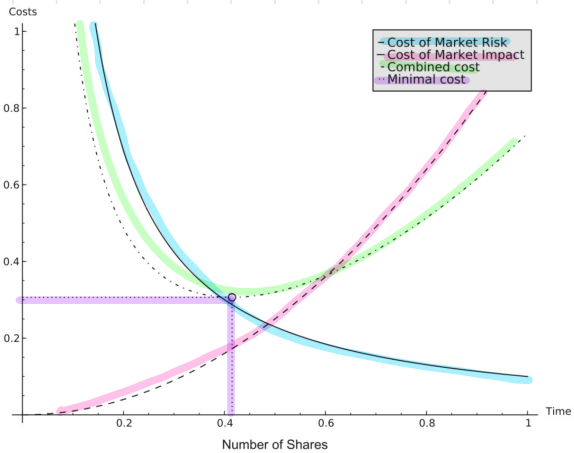


Figure 1.11. Market impact vs. market risk.

combined cost:

arbitrary risk aversion param, line dec then inc

- temporal slice of large orders (atomic/child order) sent to destinations per liquidity thy. offer

Using Smart Order Router

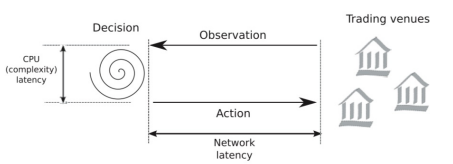


Figure 1.13. Functional diagram of a smart order router.

accelerate execution by consuming volume it not at main trading destination

- minimize exec. in market using SOR

SOR takes limit / market order and splits with advanced knowledge of state of liquidity on trading destination

↓ selects most efficient (where liquidity is available)

Aggregate liquidity to min. impact

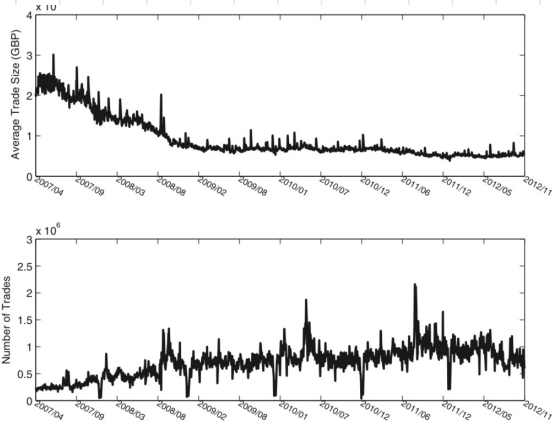


Figure 1.15. Indicators of the average trading size (ATS) and of the daily number of trades for the FTSE 100.

- ATS (avg. trading size) ↓
- number deals ↑
- ← conditioned on size of passive orders

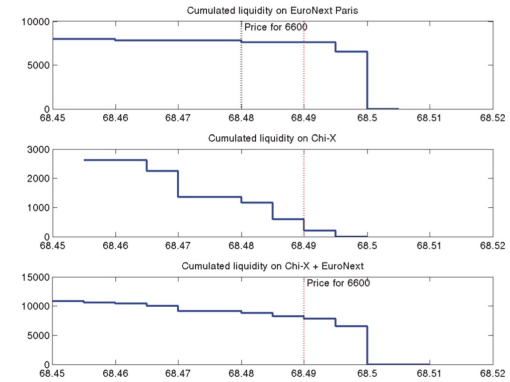


Figure 1.16. The aggregation of two orderbooks (Chi-X and Euronext) gives access to more liquidity than only one of them. This is an example of a selling order of 660 shares.

- with market frag. ATS ↓ passive orders spread over more venues
- summing liquidity on 2 venues decreases price impact of market order

Duplicate liquidity

HFT to be present at both bid & ask on multiple venues.
- market risk (have inventory)

Once MM post liquidity
- as soon as one order executed, rest cancelled
- duplicate quantities in order book

(why dark pools are attractive, pre trade transparency not valuable anymore)

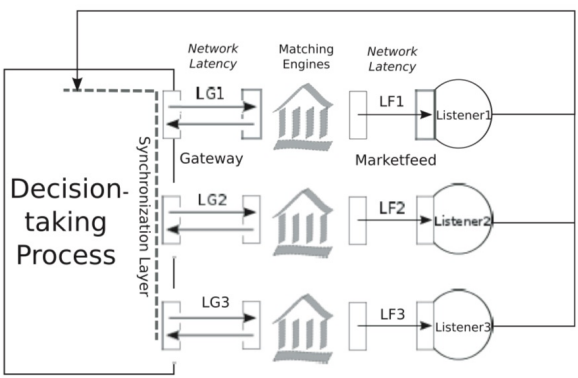


Figure 1.17. Simplified diagram of trajectories of messages.

1. sync layer: updates come in from market
2. Decision taking process: SOR makes decisions
3. SOR to trading venue
4. orders reach matching engines of venue (have different priorities)
5. execution reports returned to SOR

↑ quantities executed ↑ results ↑ efficiency of SOR

1.2.2 Fray is a concequence of primary market variance

passive orders: wait for execution, often inaccessed

SOR simulations

traders adjust SOR dynamically given historical performance of execution

→ SOR lower expectation & send smaller volume of orders

→ SOR minimizes order variance

Market share dynamics

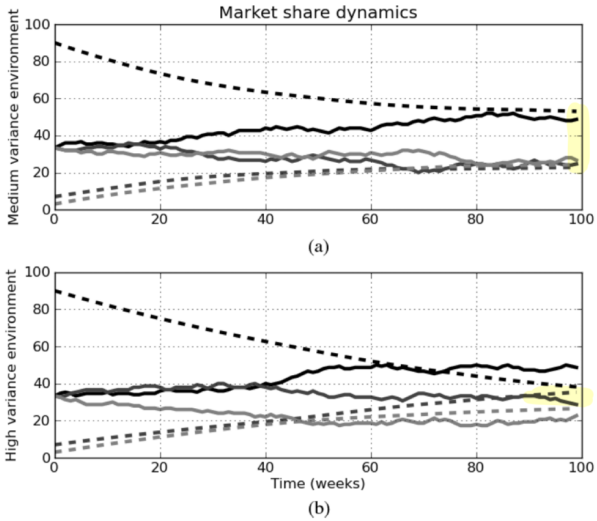


Figure 1.18. Simulation of the evolution of market shares when all trading ve have a medium variance (a) vs. a high variance (b).

Medium var

stabalizes 87-56

large var

decreases to 40

Variance of Market share

→ main markets have more variance

Remark:

1. sign. percentage investors have avg. size lower than overall market size

2. avg. larger than market leads to eroding market share

main market loses market share each month when flow volatile

1.3 Still looking for the optimal tick size

Why tick size matters

dynamic tick size: tick size dependent on quotation group (theoretically groups by liquidity)

- tick size defines discreteness of traded prices
- without any other info volatility can be seen as a function of tick size

- relationship between spread & volatility found on small ticks not found in large ones

How does tick size affect quality of liquidity

- size affect market quality
- size earn market share
- change profitability

1.3.2 How tick size affects market quality

Decreasing tick size lowers spreads when tick size is a constraint.

tick size acts as minimal bound for bid-ask spread

decrease minimal price variation $\Rightarrow$ decrease in spread

↑ constrained by tick ↑ expected decrease of spread for small enough tick

How much does tick constrain spread

Building probability: % of trades / monetary value / duration of quotes with bid-ask spread equal to one tick

spread leeway: expressed: tick unit -7

greater, less constrained stock

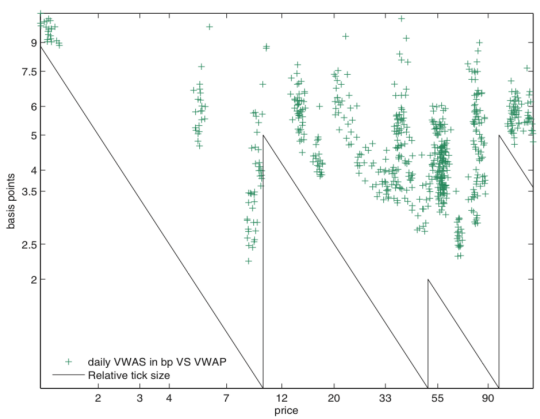
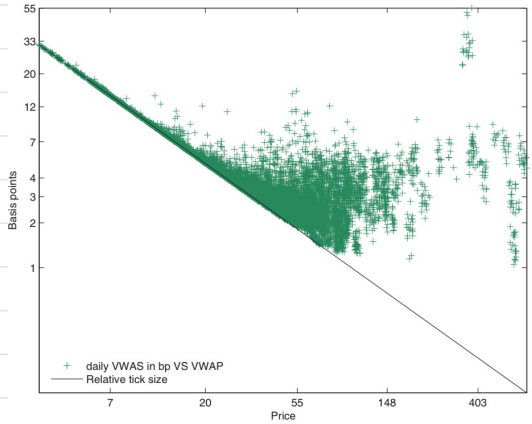


Figure 1.19. Average daily relative spread against stock price for DAX stocks on XETRA, July 2012 (log–log scale).

basis point: 1% change

- daily volume weighted avg. price over (VWAP)

volume weighted avg. spread (VWAS)



Relative tick size = $\frac{\text{Tick size}}{\text{price}}$ (Tick size constant)

- VWAP & VWAS rely on dist. of traded prices
  - ⇓ tick size large, slippage in VWAP
    - can't improve beyond certain threshold (set by tick size)
  - price can not go below tick size, VWAS bounded

Does increasing tick size increase cost for liquidity taker

smaller & faster liquidity → more stabilities?

- smaller tick, less quote size at each limit price
- quote jumping with marginal increments

quoted sizes on best limits are therefore lot smaller with small tick size

- unclear if crossing spread for larger volume exceeding quoted size will be higher or lower

front running: traders trade ahead of large orders to profit from price movement

traded volume does not change with tick size
trade sizes decreased (more trades)

smaller tick size
- liquidity jumps
- value of quote decreases

given smaller size and life

more fragmentation of liquidity less visible liquidity vs. it all centralized.

effect of spread & quoted size in order to shed light on execution cost of given volume

- limit order exposure discouraged with smaller tick size participants use hidden liquidity
- tick size reduction harms liquidity by increasing costs

off lit market trading > lit market

- able to trade on finer grid, allow one jumping

This is because
1. big tick size ⟹ larger spread
   - able to undercut limit order
   - able to make market, earning large spread vent

Queue jumping and profitability of limit orders relative to marketable ones

Large Tick size, spread equal to tick size

- volume large
- fast execution → forced to use market order
  - may take long time for limit buy at best bid to be executed

small tick size

- fast execution → improve best bid
  - liquidity provider has much more space for its strat

Small tick will more attention from queuing issues to limit pile issues

- undercutting strat creates uncertain competition and allows lit market race to bottom for tick size

makes lit market pre and post transparency meaningless

How can tick size be used by trading venue to earn market share

Tick size war

US equity trading market

Sub-Penney rule: prohibits accepting, ranking, displaying orders, quotations unless prices at less than $1/share

Brokers can either

- price improve
- reroute to public markets

⟹ can improve price (internalize) without posting order
- retail investors get better price
- reduces displayed liquidity, impact price discovery

Artificial wide spread low priced stocks

artificial wide spread of 1% there are considerable profits to make if don't have long que

- artificially wide for low priced stock (increases room to under cut)

European Tick war

- venue that offers tick size that best fits a stock immediately rewarded with increase in market share

- when tick size used to gain market share, race to bottom no reason to stop before reaches economically insign. level

⇓ tick size below optimal level, harm market quality

How does tick size change the profitability of various participants in the market

spread decrease, reduce cost of retail investors

- lower transaction (pay less entering & exiting)
- improve liquidity
- reduced slippage
- ↑ market efficiency

Goal of stock markets → provide capital to firms from investors

larger tick size: more participants wait in orderbook, lowers advantage of being fast

- value of first insert increases
- advantage to low latency traders

Value of quote
- smaller quote size, quote exist shorter time
- value of quote drastically decrease

Decrease in tick size leads to:

1. ↑ order to trade ratio
2. smallest size of each order posted on the best limit
3. less orders posted on the best limit
4. ↑ hidden orders

Usefulness of consolidated tape ↓ as tick size ↓

- ↑ hidden liquidity
- ↑ noise
- ↑ market frag

1.4 can we see in the dark?

Dark pools: generic name to alternative exchange where available liquidity not visible to public

→ protect institutional investors willing to execute large blocks from opportunistic traders

Paradigm:

- prices no longer in centralized order book
- different exchanges competing (fragmentation)

Mechanism of dark liquidity pools

- do not publically announce available liquidity

different categories:

Crossing Networks:

- pools of liquidity cross buy and sell orders for the same stock using prices derived from primary market

Internalized Pools:

- broker internalizes own flow
- retail / institutional orders matched within firm

Electronic MM:

- cross orders with operators flow
- automated algo execution
- like lit pools but can have price improvement

Exchange-based Pools:

- dark liquidity that is hidden on lit exchanges

Dark aggregators:

- provide all dark pools simultaneously
- receive an order and split between various pools

Size discovery pools:

- large block dark pools that host natural liquidity (institutional investors only)

- reference point waiver: permits orders to be crossed at the midpoint / best bid and offer

Protecting smaller orders

integrated book: accepts all visible orders and hidden orders that are large in scale (LIS)

Dark/mid point book: accepts orders less than LIS, matches only at midpoint of primary best bid & offer

- LIS participate in PFP
- small matched in midpoint book

↓

for low impact orders

In depth analysis of dark liquidity

Dark pools and price discovery

- prices can not be created in dark pools and only serve as a liquidity reservoir

Transactions in dark made at mid-price of primary market

↳ don't directly affect PFP but indirectly influences

How does dark pools affect PFP

- dark pool activity concentrated in liqrid stocks
- stock activity higher if ↑ share volume, ↑ depth, ↓ intraday volatility
- activity ↓ if ↑ order imbalances relative to share volume
- improve market quality in terms of spread, depth, and daily intraday volatility
- activity associated with short term overreaction (auto correlation, volatility)

Main characteristic of dark liquidity

motivation to trade in dark pools:

- decrease info leakage/front run
- be more aggressive w/o paying whole spread (midpoint order book)

Note: spread represents the cost of executing trade at best available price

Does dark pool activity increase bc of market impact or midpoint pricing?

Analyze:
- increase in dark pool volume when volatility is high
- observe joint dist of dark volumes and spread

- link between volume and volatility is stronger than between spread and volatility
- higher spread easier to find liquidity in dark pool

Bilateral vs. Multilateral trading

Multilateral: anyone can provide liquidity / consume liquidity

Bilateral: asymmetry between liquidity providers & consumers
→ protects providers from adverse selection

Risks and vice of toxic liquidity

Risks:
- info leakage
- adverse selection
- gaming

fishing: small orders to detect large ones