ch2 Stakes and Roots of fragmentation

2.1 Intraday market share to volume curves : stationary issues

- liquidity remains highly concentrated
- dependent on intraday time conditioned volume distribution (patterns & intentions of different investors)

being part of reference price → primary markets
- they set prices

closing auction prices

- closing auction prices used to compute Net Asset Value (NAV)
- primary market monopoly
- 1/5 total volume is auctions

Exchange Delivery Settlement Price EDSP

- reference price used for valuation of derivatives at expiry monopolized by primary markets

⇓ prices traded in primary markets used to set the reference prices

trading volume linked to expiration of derivatives

patterns affect trading destination market share

2.1.1 Inventory driven investors need fixing actions

Worldwide equity trading:

→ continous phase

→ fixing auction phase
- important to fill orderbook

Fixing actions: whats at stake

witching day : 3rd friday each month option / futures contracts expire

triple witching day: simultaneous expiration of options, futures on third friday of 3, 6, 11, 12

- fixed turnover very high during witching days

Purpore of fixing Auctions

- concentrating more agents, forming more consensual price for the whole volume traded

→ closing prices used for valuations & building orderbooks

- consolidation order flows reduce price impact of trade, enhancement into revelation improves PDP by ↓ intraday 62 ↑ price stability

- At auction time market performs single price call auction to match at one price (auction clearing price)

- auctions bookend continous trading session

Basic matching rules during call auctions

fixing price determined by conditional decision rules:

1. **Max Executable Volume**
   - establish prices at which highest quantity will be executed

2. **Min surplus**
   - where quant. left in market at fixing price is minimum

3. **Market Pressure**
   - surplus buy side: highest potential auction price
   - surplus sell side: lowest potential
   - if both buy / sell surplus apply 4.

4. **Reference price:**
   - consult generally last price traded (ref price)

End time fixing auctions

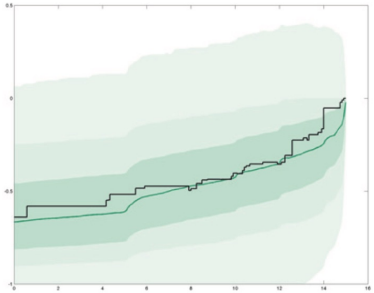
- some markets use random time after theoretical end during which orders still can be sent

Prefixing dynamics demystified

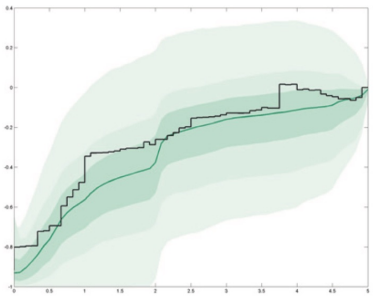
Matching curves

- shows volume that would be matched at time t if auction were held at t (fixing)

- relative diff between matched vol at t and final matched vol at fixing time



(a)



(b)

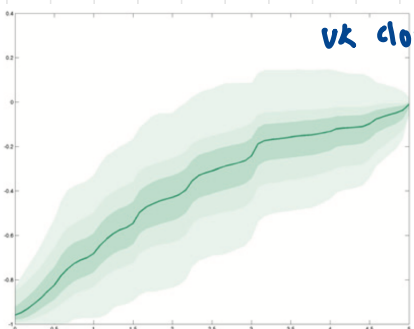
Figure 2.2. Matching curves (convergence of theoretical fixing volume to its final value) with the inter-quartile range (grey) and a sample day (black) for Crédit Agricole during opening auctions (a) and closing auctions (b).

beginning (convex)

- book building accelerates as time goes on
- theoretical matched vol only reaches final level in last few moments
- longer to intervene vs. closing

closing (concave)

- agents present in market must participate to unwind
- less uncertainty & less patience
- more constraints

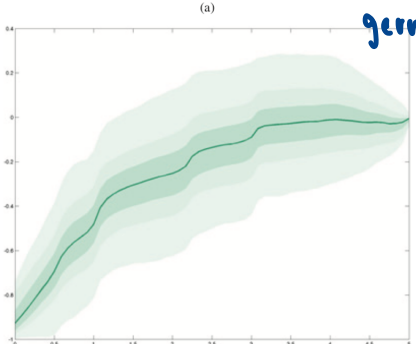


(a)

UK closing

opaque German orderbook

- max vol curves go above 0 threshold



(b)

German closing

- median curve already reaches 0 threshold
- 50% time final vol reached before the end of fixing auction
- above 0 thresholds means large amount cancelled / modified orders

Figure 2.3. Matching curve with the inter-quartile range (grey) and a sample day (black) on closing auction on FTSE 100 stocks (a) and DAX stocks (b).

German auctions : orderbook not revealed during fixing auctions
- players fish for vol and price by sending orders

- testing order book : getting into on new theoretical price, vol, surplus from settled order

Information peaks

- pace at which info arrives follows similar pattern
- Almost every stock every day has important number of updates around a particular time

↳ bring matched vol to final value

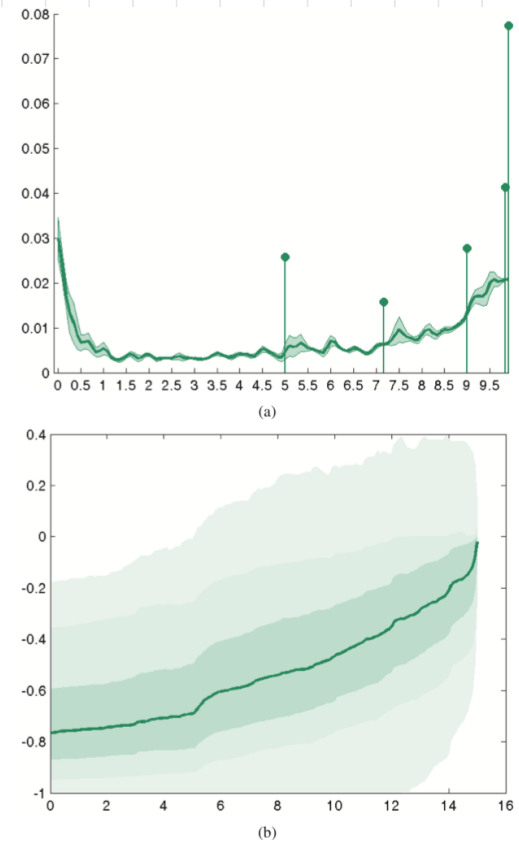


Figure 2.4. Probability that an update during the closing auction happens on a 5-s range (a). Matching curve on DAX stocks during the closing auction (b).

- illustrates prob. update happens in closing auction in 3s range

- opening auction last min time t
  peaks located around t-10s

- closing last min time t
  - t-30s
  - t-5s

Summary: fixing auctions

- useful for dealing with large positions (dedicated to inventory driven investors)

2.1.2 Time is money, investor optimal trading route

Market design & info flow → imply liquidity patterns

- intraday vol patterns important
  → concentration trading in specific time reflects how informative traded prices in interval

- there is an incentive for both informed & liquidity to trade simult.

- meeting points of info create specific patterns

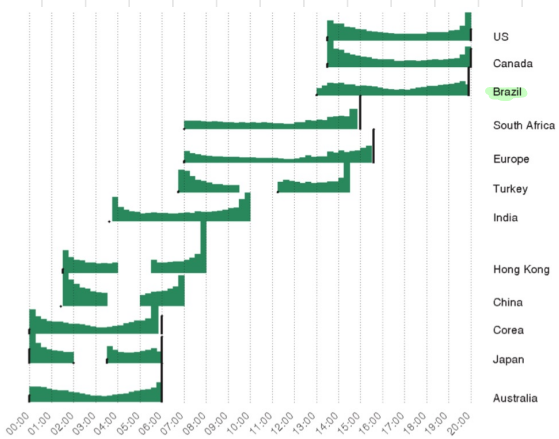


Figure 2.5. Intraday volume patterns across the globe.

- 15 min bins, accumulate trading vol on specific market

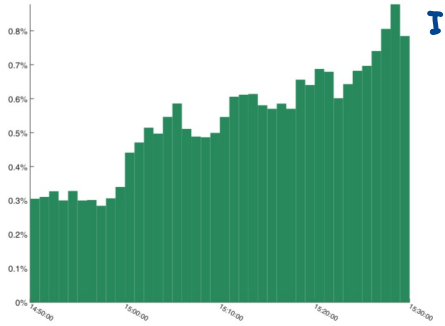
J / U shaped patterns induced by:

1. opening of another linked market

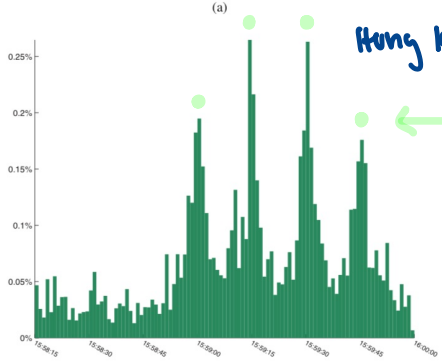
2. release of news at pre determined time on reg. basis

3. reference price computation or fixing phase

- third driver: NAV computations & margin comp use price of closing auction (important source of liquidity)



(a)



(b)

Figure 2.6. (a) Reliance Industries Ltd's volume pattern in India during the last 40 min of trading (1-min bins). (b) CNOOC Ltd's volume pattern on Hong Kong during the last 2 min of trading (1-s bins).

India

Hong Kong's J shape

- 17% traded vol falling in last 15 min bucket
- 25% vol concentrated last min

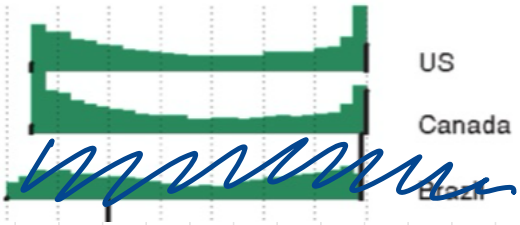
- ref price median prices of 15s bins in last min (causes J shape)

Hong Kong

Volume pattern driven by specific way ref price is computed on this market

- 4 spikes exact times of price snapshots for ref price computation

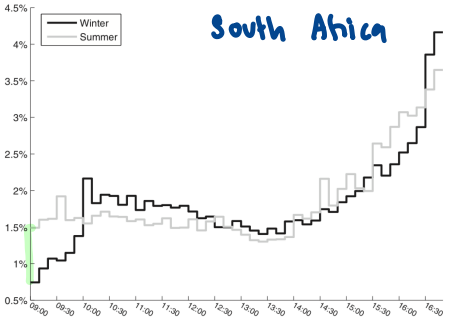
- No 5th spike → risk of not completing order when trying to get the price at exact time of close



Market opening influence

- delay real opening of brazilian markets until US markets open

- real price formation only take place after US markets open



South Africa

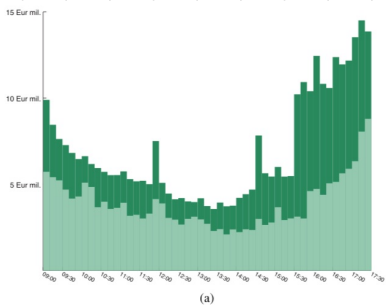
Figure 2.7. South Africa volume pattern excluding fixing (10-min buckets).

Summer / winter volume pattern

- summer, SA and Europe open same time
- winter opens one hour earlier

Examples mixed effect

- plot mean traded turnover (observe whole day activity)



any SA

US closed

Figure 2.8. Total SA's volume pattern on the French market during continuous auction. (a) The average pattern (dark) and the pattern when US markets are closed (light). (b) We added in the average pattern during the "NY shift".

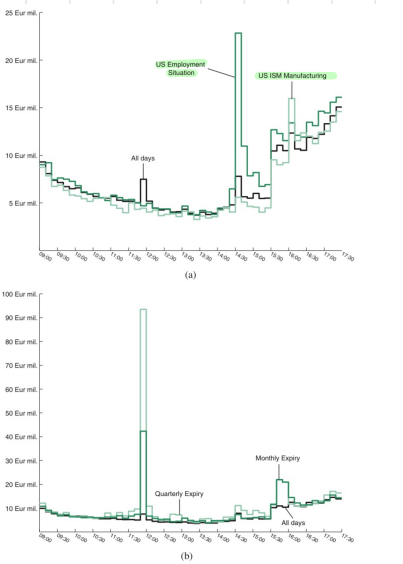


Figure 2.9. Total SA's volume pattern induce by US Macroeconomic News (a) and derivatives expiry (b).

Opening of US Market (1)

NY shift

- NY shift pattern has been computed using days where there is a 5h difference between french and us time
- increase in volume in US markets one hour earlier

- large jump at 12:00 due to witching day

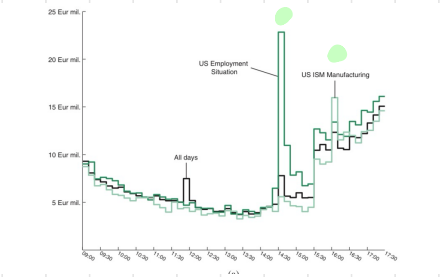
NY closed

- US market closed, French market open
- reluctance to trade when no info comes from leading US market

Opening linked market can have impact in 3 ways

- invest in other market → extra volume traded
- new info: increase vol traded, correction in eval of fundamental price of stock
- Arbitrages: generate extra vol

US Macroeconomic news (2)



Relase US employment s.t.

- volume pattern computed exclusively when report released

ISM manufacturing: mitigated effect given only portion economy concerned

- immediate effect dictated by how suprising news is

3) Equity derivatives expire

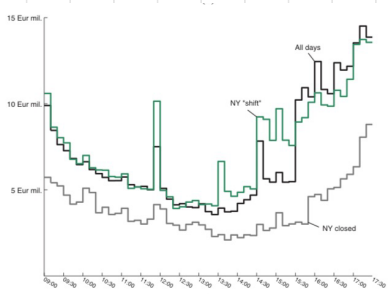


Figure 2.8. Total SA's volume pattern on the French market during continuous auction. (a) The average pattern (dark) and the pattern when US markets are closed (light). (b) We added in the average pattern during the "NY shift".

- witching days: dates equity derivatives expire
- derivative with expiraray are futures and options Euro stoxx 50 and CAC 40

Exchange Delivery settlement price (EDSP) arithmetic mean 11:50 - 12:00 CET

If you have position in future hedged by stock, don't want to roll position over

↳ unwind cash position in same venue around EDSP
↳ hence large vol

Equity derivative expires has an effect on volume tracked at closing fixing

↳ EDSP for single stock futures / options closing call auction price

2.1.3 Frag & evolution intraday vol patterns

- Euronet large market share beginning of day

→ ptp takes place on primary market be only venue to have order book filled due to not matched opening fixing orders

large end of day:
→ players stop / start SOR

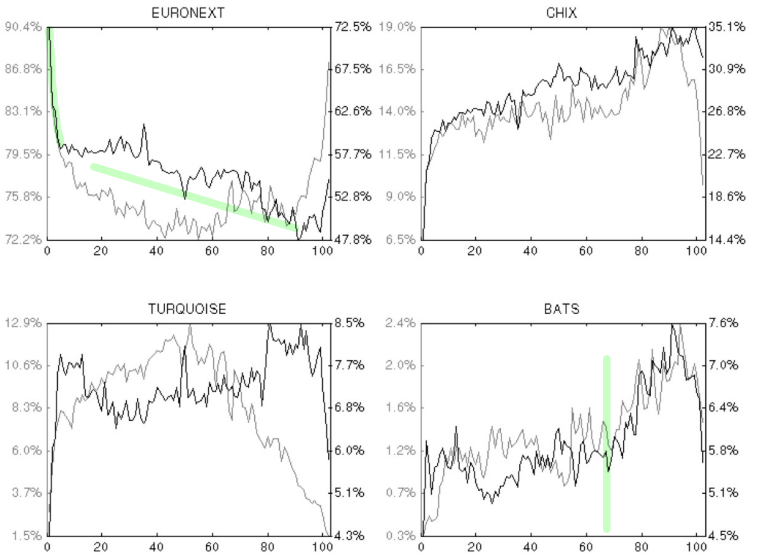


Figure 2.10. Intraday market share on CAC 40 stocks (January and February 2009 in grey, January and February 2012 in black).

when US markets open

Decreasing monotonicity euronet

link between
- higher prop liquidity providers in ChiX v. primary markets
- monotone decreasing bid/ask spread as day progresses
- need for liquidity providers to ↑ activity toward EOD

U shape Euronet v. Turquoise

-inverse shapes, Turquoise intraday market share nearly flat

- Turquoise MM agreements among its founding members

BATS consistent until US markets open

Stocks traded price used in computation EDSP

- intraday market share pattern:

→ Market participants need to unwind cash hedging positions as close as possible to EDSP

→ trade on market where price observed

2.2 4 main liquidity variables: Traded vol, Bid/ask, Volatility, Quoted Quant

- effective traded amount shows state of fragmentation
- participants monitor traded value to understand where traders currently agree to trade

- liquidity has to be described by more than past traded volume opposite offered liquidity

offered liquidity

quantity best bid & ask

liquidity in the book / book size
→ avg between quantity at first limits

tick sizes

book size significant of max tradable quantity, hence lb for traded vol

↳ but orderbooks replenish

bid/ask spread

spread price difference between best ask price and best bid price

less liquid: large spread

more liquid: small spread

relation spred ψ_1 with ψ_2 given small tick size

$$\psi_i = a + b \cdot {}^{1}/\sqrt{N_i} \cdot \sigma_i$$

σ_i volatility

N_i avg num trades per day

a, b constants shared by all instruments inside given asset class

large tick instruments

use η: captures bid/ask bounce

$$\psi_i = a + {}^{1}/\sqrt{N_i} \left(b_1 \cdot \sigma_i + b_2 \cdot \eta \cdot \text{tick}\right)$$

η parameter estimation

$$\eta = \frac{N^c}{2N^a}$$

N^a: number alternations (price increase then decrease) (and vice versa)

N^c: number of continuations (increase - increase) (decrease - decrease)

bid ask bounce: traded price oscillates between best bid vs. best ask)

↑ bounce ↑ alterations ↓ η

Intraday seasonalities

Traded vol, spread, quantities first limit, $\hat{\sigma}^2$

→ more uncertainty after opening
→ less activity mid day
→ run to end trading before close

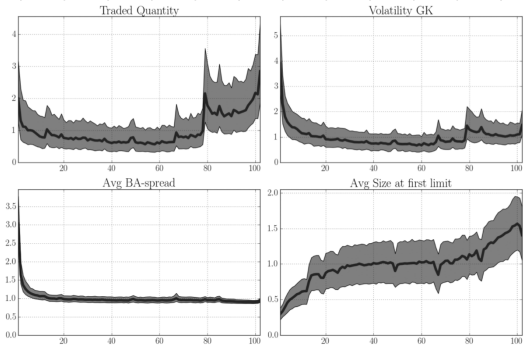


Figure 2.12. Renormalized intraday seasonalities on Royal Dutch Shell (UK listed stock), from top left to bottom right: traded quantity (i.e. volumes), volatility (estimated using the Garman-Klass method on 5-min bins), bid–ask spread, average volume at the first limits (i.e. book size). All trading days from 2011 to 2016 have been used to compute these medians (dark lines) and +25% to +75% quantiles (grey zones).

All 4 liquidity variables exhibit intraday seasonalities

* volatility difficult to estimate (abstract def)

- Brownian model
- semi martingale
- implicit volatility

(not very good, values uncertainty over microstructure friction)

- $\hat{\sigma}$ naive estimator

not good, polluted by bid/ask bounce

* bid ask avg
  - spread at given freq
  - spred at specific event
  - weighted by vol

EOD movement

- finish orders, start a little before close to reduce market impact during closing call auction

Joint movement of bid-ask spread & book size

bid-ask spread large
→ volume on book small

bid-ask spread small
→ volume on book large

EOD activity: spread at min, book size increases to compensate

liquidity providers who can't step into spread (tick)
→ increase sizes at best bid and bid size to provide liquidity

liquidity provision at tick sized spread

- liquidity providers locked out of price improvement so can only improve quantity
  → post larger order sizes which increases depth at top of book
- interplay: spread stuck to one tick, increase in book size plays role similar to spread decrease

liquidity provider competes with other LP by quoting best price (tightest spread)

price improvement ⇒ narrow spread
- less profitable
- adverse selection
- inventory risk

2.3 Does more liquidity guarantee better market share?
European Bid-Ask spread

Attracting MM → maker/taker fees

- give rebate to MM to liquidity providers
- charge liquidity takers

Attracting members → refund connecting costs

Kadan, Foucault, Kandel (into seeking and price discovery)

expect gain of each participant in terms of costs and fees
- lack of HFT: rebate HF MM
- too many HFT: rebate investors

Connected members

- number of connected members & satisfaction MM conditioned on liquidity of exchange

Main liquidity features
- volume
- volatility
- tight bid-ask spread

- ↑ volume ↓ volatility
  Tight spread
  [liquid stock]

- ↑ volatility wide spread
  [illiquid stock]

- bid-ask spread coincided an element of market design choices for an exchange (not volatility)

Bid-ask spread representations

- Bid ask represents reward given to MM for risk they are taking when liquidity providers
- As liquidity feature: way for exchanges to grab market share
  → SOR / Best execution policy → incremes chunges of venue to host transactions

In US American trade who mandates exchanges execute orders at prices given by consolidated tape

US consolidated tape vs. European fragmented markets

US consolidated tape
- centralized stream of real-time data across all US stock exchanges
  → Best bid/ask NBBO (National best bid offer)

Immediate best execution, transparency, equal access price into across all venues

European Fragmentation
- hard to see full market depth
- miss better prices

creating & maintaining trading venue

Requires 3 qualities

1. Liquidity providers (MM)
2. competitive bid/ask spread
3. connected members

Bid-ask spread and volatility move accordingly

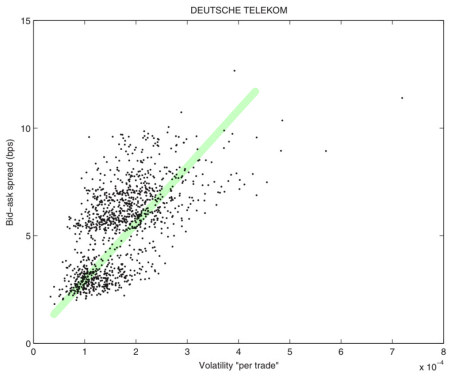


Figure 2.14. Bid–ask spread and volatility per trade on Deutsche Telekom.
Note: Data from January 2008 to July 2012 on the primary market.

Daily patterns

- adjusted by level of volatility / trade
- bid-ask spread evolves as function of daily volatility divided by trade vol

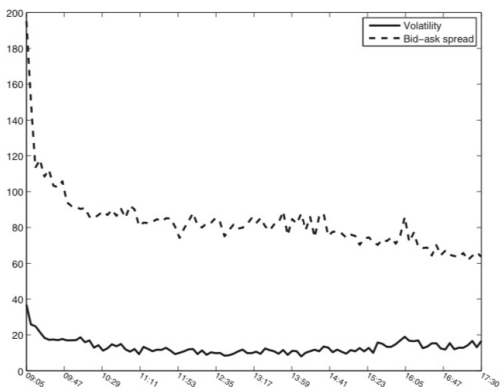


Figure 2.15. Bid–ask spread and volatility intraday curves on SBM Offshore NV.

Intraday patterns

After opening: suffers cost of noise
- bid-ask spread, volatility ↑
  - account for uncertainty due to overnight moves
  - time needed to start SOR

EOD: HFMM need to flatten residual inventory
- makes them take tighter bid-ask spreads regardless of relative risk

Middle period: most DFP without opening & EOD patterns

2.3.2 Bid-ask spread and market share deeply linked

- MM activity is more risky on less traded stocks hence their reward is higher

→ study relative values of bid-ask spreads among venues compared to shares

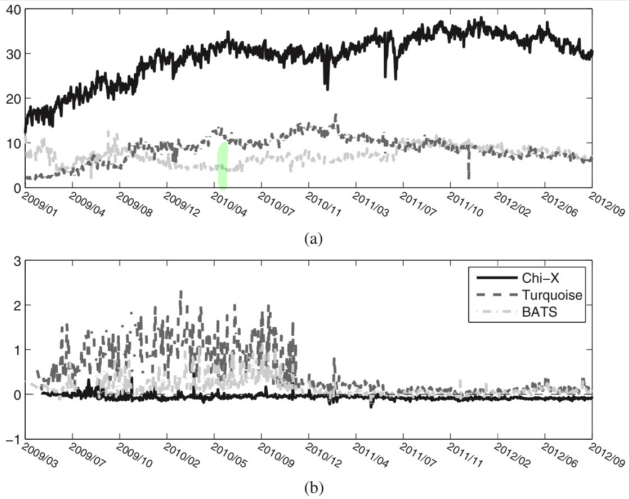


Figure 2.16. Market shares (a) and relative bid–ask spreads (b) on DAX30 stocks since 2007.

Market share

relative bid ask

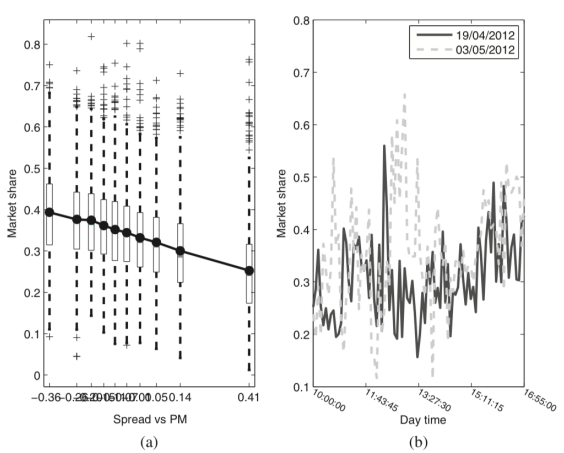
Market share of each trading firm moves according to quality of bid-ask spread

Turqoise bump

- bump corresponding to lapse of MM agreement
  - agreed to initially trade on Turqoise (provide constant liquidity)

Tight relative bid-ask spread implies increasing market share

SOR mandated to generate transactions on venue providing best price



- decrease in market share when relative quality of bid-ask spread becomes poorer

exchanges providing better liquidity are favored

2.3.3 Exchanges need to show volatility resistance

MM choose markets that are resiliant to high levels of volatility
- MM have duty to provide liquidity to other participants

→ relationship between number of trades on a trading venue and price volatility

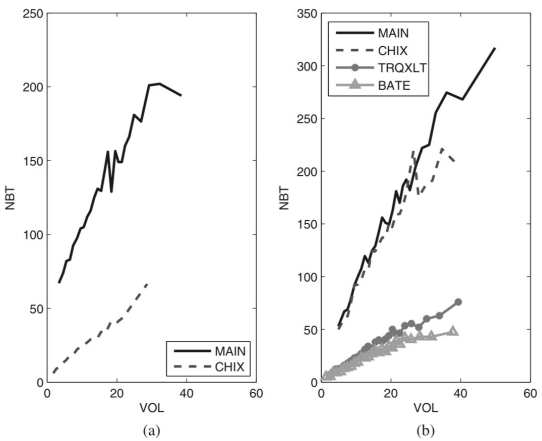


Figure 2.18. Median number of trades over quantiles of high frequency volatility for Total SA in 2008 (a) and 2012 (b).
Note: 15-min data.

- larger slope: more trades relative to vol
- Chi X gained similar pattern to primary markets

More resiliance, more part in PFP

Flow Reactivity

Flow reactivity: correlation between the number of trades and high frequency volatility

- used to compare venues and indexes (by measure of resiliance)

Strong relationship between
- quality trading venue
- success
- HFT MM

improve market share → smaller bid-ask spread
→ resilience to vol
→ better liquidity

2.4 HFT: How do they extend their universe

HFT: arbitrage and prevent price inversions

Do they have negative externalities?

2.4.1 Metrics for balance in liquidity among indexes

Did fragmentation live up to expectations, was it efficient for all european stocks?

Turnover

choose measure of heterogeneity of liquidity among stocks

→ Turnover: number shares compared with number shares traded

- How well turnover dispatched?
- What is the weight of stocks contributing to activity of index?

Coverage liquidity metric & gini coefficient

Coverage liquidity metric / LC ratio (CLM):

- % number stocks needed to realize 80% total turnover

Repartition of turnover across stocks

Repartition turnover across stock: how volume / value is distributed across different stocks in market, who trades how much, how concentrated

- CLM static → don't take repartition into consideration

Gini coeff:

- uses whole repartition curve to estimate degree of ineq. among stocks
  (0 perfect ineq)

- repartition curve of turnover obtained by

1. sort components decreasing order
2. summing intraday turnover on each component
3. divide by sum (obtain max 100 %)

higher coverage liquidity metric / lower gini
→ more evenly turnover distributed
→ more can find equivilent quality of liquidity on every stock of index for specific exchange
→ larger number components harder to find equal dist

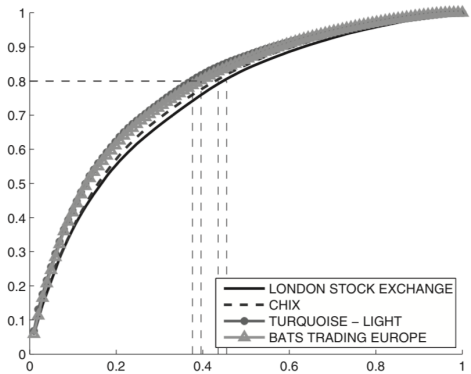


Figure 2.19. Repartition of turnover among FTSE 100 stocks on the four main trading venues: The primary market, Chi-X, Turquoise and BATS. The dotted lines show how the coverage liquidity metric is built: Trace an horizontal line at a level of 80%, and read the value on the horizontal axis when it crosses the repartition function. The Gini index equals two times the area between the repartition curve and the bisector line.
Note: Data from January 2012 to June 2012.

Turnover on 45 FTSE 100 stocks equate to 80% total turnover of LSE

LSE CLM on FTSE

45/101 = 45%

gini 0.99

	CLM	gini
FTSE	45 %	0.99
AEX	52 %	0.96
CAC	55 %	0.97
DAX	56 %	0.97

DAX most balanced index in terms of liquidity

2.4.2 History of coverage

coverage value: how many of index's stocks are actively traded on particular venue / how much volume is traded there

in 2009 - 2012 coverage values increased
→ positive homogeneity

illiquid stocks

positive homogeneity less seen on illiquid stocks

Market share depends on stock liquidity

Strategies carrying over

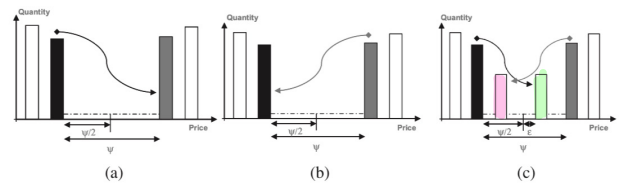
- gradually extend hedging
- extending stock coverage easy to improve profitability
- diversification

→ still liquidity threshold for HFT

→ HFT extending coverage to less liquid stocks justifies increased coverage for MFTs

HF MM have strategy to extend perimeter of action
MTFs help to remain competitive

2.4.3 HF traders do not impact all investors equally



(a) (b) (c)

Figure 2.21. Three cases of orderbook: Without HFT (first player is aggressive, (a)), without HFT (second player is aggressive, (b)) and with a HFT (c).

a) first 2 players alone, A becomes impatient and hits players B price (Ψ)

b) player B becomes impatient (given A has already crossed spread) cost Ψ

Both A and B bear avg. cost $\Psi/2$

c) HFT intervened:

HFT takes position just inside of player B
→ Player A becomes impatient and hits HFT price
cost $\Psi/2 + \varepsilon$

HFT takes position in front of B
→ B order not matched, B needs to hit HFT price
cost $\Psi/2 + \varepsilon$

- avg. execution cost for player A and B is still $\psi/2 + \varepsilon$ (forced to be aggressive for each trade)

- HFT prefer smaller trades, actors have to fraction trades (↑ reporting costs)

fixed losses unevenly distributed → lead to deteriation of trading conditions

Bid-ask spread: cost and uncertainty for investors

ψ_B: spread before 2007 (HFT not found)

ψ_{HFT}: HFT in market

HFT involved in q% of trades, new bid-ask spread is ψ_N

$$\psi_N = q\,\psi_{HFT} + (1-q)\,\psi_B$$ new bid ask spread

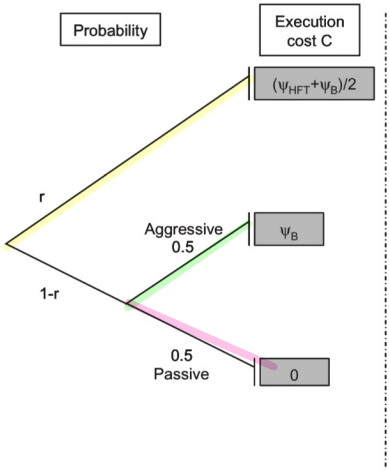


Figure 2.22. Execution costs for investors.

- meets an HFT, has to become aggressive and pay $C = \frac{\psi_{HFT}}{2} + \frac{\psi_B}{2}$
- doesn't meet HFT, still aggressive, $C = \psi_B$
- does not, passive $C = 0$

cost C for investor and uncertainty of cost C

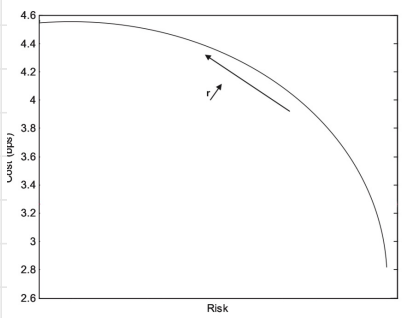


Figure 2.23. Execution cost (y-axis) and its uncertainty (x-axis).

- smaller the cost, higher uncertainty
- can't increase expected gain without increasing the risk one takes
- increasing prob to met HFT increases cost by $\varepsilon = \Psi_{HFT}/2$ but reduces uncertainty of cost

2.5 link between fragmentation and systematic risk

Systematic risk

- residual risk when all other risk has been hedged through all possible financial instruments

Extra v. intra day volatility

investors are impacted by extra day (closing, next open) vol but not intraday vol

How does intraday impact extraday

2.5.1 The spanish experiment

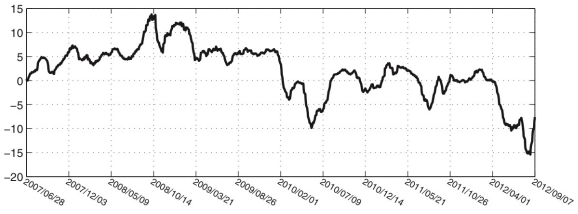
What is the impact of fragmentation and HFT on vol of markets?

Vol important point of market behavior
- random component of PFP

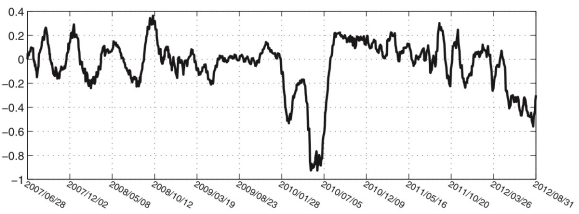
daily vol : amount risk taken by investor
stock with more vol should offer more return

Intraday Vol

- intraday vol is a proxy for intraday market risk
- implicit cost of trading
- significant param in market impact caused by a trade



(a)



(b)

Figure 2.26. (a) Difference between 20 days moving averages of intraday volatilities for FTSE 100 and for IBEX 35 (base: 0). (b) Difference between 20 days moving average of intraday to daily volatility ratios for FTSE 100 and for IBEX 35 (base: 0).

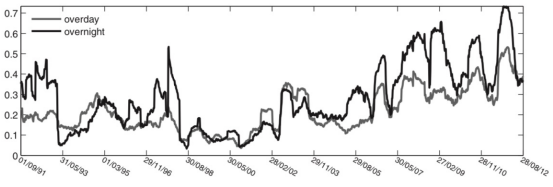
- both figures do not show any significant effect of increase of British market fragmentation after implementation of MiFID on intraday vol

Uses garman-klass vol:

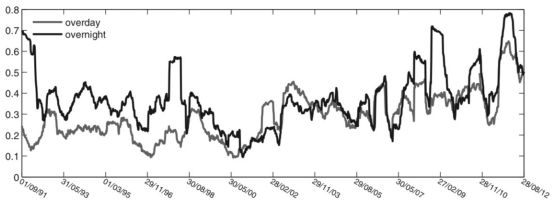
$$\text{15-min Vol}_{GK} = \frac{\sqrt{1/2\,(\text{high}-\text{low})^2 - (2\log(2)-1)(\text{close}-\text{open})^2}}{\text{Avg. price over period}}$$

Overnight vs. intraday correlation

- Intraday correlation among components of index usually well explained by overnight correlation



(a)



(b)

Figure 2.27. CLES 60 (a) and DAX (b) overnight vs. intraday correlation.

avg. pairwise corr

intraday corr =
Corr(intraday return^A, intraday return^B)

overnight corr =
corr(overnight^A, overnight^B)

$\text{intraday return}_t = \log(\text{close}_t) - \log(\text{open}_t)$

$\text{overnight return}_t = \log(\text{open}_t) - \log(\text{close}_{t-1})$

- value of price was strongly dependent on microstructural parameter

- During night market is organized as auction fixing
- During day market is continous double auction

opening fixing > closing fixing

- opening tex liable to being contaminated by noise, better reflection price vs. closing fixing

2.5.2 Flash Crash : How far are we from systematic risk

large order caused flash crash

- volatility high and liquidity low
- HFT counterparts hedge in equities market

↳ escalation volume exchanged while liquidity remained unchanged

- Jump volume incurred by market followed by large number of HFT players liquidating positions

Liquidity Replenishment Point (LRP)

NYSE specific system that slackens market for period of time in order to let liquidity return

- aggressive orders rerouted to other exchanges
- removes passive liquidity while retaining aggressive

Single stock circuit breakers

- Trading paused for 5 min if stock price moves up/down sharply in 5 min window

banning MM stub quotes

Stub quote: offer to buy/sell a stock at a price so far away from the prevailing market → not intended to be executed

- used to comply with two sided quotations

banning naked access

Prohibit Brokers from granting unfiltered access to ex and venues

Components of flash crash

- investor selling without taking into account liquidity risk
- trader blindly using algo
- HFT hedging position (futures/equity)
- internalization retail orders
- trading destinations doing nothing

2.5.3 Systematic risk to circuit breakers

Circuit breakers

- crucial protection against sudden demand of liquidity by market participants
- automatically halting trading process local or global
  - ↳ difficult at local level to tell imbalance

which instruments to halt (ETF or components?)

expectations of circuit breakers

1. look at prices
2. activated in case of abnormal price swings (vol good proxy for usual price range)
3. Instruments indexed on halted assets should be halted
4. highly correlated instruments should be halted
5. trading venues halt same assets

(sync of circuit breakers & propagation)

2.6 Beyond Equity Markets

Trading Futures

- no call auctions
- participants agree to liquid hours
- PFP future affect PFP components

- large ticks (bid-ask bounce, price aversion)
- sizes larger vs. equities
- not fragmented (post trading process more complex)

Trading options

Post trading process on options more complex
- US options markets are fragmented
- Europeans not frag

Practice is MM post liquidity (sell side) for asset manager, insurance (buy side) to consume