

Trading Equities: Market Structures and Costs

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Overview of talk

Topic of this lecture: “Market microstructure for investors.”

- ▶ How market places have changed – 2000 vs 2016.
- ▶ How methods of trading have changed. From people to Algorithms.
- ▶ Measuring the cost of trading - Some estimates
- ▶ Regulation.
- ▶ Lessons for trading
- ▶ Gazing into the Crystal Ball

How the market places have changed – Year 2000

USA

- ▶ NYSE, the largest, blue chip stocks.
Trading on the floor, with electronic support
- ▶ Nasdaq, smaller companies, tech stocks
Electronic limit order book
human interaction.
- ▶ Minimum spread: sixteenths (down from eights in 1997)

The stocks listed on NYSE/Nasdaq also trade on

- ▶ ATS – Alternative Trading Systems (alternative limit order books at major investment houses)
- ▶ ECN - Crossing Networks (between-investor trading using prices from NYSE/Nasdaq)

Limited in scope.

How the market places have changed – Year 2000

Europe

- ▶ The national exchanges (LSE, Paris, Deutsche Börs....) dominant.

Norway

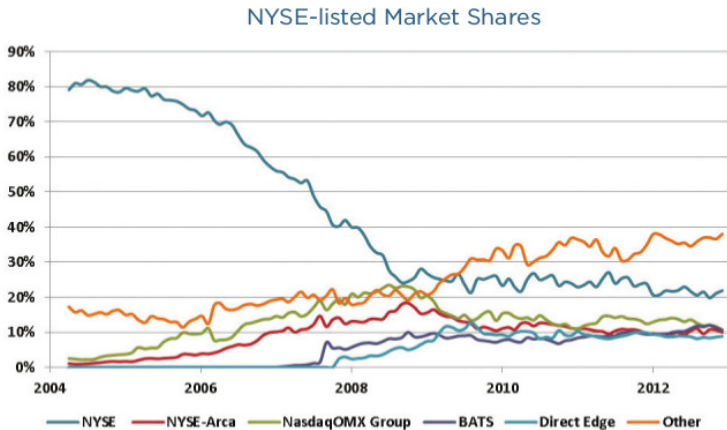
- ▶ Oslo Stock Exchange dominant.

How the market places have changed – Now (ca 2016)

USA

- ▶ Regulation (SEC): Reg NMS(2006): Monopolies disappeared.
 - ▶ Important for traders: NBBO (National Best Bid and Offer): Baseline Price.
Obligation to trade at best prices.
- ▶ Almost all trading electronic.
 - ▶ Big markets (NYSE, Nasdaq, BATS, etc): Limit order markets
 - ▶ Numerous alternative market places (Dark Pools). Not necessarily independent price discovery
- ▶ All trading is fragmented.
- ▶ Uniform spread: One cent

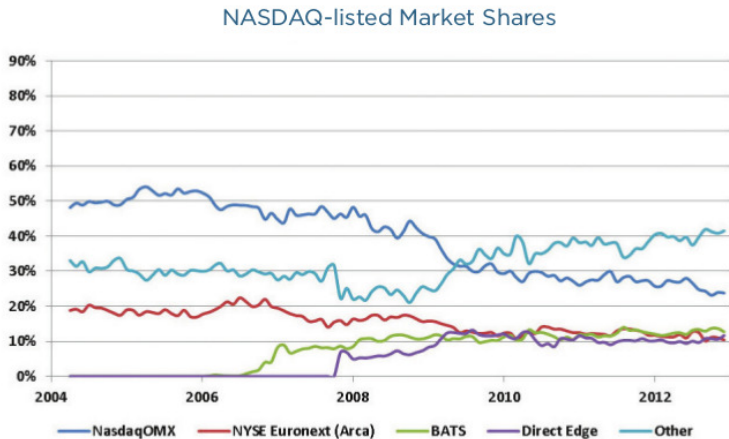
Examples - USA - Fragmentation of NYSE stocks



Source: Barclays Capital Equity Research

Source: Angel et al. [2015].

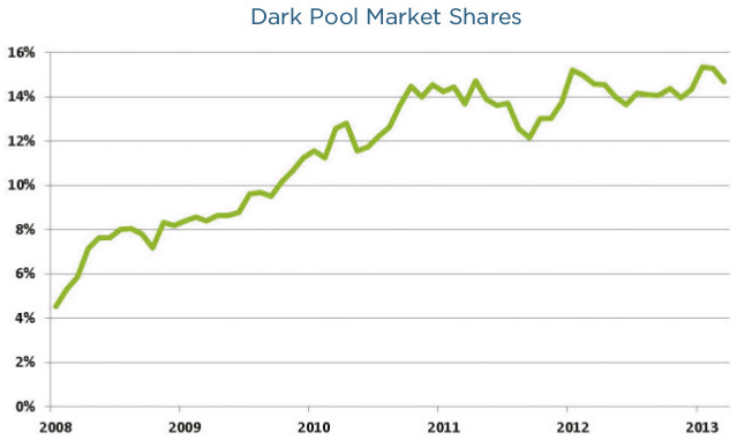
Examples - USA - Fragmentation of Nasdaq stocks



Source: Barclays Capital Equity Research

Source: Angel et al. [2015].

Examples - USA - Dark Pool Market Shares



Source: Rosenblatt Securities

Source: Angel et al. [2015]. Dark Pool Market Shares

How the market places have changed – Now (ca 2016)

Europe

- ▶ Regulation (EU): MiFiD: Mandate Competition between market places.
 1. Regulated markets (RMs)
 2. Systematic Internalizers (SIs)
 3. Multilateral trading facilities (MTFs)

Existing exchanges merge:

- ▶ Euronext, merger of Paris, Amsterdam, Brussel and Lisbon
- ▶ Stockholms OMX - Nasdaq
- ▶ LSE, acquires Borsa Italiana, Turquoise

Entry of new MTFs

- ▶ Chi-X (Mar 2007)
- ▶ Turquoise (Mar 2007)
- ▶ BATS Europe (April 2008)
- ▶ Nasdaq OMX (Sep 2008)
- ▶ NYSEArca (March 2009)
- ▶ Burgundy (May 2009)

Additionally, numerous Dark Pools, other OTC markets.

How the market places have changed – Now (ca 2016)

Europe

- ▶ Result: Fragmentation of trading
 - ▶ Major markets: Electronic limit order markets, little manual trading
 - ▶ Sattelite markets (Dark Pools)
- ▶ No Europe-wide reporting of single price (ie. no NBBO)
- ▶ Spread schedules with ticks below US one cent minimum tick (spread)

Examples - Europe

Distribution among lit market places, 2011

Trading Platform	Market Share	
	CAC40 Stocks	FTSE100 Stocks
Euronext	60.5%	n.a.
LSE	n.e.	54.77%
Chi-X	24.95%	30.43%
Turquoise	5.67%	7.93%
BATS Europe	4.31%	6.66%

Market Fragmentation in Europe, CAC40 (French) stocks and FTSE100 (UK) stocks.

Source: Foucault et al. [2013]

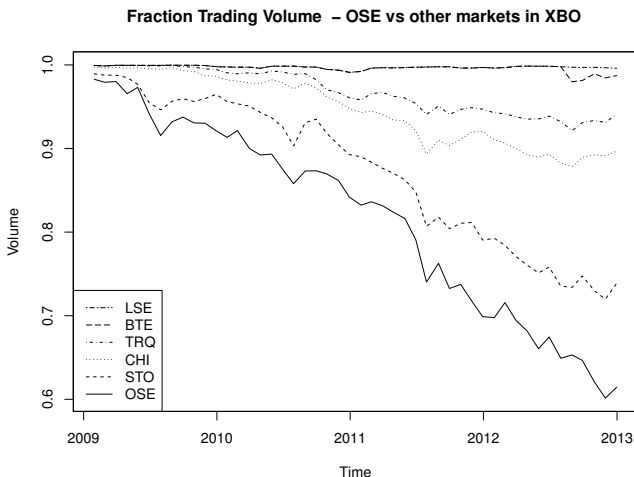
How the market places have changed – Now (ca 2016)

Norway

- ▶ Regulation (EU): MiFiD: Applies also to Norway (even if not in EU).
- ▶ Result: Fragmentation of trading
 - ▶ Oslo Stock Exchange currently about a third of total trading in Norwegian Stocks.
 - ▶ Other market places for Norwegian Shares
 - ▶ Other Exchanges (Stockholm, BATS, Chi-X...)
 - ▶ Satellite markets (Dark Pools/OTC trading)
- ▶ Spread schedules with ticks below US one cent.

Examples - Norway

Norwegian stocks traded at the OSE and other lit markets



The figures illustrate where Norwegian stocks are trading. The figure shows fractions of trading in each market. The bottom line is the fraction of the XBO traded at the OSE. The other exchanges adds to the total. The fractions sum to one (we have left

How methods of trading have changed

2000

- ▶ Human Interaction
 - ▶ Floor (NYSE)
 - ▶ (Human) entering in limit order book

2016

- ▶ Most of the human interaction has been replaced with computerized trading.

High Frequency Trading (HFT)

Terms of usage:

- ▶ **Algorithmic Trading:** Trading where computers involved in trading *decisions* (not just as an order entry system.).
- ▶ **High Frequency Trading (HFT):** A subset of algorithmic trading where *speed* (of communications, of trading decisions) is important determinant of *profits* from trading strategy.

Informally, High Frequency Trading (HFT) is used more broadly to refer to all computerized trading.

Why computerization?

Replacing (highly paid) brokers with computers.

Computers win because:

- ▶ Computers have a quick and wide attention span: They can react faster to new information.
- ▶ Computers are disciplined, they do only what they are programmed to do. (Which may also be a liability).
- ▶ Computers do not forget.
- ▶ Computers do not argue about office placement, holidays, pay,
...

Finance is the last industry to enter the industrial revolution...

HFT Controversial

Lots of negative press against HFT.

Give a more balanced view.

Everybody agrees:

- ▶ HFT opens for more efficiently performing the traditional role of financial intermediaries:
Market Making – Providing liquidity, and being compensated for it (earning the spread).

HFT Controversial

Agreement that:

- ▶ HFT gives advantages to the fastest traders.

Disagreement about:

- ▶ Are the advantages to the fastest trades of a nature that we should worry about? (and regulate)?

HFT Controversial – arguments

Some of the arguments in the HFT debate:

- ▶ *“The speed advantage removes the level playing field.”*
The playing field of market trading has never been level.

HFT Controversial – arguments

“HFT traders frontrun other traders”

The main theme of Michael Lewis [2014]' book *Flash Boys*. Frontrunning in its pure form (trading ahead of your customers orders) is illegal.

But what about practices like:

- ▶ HFT traders uncovering direction of trader interest?
- ▶ HFT traders trading in correlated assets?

HFT Controversial – arguments

“Some HFT trading practices are market manipulation”

Market manipulation is illegal.

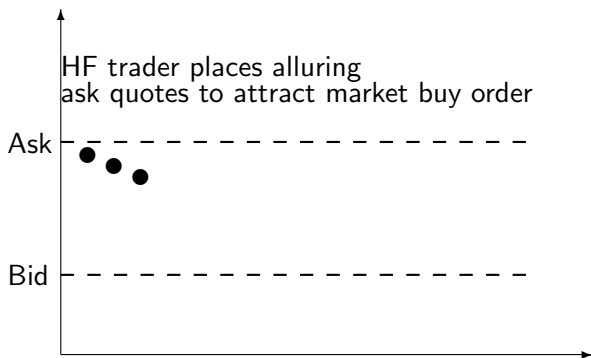
- ▶ However: boundary of trading and manipulation blurry.
- ▶ Need to “prove intent” – difficult

Hypothesized games HFT traders play.

- ▶ **Smoking**
- ▶ **Spoofing**

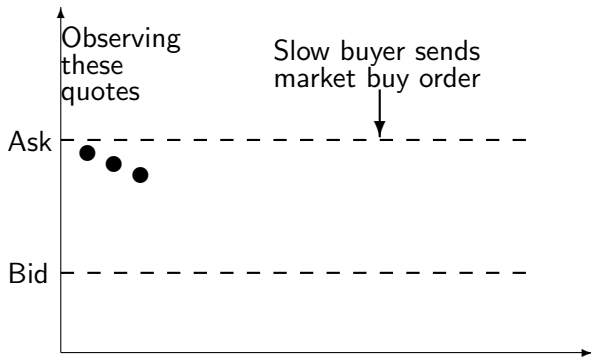
Smoking – illustration

HFT trader wants to sell.



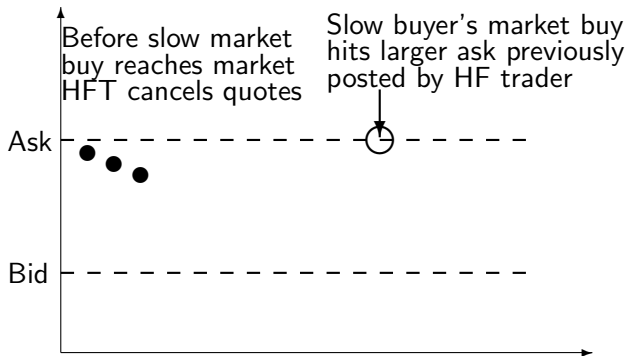
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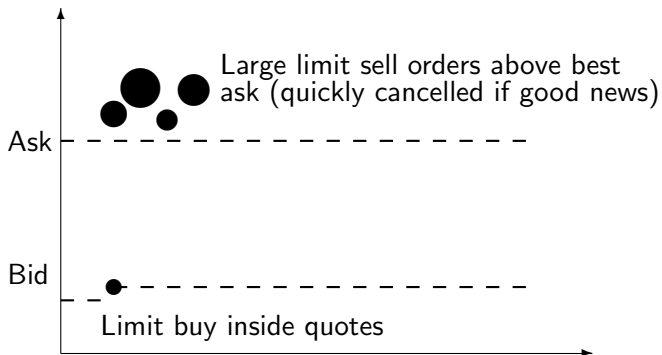
Smoking – illustration

HFT trader wants to sell.



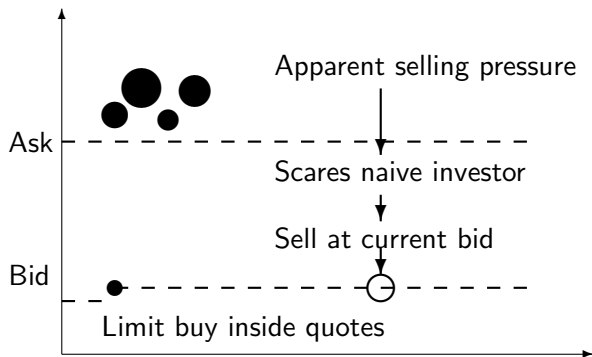
Spooing

HF trader wants to buy



Spooing

HF trader wants to buy



Illustrating the concept of *spoofing*. Pictures borrowed from Biais [2011].

HFT Controversial – arguments

“Automated trading leads to a fragile system”

(or – Crash testing market structures)

The Flash Crash was an event where trading in New York and Chicago broke down for half an hour on May 6, 2010.

The Dow Jones index lost 9% within minutes.

Recovered after 38 minutes.

Critics: Flash crash an example of the systemic fragility of an automated market.

“Systemic Risk”

Is there a conclusion about HFT being good or bad?

Not really.

Primary evidence: Substantial lowering of measured transaction costs as HFT takes over. (See later)

But can not rule out that some of the negatives are large enough in magnitude to offset the lower transaction costs.

Differentiate:

- ▶ HFM – High Frequency Market Making – Benign HFT.
- ▶ HFB – High Frequency Bandits – e.g. manipulative practices.

However, some recent evidence: High Frequency Traders are getting out of the business.

“Top high-frequency trader Teza to quit proprietary trading



Group founded by Misha Malyshev switches focus to quantitative hedge fund

One of the biggest and fastest traders in financial markets is abandoning its core business after its revenue engine stalled, a sign of the challenge of adapting in markets that unfurl in nanoseconds. Teza Technologies of Chicago plans to exit its proprietary trading business in the next six months to focus on building up a quantitative hedge fund that manages more than \$1bn, company executives said. The new tack comes after net revenues at the proprietary business, which bets Teza's own money in markets from futures to bonds, steadily declined from about \$250m four years ago to \$80m in 2015, according to three people familiar with the figures. In 2016, the business has struggled to make a profit, the people added.

“Generally, it is harder to make money,” Misha Malyshev, Teza chief executive, said in a rare interview.’’

Consequence of HFT: Colocation

We are used to thinking about the NYSE as beehive of activity (this is in 1987).



New York Stock Exchange, floor in 1987 Photo Source: WSJ.

Colocation

As the computers are taking over, the floor of the NYSE looks like this:



New York Stock Exchange, floor in 2008. Photo Source: Wikipedia.

Colocation

Instead, the activity has moved across the river, to Mahwah, New Jersey, where NYSE has built its data center.



New York Stock Exchange, Move to Mahwah

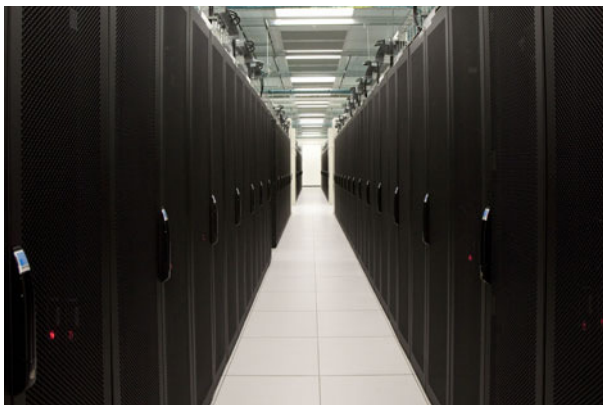
Colocation



New York Stock Exchange, Mahwah, NJ. Entrance

Photo Source: NYSE

Colocation



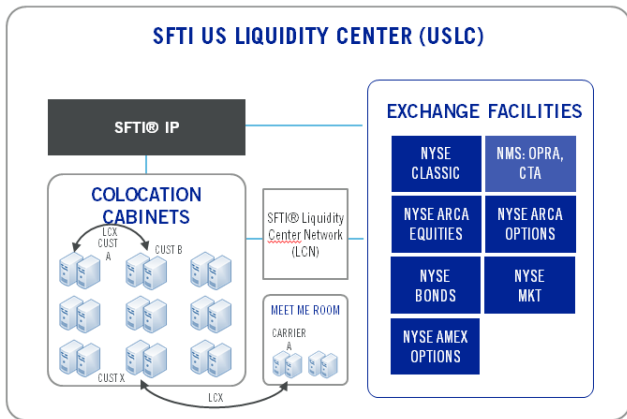
New York Stock Exchange, Servers, 2016

Photo Source: NYSE.

Colocation

Is a source of revenue to the NYSE.

How NYSE are selling their colocation services:



New York Stock Exchange Offer colocation to customers

Source: NYSE.

Consequence of HFT: The search for speed

HFT: Willingness to pay for infrastructure improving speed of data transmission.

Plot line in *Flash Boys*: Laying optical cable the straightest line between Chicago and New York

Optical cable lost out to **Microwave Towers** – line of sight, faster than optical cable.

Realization of speed advantage came in 2012.

The search for speed, ctd

Microwaves between New York and Chicago

New Applications for building microwave towers:

Before 2012

2012

10



FIG. 10: A map of 93,600 paths present in 187,338 microwave site-based license applications for the two years prior to September 1, 2012 (left) and of 191,290 towers culled from the FCC database (right). Colors indicate frequency bands: 6 GHz (black), 11 GHz (charcoal), 18 GHz (dark gray), and other (slate gray).

Figure taken from: Laughlin et al. [2014]

The search for speed, ctd

It is not just the US.

Making Connections

A 300-metre-plus radio mast proposed in Richborough, Kent would increase trading speeds between London and Frankfurt



Figure source: Bloomberg, article 28 jul 2016.

The search for speed, ctd

Why a 322 m mast is needed to reach Europe

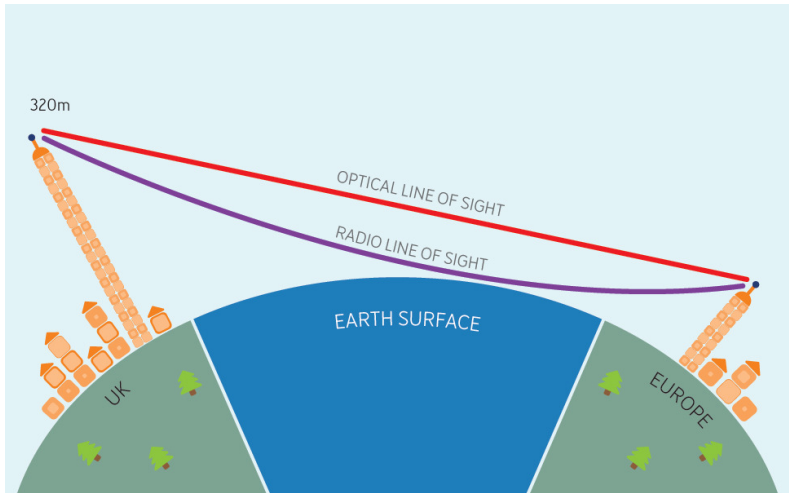


Figure from: Promotional material by Valiant.

How exchanges' methods of making money has changed

Historically: two major sources of revenues for exchanges
(Remember, exchanges used to be run like clubs by its members.)

- ▶ Listing fee (from issuers)
- ▶ Fee per trade.
- ▶ (plus membership fees for a seat on the exchange)

Changed: Exchanges – for profit companies, with more sources of revenue.

- ▶ Listing fee (still important)
- ▶ Fee structure more creative
(and important for traders to know)

Examples:

- ▶ Maker / Taker pricing
- ▶ Payment for Order Flow
- ▶ Colocation, paying for better access to the exchange.
- ▶ Selling (Fast) Market Data: Another source of revenue.

Maker/Taker Fees

The make/take fee construction:

way for stock exchanges to compete for order flow

Exchanges charge liquidity-demanding orders (marketable orders – demanding immediated execution) a fee (the “take fee”).

This fee is offset by a rebate (the “make” rebate) for liquidity-supplying orders (nonmarketable limit orders).

Difference make/take fee: Significant part of exchange revenues

Maker/Taker Fees - Why?

Encouraging resting limit orders (through the make rebate), the exchange encourage traders to choose their limit order book to place their resting orders.

Exchanges show a wide variety in their fee schedules

Venue	Take Fee (\$/100 shrs)
AMEX	0.30
NYSE-Arca (ARCA)	0.30
CHX	0.30
DirectEdge X (EDGX)	0.30
Nasdaq (NDAQ)	0.30
BZX	0.29
NSX	0.29
NYSE	0.23
PSX	0.19
BYX	-0.02
EDGA	-0.04
Nasdaq OMX BX (BX)	-0.14
CBSX	-0.17

(Take) Fee schedules at US exchanges November 2012. Source: Battalio et al. [2016]

Maker/Taker schedules becoming ever more complex

Fee Schedule NYSE (extract)

LIQ	DESCRIPTION	TAPE A	
1	Taking Liquidity	\$0.00275	\$0.0030 if Adding ADV < 250,000
1	Floor Take	\$0.0024	
1	SLP Take	\$0.00275	
1	DMM Take	\$0.00275	
2	Providing	\$(0.00140)	\$(0.0000) If Non-Displayed
2	Providing Tier 3	\$(0.00180)	Adding ADV > 0.35% Tape A CADV and MocLoc > 0.05%. \$(0.0000) if Non-Displayed
2	Providing Tier 2	\$(0.0020)	Adding ADV > 0.75% Tape A CADV and MocLoc > 0.10% \$(0.0000) if Non-Displayed
2	Providing Tier 1	\$(0.0022)	Adding ADV > 1.10% Tape A CADV and MocLoc > 0.12% \$(0.0000) if Non-Displayed
2	Floor Provide	\$(0.00190)	\$(0.0022) if Floor provide > 0.33% Tape A CADV, \$(0.0020) if Floor provide > 0.07% Tape A CADV, \$(0.0022) if member is at providing Tier 1, \$(0.0020) if Tier 2

Maker/Taker Fees – Problematic

- ▶ Best execution standards require brokers to take the “best” price without regard to the access fees. Should be net of fee.
- ▶ Incentives for brokers to maximize fee payments (if fees not passed on to customers). [Battalio et al., 2016]

Payment for Order Flow

An exchange pays brokers a fee for routing certain kinds of orders to their exchange.

Want to attract: “*uninformed order flow*” (e.g. retail order flow)

Payment for order flow is allowed in the US market, but not everywhere.

The UK FSA outlaws the practice in the London market.

Why?

If retail traders are not aware of the practice, their brokers may choose to route trades to the venue that maximizes payment for order flow, not venues that offers the best price.

– Violation of best execution.

Measuring the cost of trading

As an investor, the most important:

The *cost* of trading.

Generally, two components of trading costs

- ▶ Direct (fees) [already seen example: Maker/Taker fees]
- ▶ Indirect (market impact)

Second source of cost the most important.

Implementation Shortfall

Implementation Shortfall conceptually introduced by Perold [1988]. To fully measure the cost of trading, need to account for both:

- ▶ the degree to which your own trading moves prices
- ▶ the probability that you are not able to buy (or sell) all or part of the portfolio (nonexecution risk)

Idea: Compare the values of two “paper portfolios”

- ▶ The desired portfolio using the prices extant when the decision to trade is made
- ▶ The actual portfolio one ends up with.

The difference of these two is the *implementation shortfall*.

Implementation shortfall, calculation

- ▶ Execution cost (prices change before one manages to buy).
Decomposed further
 - ▶ Delay between order decision and implementation (sending order)
 - ▶ Execution cost
- ▶ opportunity cost (one can not trade what one want)

Very hard to measure all components.

Most common: Estimate the execution costs from difference

- ▶ Price when sending order (unperturbed price)
- ▶ Price achieved.

ITG

ITG: company providing services to “buy-side” investors.

Best known for its report on trading costs.

Using data from trading by institutional investors, estimate implied trading cost.

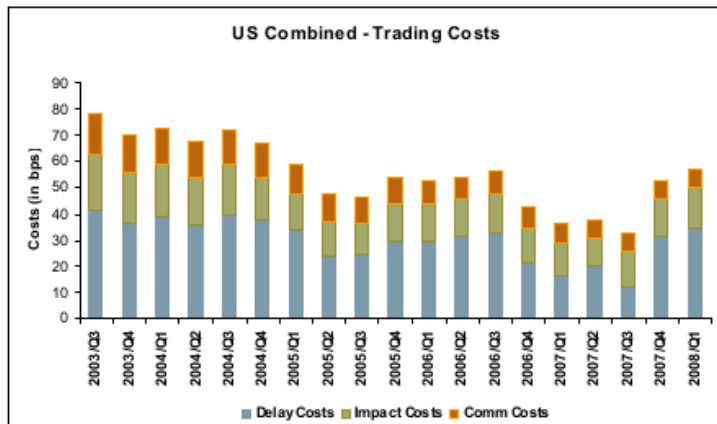
Implementation Shortfall

$$= \begin{cases} \text{Trade Price} - \text{Benchmark Price} & \text{for a buy order} \\ \text{Benchmark Price} - \text{Trade Price} & \text{for a sell order} \end{cases}$$

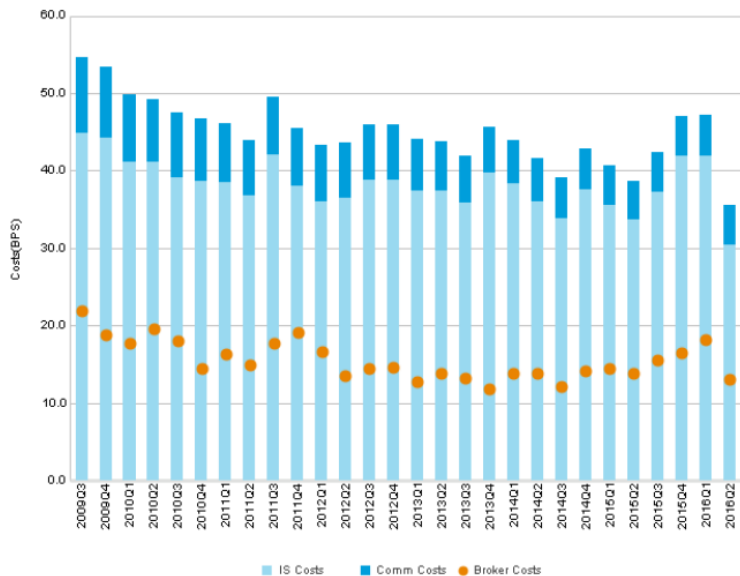
ITG reports:

$$\text{Total Cost} = \text{Implementation Shortfall} + \text{Commissions}$$

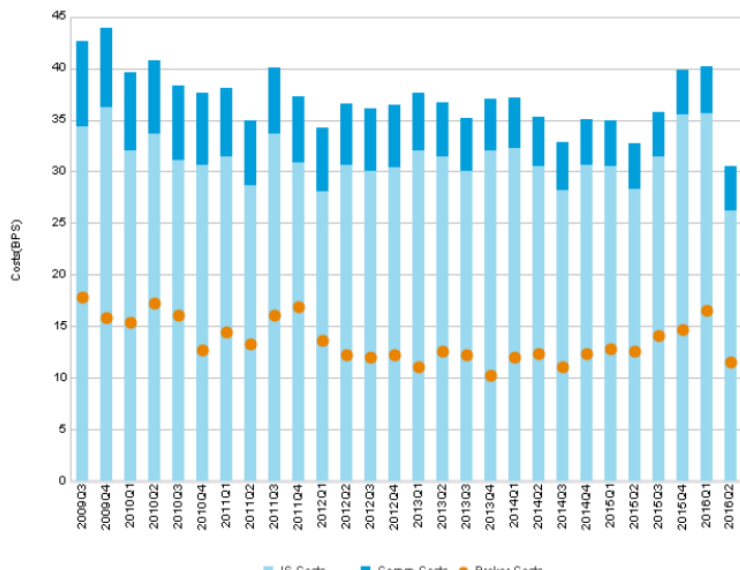
Trading costs estimates 2008 report US Combined



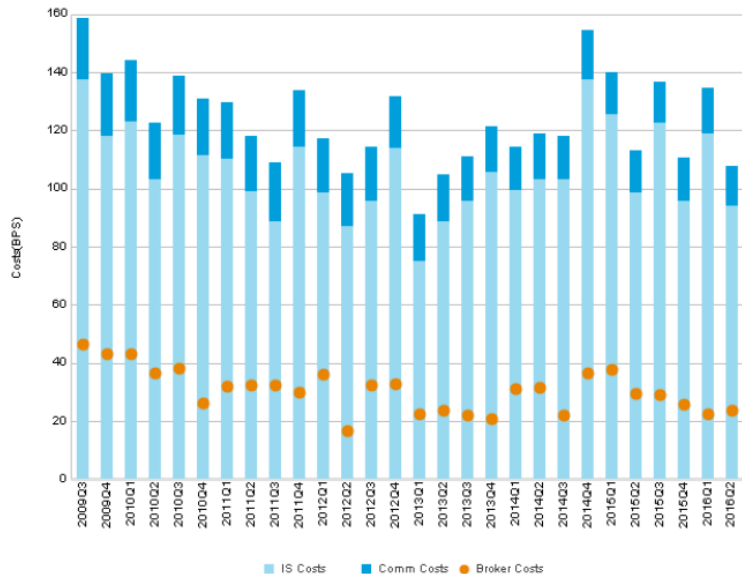
Trading costs estimates 2016 report US Combined



Trading costs estimates 2016 report US Large Cap

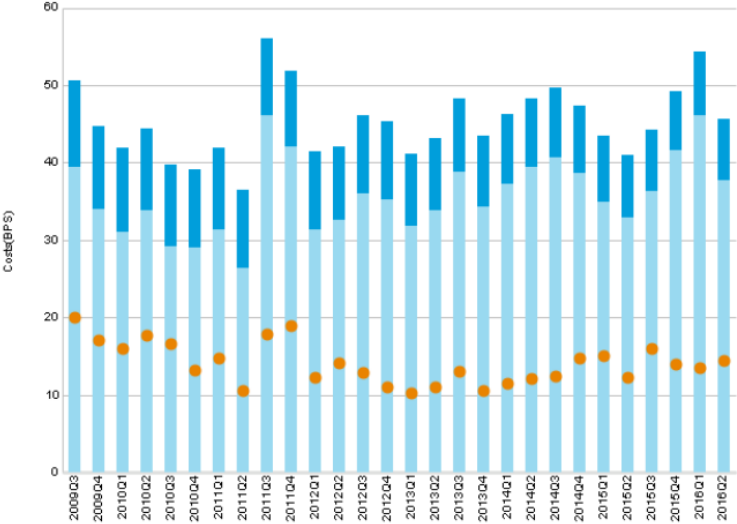


Trading costs estimates 2016 report US Small Cap



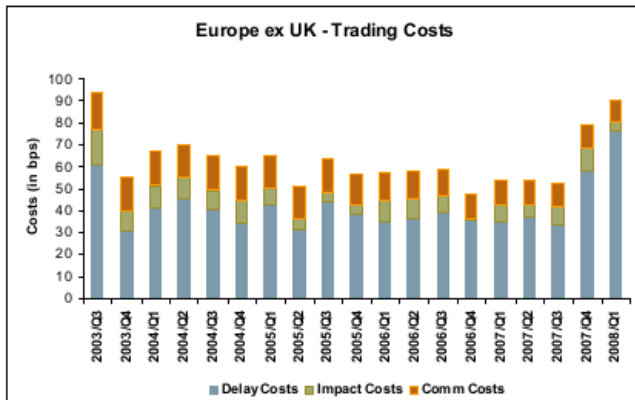
European costs

Let us also look at the case of Europe (ex UK)
2016 Report



European costs

2008 Report



Longer term trends, US

ITG estimates attempts to measure trading costs using actual trades.

Academics do not have access to that data.

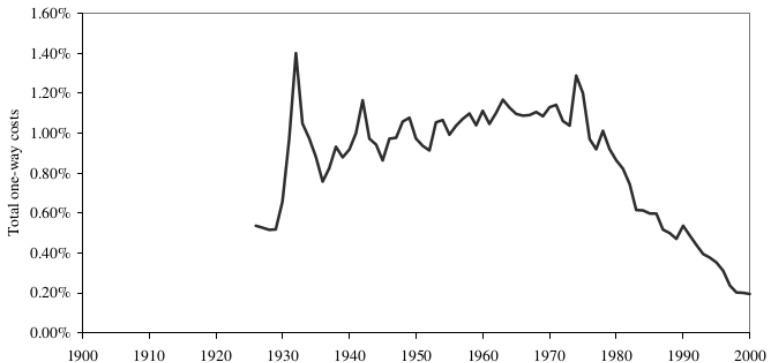
Instead measure similar cost measures using all trades at exchanges.

- ▶ Bid/Ask Spread (in percent of price). The theoretical cost of a round trip. Going back in history observed at the end of the day.
- ▶ Effective spread. Close to the trade impact calculation. The difference between a transaction price and the midprice just before the trade took place (the “unperturbed” price).

Long term trading costs, US, 1900–2000

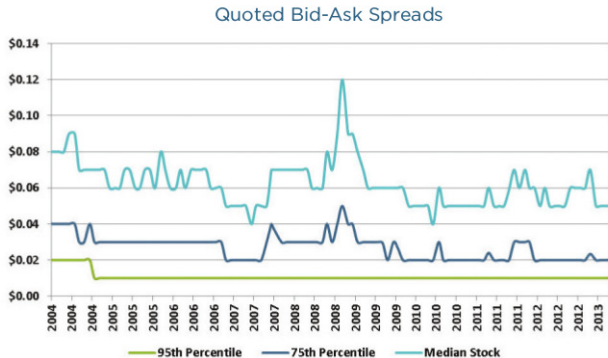
Average Transaction Costs Dow Jones Stocks, 1900–2000

Figure 4. Average one-way transaction costs (half-spread + NYSE commission)



Source: Jones [2002].

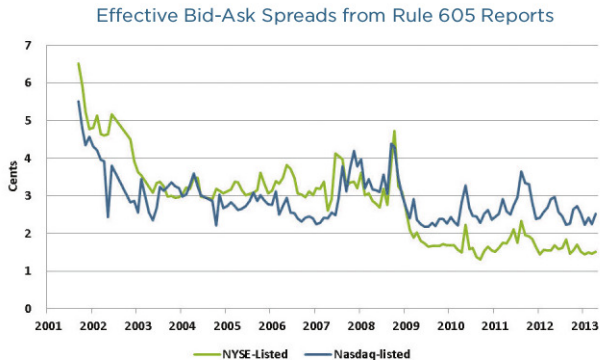
Quoted Bid-Ask Spreads, 2000–2011



Source: NYSE TAQ data

Source: Angel et al. [2015].

Effective Bid-Ask Spreads, 2000–2011

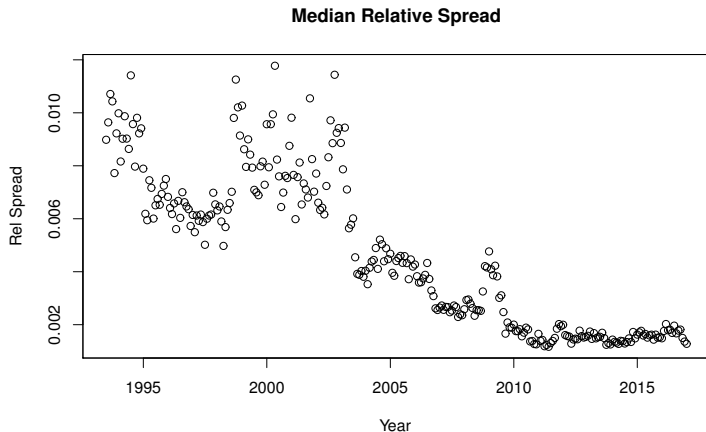


Source: Public Rule 605 Reports from Thomson, Market orders 100-9,999 shares

Source: Angel et al. [2015].

Longer term trends, Norway

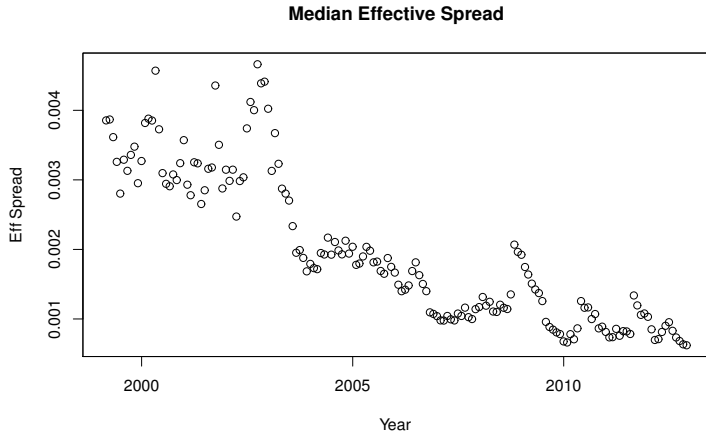
Time Series, Closing Relative Bid/Ask Spread, Monthly Median, OBX constituents



Time series plot of median relative spread across stocks on the Oslo Stock Exchange. The sample is restricted to stocks in the OBX index, an index of the 25 most active stocks on the OSE. The relative spread is the difference between closing

Longer term trends, Norway

Time Series, Effective Spreads, Monthly Median, OBX constituents



Time series plot of effective spreads across stocks on the Oslo Stock Exchange. The sample is restricted to stocks in the OBX index, an index of the 25 most active stocks on the OSE. The effective spread is the difference between a trade price and the midquote just before the trade, relative to the midquote. Actual numbers (not

Bottom Line – Trading Costs

For a *small, random trade*: Estimates of trading costs fallen everywhere.

BUT

What about larger traders/institutions?

Institutional traders

- ▶ trade larger quantities.
- ▶ worry about revealing trade intentions (strategies)
Incentives for others to “get in ahead of you” (pinging).

Ultimate worry:

- ▶ The cumulated market impact may be larger for institutions.
Is it?

Active (and unsolved) research issue.

- ▶ Academics are actively looking for a smoking gun here.
- ▶ Still haven't found it.
- ▶ But: the effect does need to be rather large to offset the generally lower transaction costs in the current market place(s).

What about the very large trades?

Larger trades have always been hard.

Old Days:

- ▶ Most Exchanges had special facilities for dealing with “blocks.” (Upstairs Market)
- ▶ NYSE: Block Desk a separate mediated market
- ▶ Final price of a block trade usually contain a premium/discount relative to market price.

Today

- ▶ Block trading replaced with algorithms trickling the block into the continuous limit order book.
- ▶ Ideal comparison: what is the aggregated price impact of this “trickled” trade, and how does this compare to the typical premium/discount for the same sized block in the “old days”

Note:

- ▶ Alternative approach: block auctions.

Price concessions for block trades

Comparing the price in a block trade (which was agreed off the floor) with the current price.

Data from 1970-71

	Relative to previous days close	Immediate price impact	Temporary (reversal)
Sells	1.86%	1.14%	0.71%
Buys	1.50%	0.75%	0.09%

Source: Kraus and Stoll [1972]

Estimates of price impact of a block sale

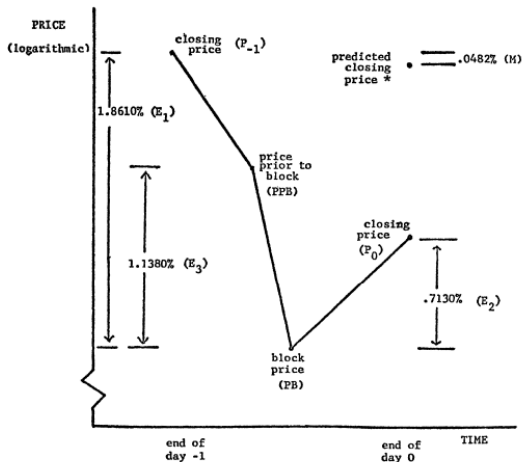


FIGURE 1

Minus Tick Blocks

Average Percentage Price Differences between Selected Prices in the Period from the Close of Trading on Day -1 to the Close of Trading on Day 0.

* Closing price if stock's price had changed by same percentage as market index.

Estimates of price impact of a block buy

576

The Journal of Finance

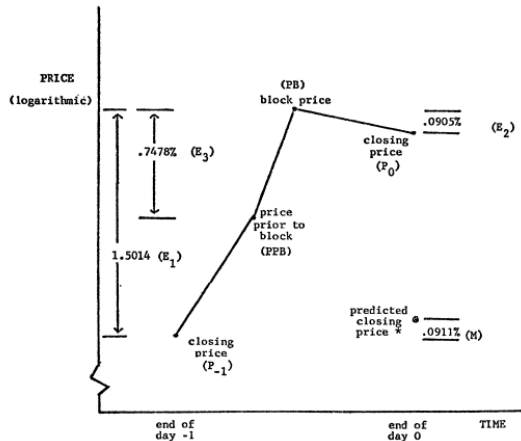


FIGURE 2

Plus Tick Blocks

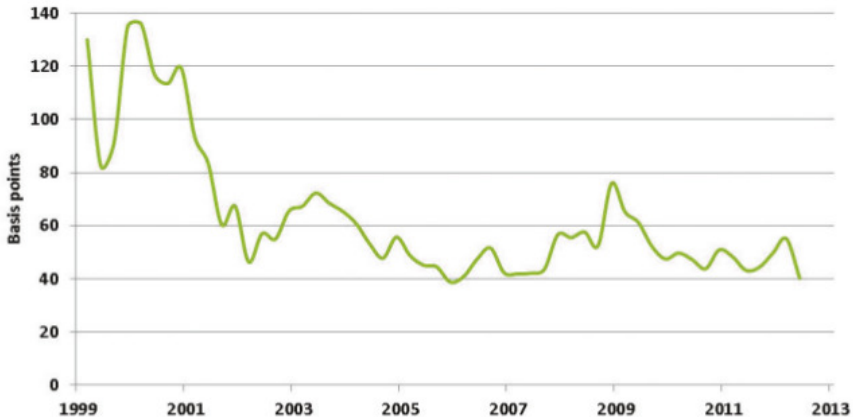
Average Percentage Price Differences between Selected Prices in the Period from the Close of Trading on Day -1 to the Close of Trading on Day 0.

* Closing price if stock's price had changed by same percentage as market index.

Figure taken from Kraus and Stoll [1972].

- ▶ Compare estimates for block trades in recent years

Average Transaction Cost Estimate for 1M Shares in a \$30 Stock



Source: Authors' analysis of Ancerno trade data.

Regulators to the rescue?

- ▶ Financial Regulation a growth industry
- ▶ Prone to over-regulating (Dodd-Frank–2300-pages)

The *goal* of most regulation

- ▶ Maintain a *fair* market.

Weapons of regulators

- ▶ Enforcing Competition
- ▶ Enforcing Transparency.

For investors: Use trade reports from exchanges to evaluate quality.

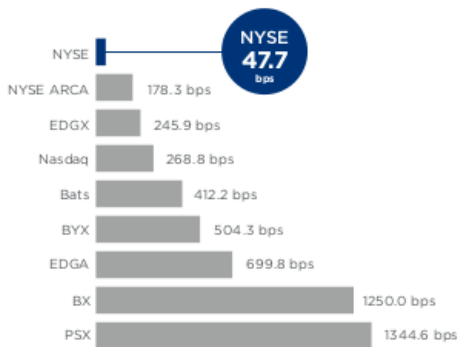
Example, US, Securities And Exchange Commission: Rule – Disclosure of Order Execution and Routing Practices – Better known as Rule 605 Reports.

- ▶ Problem: Exchanges gaming this by not making it particularly easy to access the data
- ▶ and the data they make it easy to find tend to be complementary to that particular market place.

Regulators to the rescue?

Example: pictures from the NYSE's summary of their market quality report, which looks more like pure promotional material for the NYSE.

Narrowest Quoted Spreads



NYSE has the narrowest quoted spreads.

Regulators to the rescue?

Time at Best NYSE

Most Time at Best Prices



NYSE is at the best price (NBBO) 62% more often than any other exchange throughout the day.

Source: NYSE Market Quality Report 2016 (NYSE's summary of the material that

Lessons for investors

The important thing is always to

- ▶ buy the right stocks and
- ▶ sell the wrong stocks.

Lesson from this talk:

- ▶ it matters how you *implement* those buying and selling decisions.

Trading costs — a Drag

Not watching trading costs – like ignoring biofouling for shipping.

Biofouling or biological fouling is the accumulation of microorganisms, plants, algae, or animals on wetted surfaces.

Illustration (magnified) of ships hull:



Biofouling a major problem for shipping

- ▶ Reduce speed:
 - In the day of the sailing ship speeds reduced by a third.
 - Even with today's motorized ships
 - ▶ speeds can be reduced up to 10%.
 - ▶ → increased fuel consumption
- ▶ Unprotected surfaces are gradually destroyed
- ▶ (Biofouling also a large problem in marine farming.)

Lessons for investors

Things to remember

- ▶ Transaction costs may put such a drag on a strategy that it should be reconsidered.
- ▶ High Frequency Trading not necessarily your enemy
- ▶ What are the available trading venues?
- ▶ What is the fee structures in a given venue (e.g. make/take fees)
- ▶ What is the liquidity (availability of quantity) in a given venue.
- ▶ There is a tradeoff pre-trade price information (public venue) and hiding quantities (dark pools).
- ▶ The importance of asking pointed questions to brokers and intermediaries about trade choices.
Why that particular venue/order type/method?

Gazing into the Crystal Ball

What can we expect to happen?

- ▶ We are not going to go away from electronic trading.
- ▶ Expect continued process of
 - ▶ mergers of trade venues
 - ▶ new trade venues
 - ▶ innovation in ways of trading
- ▶ But:
 - ▶ There *are* economics of scale in the trading industry.
 - ▶ At some point we may see concentration of trading in larger venues.
- ▶ Regulation is a driver of change in this industry
 - ▶ Much regulation it is the outcome of political processes.
 - ▶ Have you looked at US/UK/European politics lately?
(The Donald, Brexit, ...)

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