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High-Frequency Trading and Price Discovery

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Overview

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- Technology has been good for markets
  - Is every use of technology good?
  - How do we think about (evaluate) HFT?
  - What are costs/benefits of those closest to the market?

- Analysis of Nasdaq HFT data in terms of price discovery
  - Statistical model of HFT and “information” and “noise” in prices

  - Explore what types of information HFT has:
    - Macro news announcements
    - Market-level (as opposed to individual stocks) results
    - Limit order book imbalances

The old trading floor, NYSE 1873

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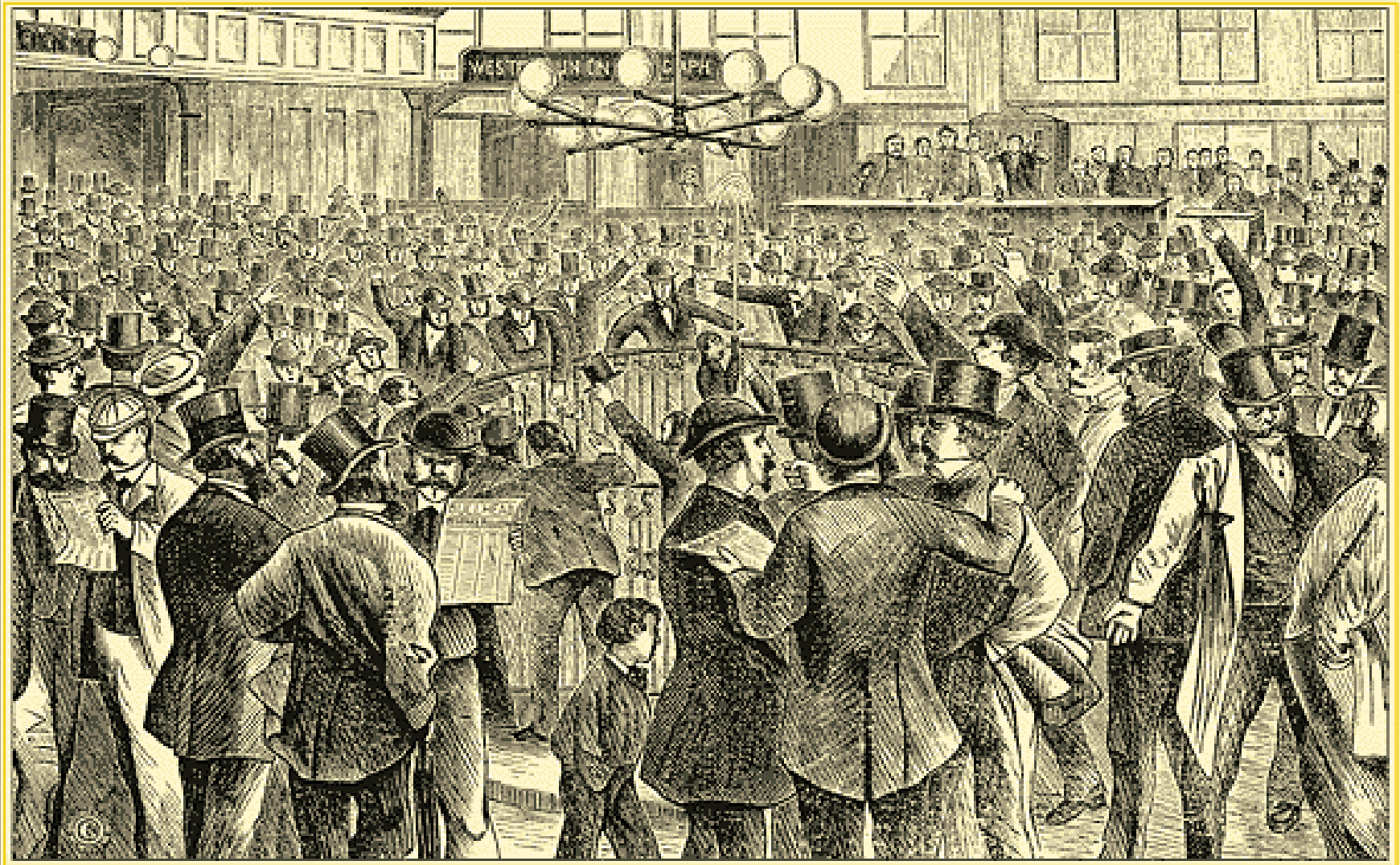

A great day at the New York Stock Exchange, 1878

More recent trading floor

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Current trading floor

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Algorithmic & High-Frequency Trading; AT algos manage trades; HFT is also short holding times

- Is this new trading floor about free entry and competition (with little regulations)?
  How do we think about the colo and market data costs? With fragmentations?

Is the evolution good?
Some News Articles

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REUTERS EDITION: UK

Ultra fast trading needs curbs – global regulators

July 7, 2011 - London

- "...rule changes are need to control risks..."
- "…development have had negative effects…"
- "HFT firms are accused of flooding markets with orders that are cancelled…, leading to volatility"

- "...the stock market is more prone than ever to large intraday moves with little or no fundamental catalyst."
- "locusts … feeding off the equity market."

THE WALL STREET JOURNAL.
WSJ.com

JUNE 19, 2009, 12:29 PM ET

Rise of the (Market) Machines

It's hard to imagine a better illustration (of social uselessness) than high-frequency trading. The stock market is supposed to allocate capital to its most productive uses, for example by helping companies with good ideas raise money. But it's hard to see how traders who place their orders one-thirtieth of a second faster than anyone else do anything to improve that social function.

Paul Krugman August 2, 2009 - New York Times

The New York Times

July 24, 2009

Stock Traders Find Speed Pays, in Milliseconds

- "High-frequency traders generated about $21 billion in profits last year."
- "...use rapid-fire computers to essentially force slower investors to give up profits, then disappear before anyone knows what happened. "

Longer perspective on technological changes affecting liquidity

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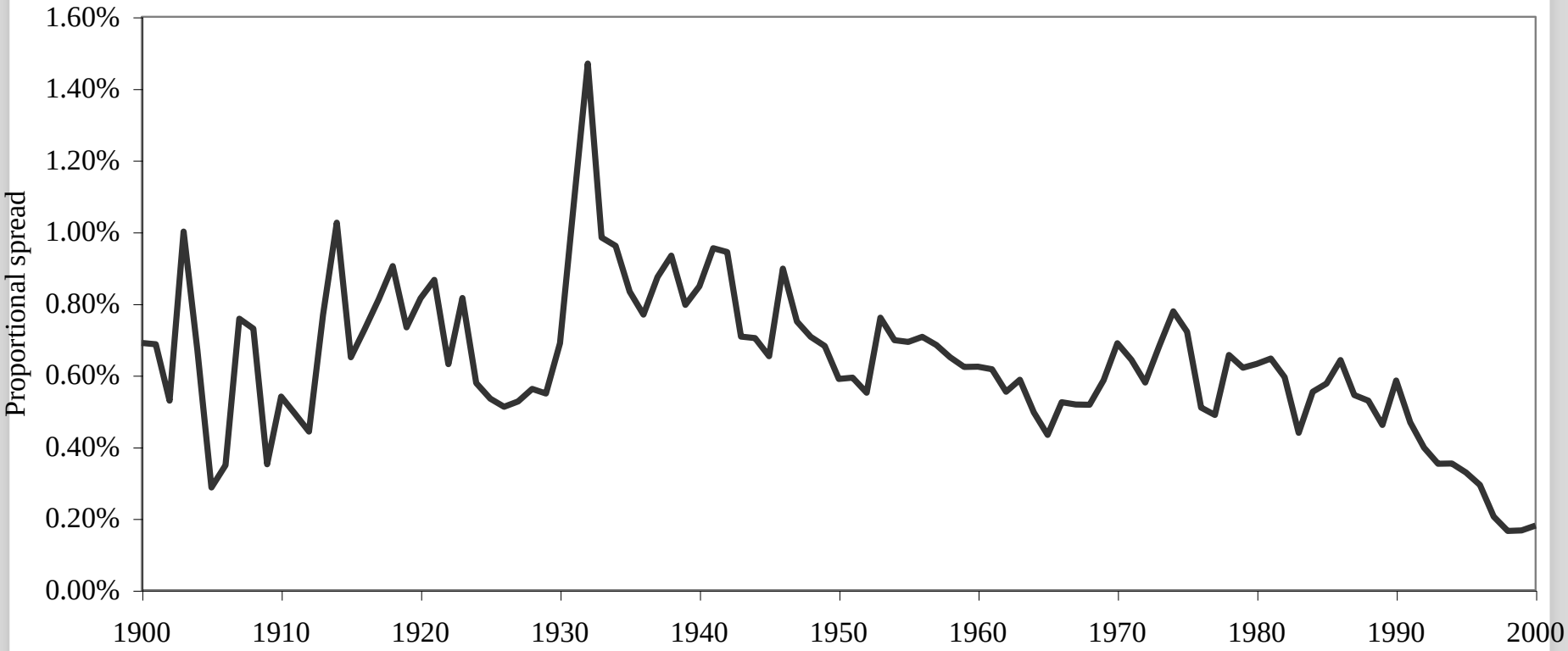
Figure 1. Bid-ask spreads on Dow Jones stocks
(all DJ stocks 1900-1928, DJIA stocks 1929-present)



Technological advances have made the markets better:
Evidence from trends and specific events/introduction

Algorithmic Trading on NYSE

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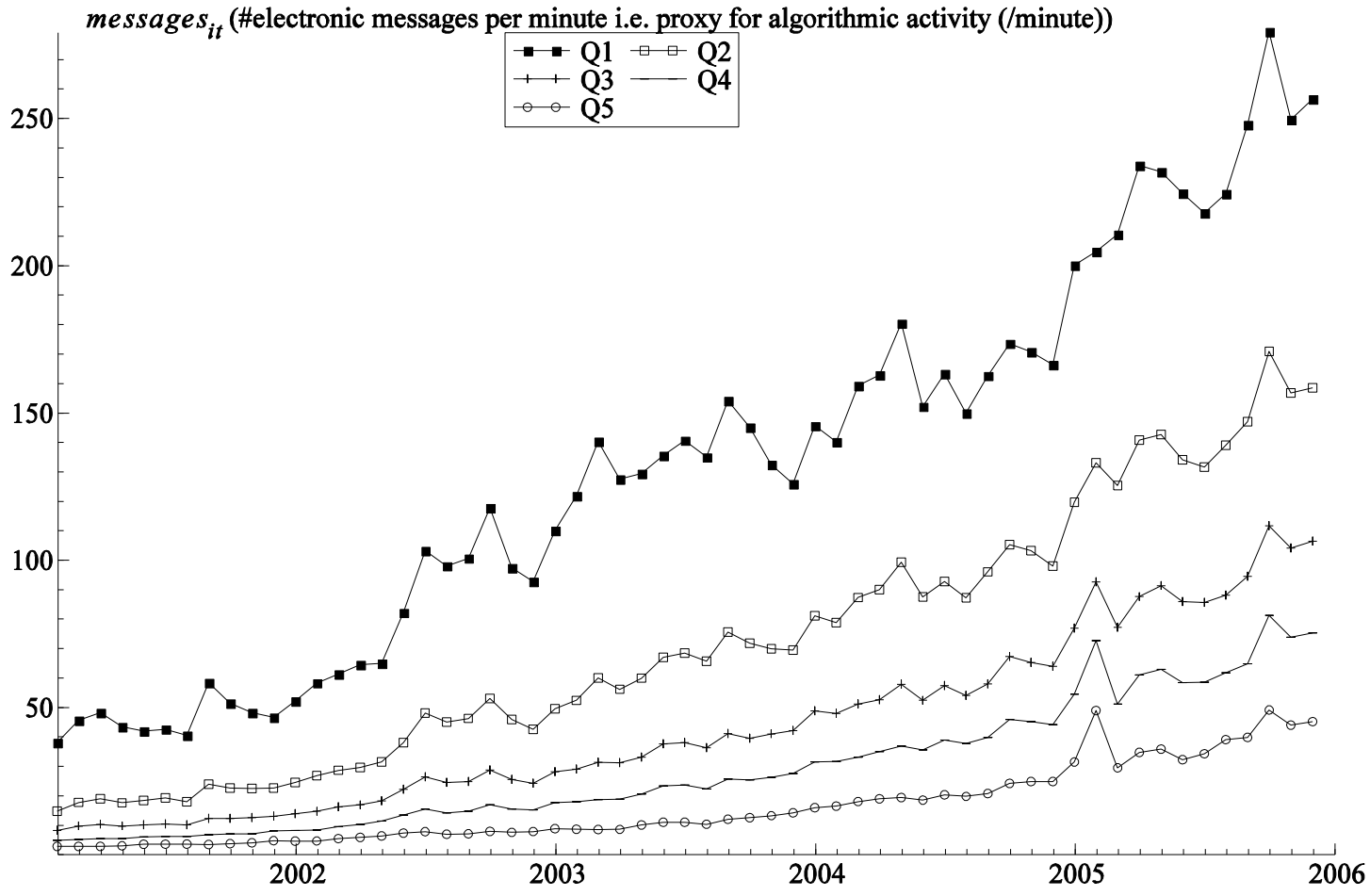

Hendershott et al. 2011

Liquidity (Trading Costs/Spreads) on NYSE

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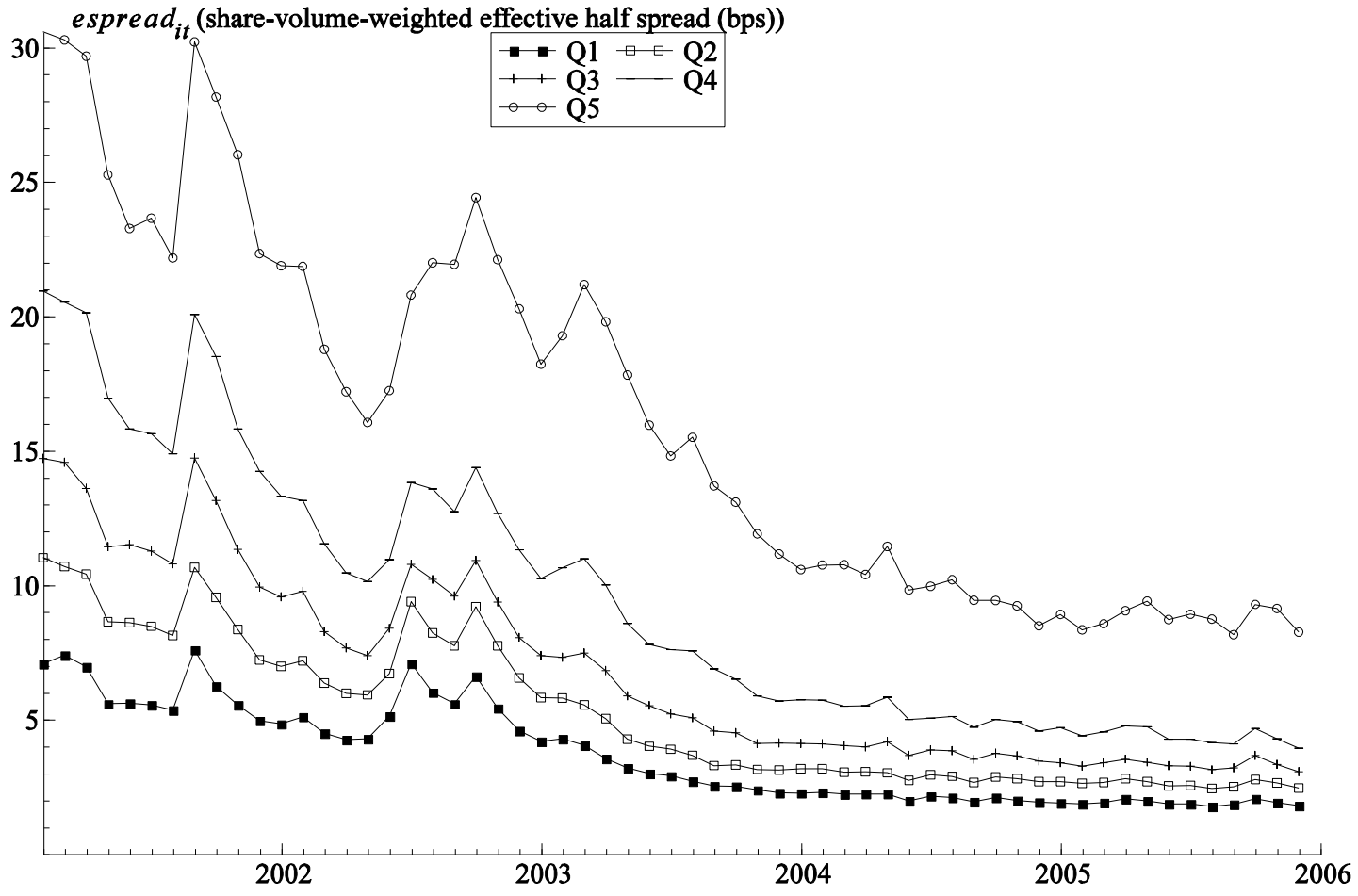

Decline is from lower averse selection (less information in trading) -- Hendershott et al. 2011

How well can we measure liquidity as trade size -> 0? Transitory impact of large orders?

Correlation is not causality: we need a "natural experiment"

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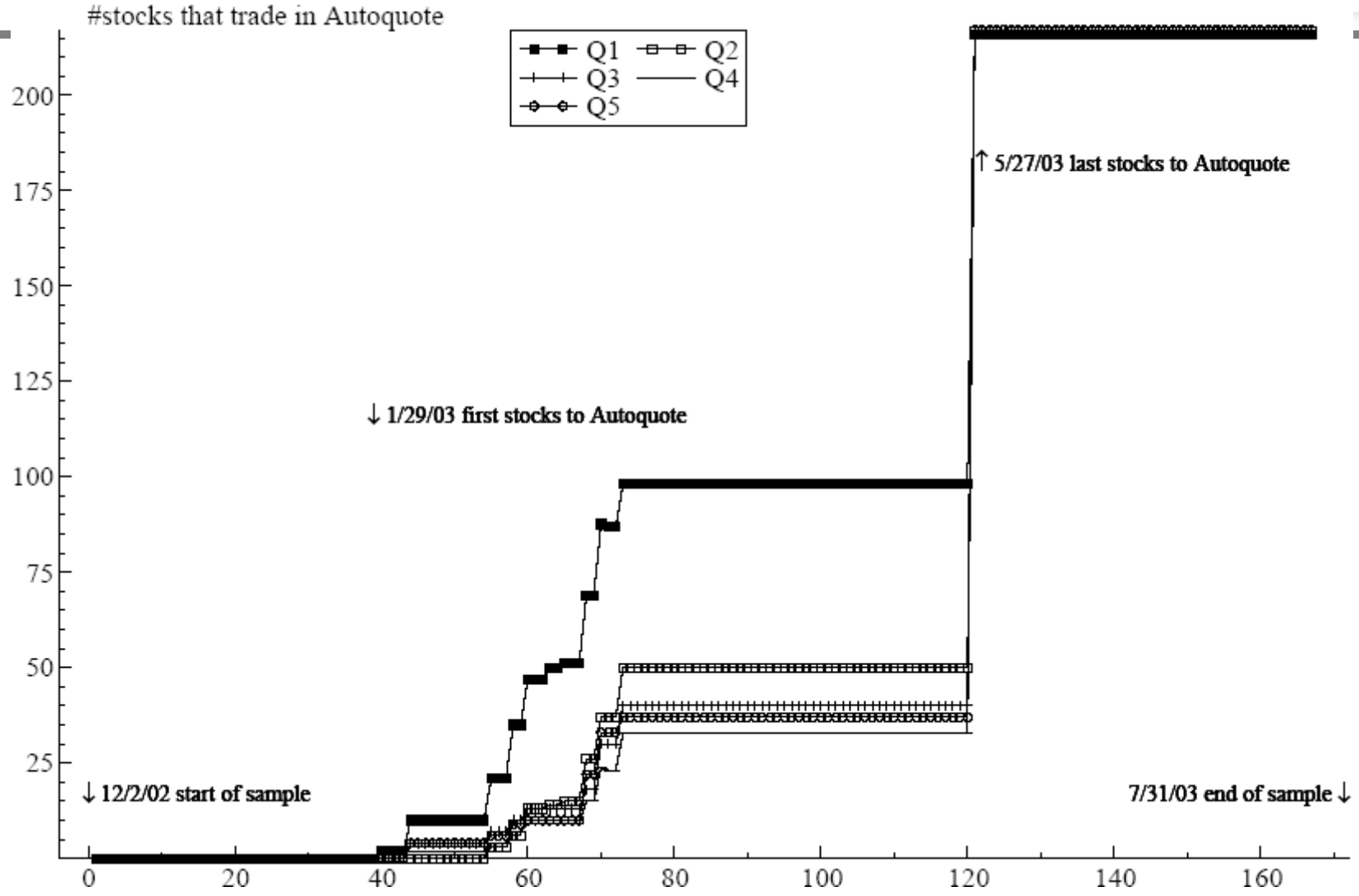
- **Menkveld (2012) for the entry of one HFT on Euronext**

- **"Autoquote" is proposed by the NYSE in 2002:**
  - Specialists had been manually disseminating the inside quote.
  - Too many keystrokes: clerks could not keep up
  - Software would now "autoquote" with any change to book

- **This is an important change for AT:**
  - More immediate feedback about terms of trade
- Algo liquidity suppliers can see if there's an abnormally wide inside quote
- Algo liquidity demanders can access quote more quickly

Autoquote introduction



What is HFT?

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HFT is always AT – but AT is not always HFT
Typical properties of HFT:

– High-speed trading

– Sophisticated computer programs

– Use of co-location services and data feeds

– Short time frames for establishing and liquidating positions, high trading volume and intensity

(SEC, 34-61358, Concept Release on Equity Market Structure)

- **HFT is a mixture of the use of technology and trading strategies (do they differ?)**
- **What is new is direct acces, increased electronic information sources, and more computing**
- **Serious issue as without a common definition we often talk past each other**

HFT Strategies (SEC)

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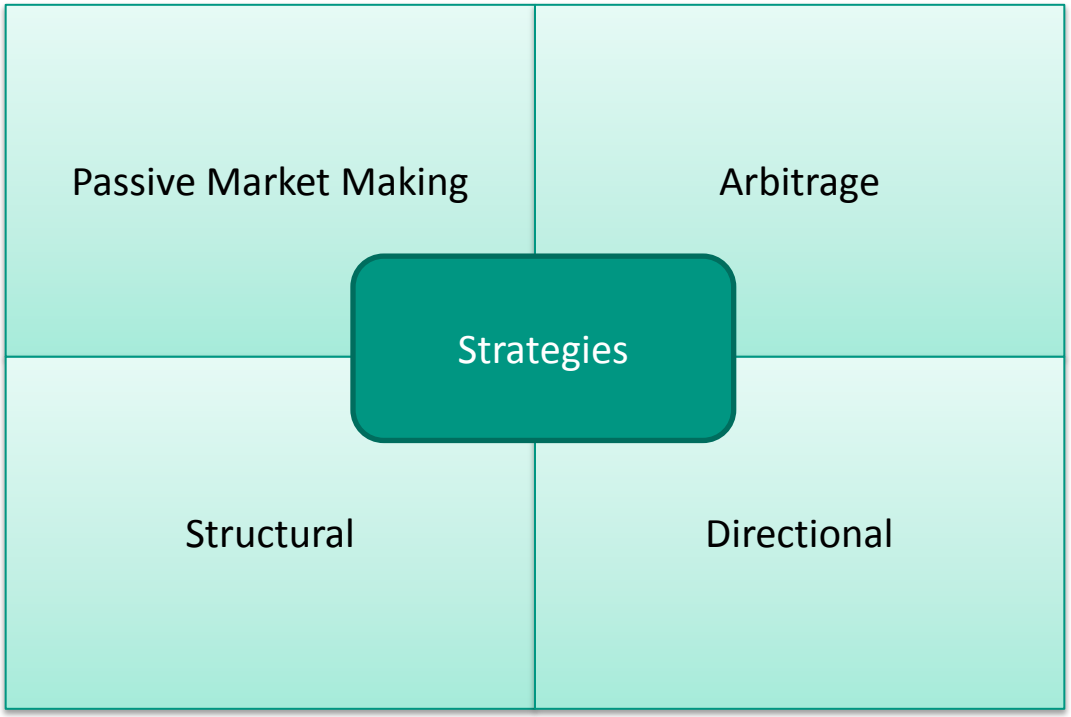
- Make money at the bid-ask spread and liquidity rebates



- Cross asset and cross market arbitrage
- Statistical arbitrage

- Latency Arbitrage
- Flash orders

- News Trading
- Liquidity Detection (order anticipation)
- Momentum trading and ignition

- **Anything new here?**
  - Short-lived strategies with tight risk management
    - Based on public information, technology, and sophisticated tools

  Is the focus the technology, strategies, or interaction?

  Really just various types of short-term speculation?

HFT and Price Discovery (beyond liquidity)

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Google News

United Airlines files for Ch. 11 to cut costs - Bloomberg

Sept. 19th, 2002 — **Sept. 6th, 2008** — **10:58 Sept. 8th, 2008** — **Sept. 8th, 2008**

Price Discovery: Efficient Price & Noise

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- Explicitly model observed prices each minute as efficient price (martingale) and noise (pricing error)

  Trading variables are order flow (buy minus sell volume)

  - Observed price is martingale (efficient price) plus noise:

$$p_{i,t} = m_{i,t} + s_{i,t} \qquad m_{i,t} = m_{i,t-1} + w_{i,t}$$

    - Trading makes cov(s,w) <> 0
  - Standard market microstructure approach: Innovations in martingale are related to innovations in trading:

$$w_{i,t} = \kappa_i^{All} \widehat{HFT}_{i,t}^{All} + \mu_{i,t}$$

  - Transitory component also relates to trading:

$$s_{i,t} = \phi s_{i,t-1} + \psi_i^{All} HFT_{i,t}^{All} + \upsilon_{i,t}$$

  - Identification from Cov(μ, υ)=0 (Hasbrouck (1993) and others)

Nasdaq HFT Data

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- 120 stocks: small, medium, large cap
- Identifies independent HFT firms
  - Via unique "port" which firms use
  - Does not identify large integrated firms, e.g., Goldman Sachs
  - All data is aggregate across all HFT firms

- HFT firms worried about regulatory response
- Data is available via NDA with Nasdaq
- Nasdaq had 20-40% market share
- HFT is 42% of volume in large stock, 12% in small stocks
- Market/limit order volume similar in large, less limit in small

- HFT and non-HFT ***order flows*** for liquidity supply & demand

Nasdaq HFT (SSM) Price Discovery Results

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- Overall HFT trade to make prices more efficient
  - Non-HFT = - HFT, so non-HFT make prices less efficient
- Results remain (and are stronger) on high-volatility days
- HFT market orders (liquidity demand) are responsible for this
  - + correlation with efficient price, - with pricing error/noise
  - Consistent with informed trading, forecasting both parts of returns
- Supply (limit orders) trading coefficients have opposite signs
  - - correlation with efficient price, + with pricing error/noise
  - Market making, profit taking, news trading, manipulation?
- Non-HFT supply/demand have same signs as HFT
  - Overall HFT results are due to higher variance of liquidity demand

Nasdaq HFT Revenue Results

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- Overall HFT have positive revenues
  - Revenues are zero sum, so non-HFT lose
  - HFT revenues and trading are concentrated in large mkt cap stocks
  - Overall HFT: ~$0.43/$10,000 traded, ~$275K/day in sample

    Sample is 4% of stocks, NASDAQ mkt share ~30%, 250 days/year, etc.

- Revenues before fees
  - HFT & non-HFT demand > 0, HFT & non-HFT supply < 0
- Revenues after fees
  - HFT liquidity demand and supply > 0
  - Non-HFT liquidity demand and supply < 0
  - HFT liquidity demanding trades overcome spread and fees
  - HFT supplying trades make money on spread and liquidity rebates
  - Getco's costs were 2/3 of its revenues (~$1B/year) in 2008-9

Interpretation of Statistical Model

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- Is HFT being informed good or bad?
- HFT liquidity demand imposes adverse selection
- But, also trade against noise in prices
- It is possible to do one without the other?
- How important is this information? How long-lived?
- Would it get into price anyway?

- HFT liquidity supply looks a lot like market making (good)
- How could we measure excess intermediation (bad)?

- Next, cross-correlations for individual stocks and market-wide and macro news announcements

Individual Stock Correlations: HFT and Stock Returns (1sec periods)

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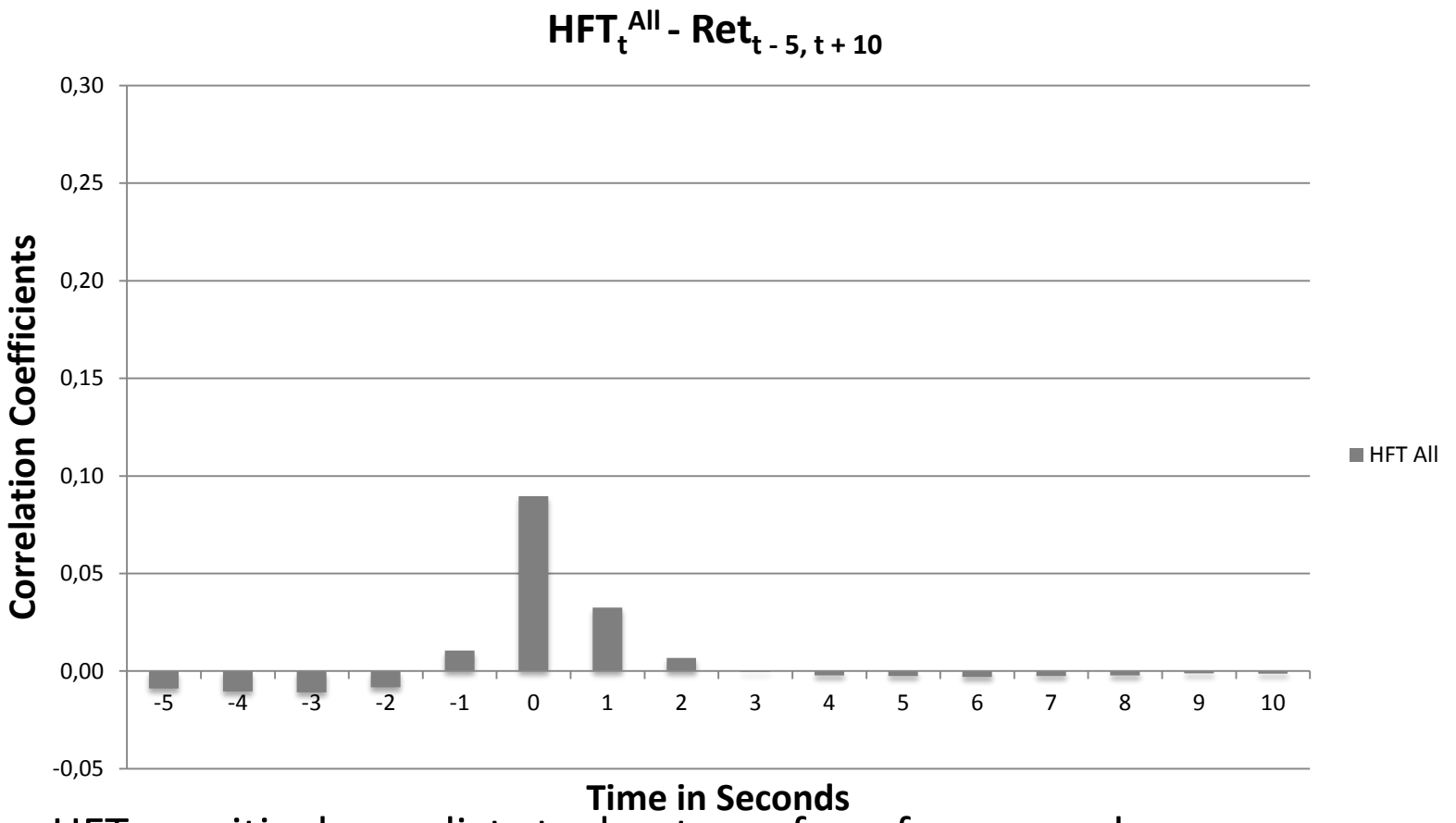

- HFTs positively predict stock returns for a few seconds
- HFTs are contrarian w/ respect to past returns
- As with SSM and profits, these are from liquidity demanding trades

Individual Stock Correlations: HFT, nHFT, and Stock Returns (1sec periods)

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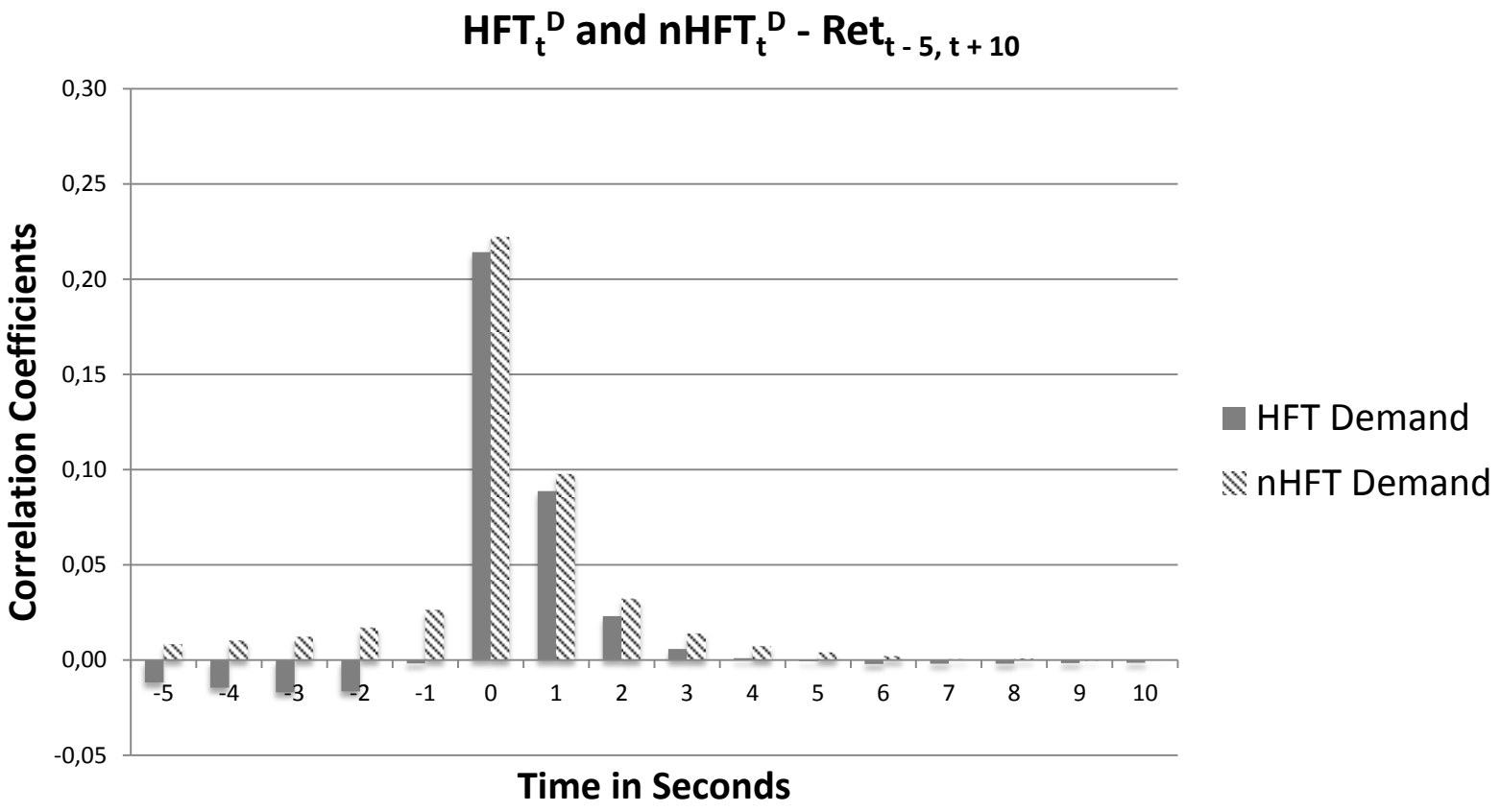
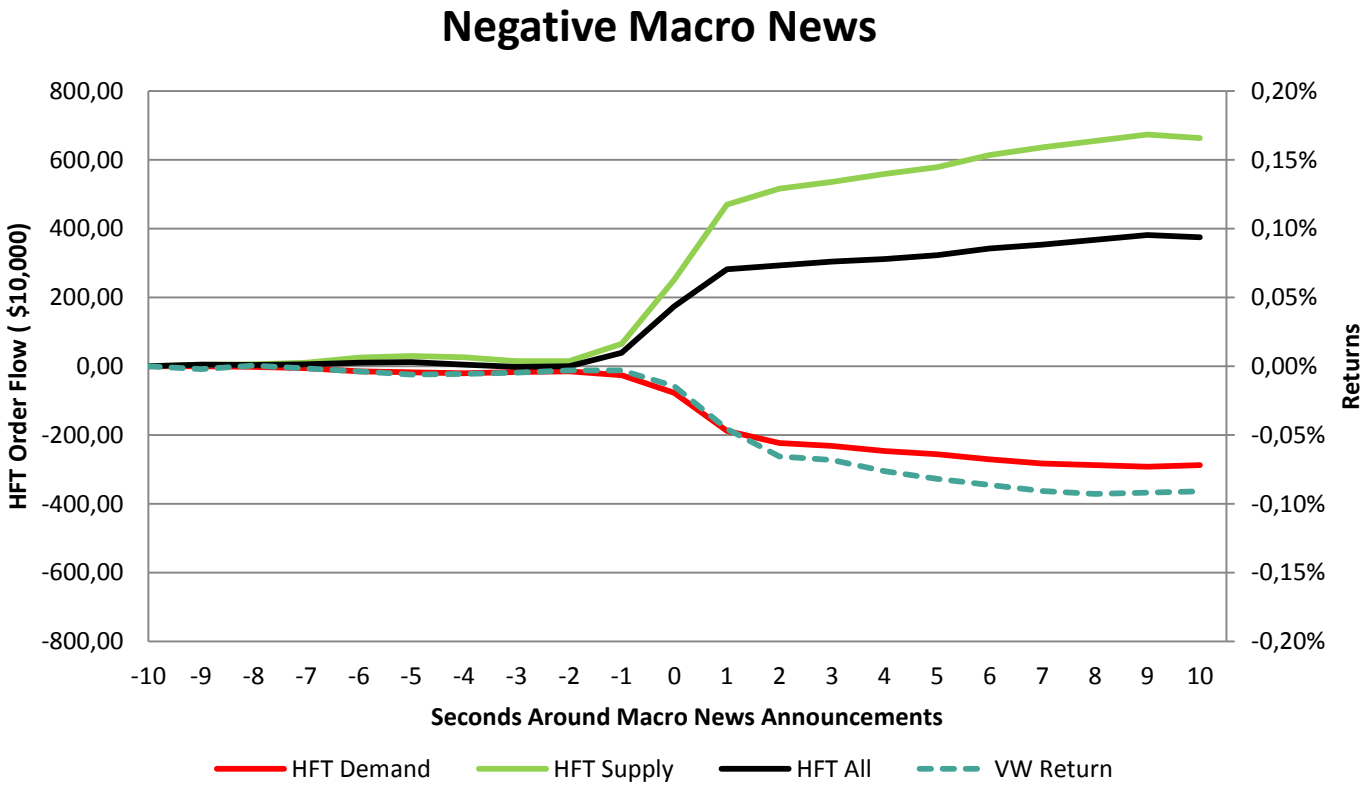


- HFTs and nHFTs similar with subsequent returns, nHFT more long lived?
- Opposite with respect to past returns, HFT contrarian, nHFT momentum
- Evidence of HFTs trading against non-info. pricing errors (overshooting)?

Event Study: Macro Announcements



- Aligning return and HFT times is challenge (Nasdaq BBO for subset)
- HFT Supply is adversely selected; HFT Demand is transmitting info
- Overall Supply dominates; provides liquidity at stressful time
- Regressions show HFT is not associated with noise

Sources of HFT Information

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- HFT trading is ***positively*** correlated with recent market-wide price changes (futures, indices, etc.); and with limit order book imbalances, which predict future price changes
- Other sources of "Public" information in past prices, orders?
  - In other assets (market-wide, announcement results)
  - Large stock leading small stocks
  - Order anticipation (Hirschey (2013))
- HFT Demand predicts returns
  - How to think about short-lived nature of (public) information?
    - Hirsh., Subra, Titman (1994), Foucault, Hombert, and Rosu (2012)
  - Reducing the transitory part is good
  - Trading on (soon to be) public information is not
  - How do we know what information will get into price without HFT?

Where are we on technology adoption/speed?

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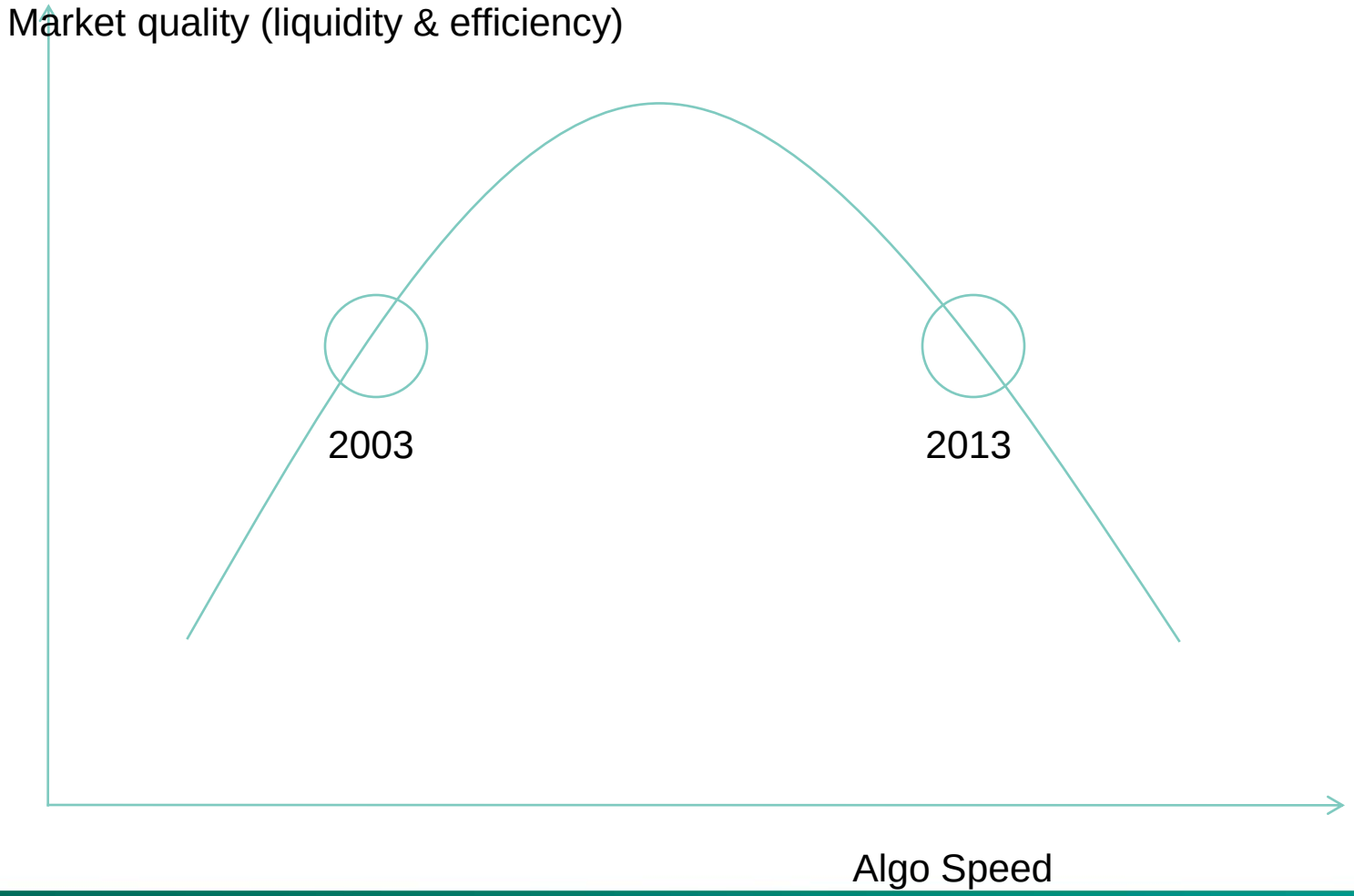
- It's possible we are now simply past the optimum



Where are we now?

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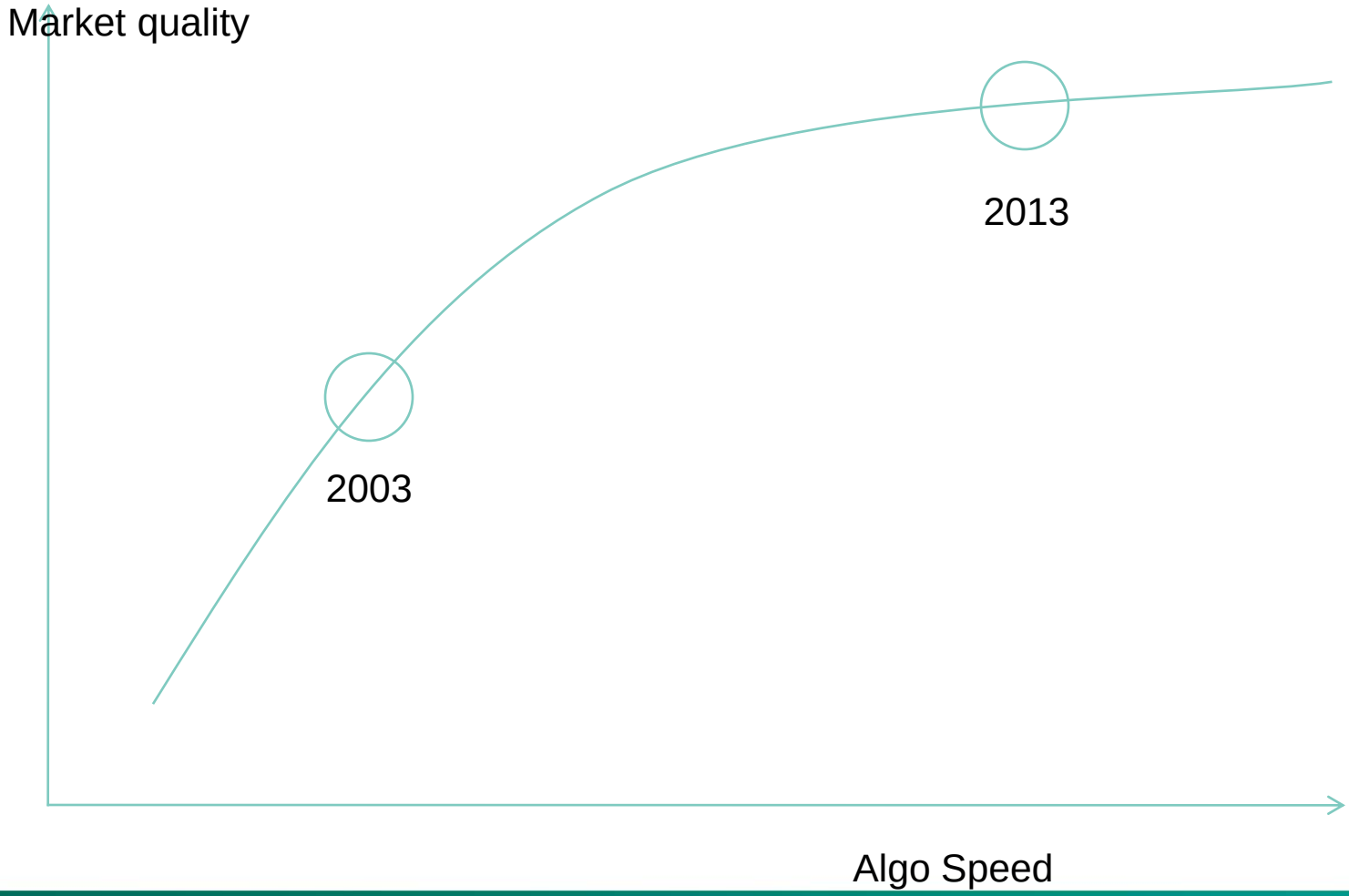
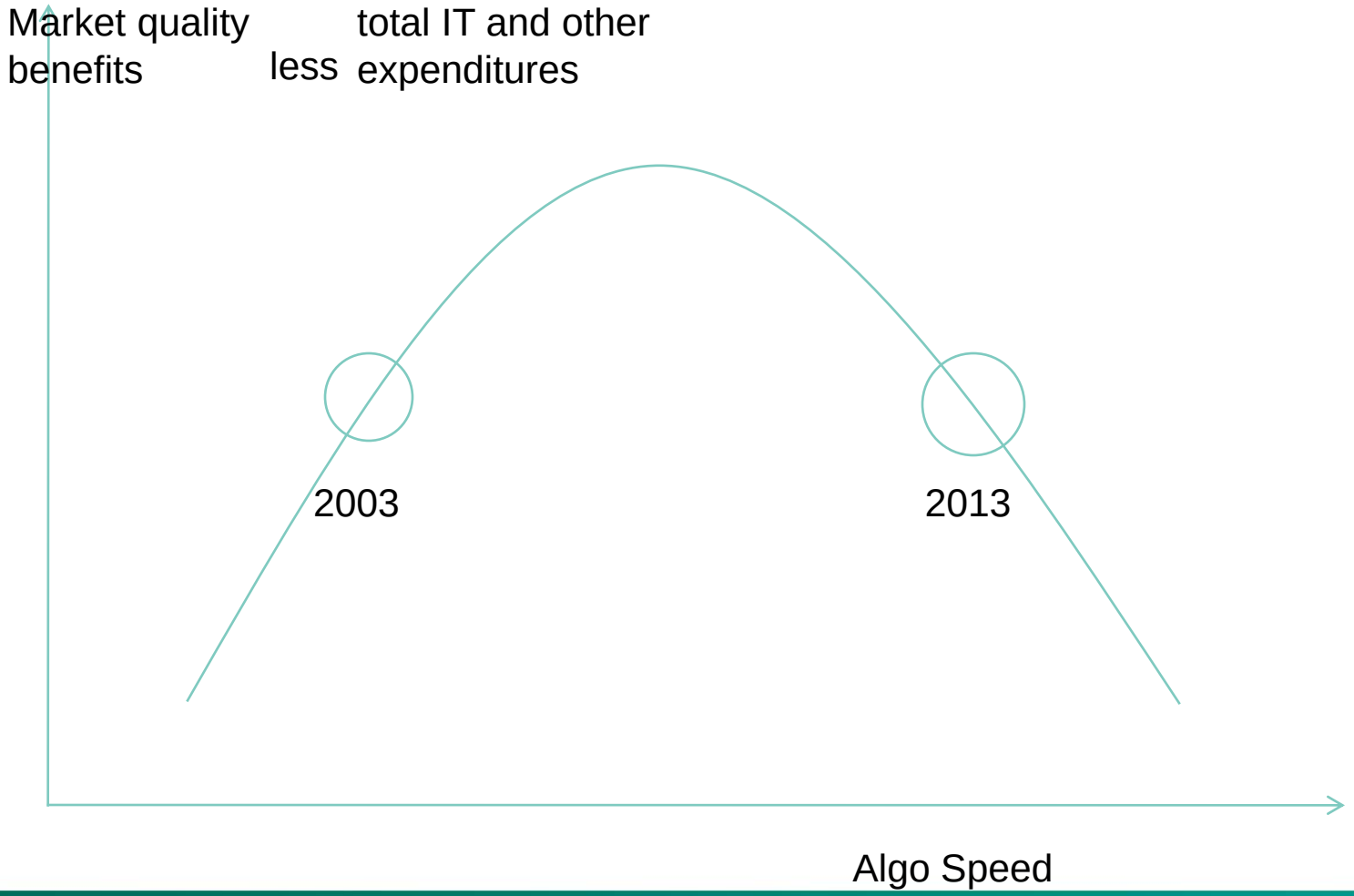
- More likely we've reaped most of the benefits already…



Where are we now?

- …but we could be seeing an unproductive arms race



Where are we now?

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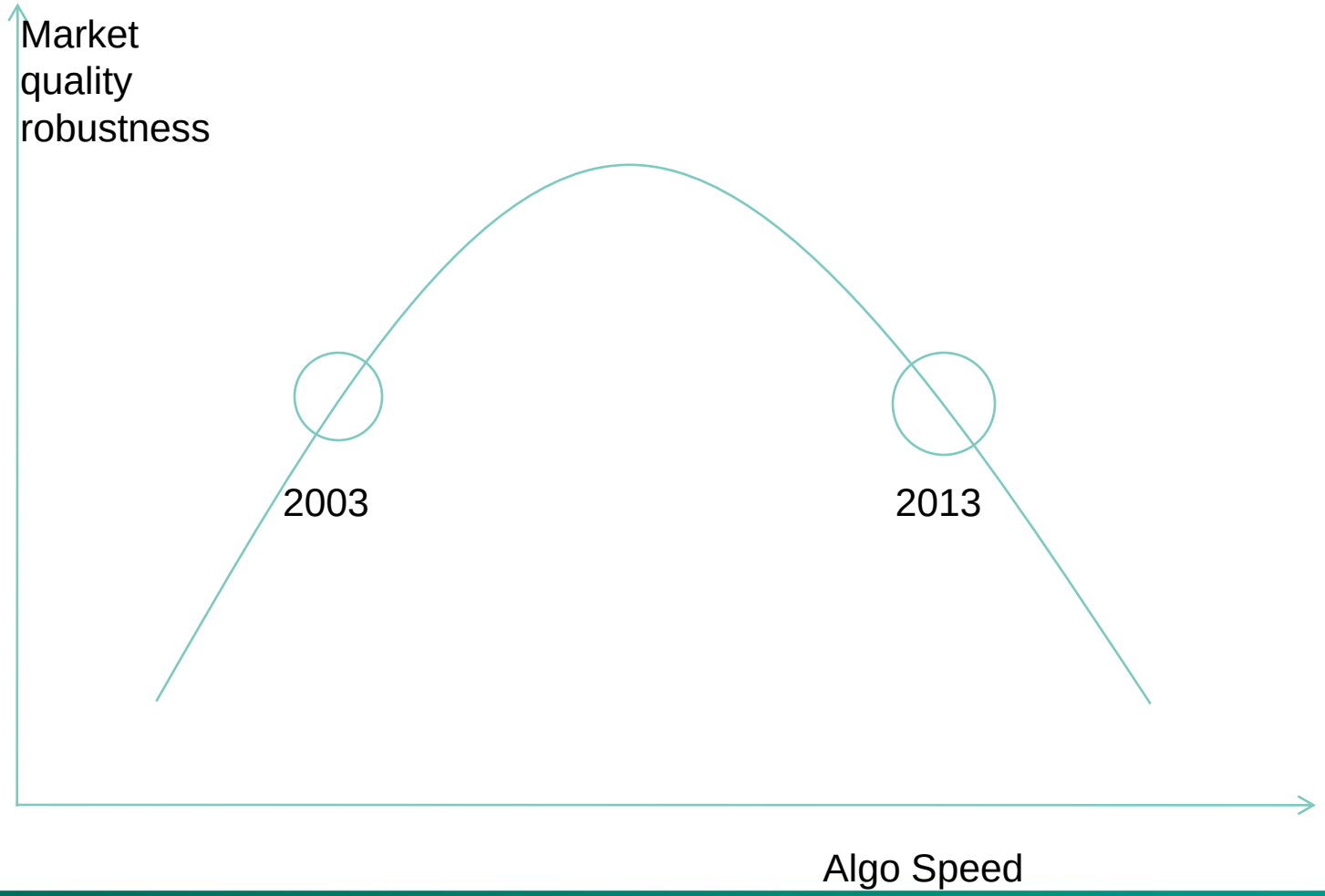
- …or we might have more fragility now



Is HFT good for market stability?
What happened (in US) on May 6, 2010?

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What happened in October 1987?

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What happened in `62?
New York Times headline

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STOCK PRICES DIVE
IN SHARPEST LOSS
SINCE 1929 BREAK

$20,800,000,000 of Values
Erased—1,212 Issues
Drop, Only 74 Rise

May 29, 1962

IBM (prior close, $398.50) fell from $375 to $365 on four downticks in two minutes, and fell to $360 moments later, before bottoming at $355. That was a 5.3% drop in 19 minutes.

Conclusions/Thoughts

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- Technology has improved markets
  - Algorithms: prices more efficient and markets more liquid
- HFT is technology applied to certain strategies
  - Make prices more efficient; true on high-volatility days also
    - What is the benefits of getting info into prices in 10sec?
    - Does this improve financing and investment decision?
  - Should traders closest to market mechanism be most informed?
    - Are long-term investors losing out (zero sum trading)?
    - If so, will HFT become competitive and offer technology services to long-term investors?
    - Will market structures evolve to support LFT (without HFT)?
  - What is the optimal configuration of intermediation sector?
    - Free entry or regulated monopoly/oligopoly?