



# High-Frequency Trading and Price Discovery Mechanisms

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## Ending an era, CME Group to shutter most futures pits

BY TOM POLANSEK  
Wed Feb 4, 2015 10:46pm EST

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Chicago Mercantile Exchange (CME) group's Chairman Emeritus Leo Melamed speaks during an interview with Reuters in Tokyo in this June 30, 2014 file photo.

CREDIT: REUTERS/YUYA SHINO/FILES

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(Reuters) - The world's largest futures market operator will shutter almost all of its open-outcry futures pits by July 2, ringing the closing bell on a once- raucous tradition that has been in decline since the rise of computerized trading.

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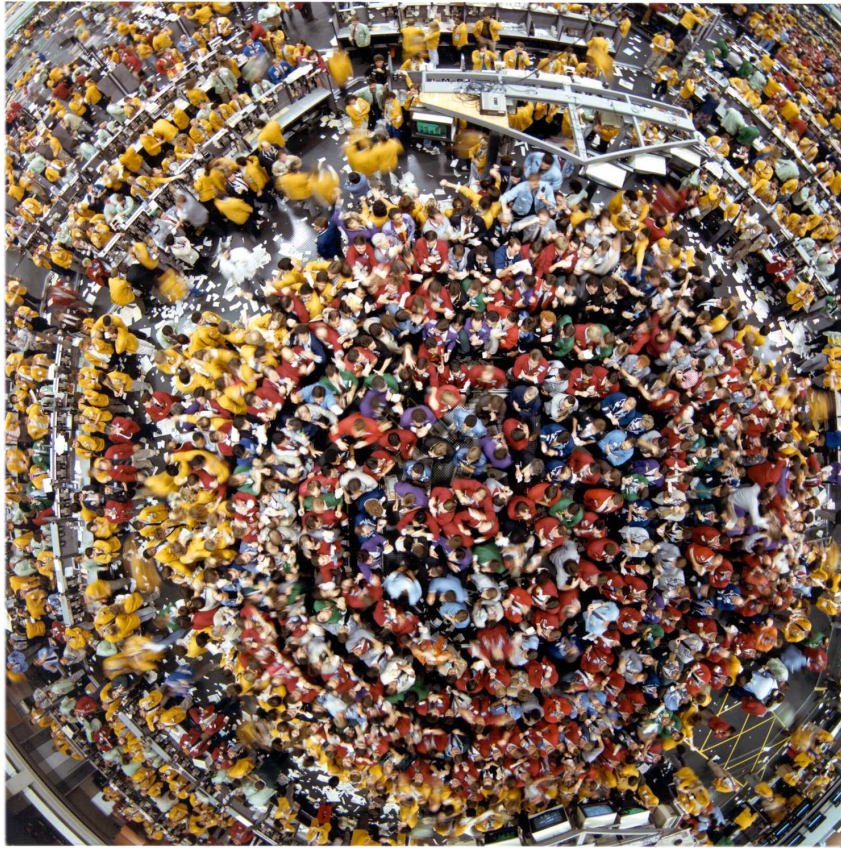
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# Trading: Then and Now



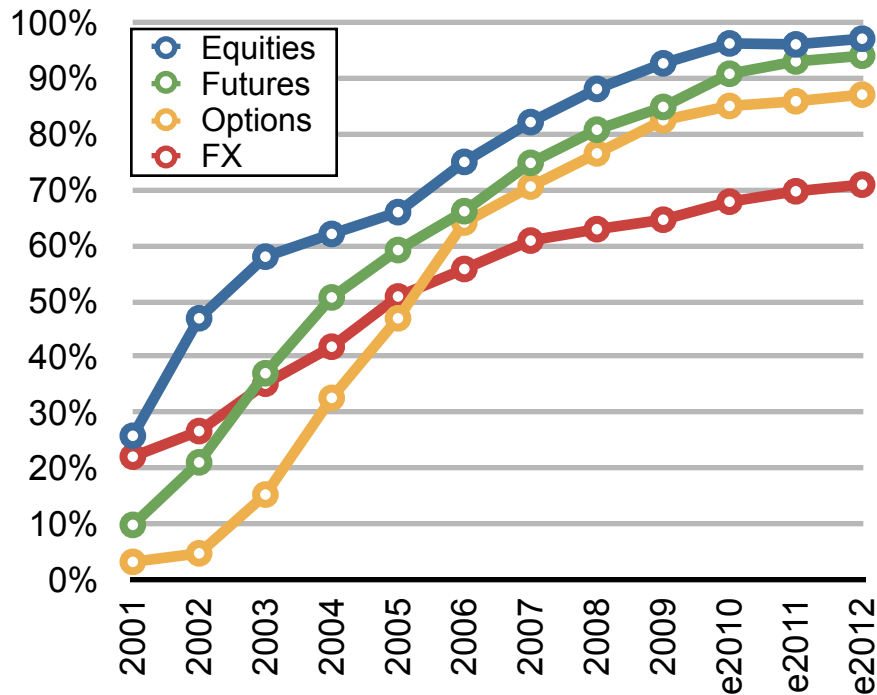
Option trading pit in CME



A look at the hot aisle in one of the data halls inside the NYSE Euronext data center in Mahwah, New Jersey.  
(Photo credit: NYSE Technologies)

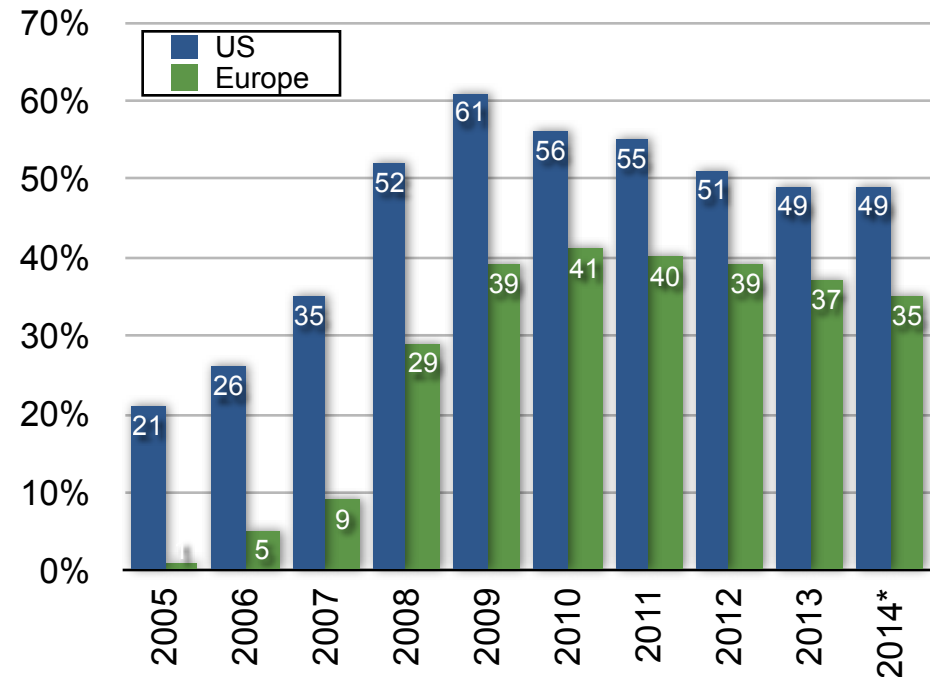
# Algorithmic and High-Frequency Trading

Adoption of electronic trading  
by asset classes



Source: Aite Group (2010)

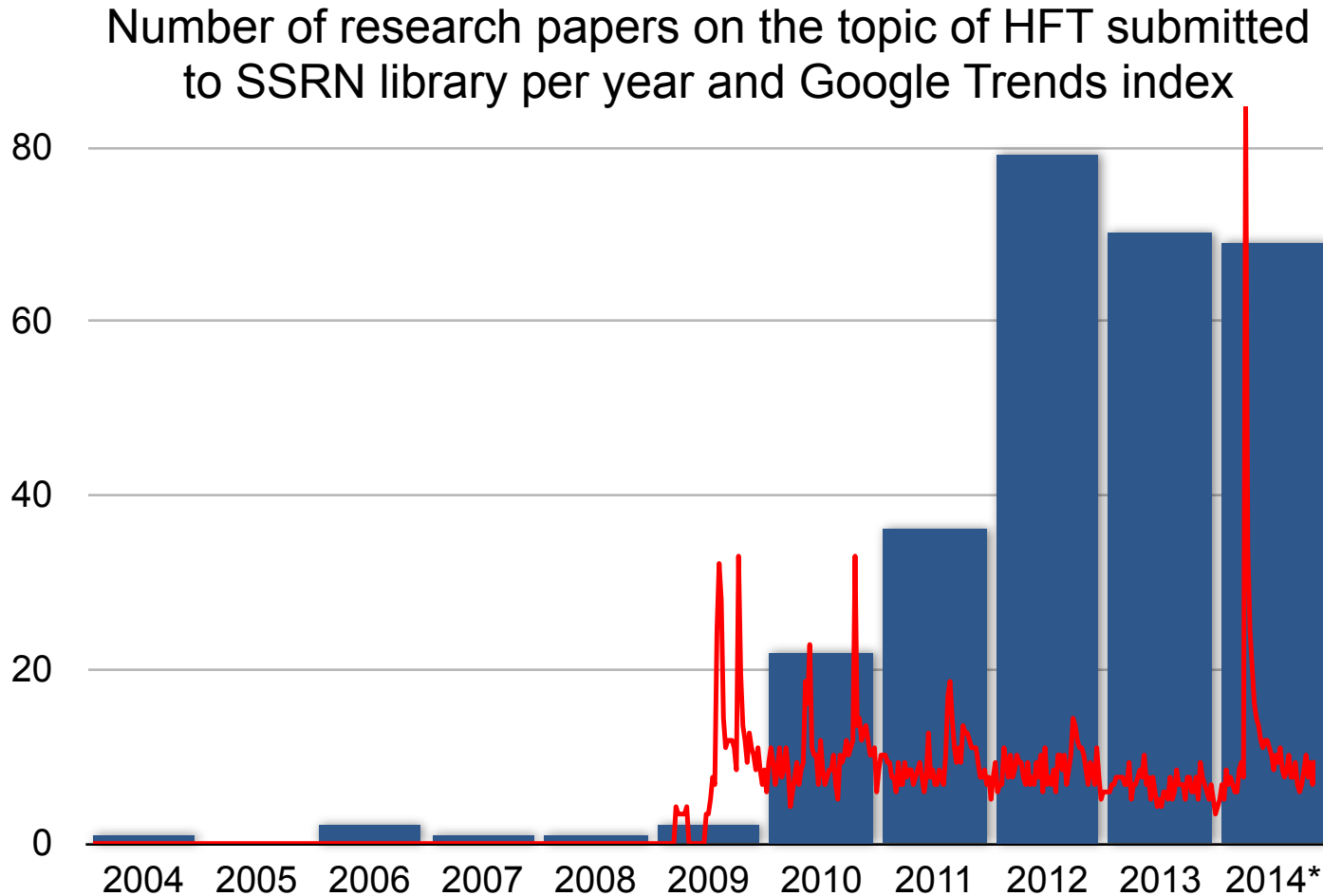
Fraction of HFT activity in equity trading  
volume



Source: TABB Group (2014)



# Academic and media interest to HFT



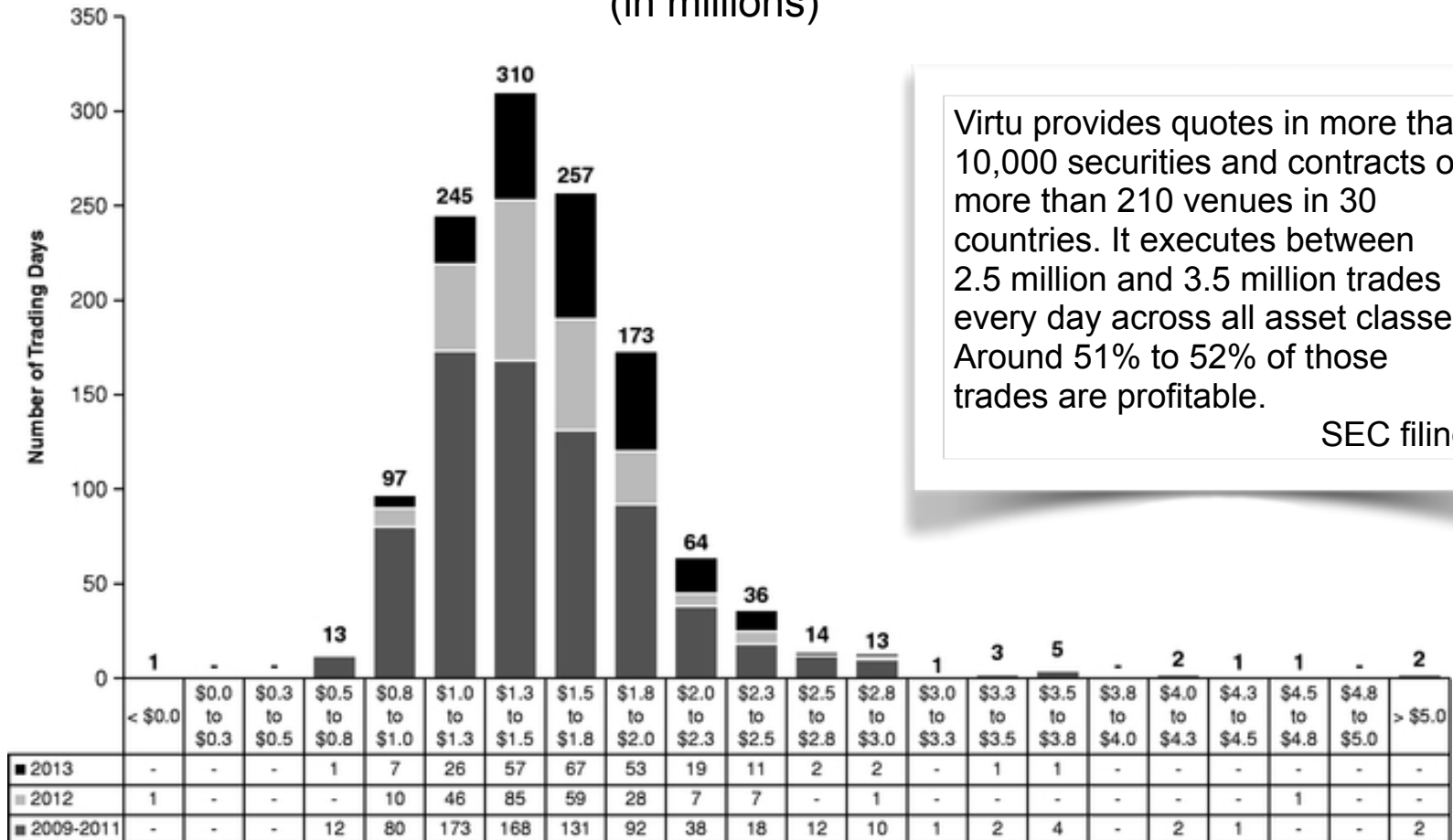
Bar chart is based on the search query on website <http://papers.ssrn.com>. Search was performed by the exact phrase "high frequency trading" in title, abstract or keywords and output was filtered by the "Date posted" field  
Line chart is a weekly Google Trends (<https://www.google.com/trends>) dynamics for the exact phrase "high frequency trading"

# “Scapegoats” of the present market system

- Typical argument in favor of HFT:
  - Increase of liquidity provision
  - Correction of mispricing and market synchronization
- Typical complaints against HFT:
  - “Front-running” of lower-frequency traders
  - Disruptive trading
  - Increase of systematic risk
  - “Socially wasteful arm race”
- In recent years HFT was blamed for many disruptive events:
  - “Flash-crash” of May 6, 2010 and smaller “flash-crashes” of consecutive years
  - Halt of BATS during IPO of its own stocks (March 23, 2012)
  - Technical glitches during IPO of Facebook (May 18, 2012)
  - Collapse of Knight-Capital (August 1, 2012)
  - A Twitter hoax wipes \$200 B of value from US stock market (April 23, 2013)
  - Goldman Sachs erroneous trades in equity options (August 20, 2013)
  - Traders in Chicago received Fed announcement before most others (Sept. 18, 2013)
  - etc.

# Profit distribution (Virtu Financial, Inc)

Daily Adjusted Net Trading Income Distribution  
(in millions)



Source: SEC, "Virtu Financial, Inc. S-1"



# Recent “flash-crash” attributed to HFT

## Flash Boys Raise Volatility in Wild New Treasury Market

By Susanne Walker and Lisa Abramowicz | Nov 18, 2014 1:45 AM GMT+0100 | [20 Comments](#) [Email](#) [Print](#)

In a flash, the bond market went wild.

What began on Oct. 15 as another day in the U.S. Treasury market suddenly turned into the biggest yield **fluctuations** in a quarter century, leaving investors worrying there will be turbulence ahead.



Photographer: Getty Images

The episode exposed a collision of forces -- the rise of high-frequency trading and the decline of Wall Street dealers -- that are reshaping the world's biggest and most important bond market. Money managers say the \$12.4 trillion **Treasury market** is becoming less liquid, meaning securities can no longer be traded as quickly and easily as they used to be, thanks in part to the Federal Reserve's bond-buying program.

“The way the market is set up right now, we'll see instances like we did on that day,” said Michael Lorizio, senior trader at Boston-based Manulife Asset Management US LLC, which oversees \$281 billion. “There's going to be a learning curve as to how to handle that.”

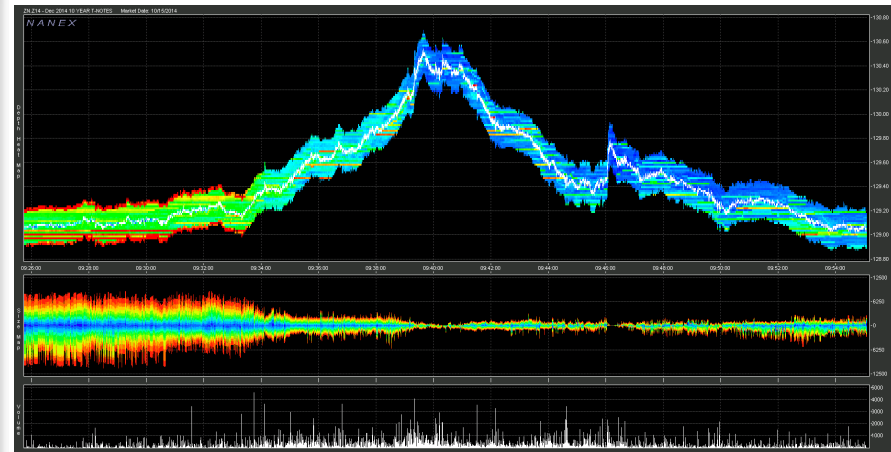
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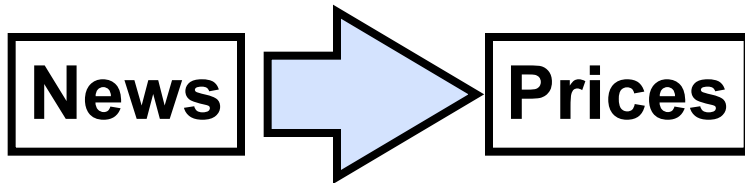
Source: Nanex (October 15, 2014)

After the Treasury market opened, the yield on the 10-year Treasury, which moves in the opposite direction of its price, plunged far below the 2.2 percent that it had closed at the day before. By 9:36 a.m. on Wednesday, it hit 1.9 percent. Then it snapped right back, and within 15 minutes, was again trading above 2 percent.

NY Times (October 19, 2014)

Source: Bloomberg Newsweek (November 18, 2014)

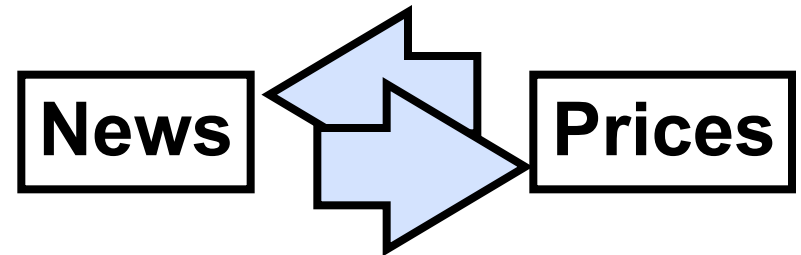
# Price discovery



## Efficient Markets (exogenous dynamics)

**Prices are just reflecting news:** the market fully and instantaneously absorbs the flow of information and faithfully reflects it in asset prices.

In particular, financial crashes are the signature of exogenous negative news of large impact.



## “Reflexivity” of markets (endogenous dynamics)

Markets are subjected to internal **feedback loops** (e.g. created by collective behavior such as herding or informational cascades).

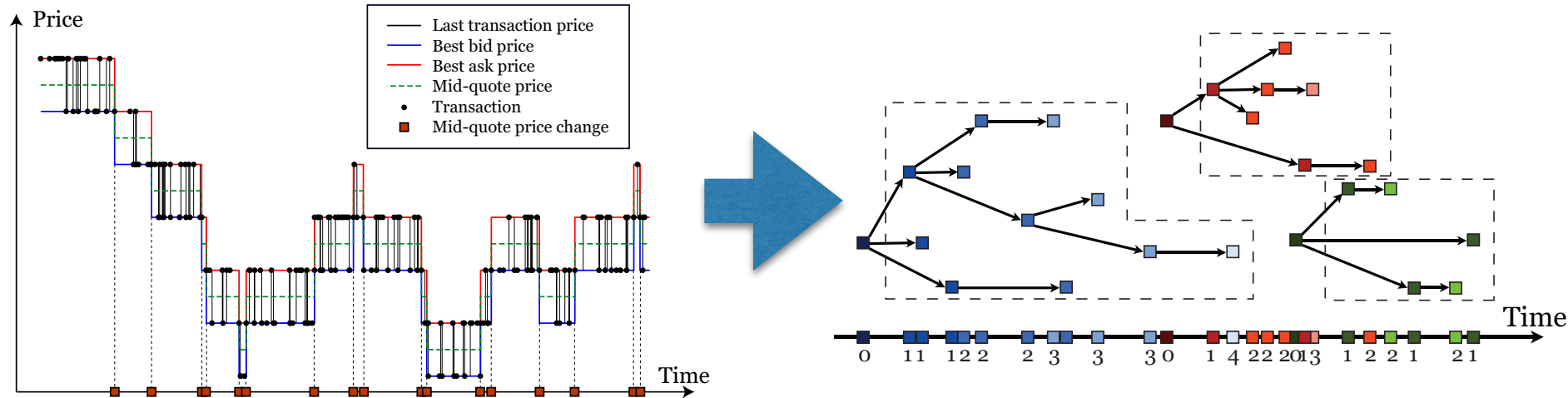
Prices **do influence** the fundamentals and this newly-influenced set of fundamentals then proceed to change expectations, thus influencing prices.

# Sources of endogeneity in financial markets

- **Imperfection** and **cognitive biases** of trading agents;
- Imitation and informational cascades leading to **herding**;
- **Hedging** strategies (also cross-excite markets);
- Replication of index with ETFs and pricing of **structured products** (also contribute to cross-excitation between markets)
- **Model-induced** feedback loops (e.g. BS in 1987, CDO in 2008);
- **Mark-to-market** accounting rules;
- Margin/leverage trading and **margin-calls**;
- Methods of **optimal portfolio execution** and **order splitting**;
- Speculation, based on technical analysis, including **algorithmic trading**;
- **High frequency trading (HFT)** as a subset of algorithmic trading;
- **Stop-loss orders** and etc.



# Quantification of the degree of endogeneity



**Degree of endogeneity** could be quantified via the  $L_1$  norm of the kernel function within the framework of self-excited Hawkes processes:

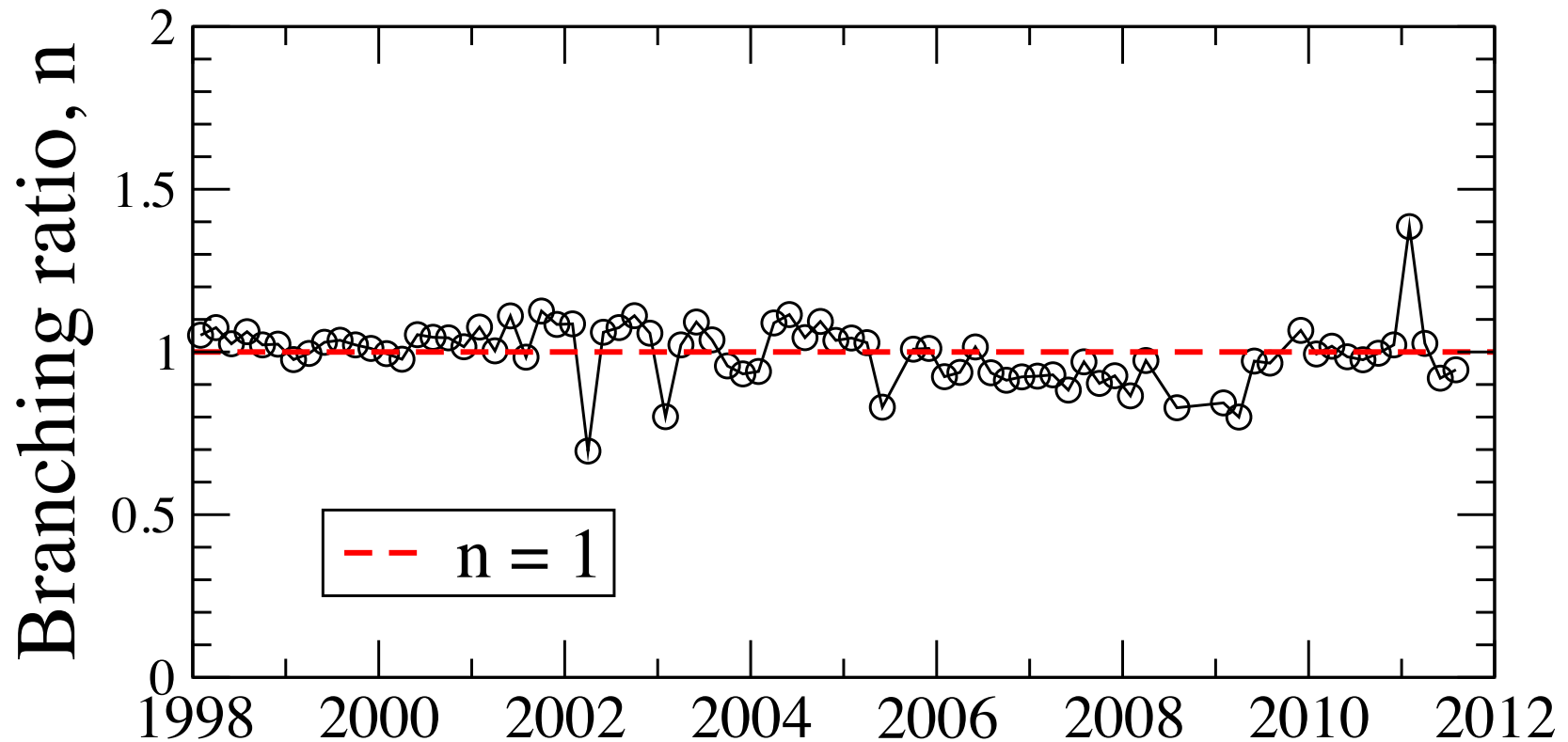
$$\lambda(t|\mathcal{H}_{t-}) = \mu + \sum_{t_i < t} \varphi(t - t_i)$$

$L_1$  norm not only defines stationarity and stability condition of the system, but also in time-homogeneous stationary regime **is equal to the fraction of endogenously generated events among the whole population.**

- Filimonov V., Sornette D. (2012) Physical Review E 85(5), 056108
- Filimonov V., Bicchetti D., Maystre N., Sornette D. (2014) J. of Int. Money and Finance, 42, 174-192
- Filimonov V., Sornette D. (2014) Swiss Finance Institute Research Paper No. 13-60. arXiv:1308.6756

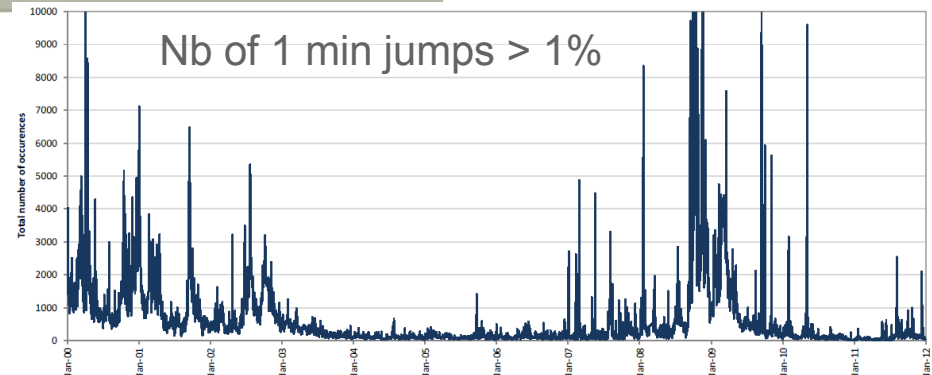
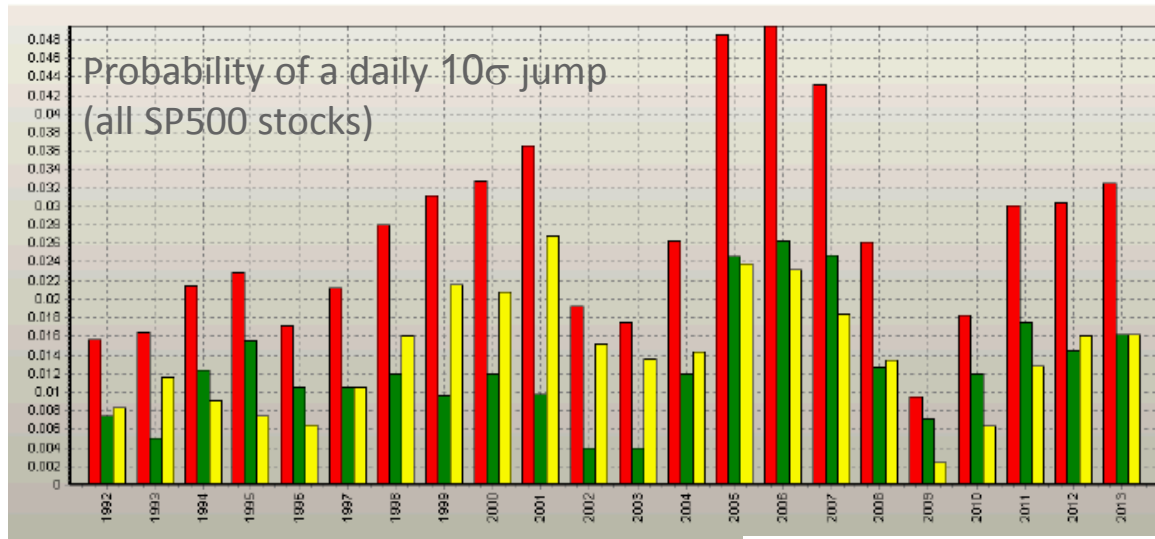
# Long-term endogeneity

Long-term endogeneity (that account for most of reflexivity mechanisms) has not changed in recent time, indicating critical or near-critical state of the markets.



# Jump statistics

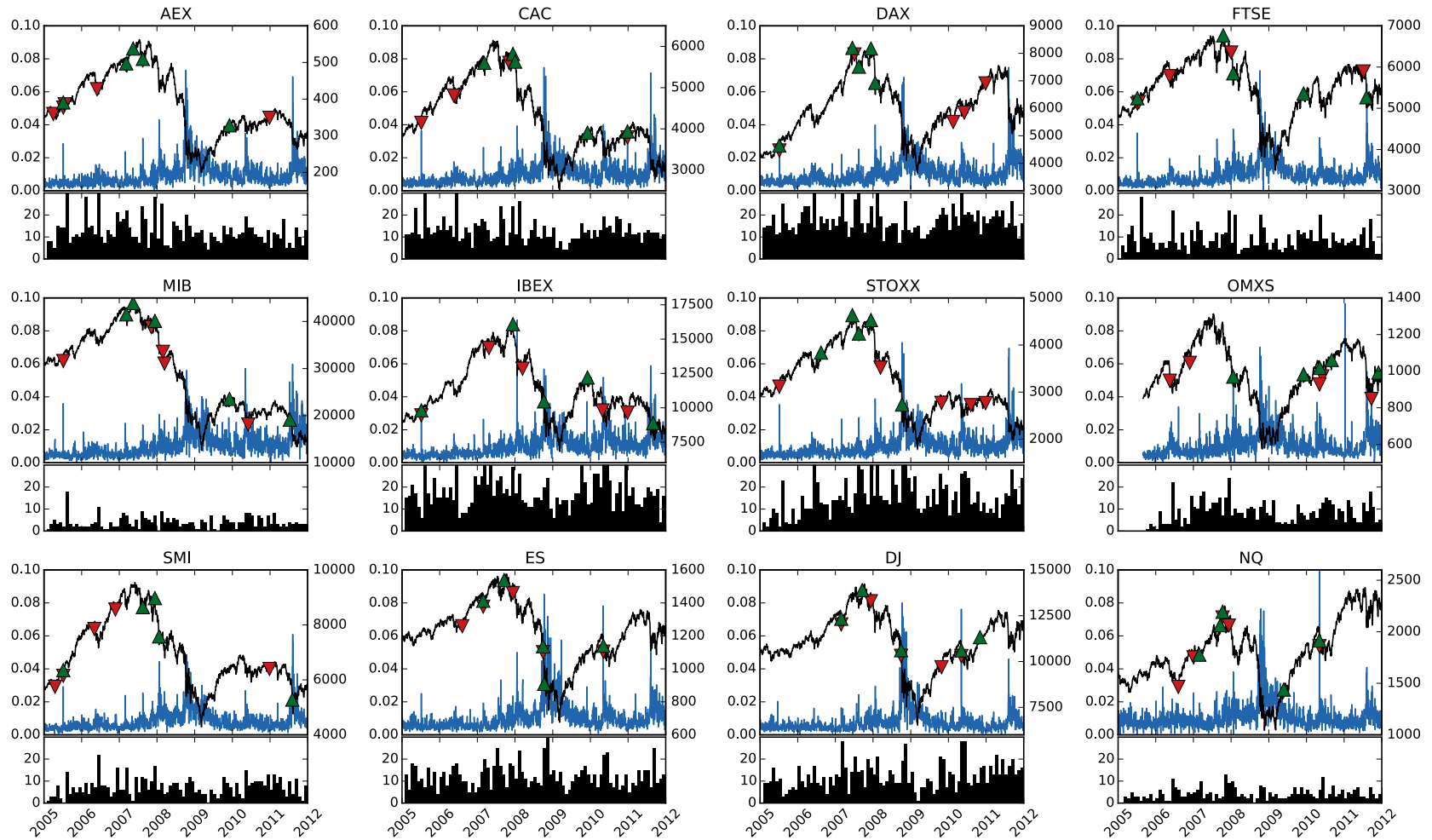
The tail of the distribution of jump sizes is stable ( $\sim 1/x^3$ ), but the frequency of jumps scales with volatility as  $\sigma^3$ .



Source: J.-P. (2013) "Liquidity, market impact, HFT:  
The complex ecology of financial markets"

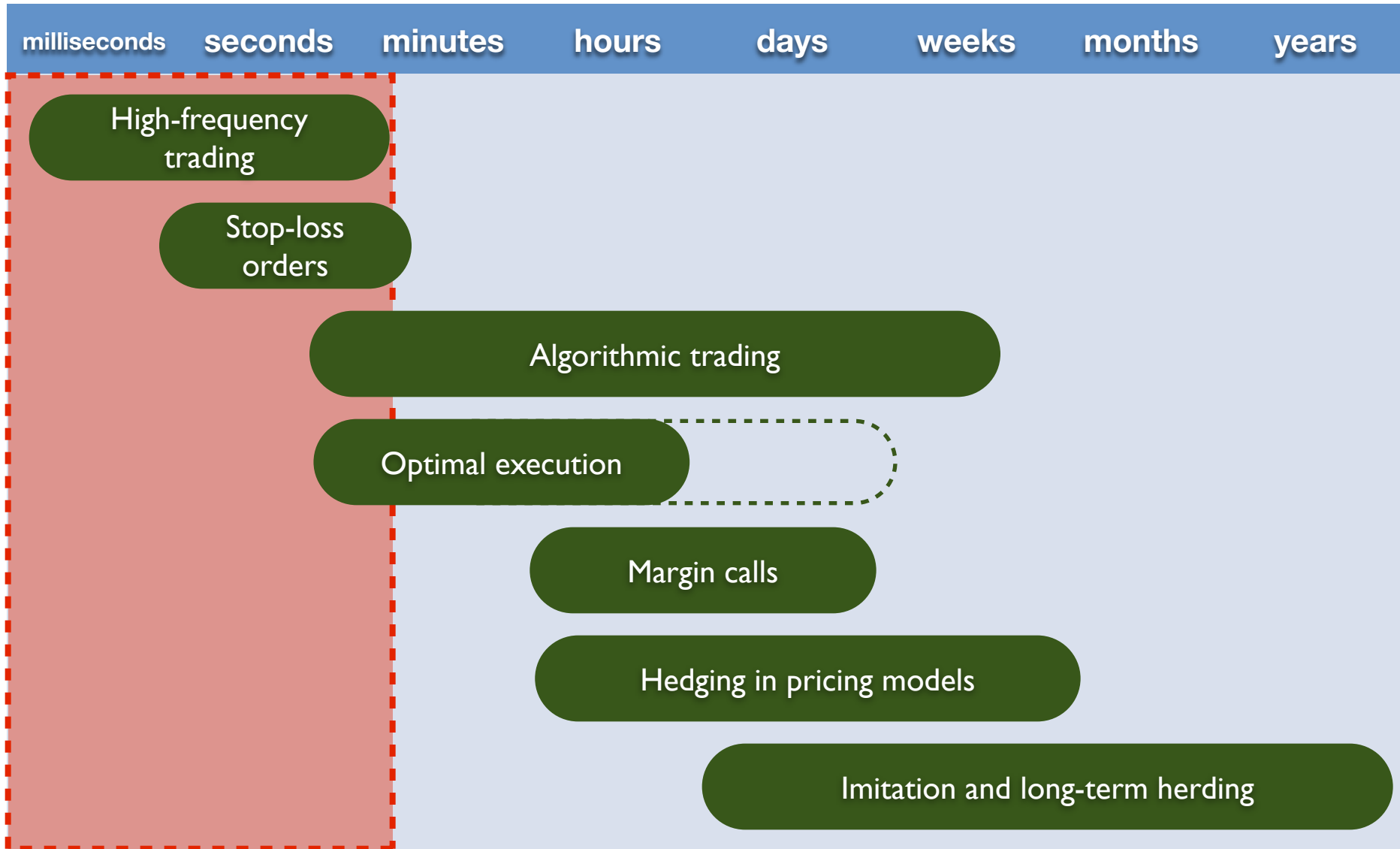


# Susceptibility at a coarse-grained scale



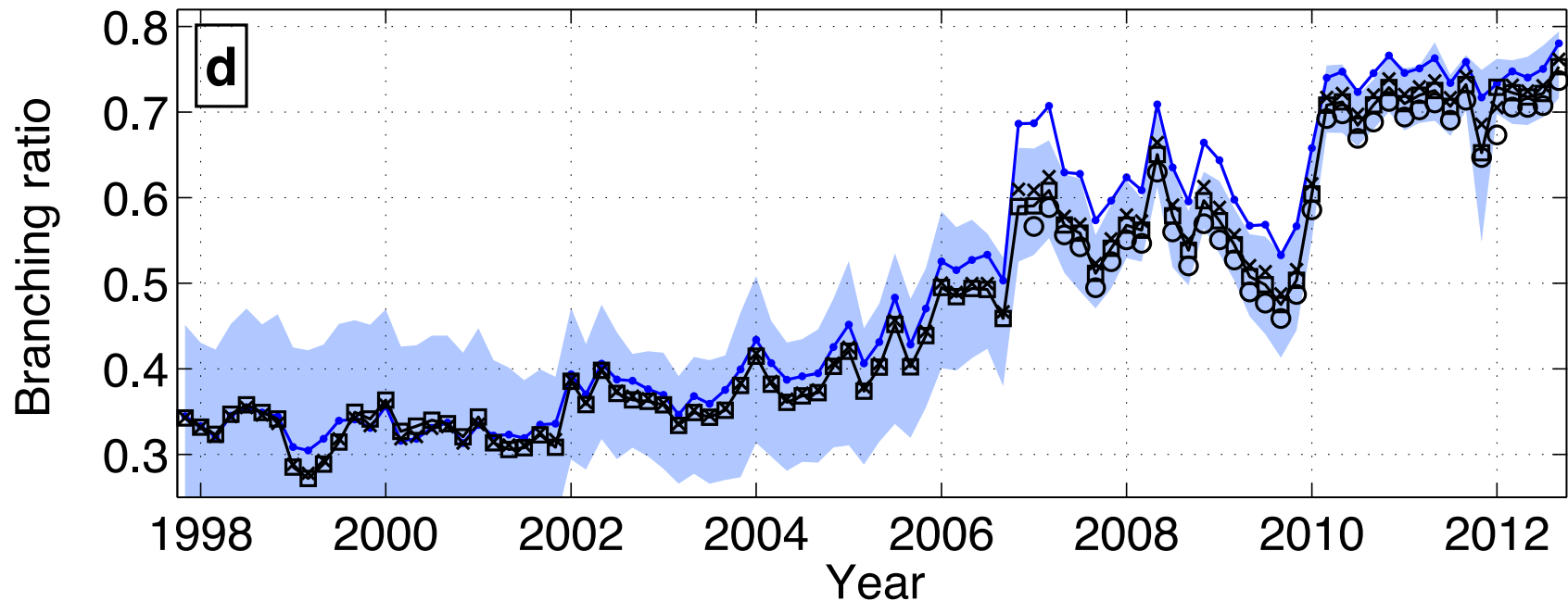
Dynamics of number of extreme intraday drawdowns (drawdowns with duration  $>1$ min and the size at the power-law tail of the distribution) per day for futures on major world's indices

# Mechanisms of self-reflexivity



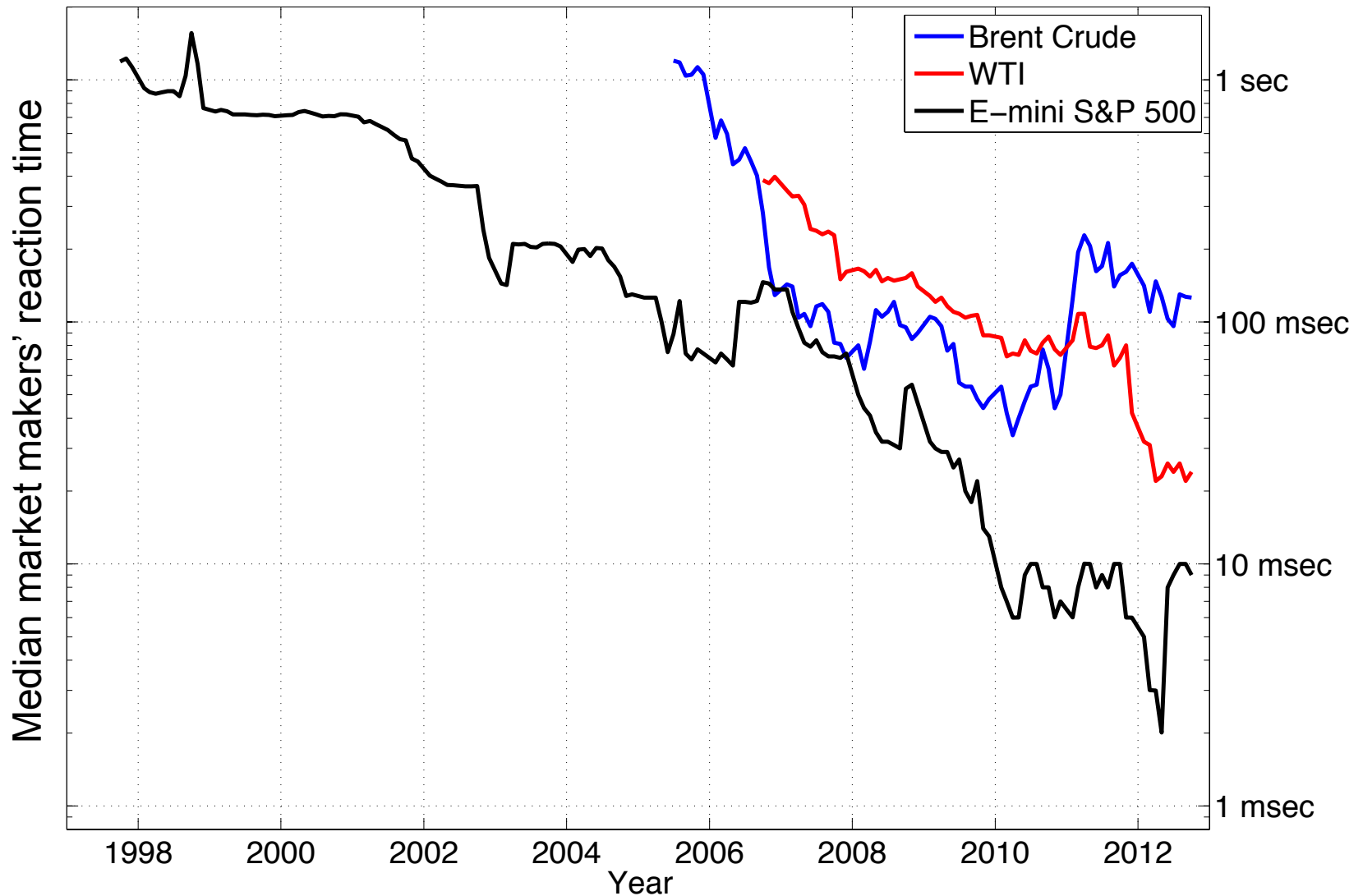
# Short-term endogeneity (E-Mini S&P 500)

Short-term endogeneity (that account mostly for fast algorithmic and high-frequency trading) has been constantly increasing since 2006 and nowadays indicate ~70% of all price movement being triggered by fast feedback mechanisms. In contrast to volume of HFT it does not decrease after 2010.

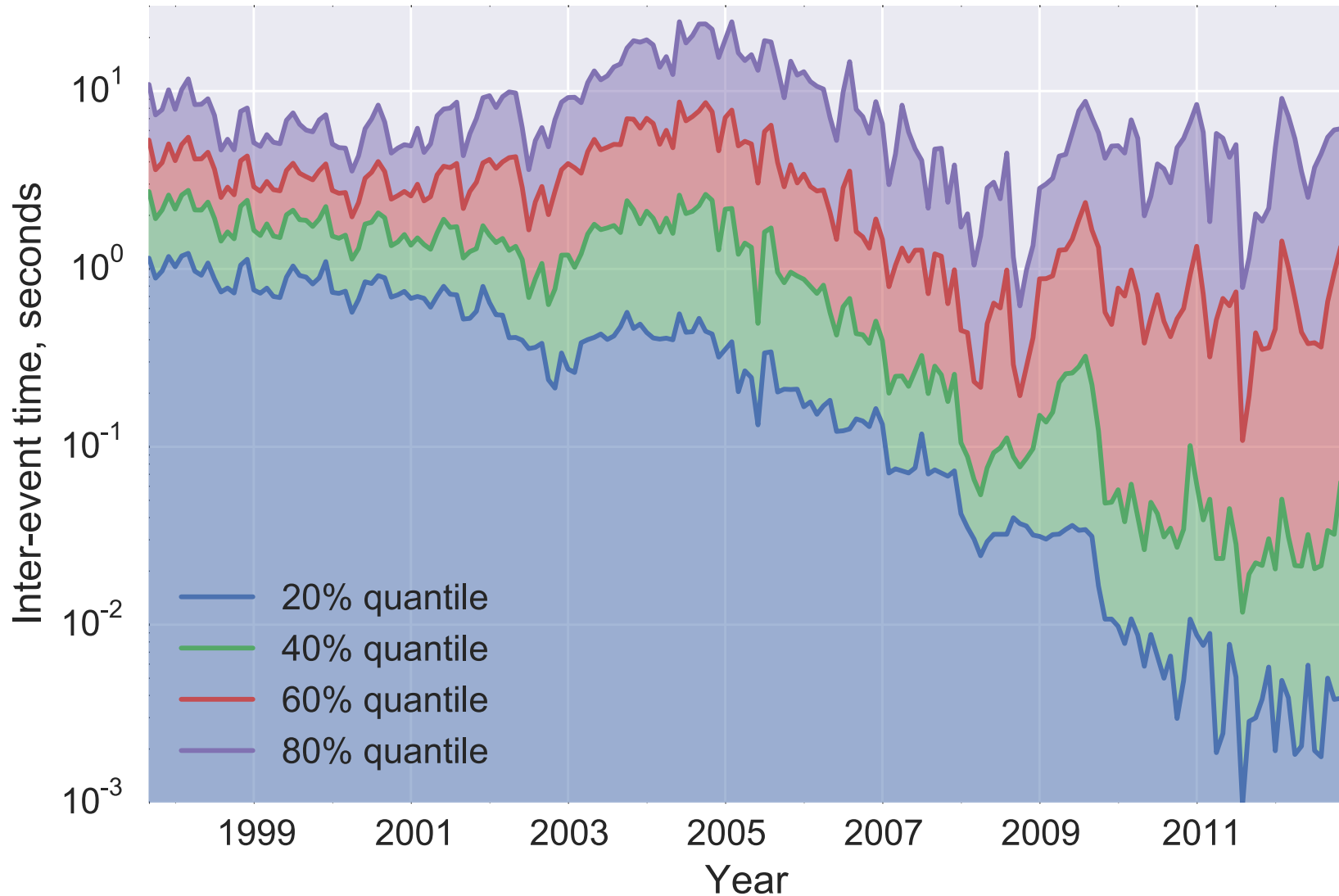




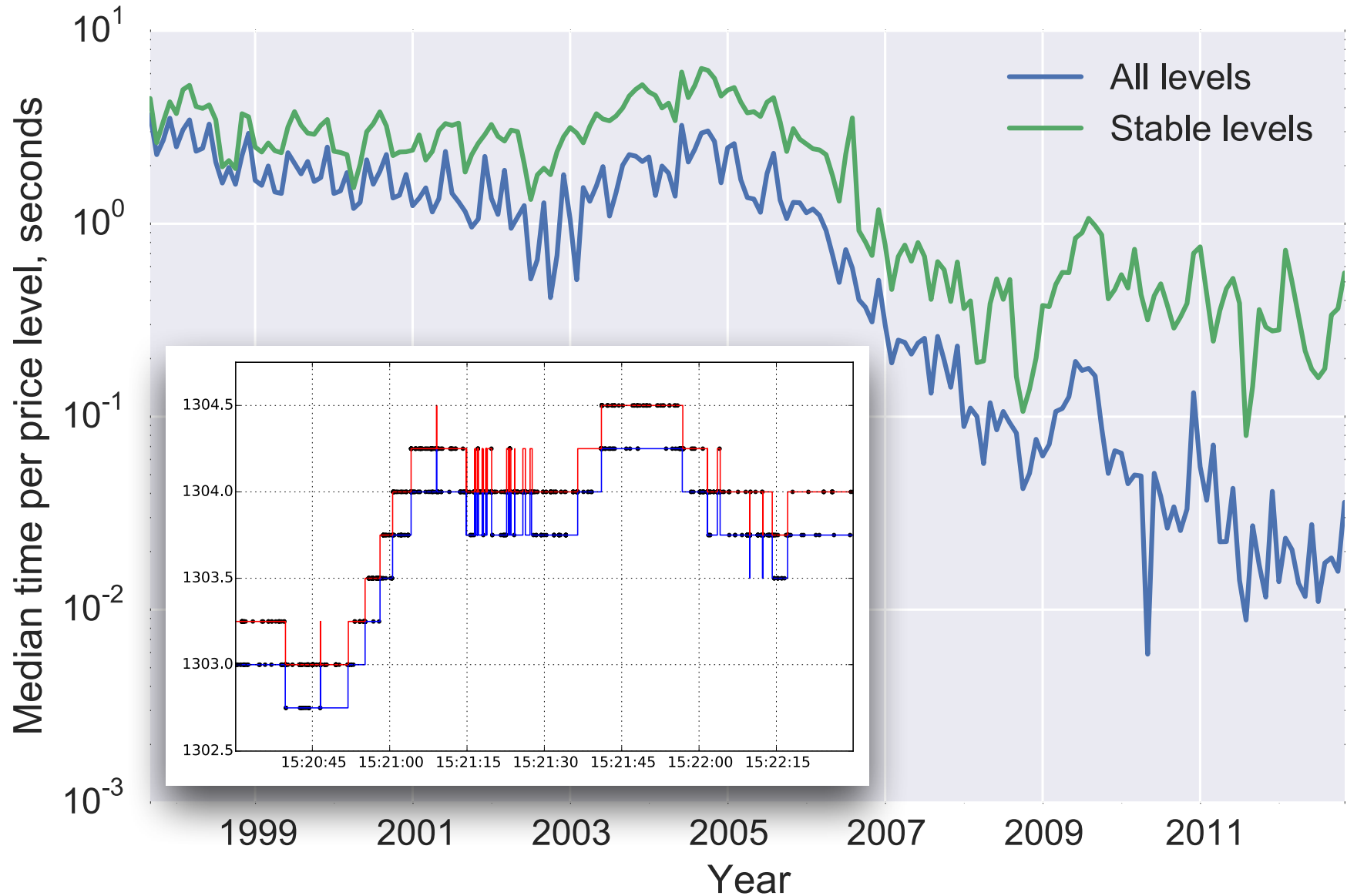
# Acceleration of market makers



# Distribution of mid-price changes inter-event times

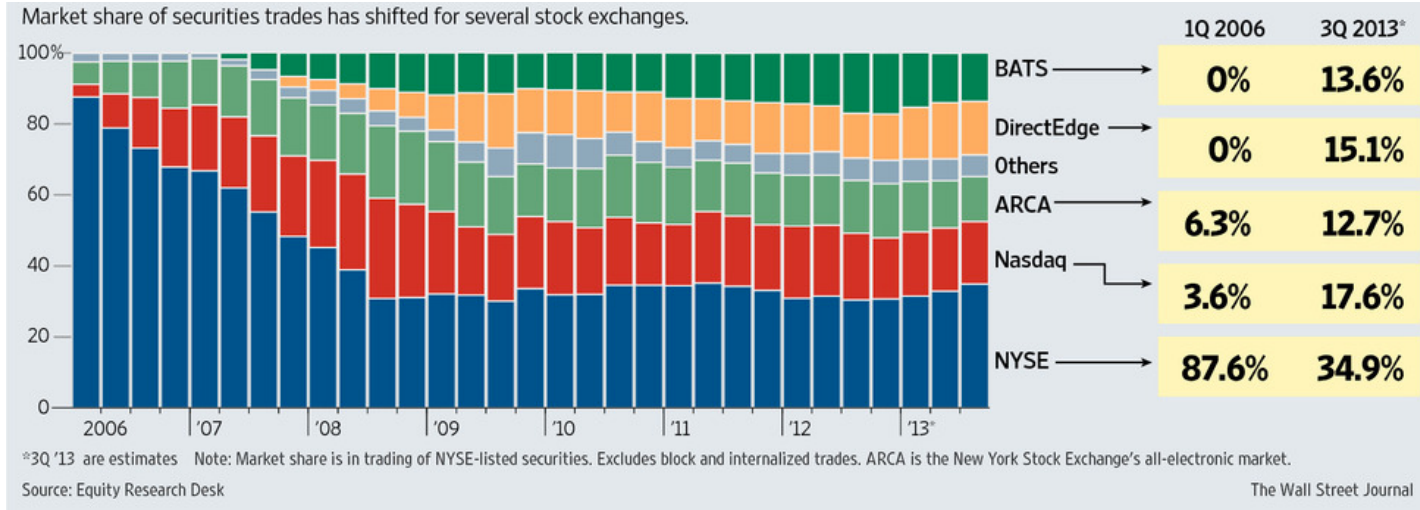


# Tâtonnement process and price discovery



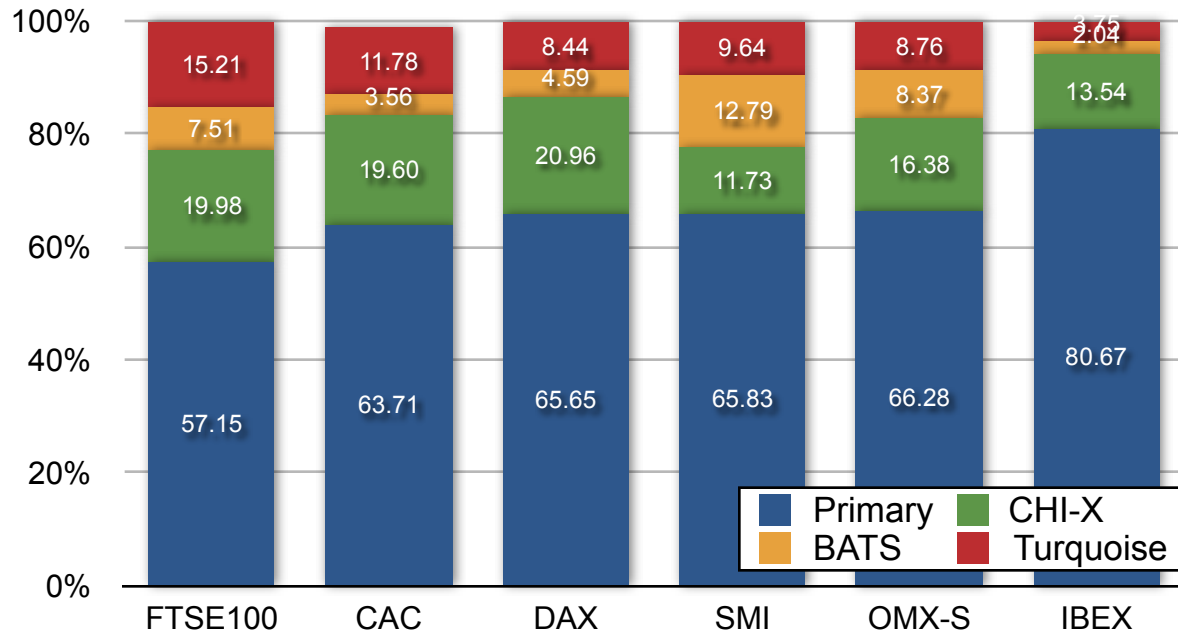
# Fragmentation of the market

Market share  
US, 2006-2013



Source:  
WSJ

Market share  
Europe, Q2 2014



Source:  
LiquidMetrix (2014) 21

# References

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