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HOW MARKET MICROSTRUCTURE AFFECTS LIQUIDITY AND MARKET RISKS

Fabrizio Lillo
Scuola Normale Superiore di Pisa
University of Palermo (Italy)
Santa Fe Institute (USA)

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MARKET MICROSTRUCTURE

- Market microstructure “is devoted to theoretical, empirical, and experimental research on the economics of securities markets, including the role of information in the price discovery process, the definition, measurement, control, and determinants of liquidity and transactions costs, and their implications for the efficiency, welfare, and regulation of alternative trading mechanisms and market structures” (NBER Working Group)

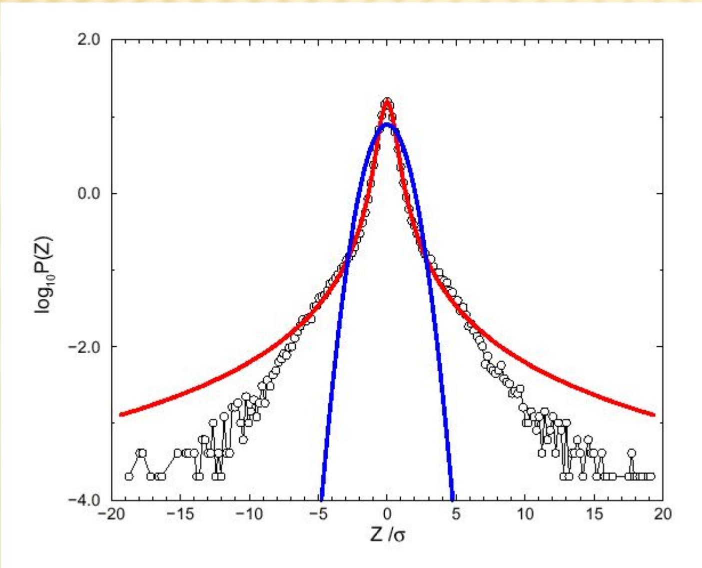
WHY SHOULD MARKET MICROSTRUCTURE BE RELEVANT FOR RISK AND STRESS TESTING?

- Connection between microscopic and macroscopic time scales
- Temporary liquidity crises
- Price impact
- Liquidity risk
- Overlapping portfolios and systemic risk

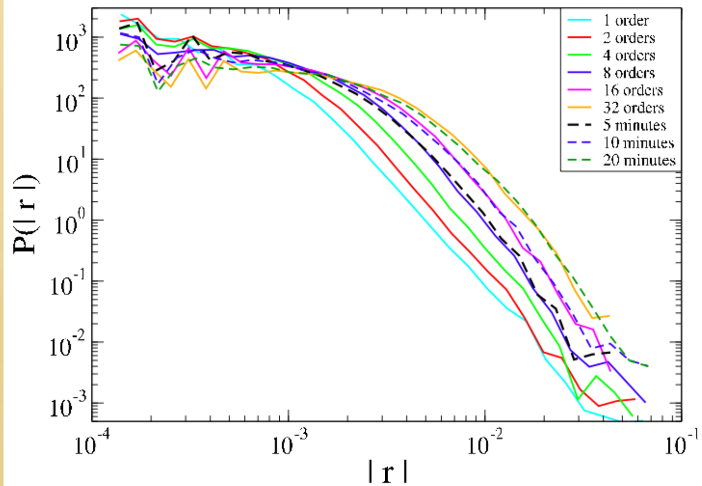
- Institutional design makes the system more robust: e.g. a clearinghouse for CDS (Duffie and Zhu, Cont)

MICRO-MACRO CONNECTION

- Financial markets are intrinsically unstable and display large price fluctuations (Mandelbrot, Fama, Mantegna and Stanley, etc)
- The origin of these short time scales large price fluctuations is weakly related to news (see, e.g. Bouchaud et al 2009)
- There is an intriguing evidence that individual trade price returns have the same properties as returns on longer time scales
- Is microstructure important to explain and model stylized facts? (fat tails, clustered volatility, multifractality, etc)

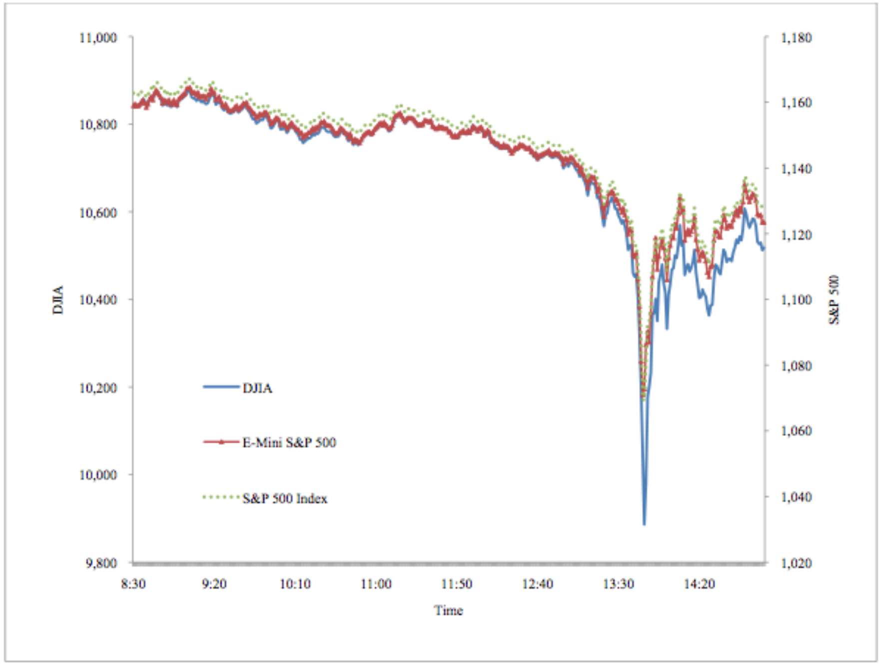


Return distributions



AN EXTREME EXAMPLE: THE FLASH CRASH

- May 6, 2010
- Initiated at E-mini S&P 500 futures
- Price drop of 1% per minute
- Contagion to other assets: ETF, Indices, and then stocks: **the 20 millisecond cascade**
- Over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Many at a penny or less, or as high as $100,000, before prices of those securities returned to their "pre-crash" levels.
- By the end of the day, major futures and equities indices "recovered" to close at losses of about 3% from the prior day.



This figure presents end-of-minute transaction prices of the Dow Jones Industrial Average (DJIA), S&P 500 Index, and the June 2010 E-Mini S&P 500 futures contract on May 6, 2010 between 8:30 and 15:15 CT.

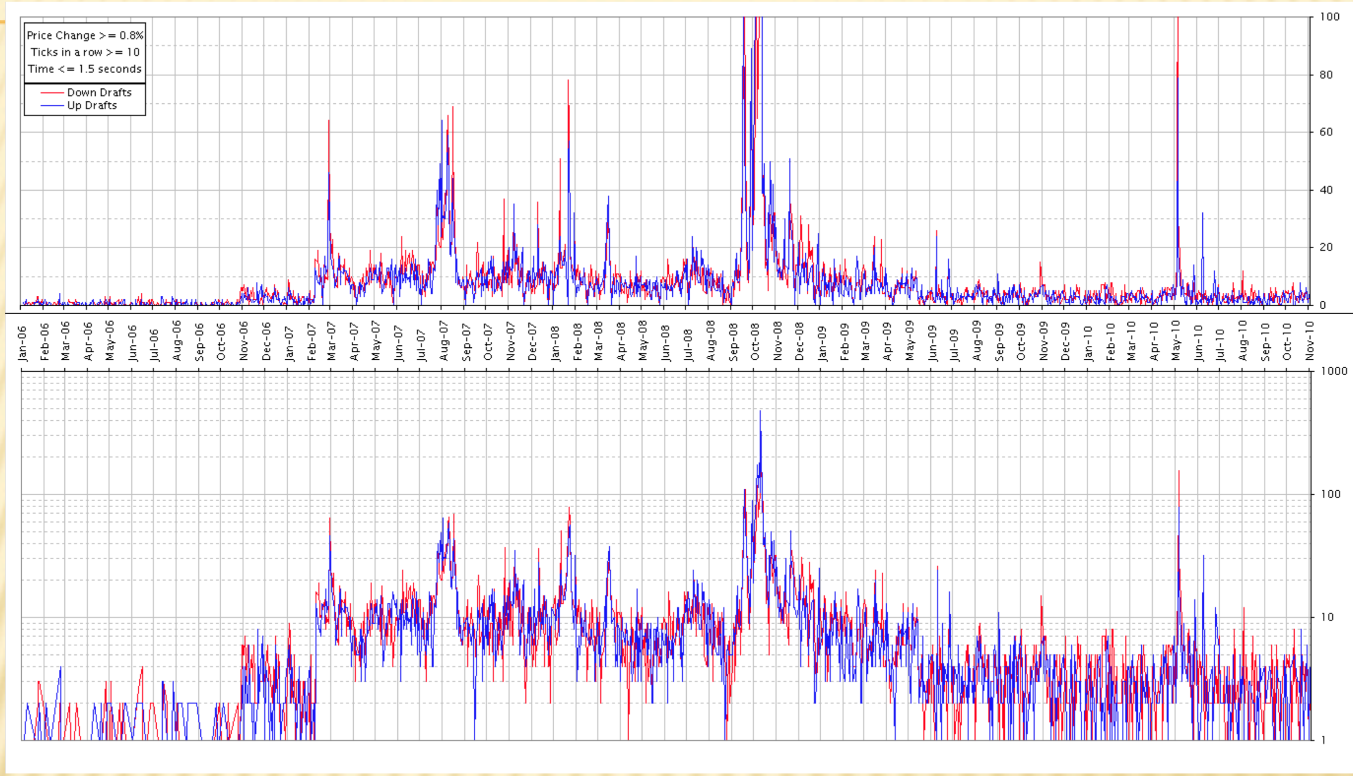
AN ISOLATED EVENT? (FROM NANEX)

- All listed equities for 2006-2011 searching for potential "mini crashes" in individual stocks.
  - **To qualify as a down (up)-draft candidate, the stock had to tick down (up) at least 10 times before ticking up (down)-- all within 1.5 seconds and the price change had to exceed 0.8%.**

	Down Drafts			Up Drafts		
Year	**Count**	**Download All**	**Examples**	**Count**	**Download All**	**Examples**
2011	69+	Download		70+	Download	
2010	1041	Download	View	777	Download	View
2009	1,462	Download	View	1,253	Download	View
2008	4,065	Download	View	4,354	Download	View
2007	2,576	Download	View	2,456	Download	View
2006	254	Download	View	208	Download	View

SYSTEMIC INSTABILITY FROM INSTITUTIONAL DESIGN?

UpDnDrafts.png 1369×766 pixels 5/9/11 9:53 AM



http://www.nanex.net/FlashCrashEquities/UpDnDrafts.png Page 1 of 1

Regulation NMS was implemented in 2007

Consider the NYSE Hybrid Market rollout:

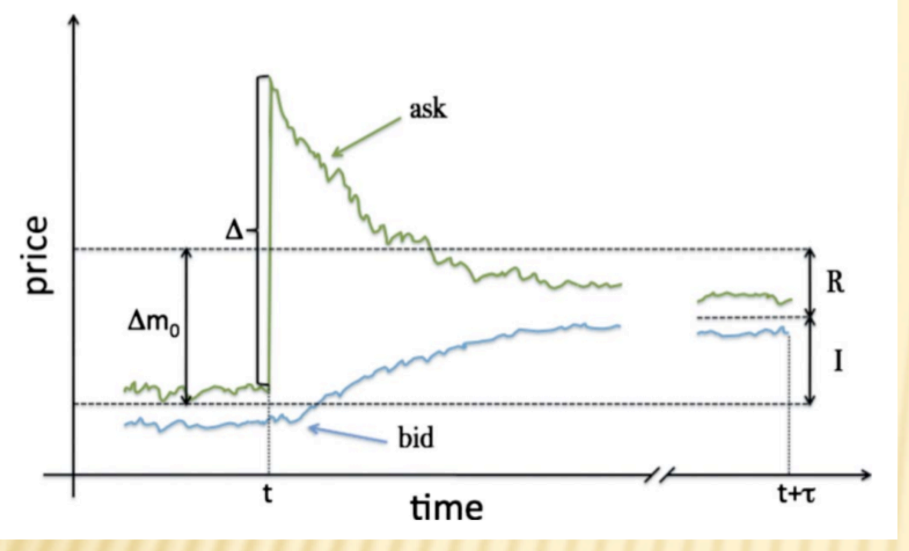
- Hybrid Phase III - COMPLETED rollout January 24, 2007
- Hybrid Phase IV - COMPLETED rollout February 27, 2007

Note that prior to Feb 2007, the NYSE had never been a reporting exchange in any incident.

From Nanex

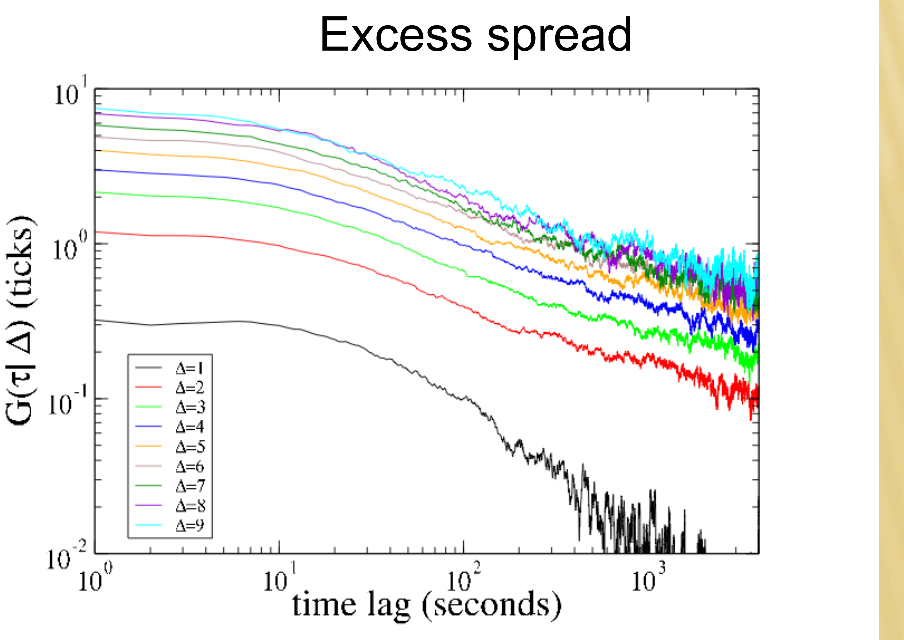
MARKET REACTION TO TEMPORARY LIQUIDITY CRISES

The market reaction to large spread changes (LSE stocks).



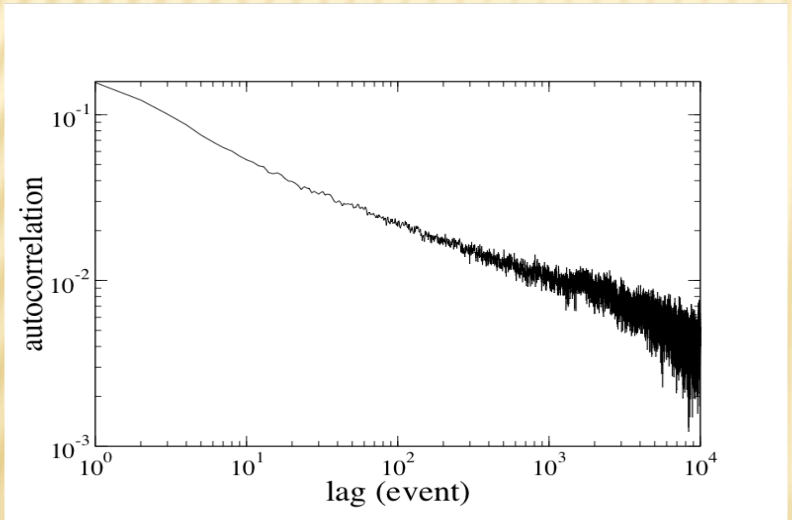
Q: How the market relaxes to the "normal" state after a liquidity crisis?

A: The spread (but also the limit order book) decays on average to the "normal" value by following a very slow dynamics

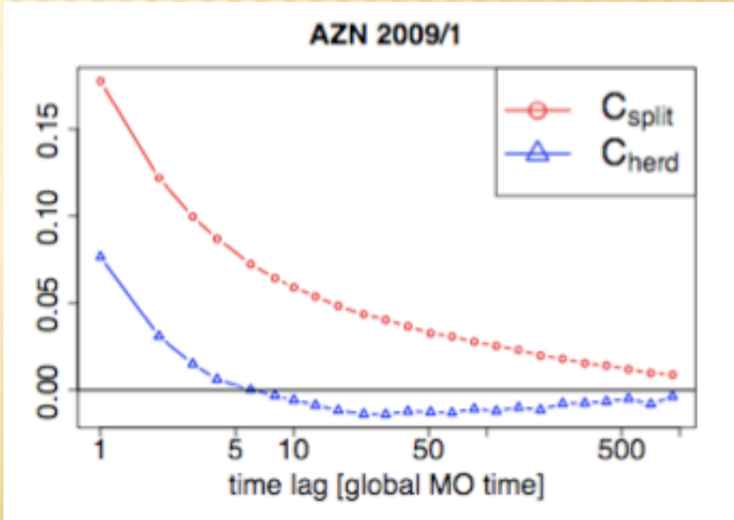


PERSISTENCE

- Also order flow (net demand imbalance) is persistent and correlated in time as a result of order splitting and herding



Autocorrelation of signs (buy vs sell) of market orders



Decomposition of the autocorrelation in a splitting and a herding component (at the broker level)

FUNDAMENTAL REVIEW OF THE TRADING BOOK

- One of the main points raised by the Basel Committee (2012) is market illiquidity
- During the recent crisis “banks were often unable to exit or hedge certain illiquid risk positions over a short period of time without materially affecting market prices.” -> violation of a key assumption of VaR
- “Conceptually, the ideal metric of market liquidity would be based on price impact of a trade”
- “Liquidity horizon represents the time required to sell a financial instrument in a stressed market, without materially affecting market prices.”

LIQUIDITY RISK

- The practice of marking to market the value of a portfolio might be misleading if either the assets are illiquid or the position must be unloaded quickly
- It has been suggested to use a mark to liquidity approach (Acerbi and Scandolo) to value a portfolio. Up to now an interesting theoretical exercise
- This requires a **price impact model** in
  - Normal situations
  - Distressed market state

FUNDAMENTAL REVIEW OF THE TRADING BOOK

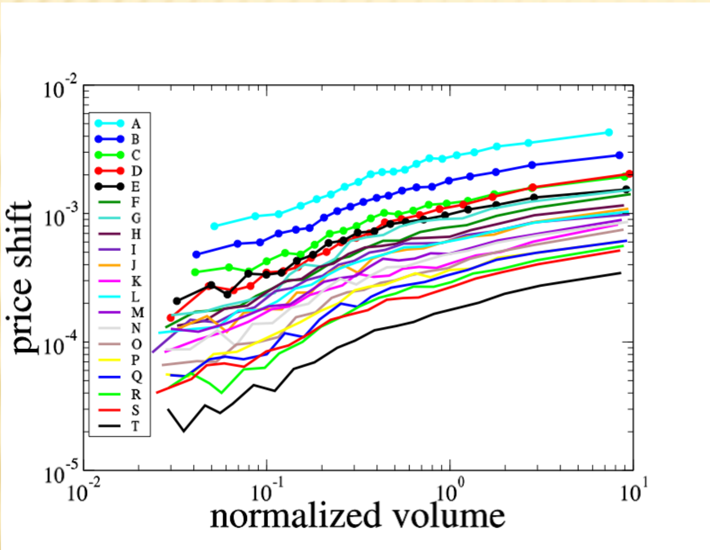
- Exogenous (i.e. normal) vs. endogenous (i.e. fire sales) component of liquidity risk
- Exogenous component often modeled by using the 99% quantile of the normalized distribution of spread.
- Bad estimator for several asset classes (equities, futures, FX) where also normal liquidations take time
- Modeling the liquidity surface

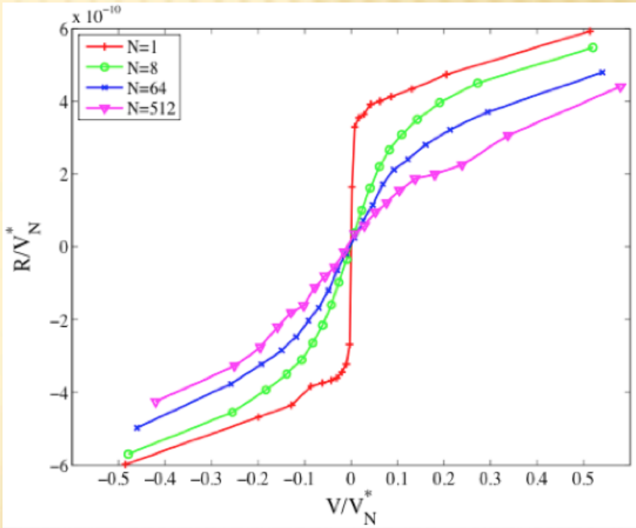
$$\Delta \equiv \log \frac{S_T}{S_0} = f(Q,T)$$

where S_0 and S_T are the price at the beginning at the end of the trade, Q is the traded volume and T the liquidation time

PRICE IMPACT

- Impact is the price reaction to trades
- There are different types of price impact

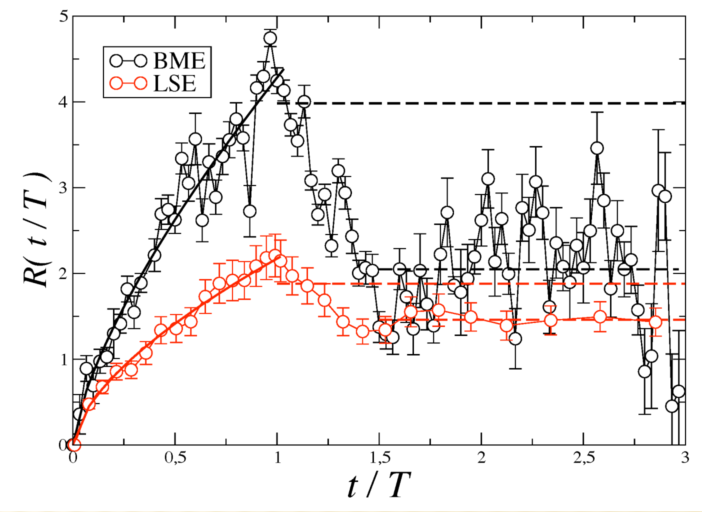




- Minimizing impact of the execution of a large trade means minimizing cost
- A satisfactory theory of price impact of large trade is still lacking, but it is key for assessing liquidity risk

PRICE IMPACT OF LARGE TRADES

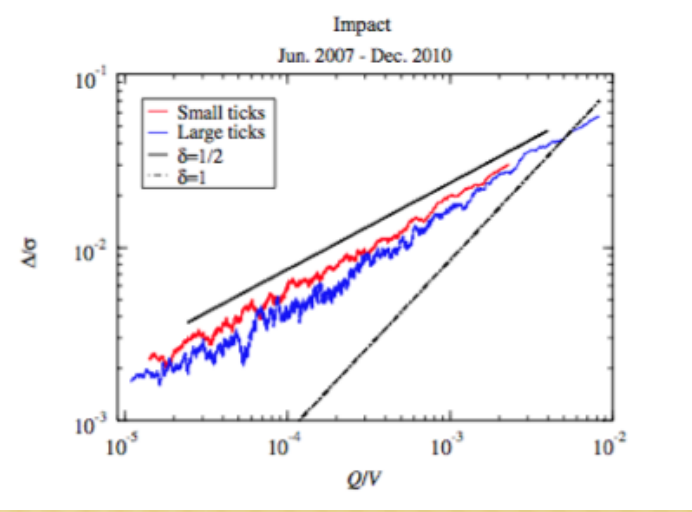
Statistically reconstructed price impact temporal profile of large orders by all brokers at LSE and BME (using brokerage data, Moro et al 2009)



Empirical evidence of

- Square root dependence of total impact from order size
- Reversion of price at 2/3 of the peak

Price impact Δ as a function of the volume Q of large orders automatically traded by Capital Fund Management, a large French hedge fund (Toth et al 2011)

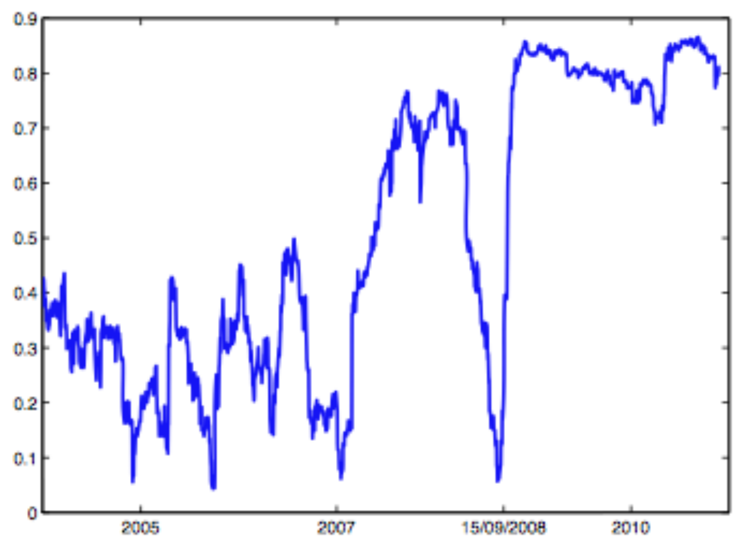


Square root impact law $\Delta = Y\sigma\,(Q/V)^{1/2}$

We recently developed a model for impact reproducing these facts (Farmer et al 2011).

FIRE SALES OR DISTRESSED SELLING

- In an extremely distressed situation a company can be forced to sell large volumes as soon as possible
- Market conditions and liquidity dramatically change and "normal" market impact is not anymore appropriate
- Other subtle effects, such as a dramatic change in correlations during fire sale events (see Cont et al 2011). Uncorrelated assets can become strongly correlated (LTCM, August 2007, etc)
- Understanding price impact in distressed markets is critical to assess liquidity risk

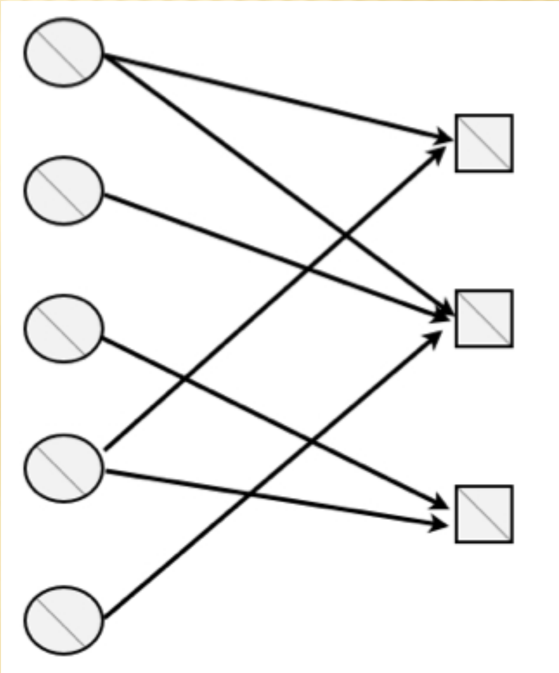


EMWA correlation between two ETF of the the S&P 500: SPDR XLE (energy) and SPDR XLK (technology)

OVERLAPPING PORTFOLIOS AND SYSTEMIC RISK

- Banks invest in assets under VaR and diversification costs constraints
- Maximization of portfolio returns gives optimal leverage λ and optimal portfolio size
- Asset dynamics leads to portfolio rebalancing
- Bank demand impacts prices

Bipartite network



Banks are circles and assets (classes) are squares.
A link indicates that a bank has an asset in its portfolio

OVERLAPPING PORTFOLIOS AND SYSTEMIC RISK

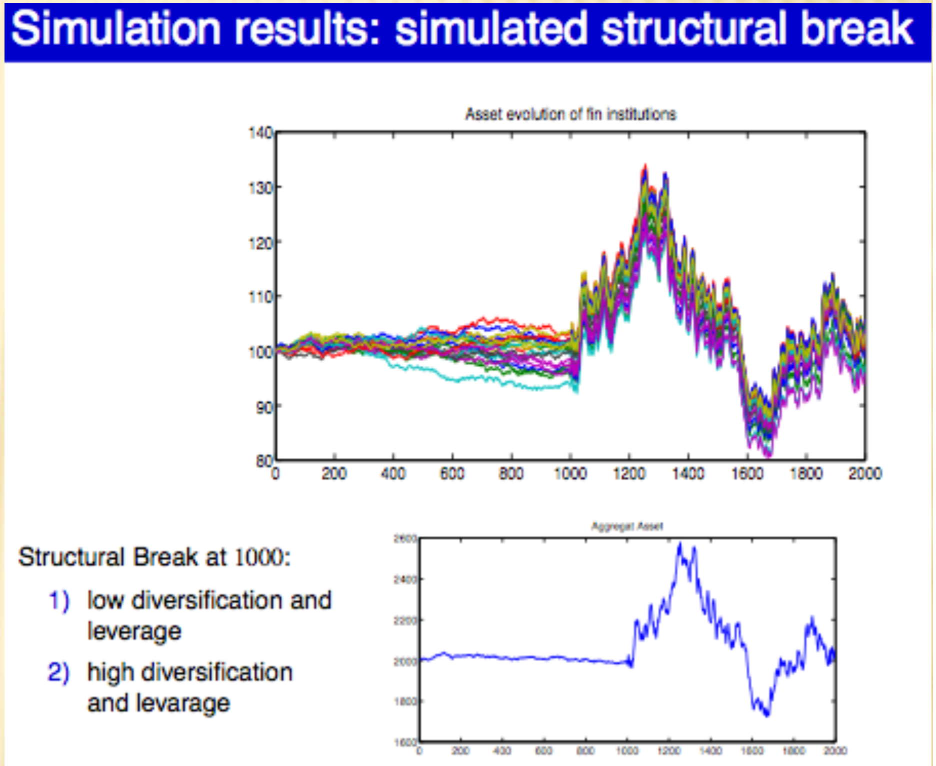
- The system becomes unstable, displaying bubbles, when

$$(\lambda - 1)\gamma^{-1} \geq 1$$

where γ is the liquidity of the asset setting the impact

- For uncorrelated assets the optimal leverage λ is

$$\lambda = \frac{\mu - r_L}{2\sigma^2\alpha^2 c}$$



where μ-r_L is the net interest margin, σ is the volatility of the assets, α fixes the VaR, and c the diversification cost.

(with F. Corsi and S. Marmi, FP7/2007-2013 grant agreement CRISIS-ICT-2011-288501)

A TANGLED WEB

- "A transaction in the market affects more than the parties involved in the transaction itself, since the price determined in the transaction is used to price other assets and obligations" (Shin, 2008)
- At a systemic level one must take into account the similarity of portfolios across banks in assessing the effective role of diversification (e.g. hedge funds in August 2007)

CONCLUSIONS

- Market microstructure is an important ingredient in assessing risk both at a local and at a systemic level
- An understanding of price impact is still lacking especially for some asset classes (e.g. fixed income) -> Lack of data
- In distressed conditions correlations and liquidity change dramatically: to assess risk we need a dynamical (i.e. context dependent) multiasset market impact model
- Stress tests and capital requirements looking at individual banks are not enough. We need to take into account “second order” effects, i.e. how a single bank is affected by the behavior of the other distressed banks.