The Impact of Computer Based Trading on Systemic Risk

SRC/FMG/LSE Conference on the Foresight Report

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ILLUSTRATIONS

Figure 4.3: Violent cycling of natural gas futures prices on NYMEX, 8 June 2011 with a resulting crash and subsequent recovery

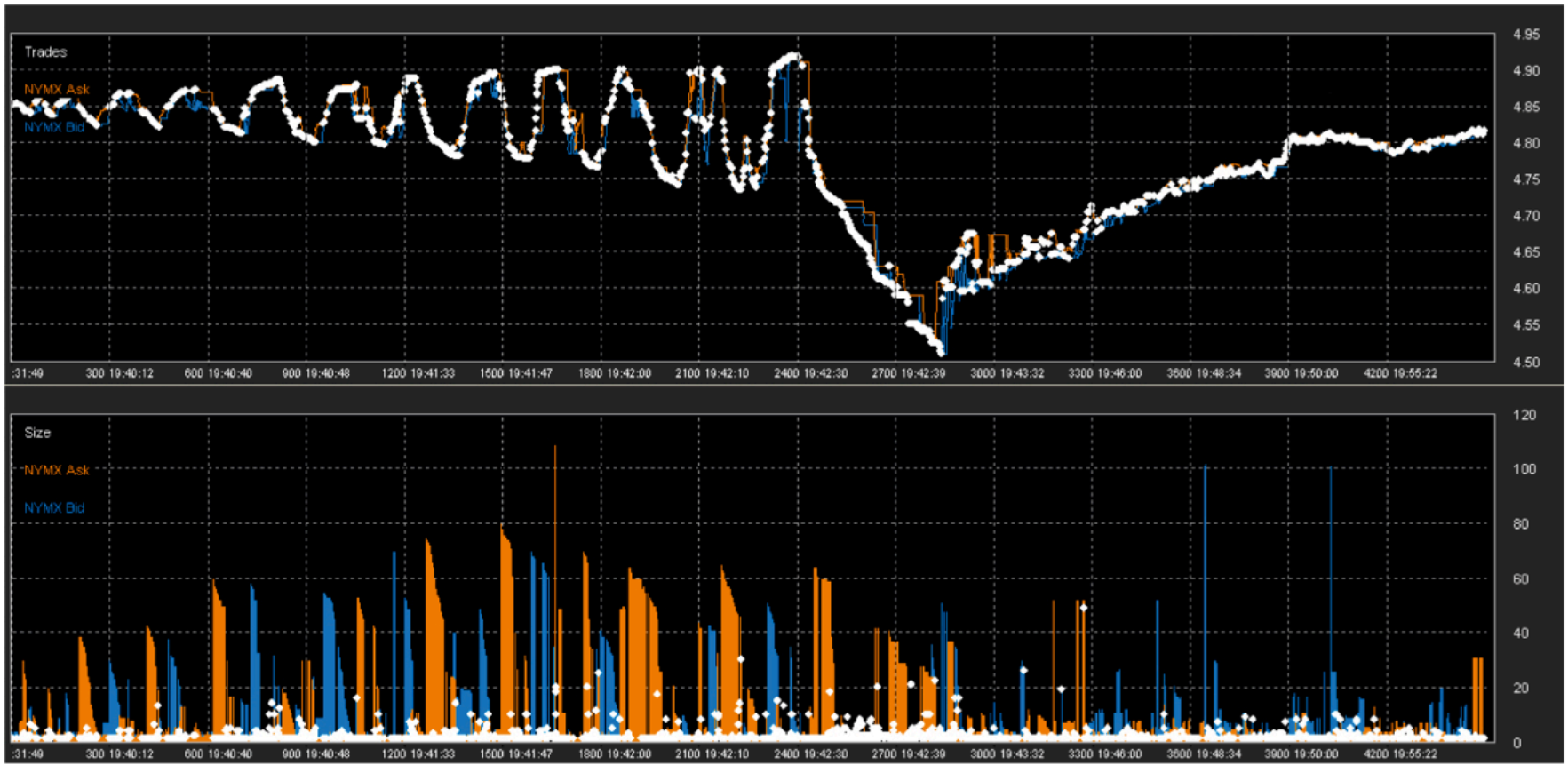
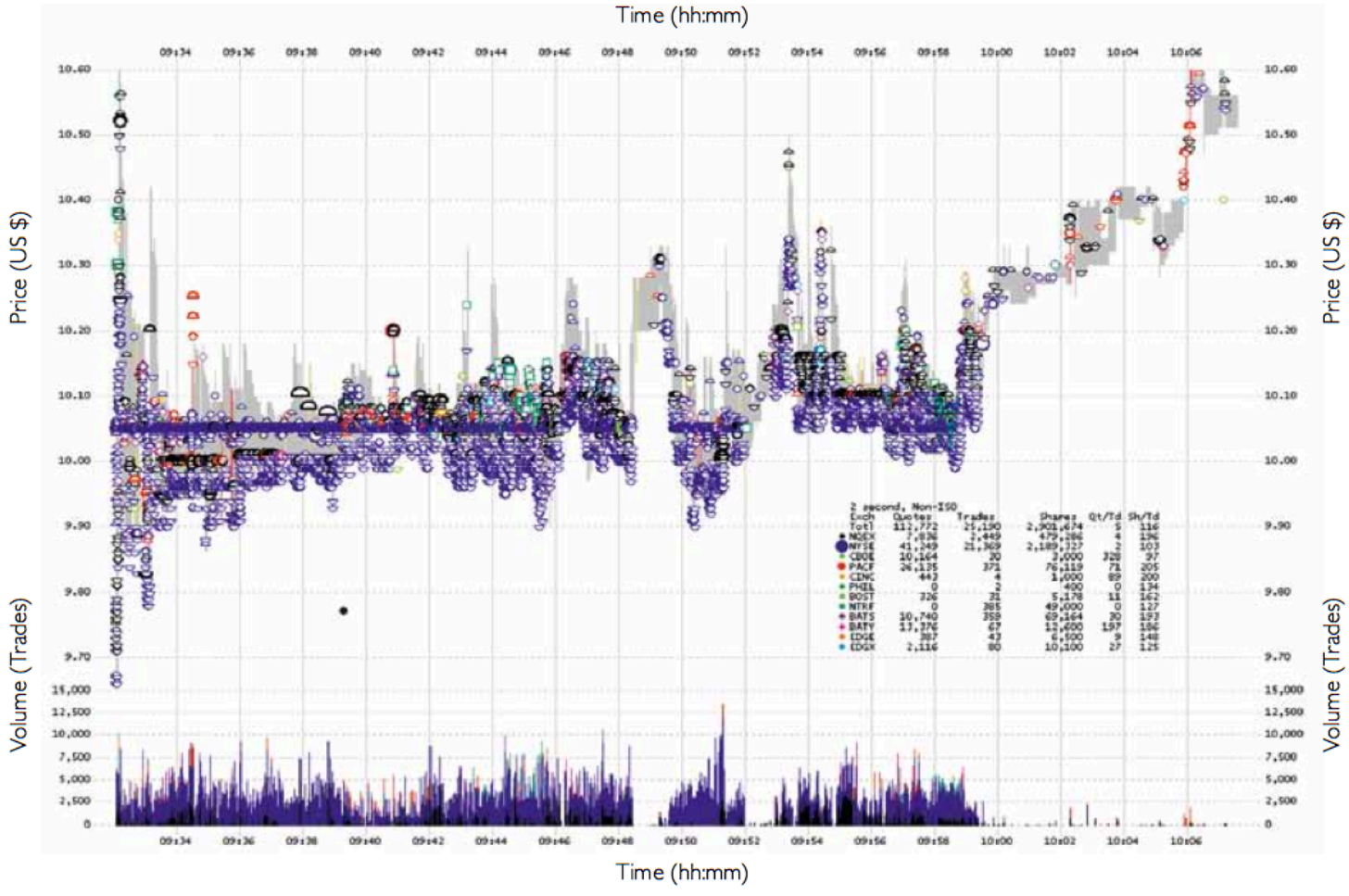


Figure 4.5: A pinning example that occurred during the recent Knight Capital algorithm malfunctioning episode where algorithms bought and sold in a way that kept prices of a stock with ticker CODE glued (pinned) around $10.05



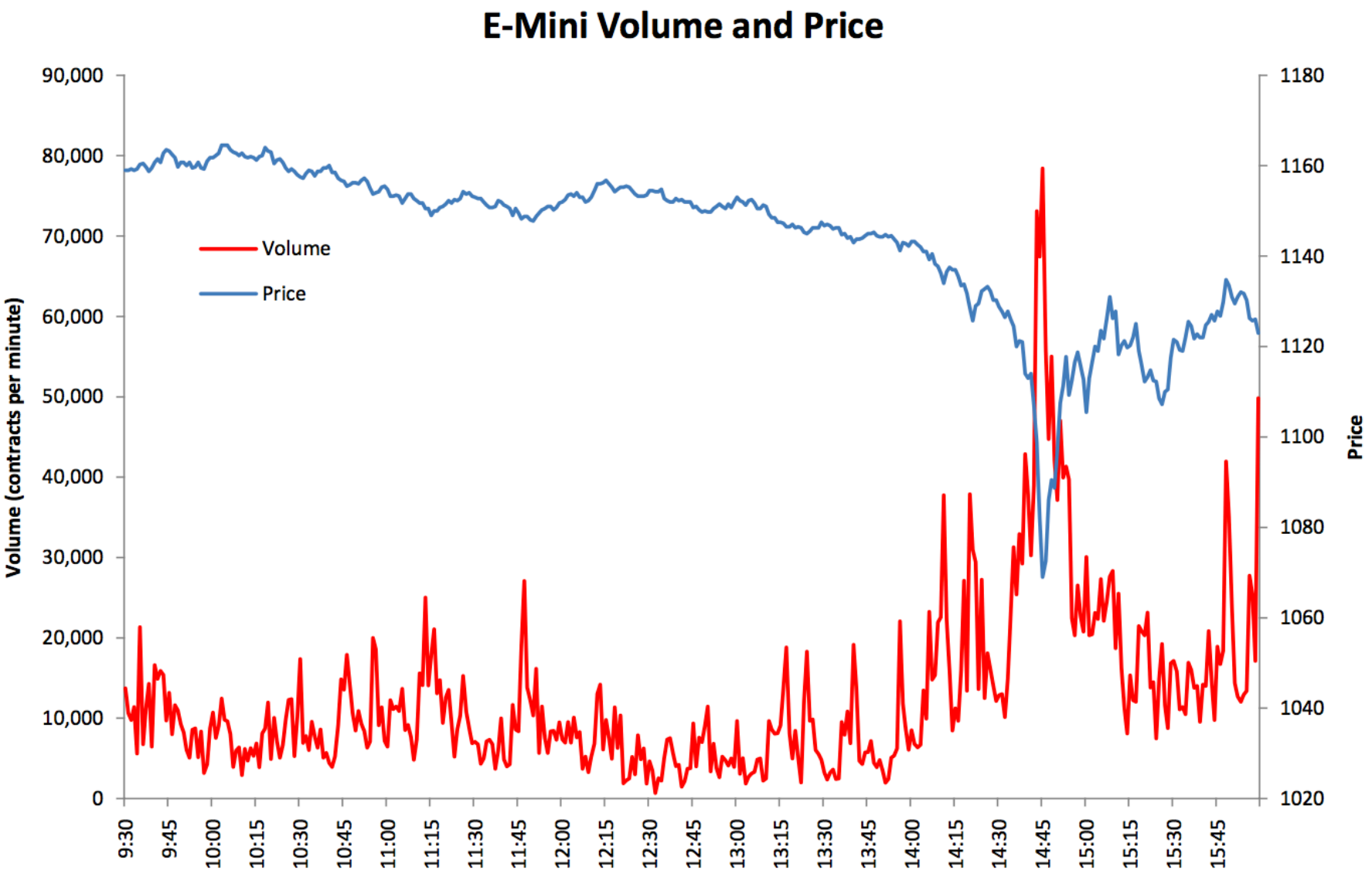

E-Mini Volume and Price
Volume (contracts per minute)
Price
Volume
Price
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1180
1160
1140
1120
1100
1080
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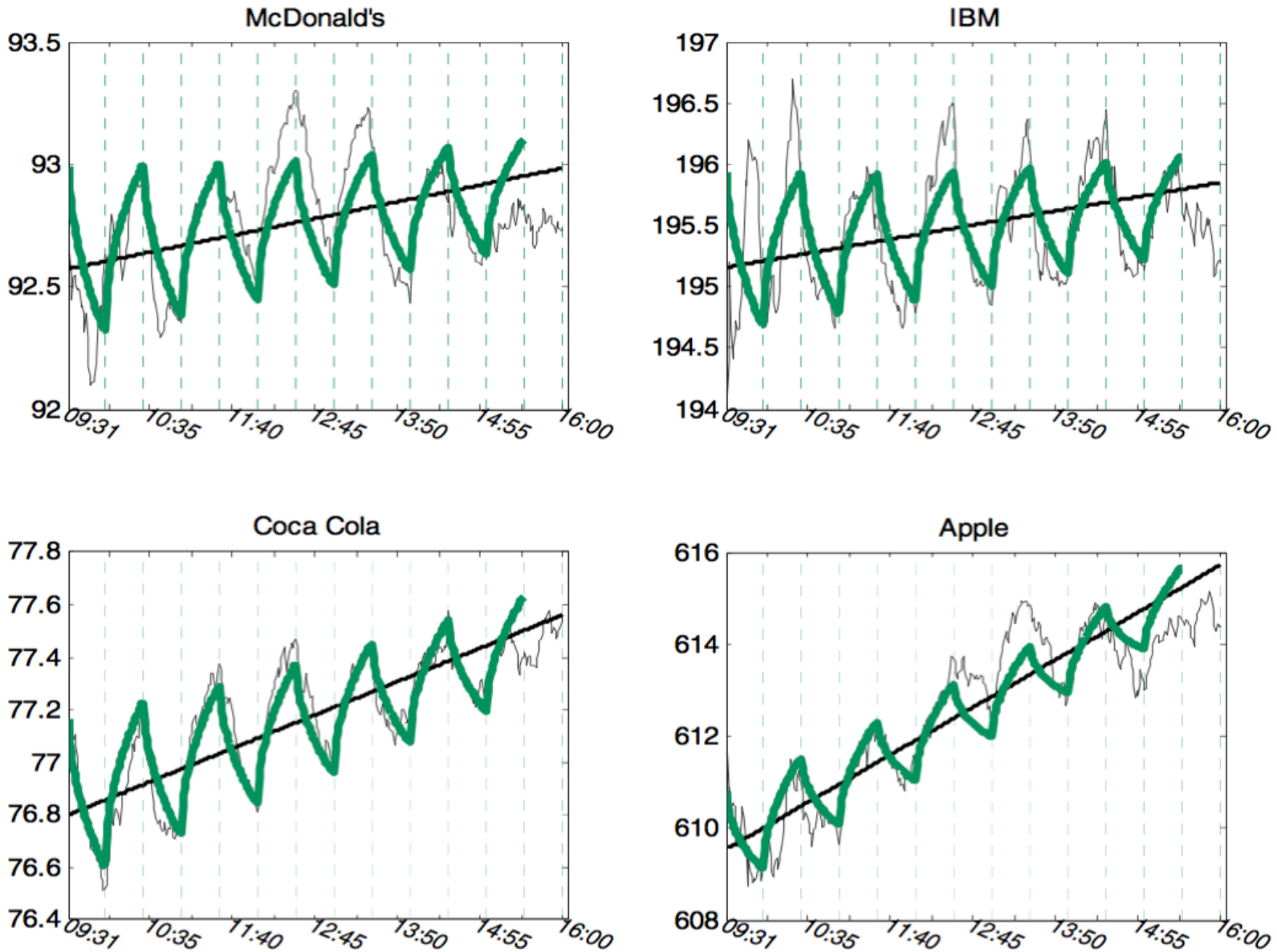
FIGURE 1: SAWTOOTH PATTERNS ON COCA-COLA, MCDONALD'S, IBM AND APPLE ON 19 JULY 2012



Mechanisms of Systemic Risk Generation by CBT

Non-linearities or jumps in prices and/or other variables that may jeopardise the proper functioning of the system, primarily (initially) for non-fundamental reasons.

Mechanism 1. Endogenous risk, positive feedback loops.

Mechanism 2. Lack of common knowledge and informational issues and lack of data integrity.

A combination thereof.

Speed and Lack of Diversity (perhaps endogenous) as Aggravators.

Endogenous Risk

- Positive feedback loops are mostly not reflecting the scale of fundamentals.
- Momentum trades, algorithms that adapt, imitate and filter naturally create positive feedback loops. VWAPs can do the same: if big move comes with big volume, VWAPs reinforce the big moves and the big volumes. DR6: Farmer and Skouros.
- Here we illustrate with some less direct positive feedback loops.

Figure 4.7: Hedge feedback loop

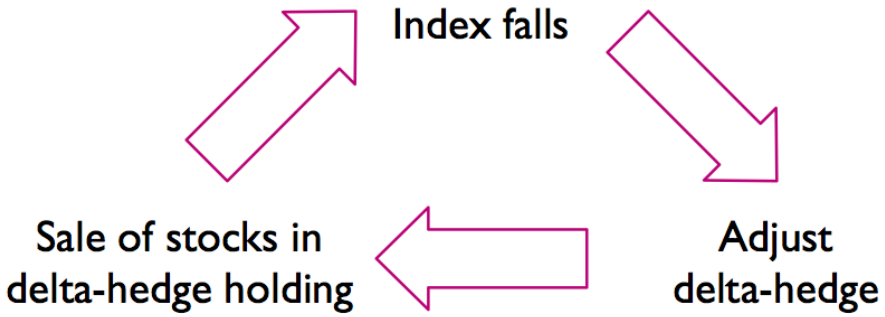


Figure 4.8: Risk feedback loop

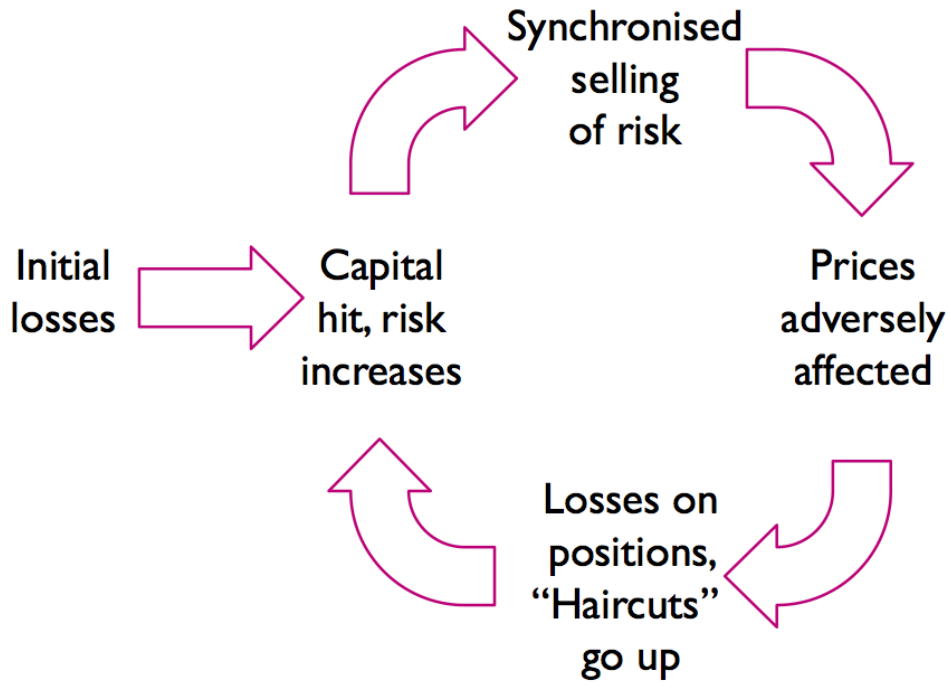


Figure 4.9: Volume feedback loop

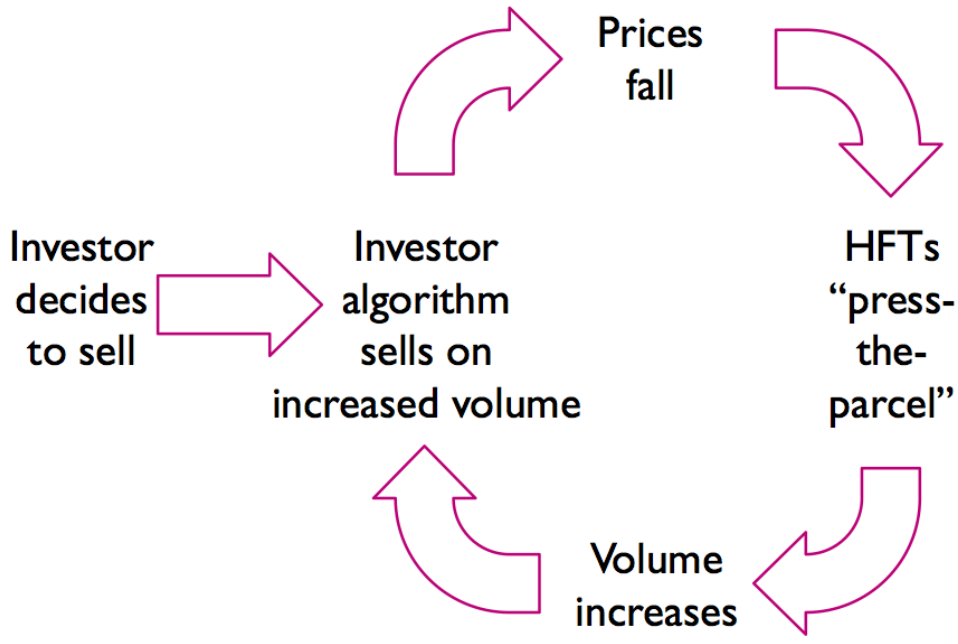


Figure 4.10: Shallowness feedback loop

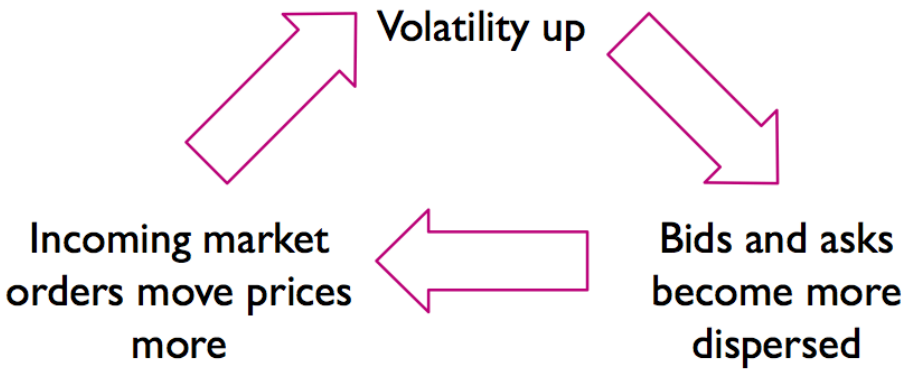


Figure 4.11: Order book imbalance feedback loop

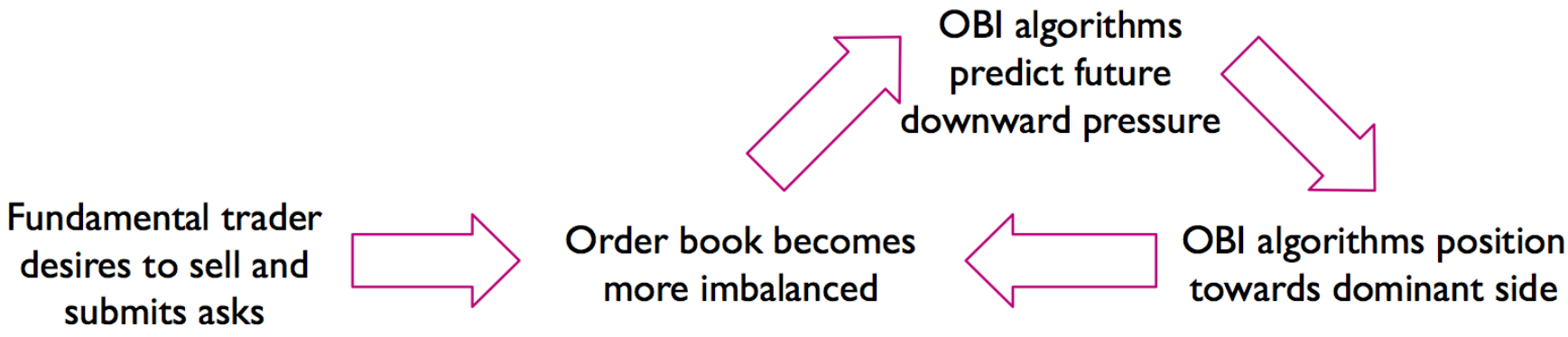


Figure 4.12: News feedback loop

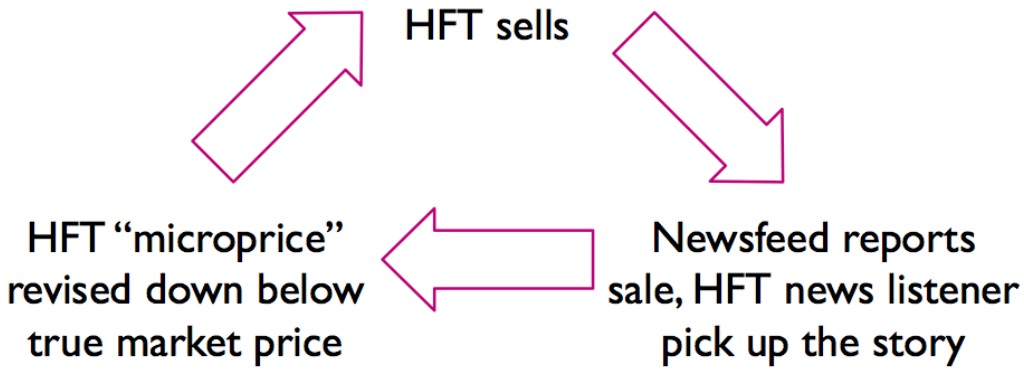


Figure 4.13: Quote-delay feedback loop

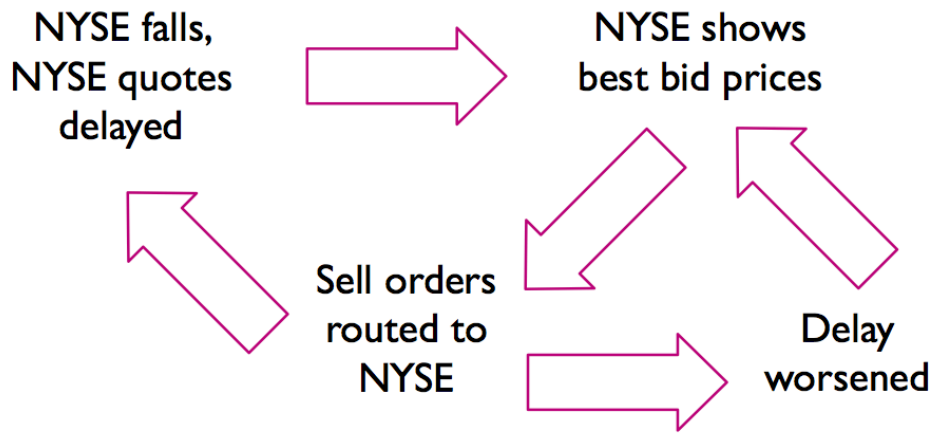


Figure 4.14: Index feedback loop

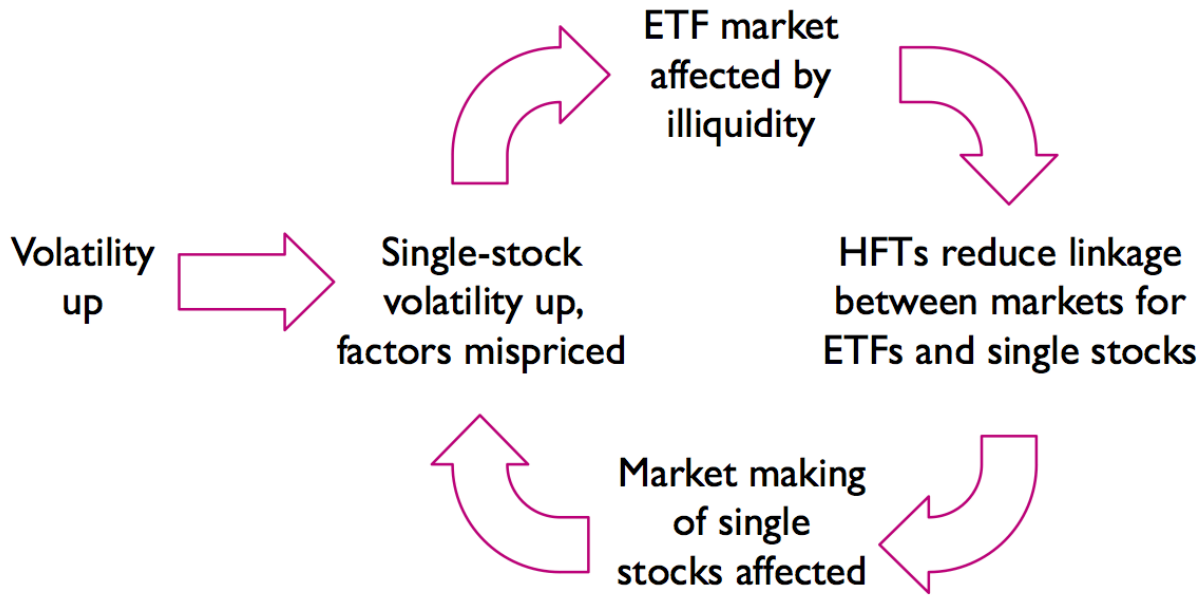
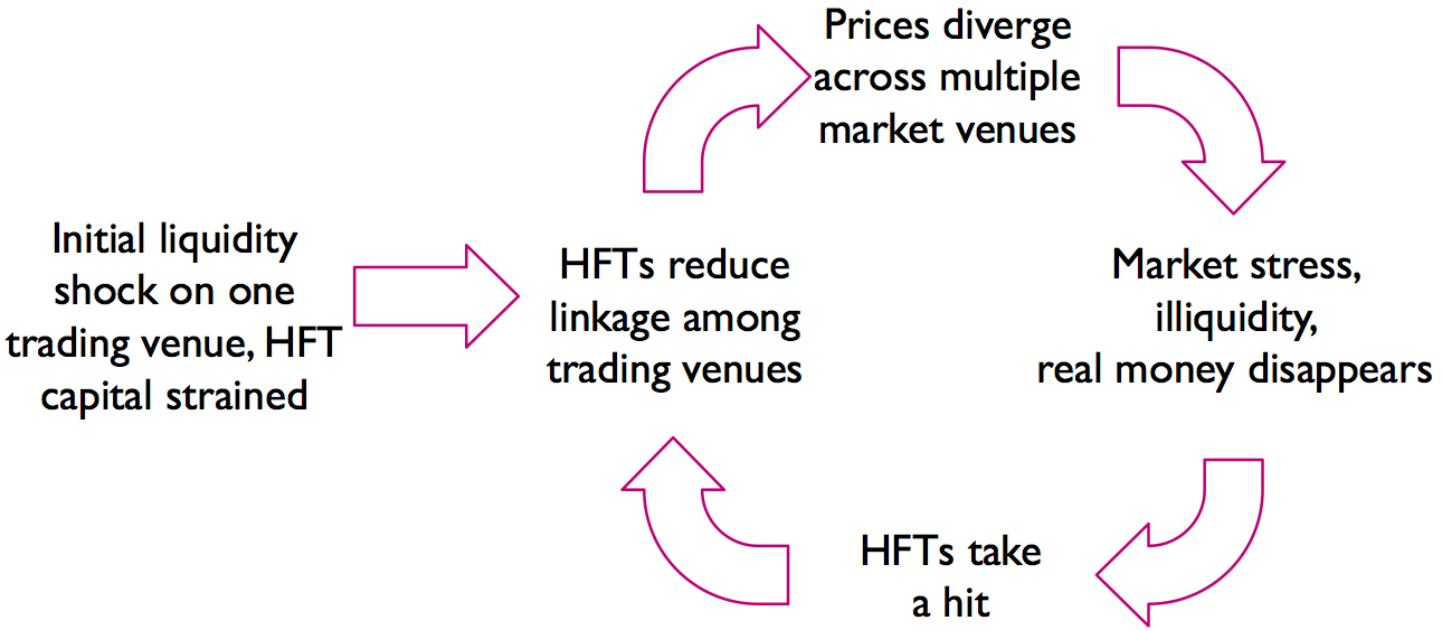


Figure 4.15: Systemic divergence feedback loop



Common Knowledge

- Fragmentation and CBT lead to less CK.
- **Inefficiencies**. Shin (1996):
  This link from fundamentals to the final outcome is subject to interference. The mark of a well-functioning trading system is one which minimizes such interference, and which ensures that the final allocation is as close as possible to that justified by the fundamentals. (. . .)
  In contrast to the dealership market, the decentralized market (employing the Shapley-Shubik rules) suffers from low trading volume, and the post-trade allocation is bounded away from the efficient allocation everywhere on the state space. (...)
  The apparent fragility of the Shapley-Shubik market to departures from common knowledge can be traced to the large effect of unrealized states on the equilibrium allocation.

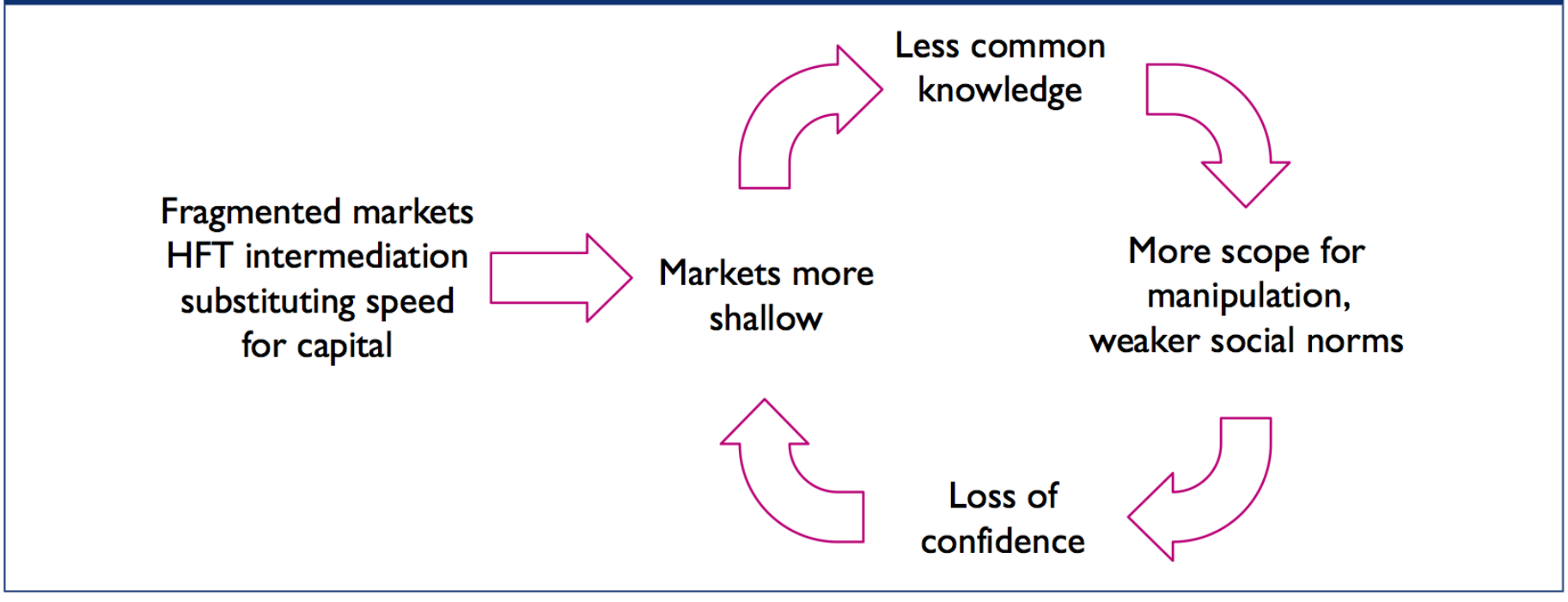
- **Crashes.** With higher-order uncertainty or higher-dimensional due to the impersonality of computer-based trading, markets may be more prone to crashes and large swings, as shown in the herding model of Avery and Zemski (1998).
- Gennotte and Leland (1990). Also Grossman (1988) and Jacklin, Kleidon and Pfleiderer (1992). The key feature is that the fraction of security holders who choose a dynamic hedging strategy is not public knowledge prior to their trading. In Grossman this leads to sudden selling pressure and liquidity issues, in JKP to an excessive price build-up prior to crash as Δ purchases on the up are interpreted as coming from informed buyers. Example in GL crash would be reduced by up to 99% if buyers were aware selling is forced.

- These observations are further **compounded in CBT environments** by the fact that markets are segmented, making coordination impossible, that the speed of computer trading itself may make it less likely that events become common knowledge and that market events may lack clarity (more on this below). Though leverage by HFT maybe less an issue?
- Less transparent, "Is it smart money?", "Does someone know something?" is now possibly harder to answer (DR9: Leland).
- In Flash Crash: "Am I the only one who does not know that Greece has exited the Euro?"

- Borne out in the structured interviews of computer-based traders conducted by Daniel Beunza, Yuval Millo and Juan Pablo Pardo-Guerra:
  - Interviewees stated that CBT actions during a dislocation to a primary market in a benchmarked price system will in part be determined by the outcomes of social communications during the event.
  - Fear of "de-skilling" among market participants, especially on the execution side. Become "anti-traders" and "lose tacit knowledge developed in floor-based trading... The chances of identifying risks early may be reduced."
  - Depersonalisation also may lead to weaker social norms and to less common knowledge that in turn can give rise to deviancy and reduce investor (as well as market maker) confidence.

Common Knowledge and ER

Figure 4.16: Systemic market structure feedback loop



Speed

- Why does speed matter? After all, speed and relative speed has always led to advantages.
- If the time scale T that is both physically possible and allowed is reduced, perhaps market behaviour at all scales qualitatively different (DR7: Sornette & von der Becke).
- Systemically, one reason may be that sensitivities & feedback loops at very high speeds may look qualitatively different from those at lower speeds, even if sped up: beyond the limits of human response times, any feedback loops must be generated solely by robots. Perhaps that discontinuity in the participation set is why self-similarity breaks down around 800-1000 micro seconds (DR27: Johnson and Zhao).

Even if the behaviour at sub-second levels is qualitatively different from a scaled version of lower frequency data, we do not know if this represents systemically relevant risks.

- Maybe faster means more stable if the fast traders who are responsible for the speed also possess good risk management tools: less hedging discrepancies and less exposures building up. May be the flash crash would have become 1987.
- Maybe faster trading is riskier (can be wasteful also):
  - Preuss (2003, 16 sec, 47 mins); Knight.
  - Less risk controls, less intelligence, less analysis (but info processing also faster)(EIA2: Farmer and Skouros).
  - Need for speed may lead to less diversity: if a nano-second matters, lines of code will be restricted and become more similar (+fads and HK), "algorithmic crowding."
  - If LOB updates faster than at a critical frequency, no trader can possibly know the LOB at any moment in time (Lehalle), so trading decisions taken under veil of ignorance.

U shape? Perhaps like for a bicycle, too little and too high speed lead to inefficiencies and instabilities.
To slow down if needs be for systemic risk reasons:

- Larger tick sizes.
- OER
- Batch auctions at a hertz cycle or sth like that.
- Pro-rata instead of time-priority (EIA2: Farmer and Skouros).