High Frequency Trading
+ Stochastic Latency and Regulation 2.0

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High Frequency Trading: Good or Evil?

Good

Bryan Durkin, Chief Operating Officer, CME Group:

"There is considerable evidence that high-frequency traders increase liquidity, narrow spreads and enhance the efficiency of markets."

Evil

Charlie Munger, Vice Chairman, Berkshire Hathaway:

"It's legalized front-running. I think it is basically evil and I don't think it should have ever been allowed to reach the size that it did. Why should all of us pay a little group of people to engage in legalized front-running of our orders?"

High Frequency Trading: An Asset Manager's Perspective

From an e-mal to me:

"I manage a '40 Act fund inside a major insurance company and see nothing but peril in HFT. The narrowing of spreads that the HFT apologists claim to provide for the rest of us redounds to their bank accounts, not ours. The other side—increased volatility, false signaling of volume and investor preference, market dislocations, exchanges' divided loyalties, and market stresses are not worth the risk. We are definitely paying for something we do not want."

HFTs and Market Dislocations: The Flash Crash

How did High Frequency Traders trade on May 6, 2010?

What may have triggered the Flash Crash?

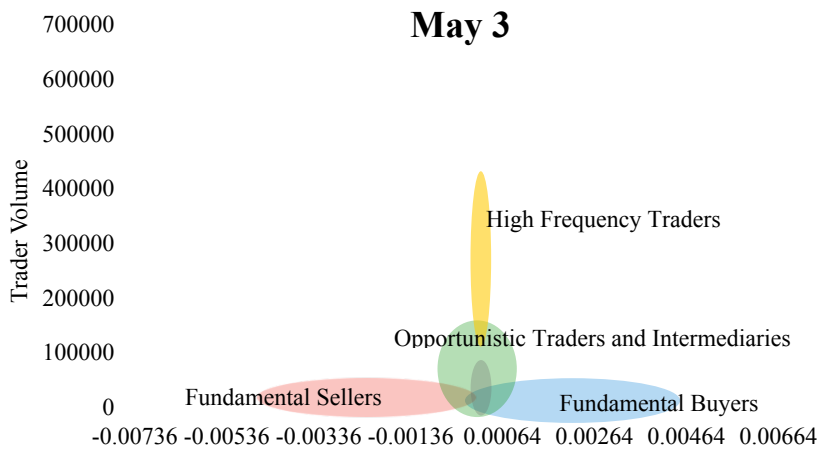
What role did HFTs play in the Flash Crash?

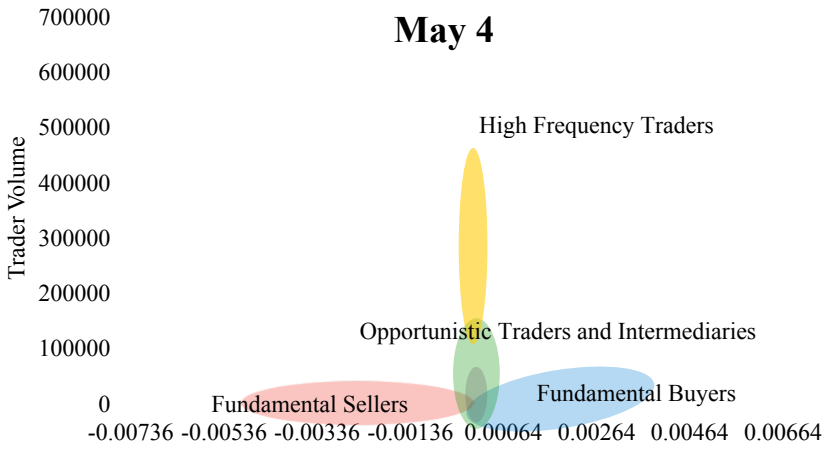
"…increased volatility, false signaling of volume and investor preference, market dislocations,…"

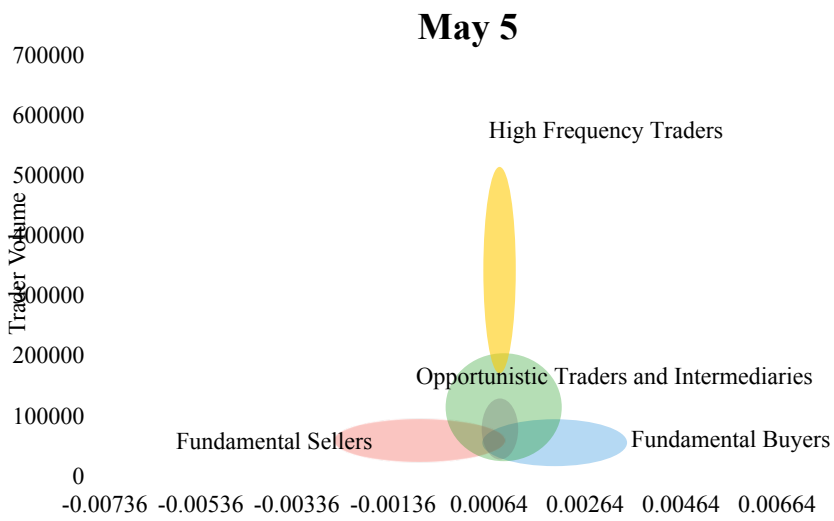
Classifying Traders

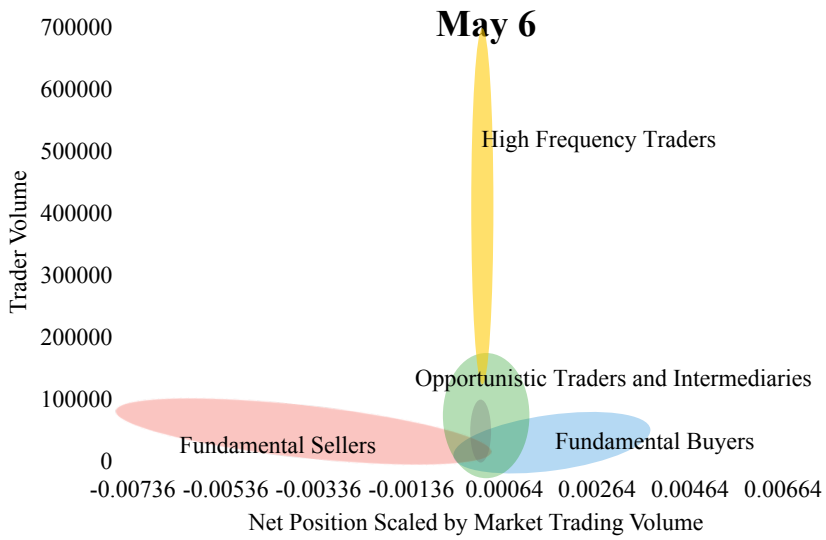
- HFTs:
  - High volume, low inventory, end the day flat
- Non-HFT Market Maker:
  - Provide liquidity
- Fundamental (Institutional):
  - Take directional positions
- Small (Retail):
  - Trade very few contracts
- Opportunistic:
  - Trade across multiple markets, against a model, during “events”

Trading Categories

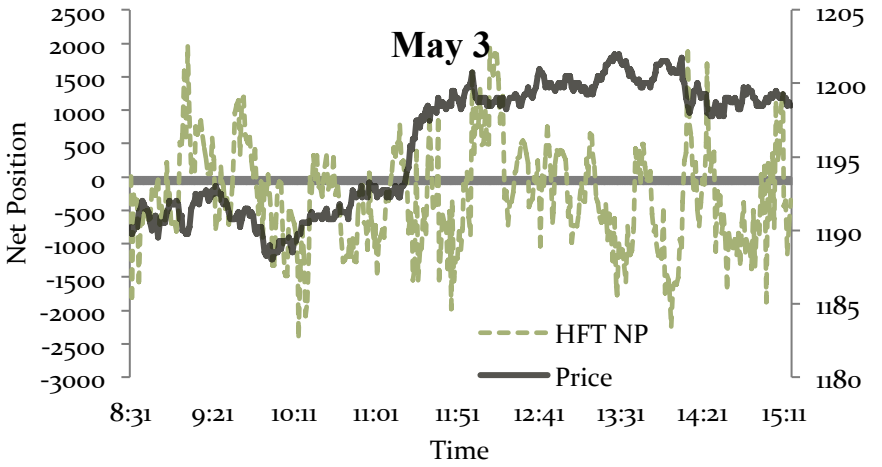


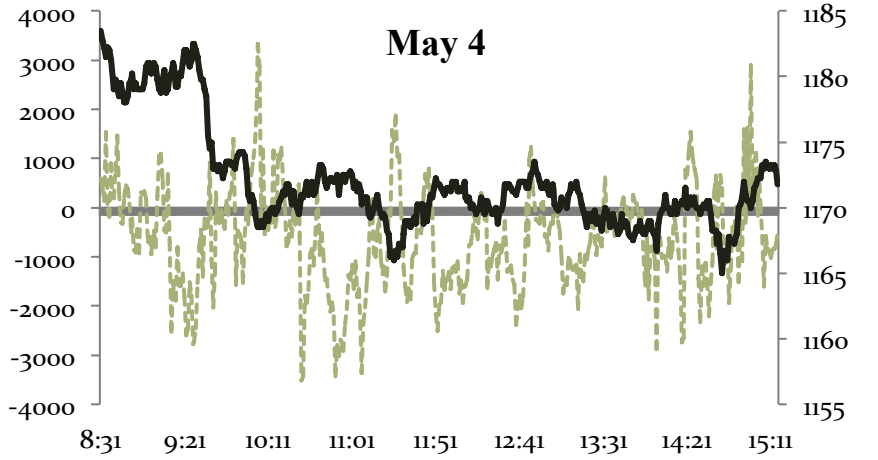


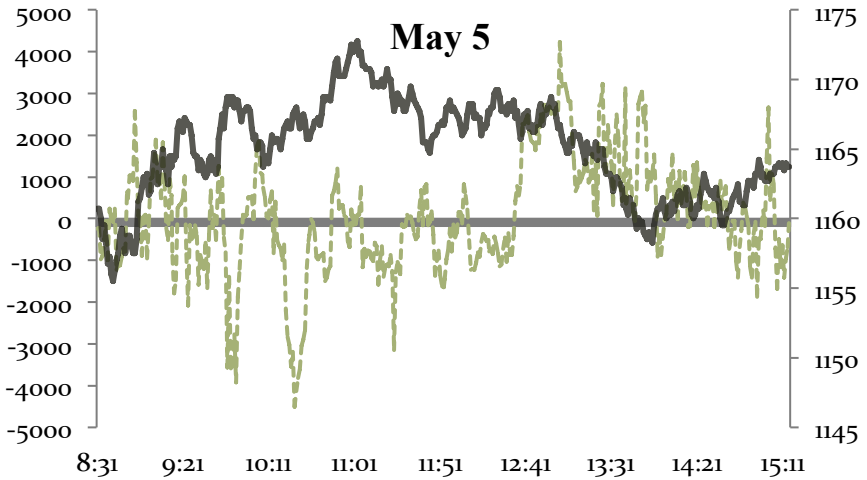


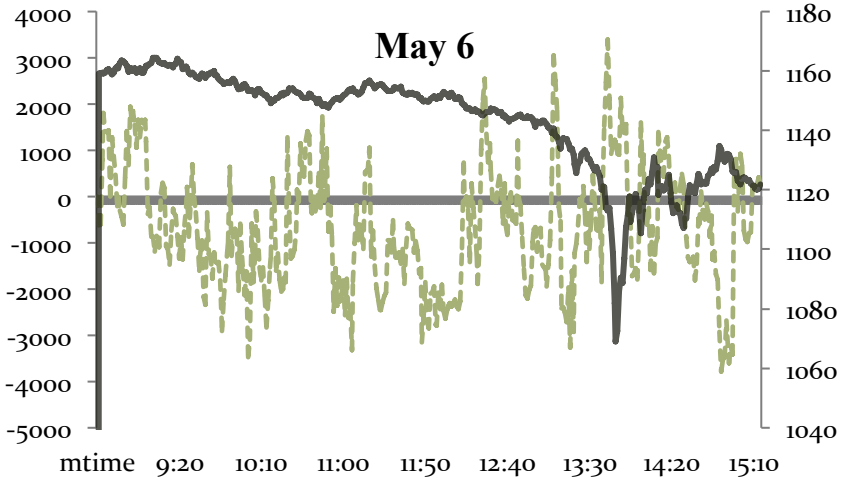


HFTs and Market Dislocations: Net Holdings









The Flash Crash

Large Fundamental Seller – hedges exposure in equities

Sell Algorithm – sell 75,000 E-mini's with 9% volume participation target

Size – Largest net position of the year executed in about 20 minutes

Price Decline – sells 35,000 ($1.9 billion) contracts in 13 minutes

Cross-Market Arbitrage – buy E-mini/sell SPY or basket of equities

Across the Board Price Declines – trigger automated pauses

Lack of Liquidity in Individual Equities – systems reset to reflect higher risk

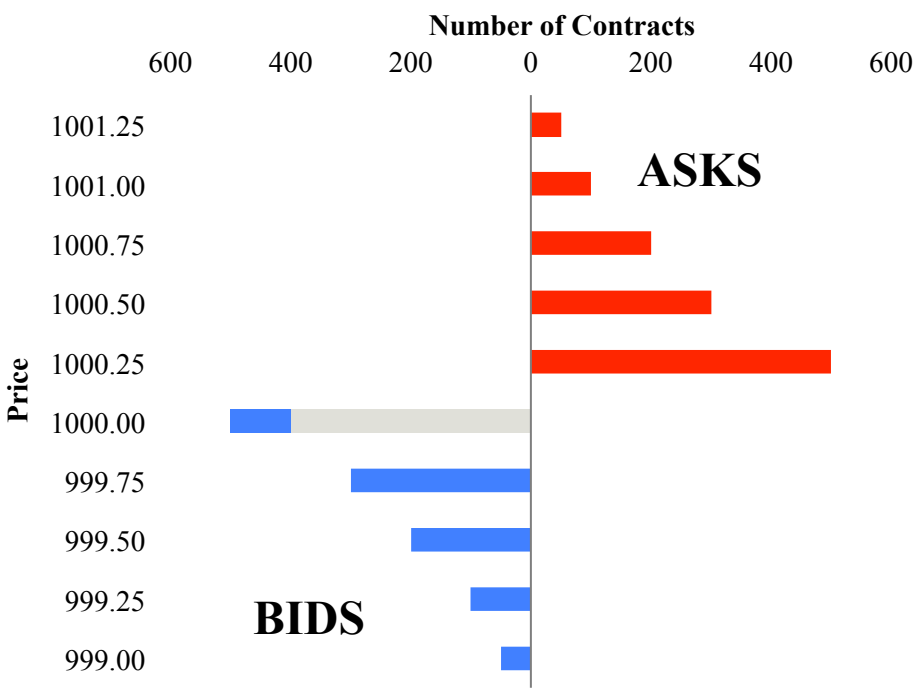
Broken Trades in Equities – retail stop loss orders executed against stub quotes

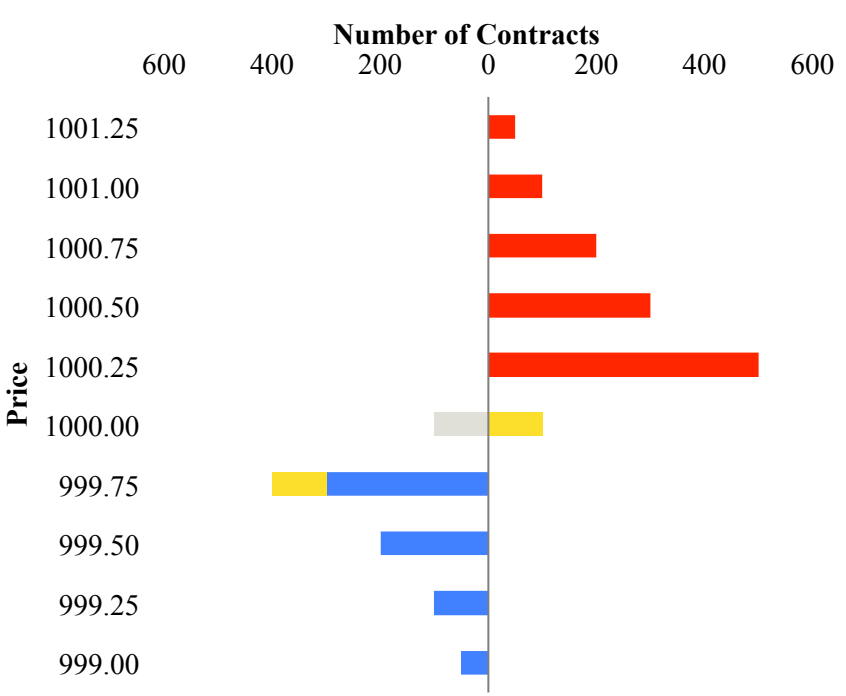
Source: CFTC-SEC Report on the Events of May 6, 2010

HFTs and Market Dislocations: The Flash Crash

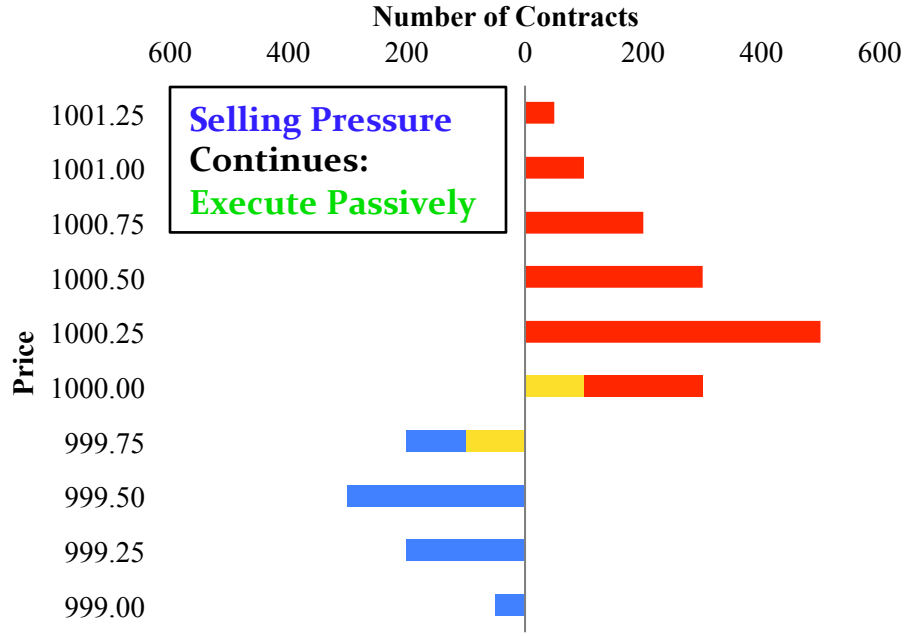
- On May 6, 2010, HFTs traded the same way as they did on May 3-5: Small inventory, high trading volume, take more liquidity than provide.
- High Frequency Traders did not cause the Flash Crash.
- A large, but short lived imbalance between Fundamental Sellers and Fundamental Buyers appeared.
- Opportunistic Traders held it, but for a massive price concession.

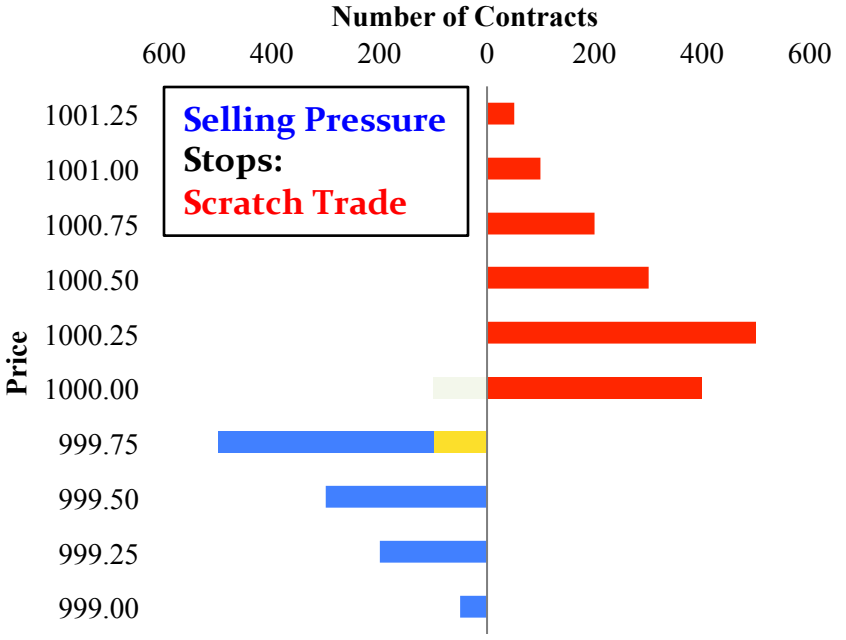
Source: CFTC-SEC Report on the Events of May 6, 2010





"...paying for something we do not want."





HFTs under regular market conditions

(1) Are HFTs profitable?

(2) Do HFTs provide liquidity?

(3) Do HFTs bear commensurate risk?

"The narrowing of spreads that the HFT apologists claim to provide for the rest of us redounds to their bank accounts, not ours."

Classifying HFTs

HFTs:

a. high volume
b. low inventory
c. end the day with near zero positions

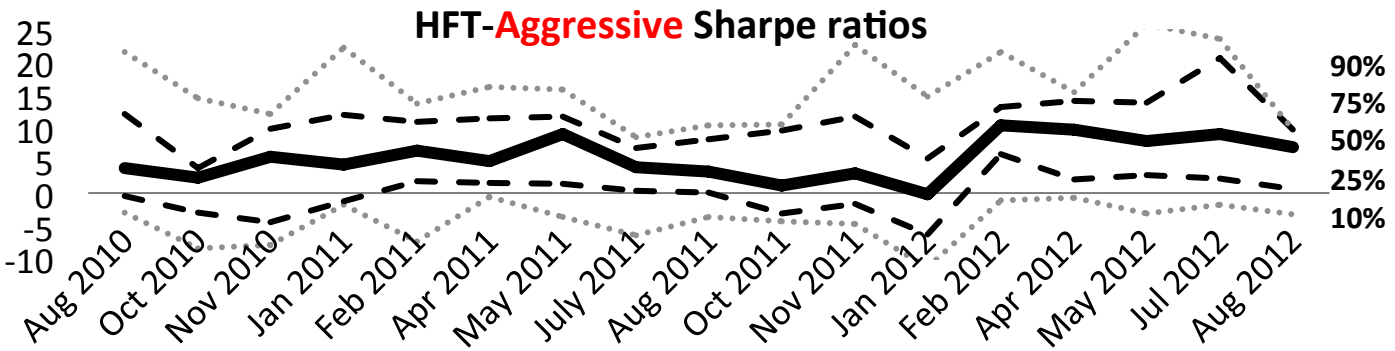
Not all HFTs are the same:

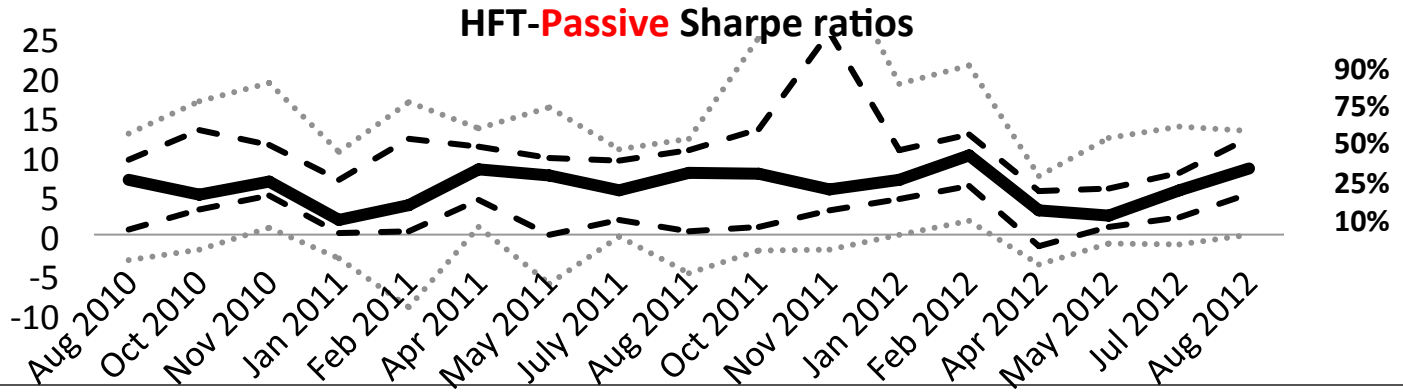
a. Aggressive – HFT + mostly take liquidity
b. Mixed – HFT + both take and provide liquidity
c. Passive – HFT + provide liquidity

Sharpe ratios

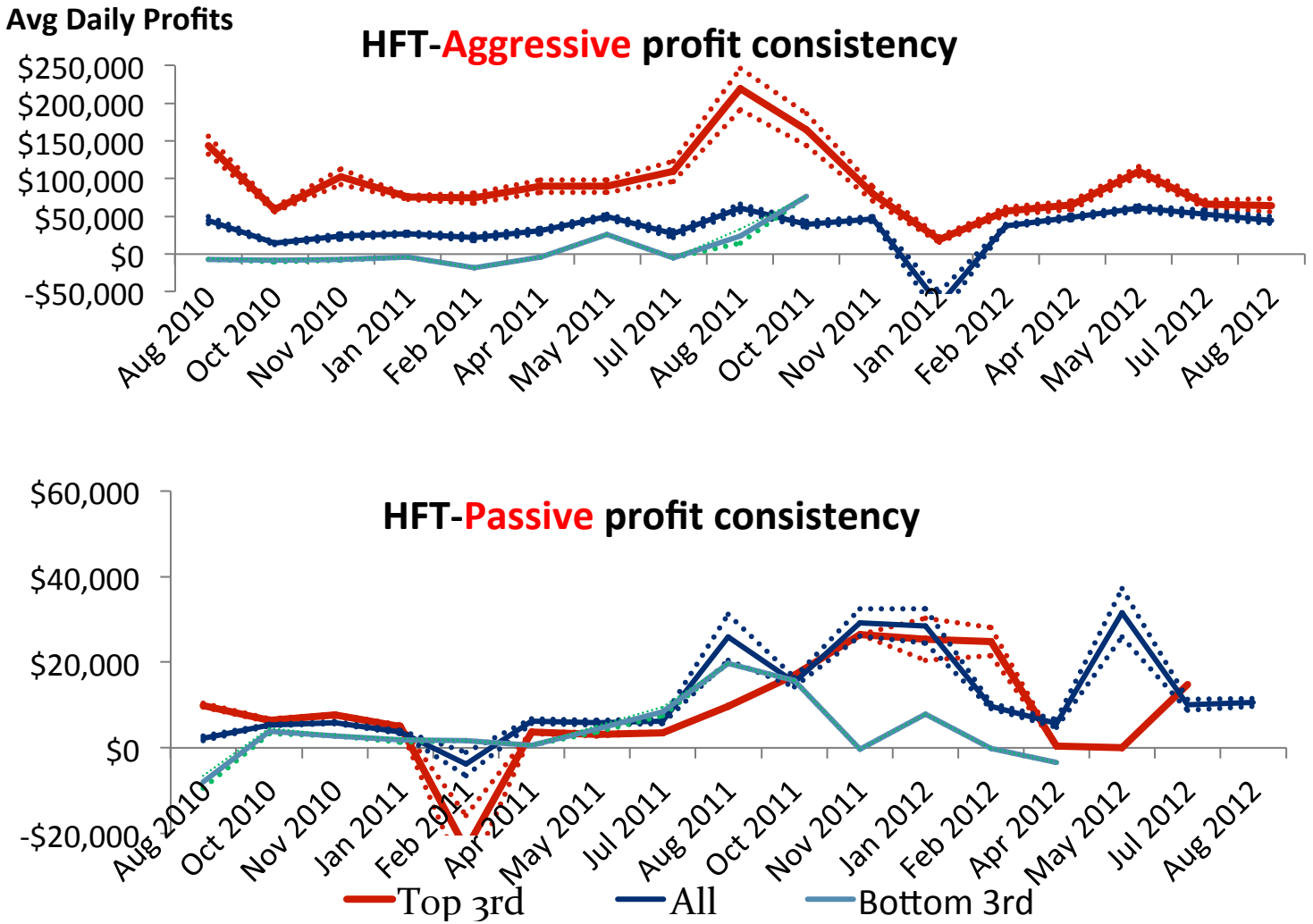
$$\text{Sharpe Ratio} = \frac{E[r_i] - r_f}{SD[r_i]} * \sqrt{252} \approx \frac{E[\pi_i]}{SD[\pi_i]} * \sqrt{252}$$

[Assuming constant capitalization over time and $r_f = 0$]

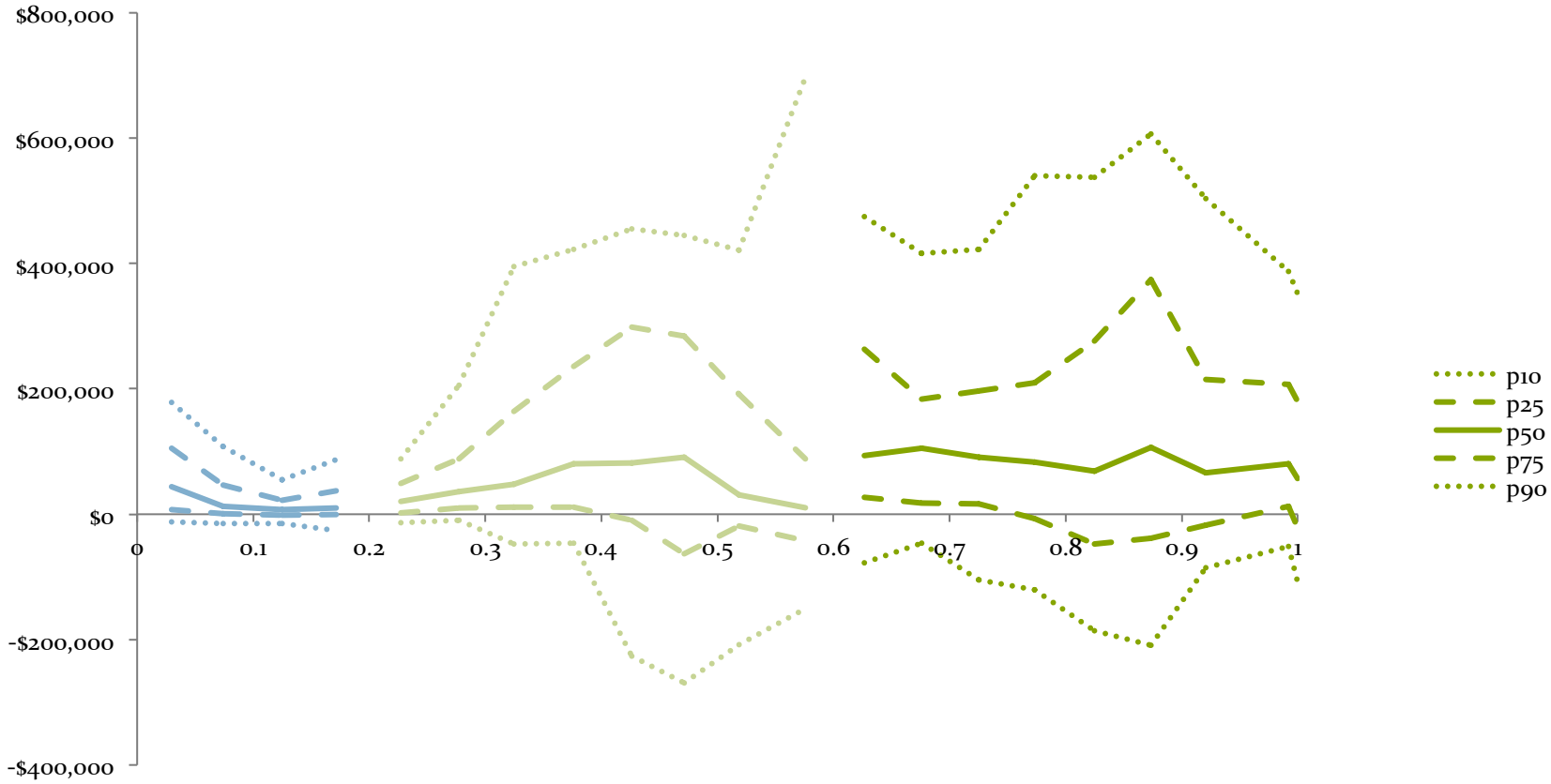




Profit consistency



Providing or Taking Liquidity?



HFTs under regular market conditions

(1) HFT Profitability:
- High profitability, very persistent.
- Very high Sharpe ratios and very low inventory.
- Large variations in profitability across firms.

(2) Sources of HFT Profits:
- Over short time horizons.
- Aggressive HFTs make money on momentum.
- Mixed and Passive HFTs make money on the bid-ask spread.

(3) HFT Liquidity Provision:
- Large heterogeneity in liquidity provision.
- Most profitable HFTs are liquidity takers.

HFTs at times of market stress

1. HFTs trade the same as under regular market conditions.
2. HFTs "hot potato trading" leads to a spike in trading volume.
3. HFTs exacerbate volatility by aggressively unwinding inventory.

HFTs under regular market conditions

1. HFTs earn large, persistent profits, take little risk.
2. HFTs exhibit wide heterogeneity in liquidity provision.
3. HFT profits increase in aggressiveness.

Charlie Munger: "I think the long term investor is not too much affected by things like the flash crash. That said, I think it is very stupid to allow a system to evolve where half of the trading is a bunch of short term people trying to get information one millionth of a nanosecond ahead of somebody else."

What about price discovery?

"…people trying to get information one millionth of a nanosecond ahead of somebody else" … can make prices more informative one millionth of a nanosecond sooner.

What does it mean sooner?

How do we measure the speed of information transmission?

What role do HFTs play in price discovery?

Latency

Latency is the delay between the occurrence of an event and its manifestation or recording.

A standard way to measure latency is by determining the time it takes a given data packet to travel from source to destination and back, the so-called *round-trip time* or RTT.

The data packet we will use is the so-called message.

A message is a standardized packet of data that enables a trader and a trading venue to communicate with each other.

Latency of Automated Trading System

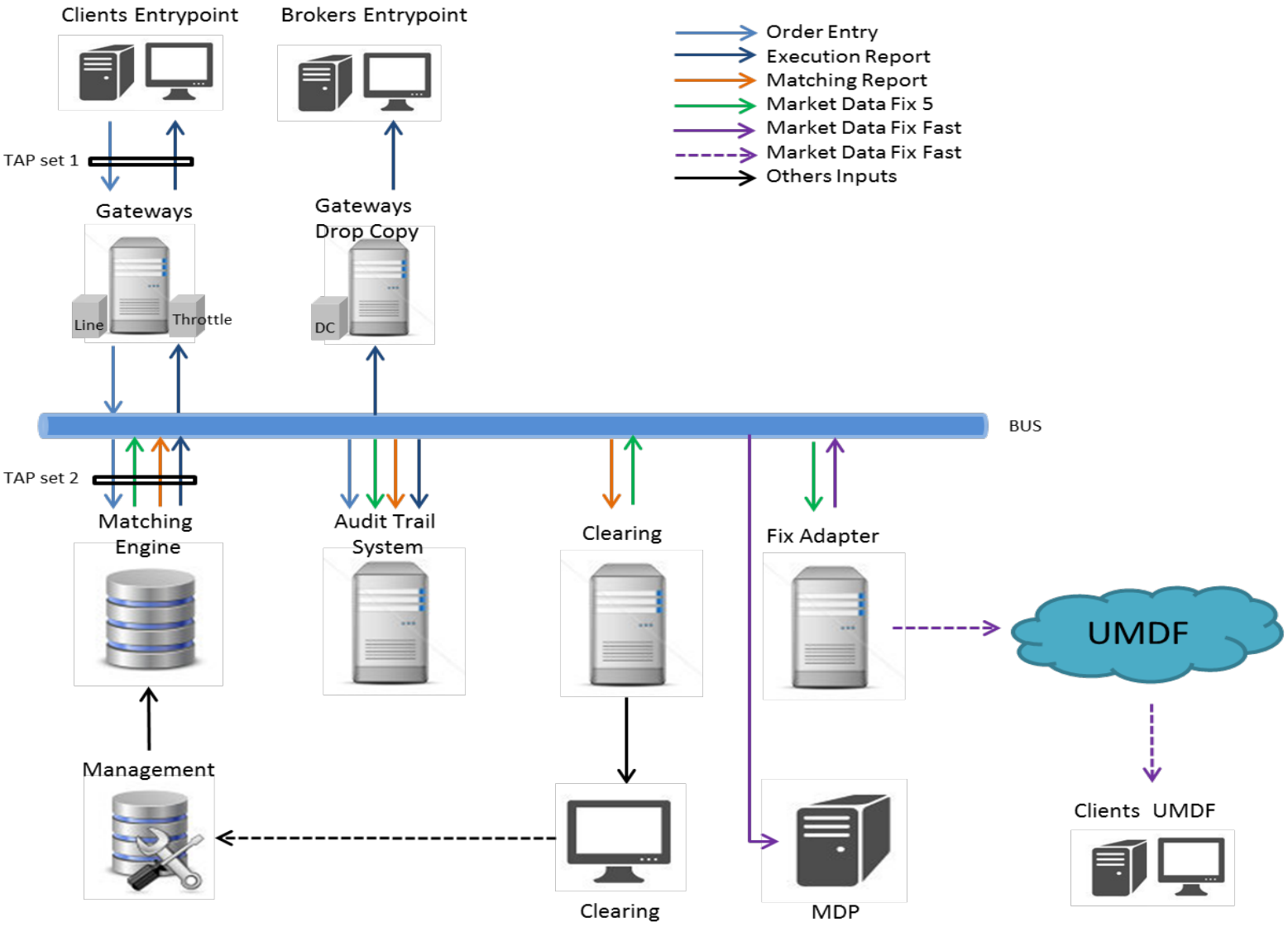
Three different types of latency.

Communication latency is the time it takes for a message to travel between an individual trader's computer and an automated trading venue.

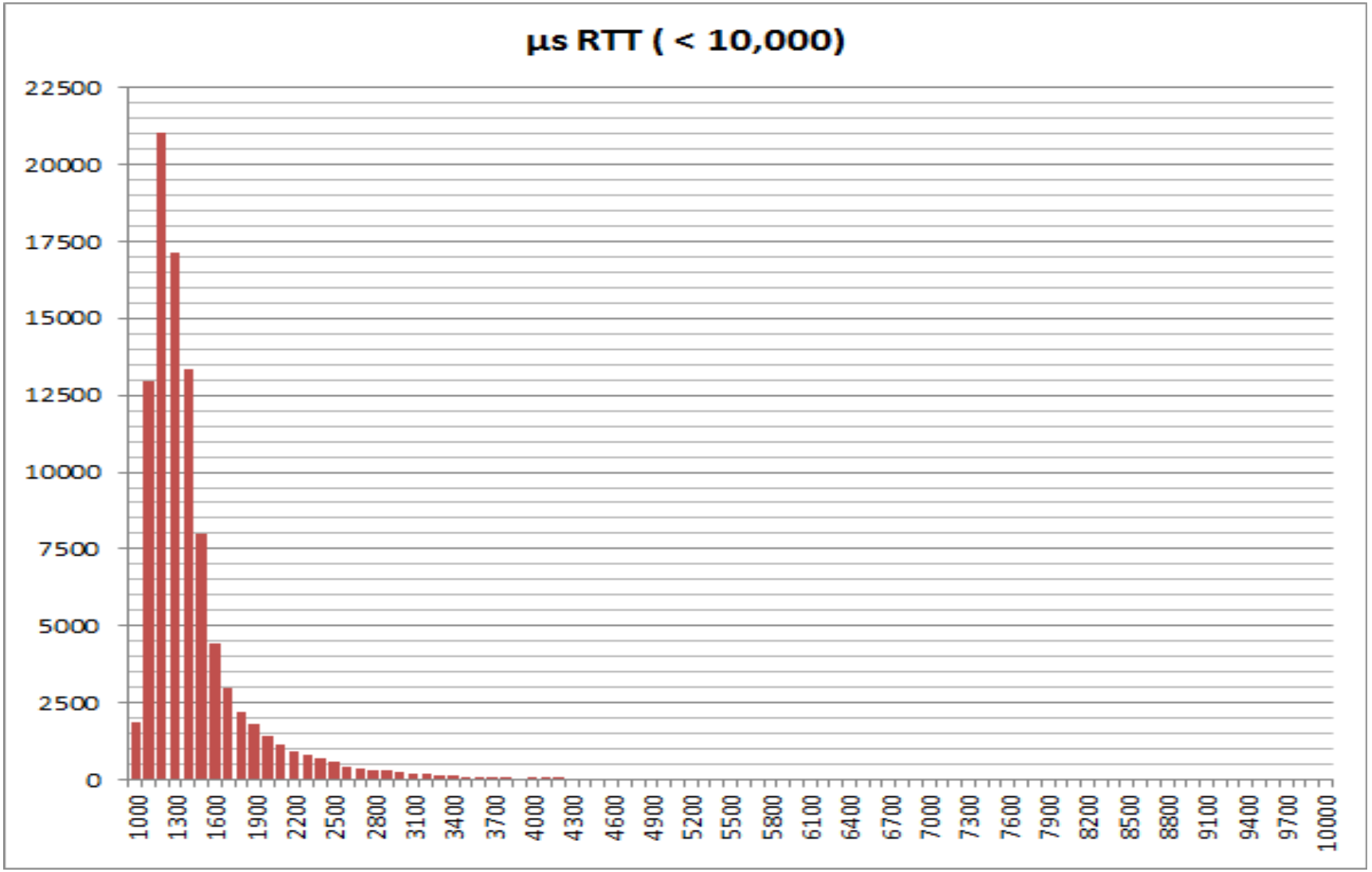
Market feed latency is the time it takes for an automated trading venue to disseminate market data out to all market participants.

Trading system latency is the time it takes for a message to travel within an automated trading venue from the initial entry to the eventual confirmation going back to the trader.

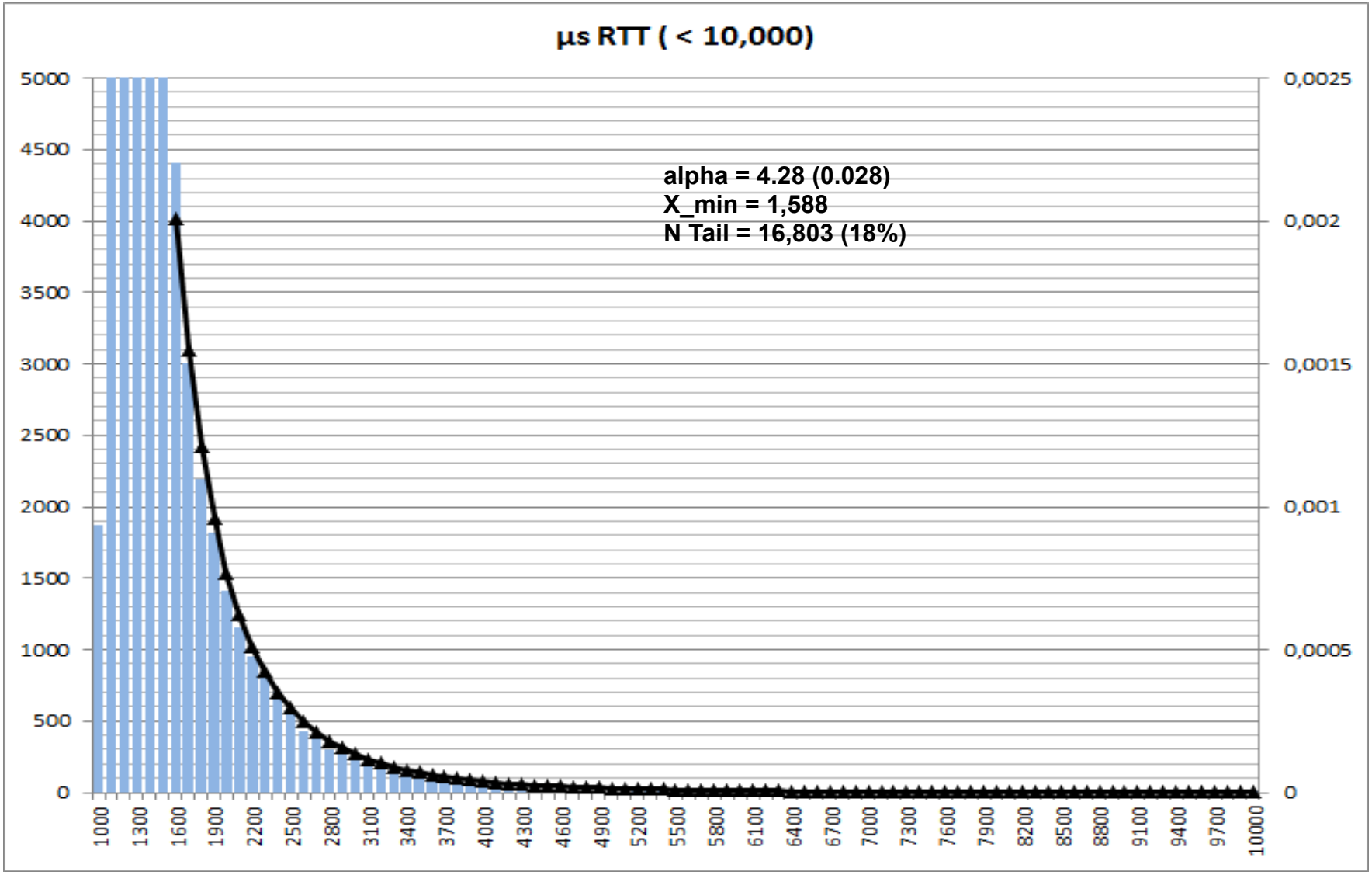
Measuring Trading System Latency



Trading System Latency: It's Random Variable!



Stochastic Latency: Power Law



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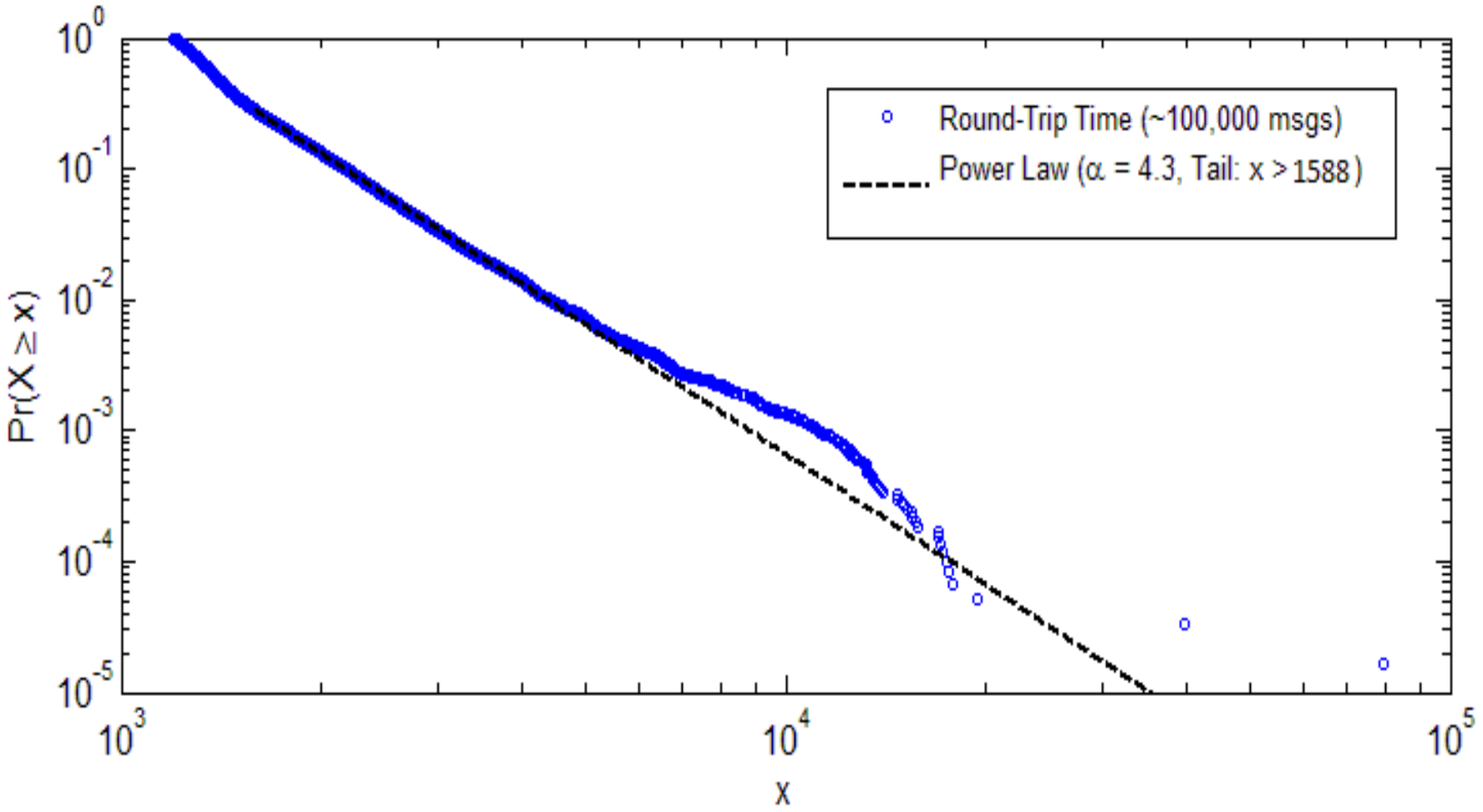
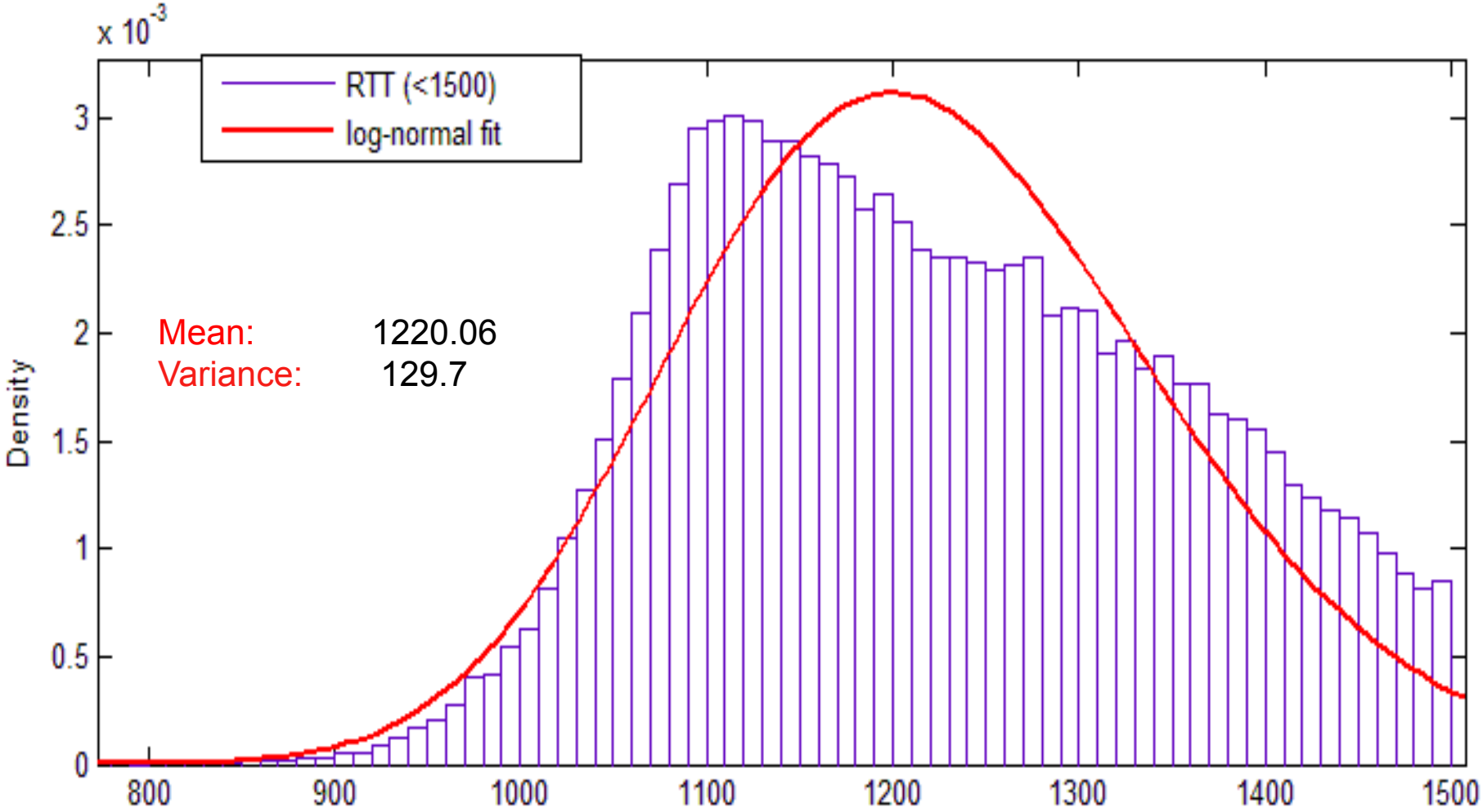
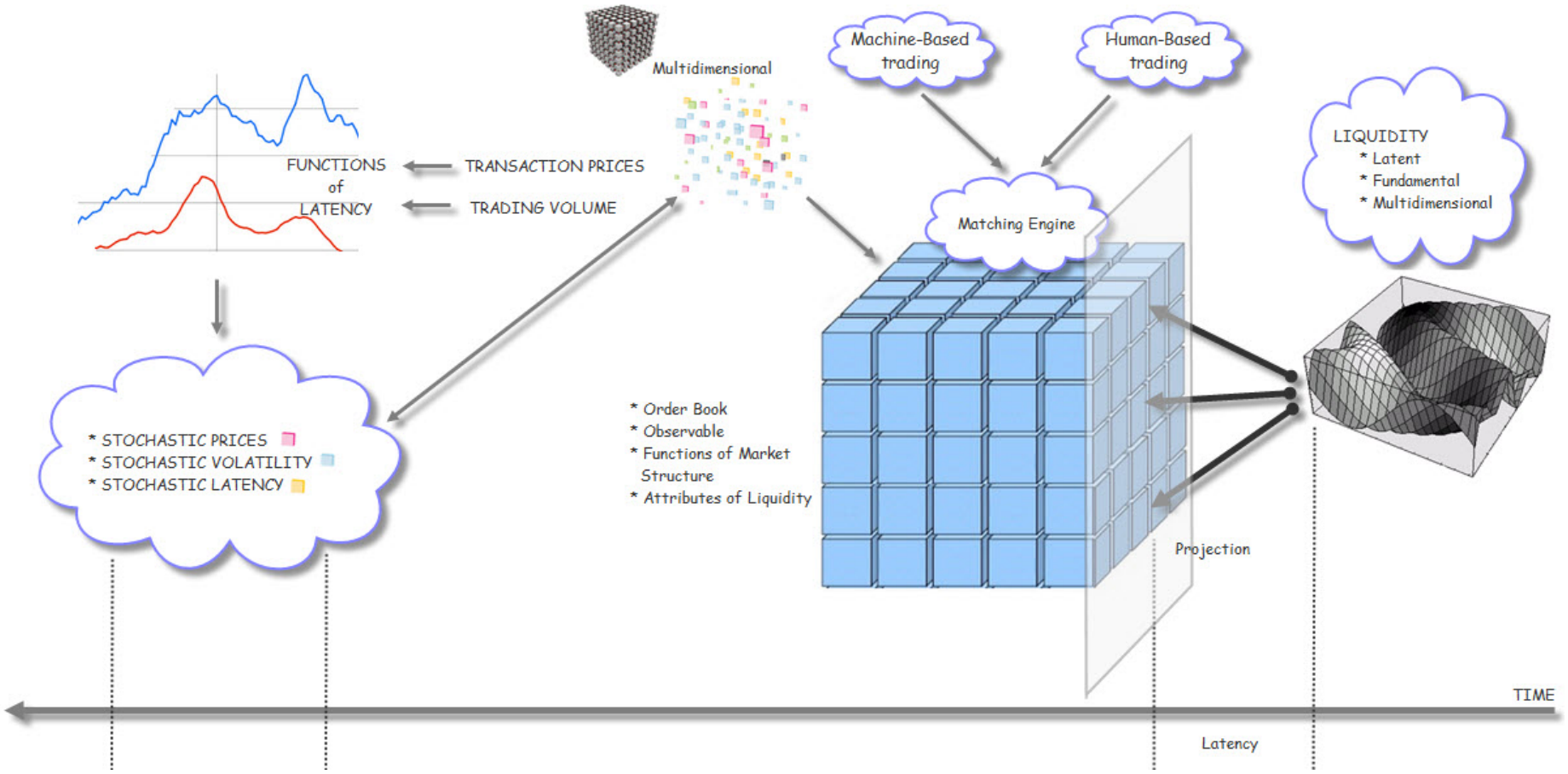


Stochastic Latency: Lognormal



Stochastic Latency: A Risk Factor in Automated Markets

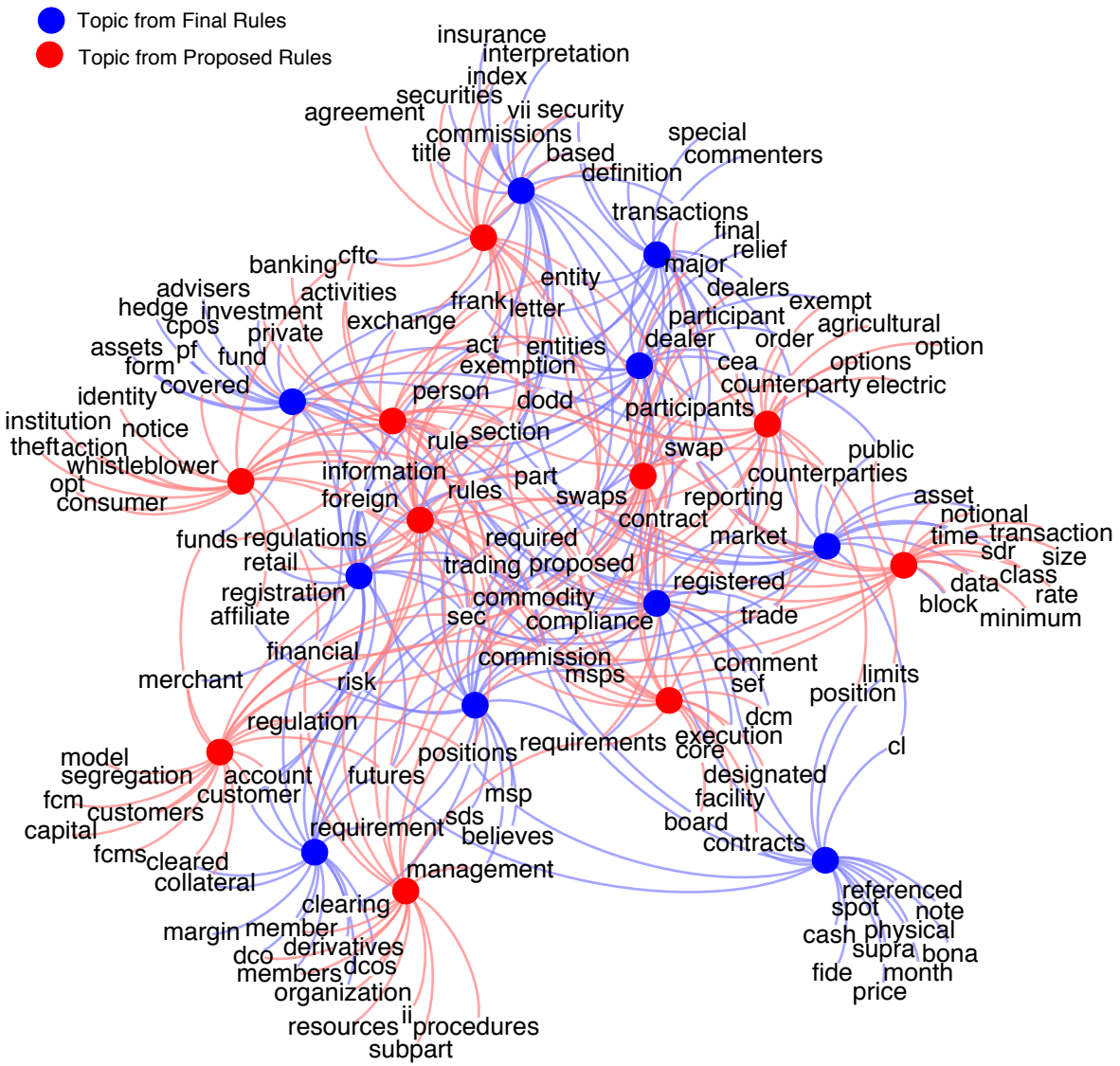


Suppose that there is a true price process with constant or stochastic volatility.

Suppose also that the true price process is observed with a stochastic delay (latency).

Stochastic latency (i.e., it's a random variable) increases the volatility of volatility.

Financial Regulation 1.0



Financial Regulation 2.0

Systems-Engineered. Regulate automated markets as complex systems composed of software, hardware, and human personnel; promote best practices in systems design and complexity management.

Safeguards-Heavy. Make risk safeguards consistent with the machine-readable communication protocols and operational speeds.

Transparency-Rich. Mandate that versions and modifications of the source code that implement each rule are made available to the regulators and potentially the public.

Cyber-centric. Change regulatory surveillance and enforcement practices to be more cyber-centric rather than human-centric.

Platform-Neutral. Make regulations neutral with respect to computing technologies.