High Frequency Market Microstructure

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Overview of High-Frequency Trading (HFT)

HFT = Algorithmic trading using sub-second decision-making.

Focus on speed, data latency, and order execution efficiency.

Operates on tick-by-tick or millisecond data.

Driven by co-location, low-latency hardware, and smart order-routing systems.

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Market Microstructure Essentials

- Defines how orders are placed, matched, and executed.
- Core elements: Order Book, Market Orders vs Limit Orders, Bid–Ask Spread.
- Microstructure Noise: Short-term deviations in price due to discrete transactions.
- Spread = Pask – Pbid;
- Mid-Price = (Pask + Pbid)/2.

BID/ASK	Price	Size
ASK	100.10	100
ASK	100.05	500
ASK	100.00	800
BID	99.95	100
BID	99.90	500
BID	99.85	50

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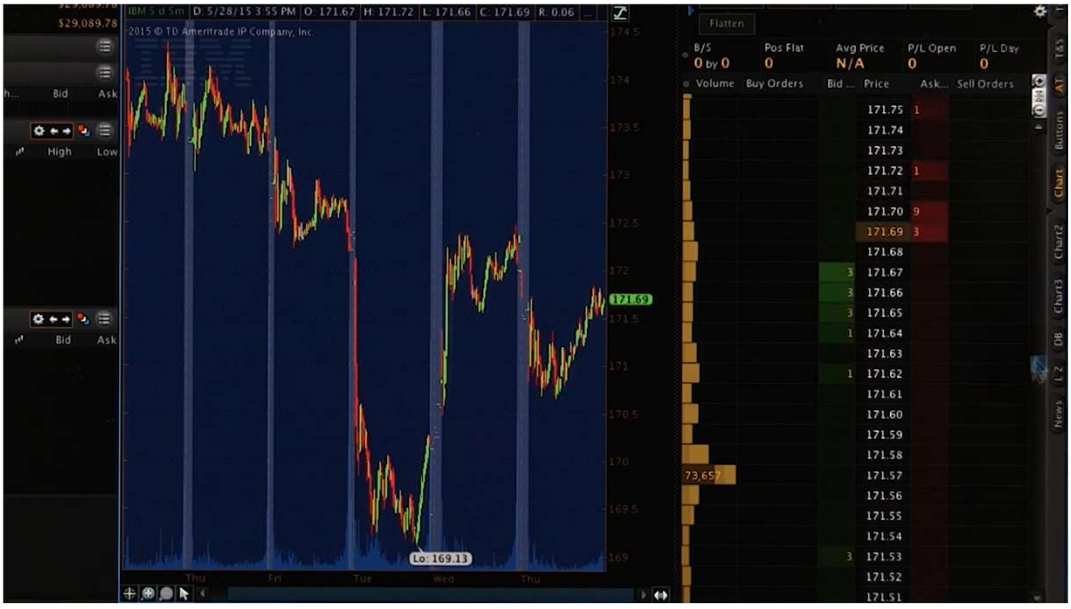
Order book



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Order Book Analytics

Order Book Depth: Quantity available at each price level.

Order Flow Imbalance (OFI): $OFI_t = \Delta Q_{bid} - \Delta Q_{ask}$.

Liquidity Metrics: Depth ratio, Market impact cost, Price resiliency.

Visualisation: Heatmap of order book dynamics or ladder structure.

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Simulation & Execution Strategies

Simulation Goals: Model order arrivals, simulate order book dynamics, measure market impact.

Execution Strategy Types:

– VWAP (Volume Weighted Average Price): Execute trades proportional to volume.

– TWAP (Time Weighted Average Price): Spread trades evenly over time.

– Implementation Shortfall: Minimise cost between decision and execution.

– Sniping / Market Making: Reactive microsecond-scale execution.

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Advanced Microstructure Analytics

High-Frequency Signal Extraction: Price clustering, volatility bursts.

Machine Learning: Predictive modeling of order flow and liquidity.

Reinforcement Learning: Adaptive trading agents.

Stress Testing & Robustness: Extreme market conditions.

Performance Metrics: Sharpe ratio, fill ratio, latency-adjusted PnL.

Conclusion: Precision execution through data-driven strategy optimization.

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Introduction

High frequency trading(HFT):

- speed
- the way traders trade
- the way markets are structured
- the way liquidity and price discovery arise
- Microstructure
- Strategic behaviour

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The high frequency world: High Frequency traders

- The technology that allowed for high-frequency trading was developing over the 1990s, but it was regulatory policy changes intended to increase competition that ushered in the high-frequency era.
- low latency (very fast connections and trading speeds)
- co-location of servers within exchanges and dedicated access to trading information
- ultra-low latency (trading dependent on being at the physical limits of sending orders through time and space)
- enhancement such as Hibernian Express, Perseus Telecom's new microwave network, and new micro-chips

Latency: time it takes to send data to a required end point

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High Frequency traders

Traders: maximize trading strategy against a particular market's matching engine

*The matching engine receives the orders sent to the exchange and determines their **priority of execution**. The matching engine also processes messages regarding the **arrival, execution, and cancellation** of orders*

Exchanges: allow high frequency traders to choose from multiple latencies when connecting to the exchanges' matching system

*Exchanges use different priority rules to sequence orders. The most common rule in equity markets is **price-time priority**. Orders with the best price trade first, and among those with the same price, the first order to arrive has priority.*

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High Frequency traders

- **Market making**: *different from traditional market making in that it is often implemented across and within markets, making it akin to statistical arbitrage; uses historical correlation patterns in price ticks to move liquidity between securities or markets.*
- **Other strategies**: *exploiting the deterministic patterns of simple algorithms such as TWAP(time-weighted average pricing) ; momentum ignition strategies designed to elicit predictable price patterns from orders submitted by momentum traders.*
- **Latency arbitrage**: technical or operational reasons
- **Unethical behavior**

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Non-high Frequency traders(i.e. everybody else)

The strategic trading by everybody else impacts the market in a variety of ways:

- Dark trading has become more important, trade sizes have fallen dramatically.
- Retail trading has also changed. A large fraction of US retail trades are either directly internalised or delivered via purchased order flow agreements to broker-dealer firms.

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Exchanges and other markets

Exchanges and trading venues face intense competition to get the right order flow, avoiding if possible the toxic orders that disadvantage other traders------strategic decisions with respect to market design

- Market's pricing structure
- Multiple trading platforms
- Different order types to appeal high frequency traders
- Access and speed
- Limit the involvement of HFTs

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Microstructure research: Information in a high frequency world

- Trades are not the basic unit of market information – the **underlying orders are**. Adverse selection is problematic because what even is underlying information is no longer clear.
- Even large traders who know nothing special about the asset's value can be lethal to market makers simply because they know more about their own trading plans.

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Microstructure research: Market Data

- Algorithms chop a parent order into child orders, and these child orders (or some portion of them) ultimately turn into actual trades. Unfortunately, neither the market nor the researcher can see these parent orders, and the child orders could have very different properties.
- Dynamic trading strategies mean that these orders need not result in the simple buy and sell trades of times past.

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Microstructure research: Analyzing Data

In the high frequency era, new tools are needed in the microstructure tool box.

Issues connected with consolidated tape*(a digital program providing continuous, real-time data on trading volume and price for exchange-traded securities)*

Data could be out of order

The high frequency world also challenges empirical analyses using quote data.

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Thank You

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