

Automated Market-Making

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Introduction

- How do financial markets work? (at the level of individual participants)
- The Avellaneda-Stoikov Model
- Results on the statistical properties of the limit orderbook

What is a market?

- Multiple buyers, multiple sellers
- Prices determined by trading: literally supply & demand
- So how does trading actually occur inside the exchange?

The limit orderbook

| Side | Price /\$ | Volume |
|------|-----------|--------|
| A | 1.02 | 50 |
| A | 1.01 | 30 |
| - | 1.00 | 0 |
| B | 0.99 | 25 |
| B | 0.98 | 45 |

- *Limit* orders guarantee price but not execution
 - ▶ Limit orders can also be amended/updated for as long as they exist
- *Market* orders guarantee execution but not price
- From a CS perspective, the order book is a *priority queue*

So who is doing the trading?

Market participants

- Investors
- Speculators
 - ▶ What if no one wants to sell? (resp. buy?)
 - ▶ What if buyers and sellers have wildly different indifference prices?
- Dealers

Dealer considerations

Idea:

- Simultaneously place bid and ask limit orders → simultaneously buying and selling
- Enables other market participants to always have someone to trade against
- Narrows the spread between bid and ask prices, increasing efficiency
- Dealer profits the (small) spread between buying and selling (multiplied by a large trading volume)

Risks:

- Informed traders
- Inventory

Modelling dealer behavior

- If large positive inventory, set a lower ask price
- If large negative inventory, set a higher bid price
- If high price volatility, set a wider spread
- Dealer may also have some predetermined risk aversion parameter

The Avellaneda-Stoikov model

Two-step process:

- Given current inventory (& other fixed params), compute indifference price for the asset
- Calibrate bid and ask quotes to the current order book
 - ▶ Consider probability of order execution as a function of distance from mid-price

Statistical properties of the limit order book

- Frequency of market orders: Poisson process (fixed rate)
- Size distribution of market orders: Power law. Exponent is market-specific
- Price impact of large market orders: Logarithmic or square root

Conclusion

- Under a few (potentially unrealistic) assumptions, it is possible to determine what the optimal dealer strategy should be
- No one model for all markets
- Still very much an open field of study bringing together ideas from maths, stats, physics, computer science and economics

Thank you for your attention!

Questions?

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