COMPUTATIONAL FINANCE & RISK MANAGEMENT

UNIVERSITY *of* WASHINGTON

Department of Applied Mathematics

The Business of HFT

CFRM 522 (010)

Introduction to Electronic Trading

Lecture Reference (Reading Assignments)

- Aldridge, Ch 7

- Presentation by Brian Peterson (2016): http://braverock.com/brian/CapeR_2016_backtest.html#1

Key Processes of HFT

- A trading idea that becomes a quantitative model
- Kind of like how a bill becomes a law:

- http://www.schoolhouserock.tv/Bill.html
- https://www.youtube.com/watch?v=tyeJ55o3El0

Key Processes of HFT

- Concept/Prototype
  - Code in a modeling language such as R, Python, Matlab, F# etc
  - Remark: Citigroup (as of 2018) runs almost all of its modeling in R
  - Produces hypothetical profitability on a selection of data
- Backtesting
  - The concept is tested on a large volume of tick data
  - Aldridge: Two years is generally considered a sufficient amount of tick data to ascertain validity
  - Also requires out-of-sample testing (we will cover this later)

Key Processes of HFT

- Paper Trading
  - Emulates real-time trading activity without placing actual orders
  - Keeps track of the orders in a program-generated log
  - Typically a fully programmed HFT system (sandbox)
- Transition to Production
  - Trade execution and real-time portfolio accounting can be complex coding exercises (algorithmic trading in this sense refers to order placement)
  - Have to be executed perfectly to avoid unexpected malfunctions and losses
  - Extended production runs with little capital at stake helps iron out various code issues and ensure a smooth and effective trading functionality

Key Processes of HFT

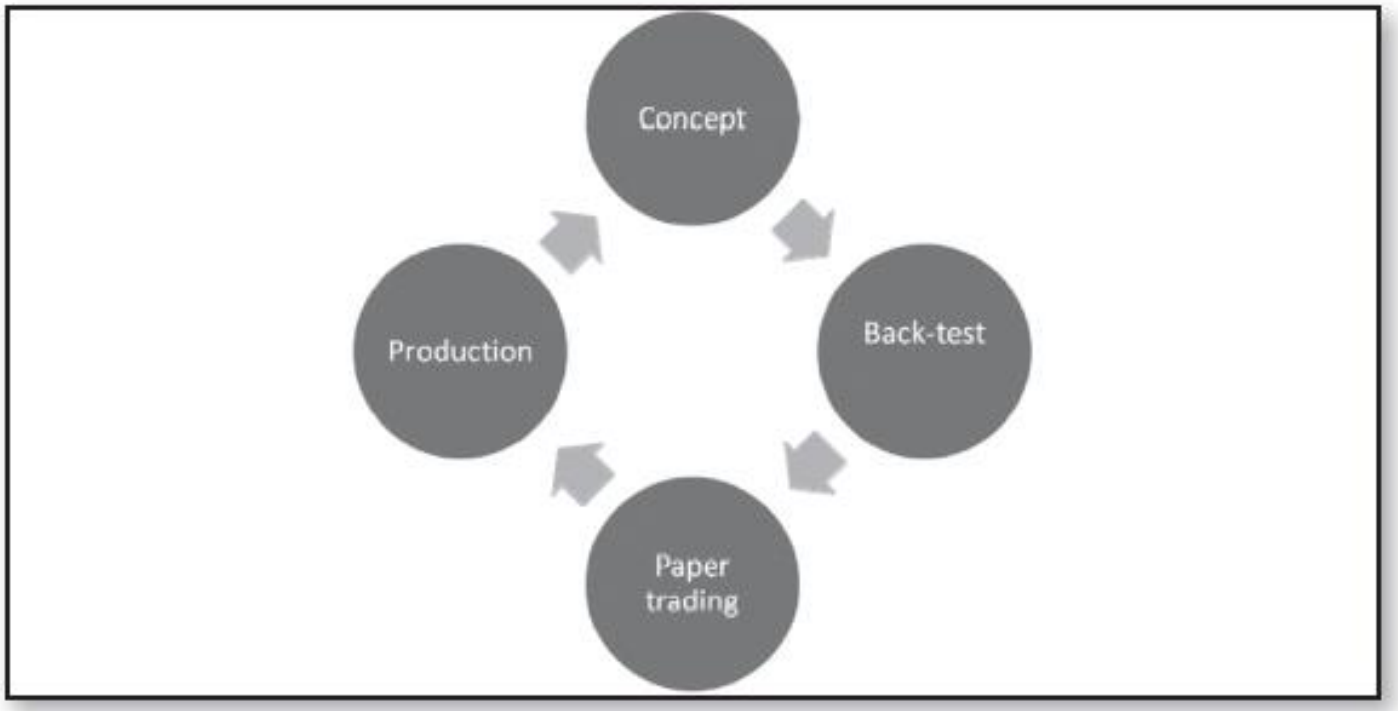

FIGURE 7.1 Algorithm Design and Reevaluation Process

Key Processes of HFT – Some Cold Realities (not in textbook)

- Just advancing to the backtesting phase is a difficult journey
- About 90% of strategies fail before reaching this stage
- Where do strategies fail?
  - Hypothesis level: evidence in market does not support
  - Hypotheses about indicators can fail; measurement insufficient
  - Signal process and prediction: does the signal predict market behavior, or just noise? Again, hypotheses must be formulated and tested before advancing further
  - Strategy implementation: more hypothesis tests

Key Processes of HFT – Some Cold Realities (not in textbook)

- Historical tests
  - Monte Carlo: resample from equity curve
  - Can also resample from transactions (Jaekle & Tomasini)
  - Duration of trade (more sophisticated Monte Carlo)
  - Post-trade analysis vs random trades (probably will see in 523)
- Look-ahead bias – some methods can be valid and useful, but could also be badly misused (eg Combinatorially Symmetric Cross-Validation (CSCV))

Key Processes of HFT – Some Cold Realities (not in textbook)

- Things to Watch Out For, or, Types of Overfitting
  - Look Ahead Bias
    - ➢ directly using knowledge of future events

- Data Mining Bias
  - caused by testing multiple configurations and parameters over multiple runs, with adjustments between backtest runs

- Data Snooping
  - knowledge of the data set can contaminate your choices
  - making changes after failures without having strong experimental design

Backtesting: Art or Science?

- See presentation by Brian Peterson (2016): http://braverock.com/brian/CapeR_2016_backtest.html#1

Back-testing. I hate it - it's just optimizing over history. You never see a bad back-test. Ever. In any strategy. - Josh Diedesch (2014), CalSTRS

Every trading system is in some form an optimization. - Emilio Tomasini (2009)

Financial Markets Suitable for HFT

- Two requirements must be met (Aldridge, p 121):
  - The ability to quickly move in and out of positions, and
  - Sufficient market volatility to ensure that changes in prices exceed transaction costs.
- The ability to move in and out of the market quickly depends on
  - Market liquidity
  - Availability of electronic execution.

Measuring Liquidity (Aldridge, p 122)

- Use the average daily volume of a security as the measure of its liquidity

- In terms of daily average trading volume
  - foreign exchange is the most liquid market
  - followed by recently issued U.S. Treasury securities
  - then equities, options, commodities, and futures

- "Swaps, traditionally traded over the counter (OTC), but entering the electronic era under the Dodd-Frank Act, are on their way to become the most liquid and optimal market for HFT." –Aldridge

- This claim, however, has been refuted by other experts

Costs of Doing HFT Business

- Data
  - tend to be either very expensive or entirely free
  - companies like Reuters and Bloomberg offer tick data for sale for a *significant* premium
  - Broker-dealers and trading venues (eg IB, Fidelity, E*Trade) may offer quality tick data free of charge to prospective traders
- IT
  - Hardware: costs are the least prominent component of HFT operating expenses.
  - Connectivity
    - Co-location
    - Proximity
    - Premium cable network

Costs of Doing HFT Business

- IT (cont'd)
  - Software
    - Computerized generation of trading signals: accepts and processes tick data, generates portfolio allocations and trade signals, and records profit and loss (P&L). Kept in utmost secrecy.
    - Modeling software: R (free), Python (free), Matlab (pricey), F# (available with Visual Studio), Haskell (pure functional programming)
    - Trading software: incorporates optimal execution algorithms for achieving the best execution price within a given time interval.
    - Run-time risk management applications: ensure that the system stays within pre-specified behavioral and P&L bounds
    - Real-time third-party research: streams advanced information and forecasts

Costs of Doing HFT Business

- IT (cont'd)
  - Electronic Execution
    - Executing brokers and ECNs quickly route and execute trades.
    - Goldman Sachs and Credit Suisse are often cited as broker-dealers dominating electronic execution.
    - UBS, Barclays and Quantitative Brokers have been the go-to venues for foreign exchange and fixed income.
    - Execution providers typically charge a per-trade fee, known in advance.

Costs of Doing HFT Business

- Custody and Clearing
  - Safekeeping of trading capital (known as custody)
  - Trade reconciliation
  - Often offered as a “prime” service by broker-dealers
- Staffing costs
  - Hiring UW CFRM graduates!
- Administrative and Legal Costs

Market Participants

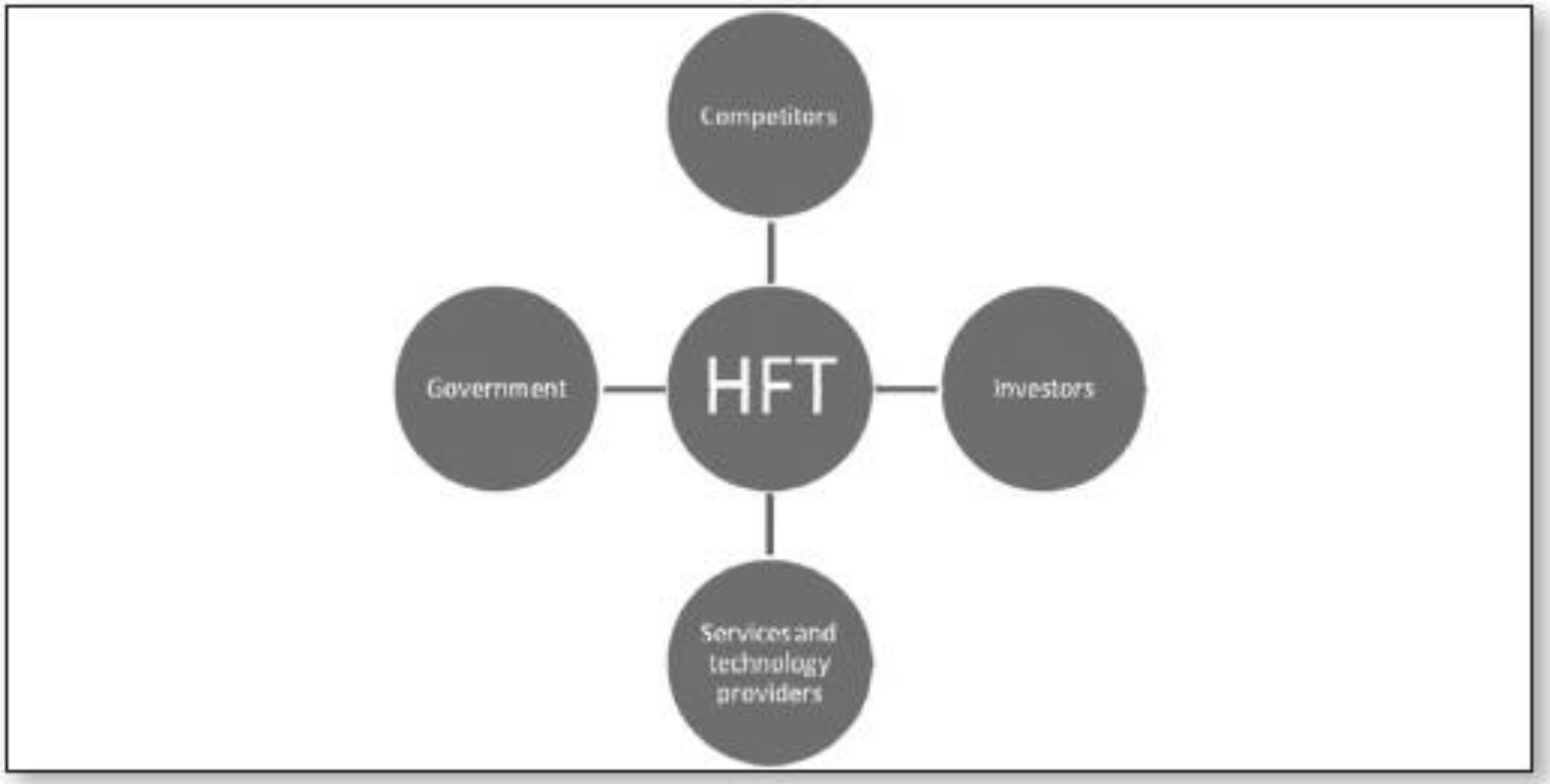

FIGURE 7.4 HFT Industry Participants

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