

NUMERICAL METHOD

The Role of Technology in Quantitative Trading Research

AlgoQuant

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Lecturer Profile

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The Ingredients in Quantitative Trading

- ▶ Financial insights about the market
- ▶ Mathematical skill for modeling and analysis
- ▶ IT skill?

The Research Process

- ▶ Start with a market insight (hypothesis)
- ▶ Quantify and translate English (idea) into Greek (mathematics)
- ▶ Model validation (backtesting)
- ▶ Understand why the model is working (or not)
 - ▶ Performance statistics
 - ▶ Calibration
 - ▶ Sensitivity Analysis
 - ▶ Iterative refinement
 - ▶

Tools Available for Backtesting

- ▶ Excel
- ▶ Matlab/R/other scripting languages...
- ▶ MetaTrader/Trader Workstation
- ▶ RTS/other automated trading systems...

R/scripting languages Advantages

- ▶ Most people already know it.
 - ▶ There are more people who know Java/C#/C++/C than Matlab, R, etc., combined.
- ▶ It has a huge collection of math functions for math modeling and analysis.
 - ▶ Math libraries are also available in SuanShu (Java), Nmath (C#), Boost (C++), and Netlib (C).

R Disadvantages

- ▶ **TOO MANY!**

Generate Trading strategy

- ▶ Identify some “invariance” (properties) in historical data (in-sample without data snooping).
- ▶ Create a quantitative model to describe those properties.
- ▶ Verify if the properties are persistent (out-sample).
- ▶ Create a trading strategy from the analysis.

Backtesting

- ▶ Backtesting simulates a strategy (model) using historical or fake (controlled) data.
- ▶ It gives an idea of how a strategy would work in the past.
 - + It does not tell whether it will work in the future.
- ▶ It gives an objective way to measure strategy performance.
- ▶ It generates data and statistics that allow further analysis, investigation and refinement.
 - + e.g., winning and losing trades, returns distribution
- ▶ It helps choose take-profit and stoploss.

A Good Backtester (1)

- ▶ allow easy strategy programming
- ▶ allow plug-and-play multiple strategies
- ▶ simulate using historical data
- ▶ simulate using fake, artificial data
- ▶ allow controlled experiments
 - ▶ e.g., bid/ask, execution assumptions, news

A Good Backtester (2)

- ▶ generate standard and user customized statistics
- ▶ have information other than prices
 - ▶ e.g., macro data, news and announcements
- ▶ Auto calibration
- ▶ Sensitivity analysis
- ▶ Quick

Iterative Refinement

- ▶ Backtesting generates a large amount of statistics and data for model analysis.
- ▶ We may improve the model by
 - ▶ regress the winning/losing trades with factors
 - ▶ identify, delete/add (in)significant factors
 - ▶ check serial correlation among returns
 - ▶ check model correlations
 - ▶ the list goes on and on.....

Bootstrapping

- ▶ We observe only one history.
- ▶ What if the world had evolve different?
- ▶ Simulate “similar” histories to get confidence interval.
- ▶ White's reality check (White, H. 2000).

Some Performance Statistics

- ▶ pnl
- ▶ mean, stdev, corr
- ▶ Sharpe ratio
- ▶ confidence intervals
- ▶ max drawdown
- ▶ breakeven ratio
- ▶ biggest winner/loser
- ▶ breakeven bid/ask
- ▶ slippage

Omega

- ▶ $\Omega(L) = \frac{\int_L^b [1-F(x)]dx}{\int_L^b [F(x)]dx} = \frac{C(L)}{P(L)}$
- ▶ The higher the ratio; the better.
- ▶ This is the ratio of the probability of having a gain to the probability of having a loss.
- ▶ Do not assume normality.
- ▶ Use the whole returns distribution.

Calibration

- ▶ Most strategies require calibration to update parameters for the current trading regime.
- ▶ Occam's razor: the fewer parameters the better.
- ▶ For strategies that take parameters from the Real line: Nelder-Mead, BFGS
- ▶ For strategies that take integers: Mixed-integer non-linear programming (branch-and-bound, outer-approximation)

Sensitivity

- ▶ How much does the performance change for a small change in parameters?
- ▶ Avoid the optimized parameters merely being statistical artifacts.
- ▶ A plot of measure vs. $d(\text{parameter})$ is a good visual aid to determine robustness.
- ▶ We look for plateaus.

Summary

- ▶ Algo trading is a rare field in quantitative finance where computer sciences is at least as important as mathematics, if not more.
- ▶ Algo trading is a very competitive field in which technology is a decisive factor.