Quantitative Risk and Trading Examples
and Finding Your First Job

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Quants in Banks

- Profile: Large institutions: 10K - 200K employees, Large AUM: 10B – 2T
- Investment Banks: Barclays, Goldman, Morgan Stanley, UBS
- Commercial Banks: BAML, Citi, HSBC, JPM Chase
- Many Types of Quants in Banks:
- Pricing/Modeling, Research, Risk, Strats, ~~Trading~~

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Bank Quant Daily Workflow

- Pricing/Modeling: Develop models for modeling dynamic quantities, including interest/FX rates, stock/bond prices, and credit profiles of products (positions are in decline after crisis).

- Risk: Develop models to understand risk profiles of financial products that the bank holds. Develop portfolio risk metrics including VaR, CVaR, etc. Implement Dodd-Frank regulation.

- Strats: Jack of all trades quants responsible for the quant work of a specific desk. Work with traders, IT, risk, and business managers to address a variety of problems.

- Research: Develop new ideas related to the above. Promising ideas make it into the bank's codebase and are often integrated by modelers or strats into production systems.

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Hedge Funds/Prop Shops

- Profile: Small companies: 10 - 1K employees, Small-Medium AUM: 50MM - 5B (typical) 10B - 100B (large).
- Hedge Funds and Proprietary Trading shops differ from banks in that most of their revenue comes from trading with client or house funds.
- Less regulated than banks, are generally more risky from a career perspective but typically have better upside potential than banks.
- Quant Hedge Funds: Two Sigma, D.E. Shaw, KCG, Teza.
- "Traditional" Hedge Funds: Duquesne Capital, Paulson & Co., Tiger Mgmt. Corp
- Mixed Hedge Funds: Citadel, AQR, Bridgewater

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Hedge Fund Quant Jobs

- Mid-Frequency Algo Trading: Use math, statistics, optimization, and machine learning tools to work with traders to find the best trading strategies subject to certain constraints

- Market Making: Post bid/ask prices for products that they trade in and try to capture the spread. Have to manage the size of inventory and consider trading market impact and execution issues.

- HFT: Execute trades at very high speeds (on the order microseconds) and need quants who can implement relatively simple algorithms in terms of model complexity in a highly optimized manner in say C/C++.

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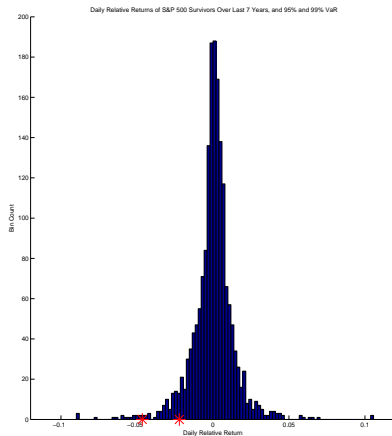
Fund Advisors/Asset Managers

- Profile: Advise endowments, pension funds, corporations, and high net worth individuals on where to invest their money. Create their own mutual funds and ETFs.
- Tend to have 100B - 3T in AUM but charge very low fees.
- Asset Managers: Vanguard, PIMCO, Fidelity
- Fund Advisors: Dimensional, Nuveen

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Asset Manager Quant Jobs

- Asset Allocation and Portfolio Construction: Variations of the Markowitz portfolio, how to "tax optimize" portfolios.

- Trade Execution: Understand potential market impact issues when executing large trades on behalf of clients (e.g. Wadell & Reed and the 2010 Flash Crash).

- Risk/Hedging Quants: How does one minimize downside (i.e. "tail") risk for different types of portfolios? How does the hedging effect the expected return of the portfolio?

- Research Quants: Look into issues that are most relevant to clients sometimes on a case by case but more often on an aggregate basis and typically write results in the form of newsletters that are distributed to clients.

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Risk Metrics
The Greeks
Regulatory Requirements

Portfolio VaR Estimation

- For a given portfolio, how much should one expect to lose on the worst day over a 20 or 100 trading day period?

- Addressing this problem involves estimating the quantiles of the return distribution of the portfolio.

- Use empirical, parametric, non-parametric methods.

- What fundamental reasons cause the large losses?

Daily Relative Returns of S&P 500 Survivors Over Last 7 Years, and 95% and 99% VaR

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Portfolio Sensitivities to Market Variables

- For a given portfolio, what is the P&L impact when underlying market variables change?

- Common variables that traders consider are interest (LIBOR) rates, r, credit (CDS spreads) c, and portfolio volatility σ.

- There are many ways to estimate these sensitivities to build a risk profile for a portfolio.

- Linearize the portfolio's price:

$$P \approx \frac{\partial P}{\partial r} dr + \frac{\partial P}{\partial c} dc + \frac{\partial P}{\partial \sigma} d\sigma + \cdots$$
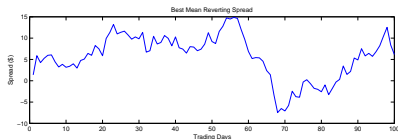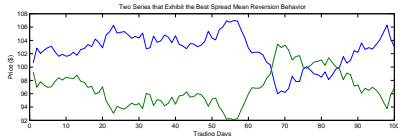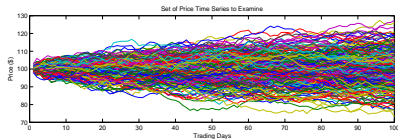
- Estimate the partials either using a model or by empirical means.

- Perform a scenario analysis, e.g. if $r \to r + \Delta r$ and $\sigma \to \sigma - 2\Delta\sigma$, then we have $P \to P + \Delta P$, what is ΔP?

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Complying with Dodd-Frank

- The Federal Reserve designed a new set of stress tests as part of the Dodd Frank Act to test whether or not banks will remain well capitalized during extreme economic environments such as during the financial crisis.

- To this point, only about half of the new Dodd-Frank mandates have been implemented at large bank holding companies.

- Failing stress tests or missing deadlines to implement regulatory requirements can result in increased regulatory scrutiny or large fines for banks.

- Risk Quants oversee the implementation of these requirements and interact with regulators to explain their models and ensure them that they satisfy external mandates.

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Finding an Optimal Strategy
Using NLP to Construct Market Signals
Making Markets

Best Mean Reverting Pair

- Given a set of 1000 stocks price time series, which two have a spread that mean reverts more strongly than any other pair?

- What is the time scale of the mean reversion?

- Does any stock's price movements lead or lag another? What time scale does this lead/lag relationship hold on? Daily, minute, second, shorter?

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Using NLP to Predict Price Jumps

- How does unexpected news and quarterly report information correspond to large moves in stock prices?

- Can you develop software that "reads the news" faster than a human?

- What does it take to build a robust system to quickly execute trades on these signals?

Heeyoung Lee[1]   Mihai Surdeanu[2]   Bill MacCartney[3]   Dan Jurafsky[1]

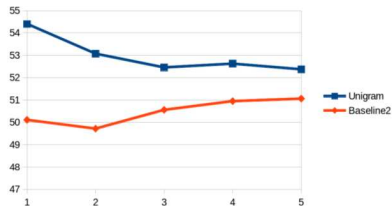[1] Stanford University, Stanford, California, USA
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Abstract

We investigate the importance of text analysis for stock price prediction. In particular, we introduce a system that forecasts companies' stock price changes (UP, DOWN, STAY) in response to financial events reported in 8-K documents. Our results indicate that using text boosts prediction accuracy over 10% (relative) over a strong baseline that incorporates many financially-rooted features. This impact is most important in the short term (i.e., the next day after the financial event) but persists for up to five days.

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Managing Inventory

- Market makers provide liquidity by simultaneously posting bid and ask prices for a set of securities in which they specialize to try to capture the spread.

- What levels do you set your bid/ask values at? They higher the bid, the more likely you are to purchase a security and increase your inventory.

- The lower the ask, the more likely you are to sell which can impact the market.

- How can you dynamically update your bid/ask values to reflect your market views, minimize market impact, and run a profitable business?

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Skills to Develop
Interview Advice

Math/Stats Skills

- Candidates with strong mathematics and statistics skills are highly sought after by employers.
- Math: Basic Probability Theory, Stochastic Processes, Linear Algebra, PDE, Optimization.
- Stats: Regression (linear, non-linear, non-parametric), Density Estimation, Monte Carlo Simulation.
- Machine Learning (Stats on Steroids): Classifers and Regression: SVMs, Neural Nets, k-means, etc.
- Book References: Wasserman: All of Statistics, All of Nonparametric Statistics.
- Software References: Python: scikit-learn, NumPy, SciPy. C++:Boost, Num. Recipes. MATLAB: Optimization, Stats Toolbox.

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Skills to Develop
Interview Advice

Programming Skills

- Quants will typically focus on either developing prototypes or writing production quality code.
- Prototyping Languages: Python (and supporting modules), MATLAB, R, Mathematica, and to a lesser degree Stata, SaS.
- Production: C/C++, Java, C#, legacy Fortran systems.
- Other: Linux/Unix, Excel/VBA, Git, SVN

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Skills to Develop
Interview Advice

Finance/Practical Skills

- Develop an understanding of how math/stats methods can be applied in practice.
- Practice explaining things you learn in class to your non-technical friends trying to get the high-level/big picture point across.
- Book References: Bouchaud and Potters, Theory of Financial Risk and Derivative Pricing. Hull, Options Futures and Other Derivatives. McNeil, Frey, Embrechts. Quantitative Risk Management.

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Skills to Develop
Interview Advice

Searching for a Job

- Finding a Quantitative Finance Job is 50% Luck, 30% Skill, and 20% Timing!
- The probability of getting any one job, *PJ*, is given by:

  $$PJ = \min\left[1, 0.5\ \mathcal{U}(0,1) + 0.3\ln\mathcal{N}(0, \sigma_{\mathrm{Skill}}) + 0.2\ \mathcal{N}(0, \sigma_{\mathrm{Time}})\right]$$

- Apply to as many jobs as possible that peek your interests during your job search.
- Try to contact recruiters directly and ask them to forward your resume to the hiring manager. Applications through websites of large corporations often are not routed to the correct people.
- Try to do at least one internship during school.
- Do not get discouraged, the process can take months and persistence often pays off!

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Skills to Develop
Interview Advice

Before/After an Interview

- Research the company you are speaking with prior to your interview and prepare questions relevant to the position you are seeking.

- Make sure you focus on the needs of the company during the interview and demonstrate how you can use past experience you have developed to solve their problems.

- Do not BS the interviewer and do not overly exaggerate or embellish your past accomplishments.

- Be ready to explain everything on your resume.

- Write a thank you note to every person that interviews you. Hit on things that were discussed during the interview and reiterate your interest in the position. If they do not give you their contact info, send the notes directly to the recruiter.

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Last Comments/The End

- Use LinkedIn
- Feel free to ask questions:
- Contact Info: steve98654-at-gmail-dot-com
- Thanks for Listening!