The Business of Quant

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Administrivia

- **Thank You!**
- Please do give feedback! http://tiny.cc/quant2021

- Contacting the instructor: Rohit Singh (rsingh@mit.edu)
- Slides will be available at http://people.csail.mit.edu/rsingh

Guest Speakers

Sanjiv Kumar
Co-founder and CIO
FORT LP
4:45-5:30pm

GameStop…

Short alpha works but.... is prone to a squeeze. Also, risk management is huge!

Recapping last week

- Factor investing
- Anticipating flows

Anticipating Flows

"Skate to where the puck is going"- Wayne Gretzky

Figure out what the big guys will buy tomorrow and buy it today

- Index rebalance and smart-beta flow
- Hedge fund and mutual fund holdings reports (13F)
- Prime brokerage reports
- Short Interest

Statistical “Arbitrage”

Relations between stocks follow some historical patterns:

- Co-integration and pairs trades
- Larger stock groupings (sector/factor)
- Supplier-consumer relationships

Can be both reversion and momentum, but the former is more common

Popular set of quant strategies

- Relatively short holding periods
- Good sharpe
- Good capacity

Trying your ideas…

Caveat: This is not investment advice!!

- The Python package 'yfinance' also has open, high, low, close data.
- Fundamentally-driven:
  - Get the 11 S&P sector ETFs (sectorspdr.com) and match a stock S to its sector ETF E
  - Fit stock return as a function of ETF returns:
    - $r_S \sim \beta r_E + \epsilon$
  - Check if residual is mean reverting
  - Do top vs. bottom decile portfolios
- Statistically-driven:
  - Similar to above, but first get 2 years of trailing return data and compute a PCA of stock returns
  - Fit stock return as a linear function of the first few PCs
    - $r_S \sim \beta_1 r_{PC1} + \beta_2 r_{PC2} + \beta_3 r_{PC3} + \ldots + \epsilon$
  - Rest is similar to above

Trying your ideas…

Caveat: This is not investment advice!!

- Other ideas:
  - Try out combinations. Also look at volumes and high/lows.
- More reading
  - Avellaneda et al. , *Statistical Arbitrage in the U.S. Equities Market*
  - Kakushadze et al., *Mean-reversion and optimization*
  - Kakushadze et al., *101 Formulaic Alphas*
    - Watch out with this paper-- it's a little crazy!

Alpha#101: ((close - open) / ((high - low) + .001))

Alpha#41: (((high * low)^0.5) - vwap)

High Frequency Trading

Key characteristics:

- Lots of frequent trades
- Close all positions by end of day
- High Sharpe

The growth of HFT over the years

- Took off after decimalization in 2001 and as markets become electronic
- Replacing the old market-makers
- Ideas from other parts of quant (esp stat-arb) started filtering in
- Did fantastically well for many years (esp 2008). More crowded now, but recent period has been good.

Three kinds of themes: market-making, flow, and gaming

HFT: Market-Making

Market-makers provide a service:

- always be willing to take the other side of a trade

They charge a payment for this service:

- Bid-ask spread

They have existed for a very long time:

- Previously: floor brokers, specialists etc.
- Now: HFTs

Math & Technology in Market-Making

Good for a market-maker

Bad for a market-maker

Order Book: the last person in the queue sees the worst adverse selection

https://www.saturn.network/blog/how-profitable-is-market-making-on-different-exchanges/
https://betterexplained.com/articles/what-you-should-know-about-the-stock-market/

HFT brought you zero-fee trading

https://www.cnbc.com/2019/04/18/a-controversial-part-of-robinhoods-business-tripled-in-sales-thanks-to-high-frequency-trading-firms.html

HFT: Structural/Arbitrage Based

- Index Arbitrage
  - Markets contain a lot of derived, second-order instruments
  - When trading independently, the two can get out of sync
  - Bringing them back into sync is profitable.

- Geographic or Asset-Class conversions
  - S&P500 futures in Chicago & SPY in New York
  - Dual-listed Canadian stocks
  - ADRs

The Gory Details:
Portfolio Optimization, Ops, Execution Costs

Probability	Scenario
	Win $2
	Lose $1
Total Expected Outcome	(50% x $2) + (50% x -$1) = $0.50

$$\frac{\text{Edge}}{\text{Odds}} = \frac{\$0.50}{\text{Win } \$2}$$

Kelly Criterion

$$\text{Minimize} \quad \mathbf{w}^T \Sigma \mathbf{w}.$$

$$\text{Subject to} \quad \mu^T \mathbf{w} \geq \mu_b, \quad \omega^T \mathbf{w} = 1 \quad \text{and} \quad \mathbf{w} \geq \eta$$

Mean Variance Optimization

Other concerns:

- Shorting costs
- Holding period vs transaction costs
- Operations

http://datascience.uconn.edu/index.php/projects/students-work/item/122-portfolio-optimization-in-python-group8
https://www.valuewalk.com/2018/04/investing-with-the-kelly-criterion-model/

Building Quant Businesses

Combining the Edges

Very few of these ideas are run in isolation

- Even with a Brawn or Bravery strategy, attempt to put a Brains edge

Mix longer and shorter horizon views:

- For longer turnover strategies, use shorter views for timing
- For shorter turnover strategies, use longer views as biases or “soft” pushes

Asset Management

- **Basic model: “I’ll try to grow your money; You pay me a fee”**
- Four ways of charging fees:
  - Per-transaction (brokers and some wealth management advisors)
  - Fixed (for small accounts, typically)
  - Percentage of assets
  - Percentage of assets + Percentage of gains

Mutual Funds

- Need to be open to all
- Minimal Leverage
- Liquid instruments
- Daily Pricing
- No performance fee!

HF + PE + VC

- Accredited investors (>$200K income or >$1M assets)
- Reporting requirements in some cases
- Fairly loose rules
- Charge what the market will bear

HF vs VC vs PE

Hedge Funds vs Private Equity / Venture Capital

- Public markets ⟷ Private markets
- Management fee in both
- Performance fee ⟷ Carry
- Capital on 1st day ⟷ Capital Calls
- Mark to market ⟷ Mark to ???
- Liquid ⟷ Illiquid

http://www.sigmavaluation.com/hedge-pe-funds/

The Hedge Fund Business

AUM	Gross Returns	Management Fee	Performance Fee	Net Return	HF Revenue	HF Costs	HF Profits
$1M	10%	2%	20%	6.4%	$36K	$0.4M	-$364K
$25M	10%	2%	20%	6.4%	$0.9M	$0.4M	$0.5M

Addendums:

- **High Watermark**
- Share Classes (Discounts to early investors or Fund-of-funds)
- Separately Managed Accounts

Revisiting the Risk/Return/Capacity Trade-off

Strategy	Risk	Return	Capacity
T-bills			
S&P 500			
Factor Investing			
Statistical Arbitrage			
High Frequency Trading			

Types of Quant Funds

Split by Bravery, Brawn or Brains

- Very few large firms based exclusively on Brains
- Brains edges more commonly seen in small firms
- Brains edges often “grow up” into a Brawn+Brains or Bravery+Brains edge

Business Size (except proprietary trading firms):

- Single-theme funds: < $1B
- Smaller multi-strat funds: $1-5B
- Mega firms: $5-$50B
- > $100B: AQR, Bridgewater

Bravery-based Business Models

Strategies Involved	Factor Investing, CTA, Risk Parity
Performance	Low sharpe, Moderate returns, Mildly correlated
Capacity	Huge >50B
Operating Cost	Low
Customer Acquisition	Large potential markets: pension funds, SWFs, retail Potential for customer churn due to risk involved
Competitive Edge	Sales, Branding (e.g. thought leadership), **Pricing**

Bravery-based Business Models

Example: The Rise & Fall of Bill Miller

The Long Climb and Steep Descent of Legg Mason's Top Stock Picker

By Jason Zweig

November 18, 2011

SHARE AA TEXT

What's the difference between a hero and a goat? Just ask Bill Miller.

The once-revered mutual fund manager announced Thursday that he will step down in April as lead manager of the Legg Mason Capital Management Value Trust. In a business that thrived for decades by nurturing the cult of the star

https://fosterwealth.com/bill-miller-and-why-you-cant-trust-stock-picking

Brawn-based Business Models #1

Strategies Involved	HFT
Performance	High Sharpe, Great returns, Uncorrelated
Capacity	Low (<1-5B)
Operating Cost	Very High
Customer Acquisition	Very easy once the model is proven Strong pricing power (but mostly, prop money)
Competitive Edge	**Large scale** to absorb high fixed costs **Spend on technology**: speed and connectivity (technology) Footprint and deal-making (e.g. Virtu)

Brawn-based Business Models #1

Brawn-based Business Models #2

Strategies Involved	Multi-strat: aggregator of various strategy types
Performance	Moderate Sharpe, Moderate Returns, Possibly Correlated
Capacity	Huge (>50B?)
Operating Cost	Moderate
Customer Acquisition	Significant sales effort needed Look for customers who can't access individual pieces Pricing power under pressure
Competitive Edge	**Talent arbitrage**: be good at picking quants (and firing them) Branding: be seen as a good talent-spotter **Scale**: Netting benefits, Alpha capture

Brawn-based Business Models #2

Brawn-based Business Models #3

Strategies Involved	Informational edges + Statistical arbitrage + Factors
Performance	Good Sharpe, Good returns, Less correlated than #2
Capacity	Medium to High (5-30B?)
Operating Cost	High
Customer Acquisition	Sales is much easier than Bravery-based models Stronger pricing power than Bravery-based models
Competitive Edge	Invest in technology and infrastructure to: - **Identify new data sources continuously** - Generate alpha from them and integrate into the system Large scale, to absorb data costs

Brawn-based Business Models #3

2σ

D E Shaw & Co

CITADEL

Brains-based Business Models

Proprietary capital

- Limited scalability. Otherwise, transition to a Brawn+Brains or Bravery+Brains model
- Under the radar, to safeguard their IP and competitive edge
- Often occupy a niche (e.g. Jane Street)

Startup, Sub-$1B funds

- Difficult space of the market: high costs
- Have to do a lot of sales to convince customers of value

Building a Quant Career

Careers in Quant

Additional Axis: Sales

Coding

- Speed, not scale
- Internal customers

Trading

- Domain knowledge
- Bet sizing and risk management

Data Science

- In addition to ML, ideas from traditional Statistics, Physics, Math

What Kind of Quant Career Might Suit You?

Depending on what you like...

- Building big systems or fast systems?
- Kaggle type ML or more research-oriented ML?
- Competing with others or collaborating with them?
- Ok making quick, possibly incorrect decisions or want to take your time?

...you can find a role that suits you best

HFT Software Dev; Bank trading algo designer; Gray box trader

Quant researcher; Portfolio manager; Quant fund sales

Quant Careers outside Quant Funds

What if you want to just trade your personal portfolio via quant algos ?

- Rule #1: Think about your taxes and transaction costs
  - Feasible quant strategies will typically look like slow-moving asset allocation ideas
- Rule #2: Figure out your edge
- Rule #3: Manage risk. Be skeptical of your signal initially.
- Rule #4: Do what is consistent with your psychology

Further Reading

Thank You!

Please send feedback: rsingh@mit.edu