Capacity Analysis: Applying the Fundamental Law of Active Management

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Portfolio Construction
For Quantitative Equity Portfolios

• The relative performance of quantitative equity portfolios will depend on:
  – How much “information” the alphas provide
    • Measured by information coefficient (IC)
  – How much of the alphas’ information is used by the portfolio
    • Measured by transfer coefficient* (TC)

• We can use these measures to develop a framework for:
  – Determining optimal turnover levels
  – Estimating capacity limits

* Clarke, de Silva, and Thorley,
FAJ: Sep/Oct 2002
Transfer Coefficient

• Introduced in 2002*, the TC is defined as the correlation between the risk-adjusted alphas and active weights.

• The TC is an objective measure of how much of the alphas’ information is transferred into a portfolio.
  – Measures portfolio construction efficiency

• For generating superior performance, maximizing the TC is as important as maximizing the IC.

* Clarke, de Silva, and Thorley, FAJ: Sep/Oct 2002
The (Modified) Fundamental Law of Active Management (FLAM)

\[ E(R) = IC \times TC \times TE \times N^{0.5} \]

- Implementing FLAM is complicated.
- Breadth (N) needs to be estimated.
- There are other assumptions that need to be made.
Breadth Calculation: Assumptions

\[ r(i) = a(i) + \text{Sum}[b(ij)f(j)] + sr(i)e(i) \]  

Where:

- \( a(i) \sim \text{N}(0,1) \)  
- \( b(ij) \sim \text{N}(0,1) \)  
- \( f(j) \sim \text{N}(0,\text{Var}(f)) \)  
- \( sr(i) \sim \text{Lognormal}(\text{Avg}(sr),\text{Var}(sr)) \)  
- \( e(i) \sim \text{N}(0,1) \)

- \( n = \# \text{ of securities in investment universe} \)
- \( k = \# \text{ of risk factors} \)

If all of the above variables are independent:

\[ \text{Breadth} \sim n \]
Breadth Calculation (cont’d)

In reality:

$$\text{Alpha}(i) = a(i) + \text{Sum}[c(j)b(ij)]$$  (standardized?)

i.e., Alpha will generally have both a stock specific component and a systematic component.

- When the systematic component is zero or very small, Breadth ~ n.
- When the systematic component is large, Breadth is small.
Alpha: Specific or Systematic?

Specific:
- Performance experience indicates a substantial specific component.
  - IRs > .5 are fairly common, while ICs > .1 are rare. With TCs typically < .5, the implied Breadth is >> 100.
- The risk profile of a “pure alpha” portfolio typically has a large specific component.

Systematic:
- The “pure alpha” portfolio may contain a systematic factor not in the risk model.
- The construction of quantitative alphas appears systematic in nature.
Where to Start?

• Instead of using FLAM, use historical portfolio simulations.
  – Use actual historical alphas
  – Use current portfolio construction process
  – Use current liquidity and risk model data (or whatever is expected in future)
  – Unlimited turnover will eliminate path-dependence
  – Choice of historical period is important

• Result is expected gross active returns, with unlimited turnover, for different AUM levels.
Use FLAM for Turnover Impact

\[ E(R) = IC \times TC \times TE \times N^{0.5} \]

- E(R) is proportional to TC, which is the only component affected by turnover.
- Use this proportionality to estimate expected gross active returns (EGAR) for different turnover levels:

\[ EGAR(X\% \ T/O) = EGAR(\text{Unlimited } T/O) \times \frac{TC(X\% \ T/O)}{TC(\text{Unlimited } T/O)} \]

- Use “sustainable” TC
• Alphas have a limited shelf-life.
• If turnover is too low, relationship between alpha and active weights can deteriorate over time.
• Result: lower TC
“Sustainable” Transfer Coefficient

- TC will stabilize at a certain level, depending on:
  - Alpha shelf-life
  - Turnover
  - Tracking Error
  - # of securities
  - Other portfolio constraints
Sustainable TCs vs. Turnover

- Higher turnover levels correspond to higher sustainable TCs.
  - More trading enables us to get more alpha into the portfolio.
Expected Gross Active Return

\[
\text{EGAR}(X\%) = \frac{\text{EGAR}(\sim)}{\text{sTC}(X\%)},
\]

• We can now use the above formula to calculate expected gross active returns for each turnover level.

• Repeat for different levels of AUM.
Expected Trading Costs

- Estimate the trading costs for each of the historical simulations.
  - Apply trading cost model to the trade lists generated by the simulations.
  - Estimate only needs to be accurate in the aggregate, not for each individual stock.
Expected Net Active Return

- Combine results

Expected Net Active Return =
Expected Gross Active Return - Expected Trading Costs
Capacity Estimates

- The capacity limit is a function of the target active return:
  - $2B for 300 bp
  - $4B for 250 bp
  - $8B for 200 bp

- This chart also illustrates a portfolio’s optimal turnover level:
  - 120% at $2B
  - 84% at $10B
Implementation Considerations

• The capacity limit is not a static number. Over time, it will need to be adjusted for:
  – Market appreciation
    • If prices double, limits will double.
  – Different levels of market volatility
    • Limits tend to increase with volatility, assuming the target active return remains the same.
    • Other assumptions may need to be adjusted:
      – Trading costs tend to increase with volatility.
      – Alpha shelf-life tends to decrease with volatility.
  – Changes in trading volume (and costs)
    • If volume increases, limits will increase.
Summary

• We can use the concept of the sustainable transfer coefficient to develop an objective methodology for determining the capacity for quantitative equity strategies.
  – Can be very sensitive to certain assumptions
  – Can vary over time due to external influences
  – Competing strategies may present additional complexities

• This framework can also help us identify potential improvements in the investment process.
  – Optimal turnover levels
  – Impact of portfolio constraints can be quantified
  – Evaluate trade-off between alpha stability and IC