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,
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The (Modified) Fundamental Law of Active Management (FLAM)

$$E(R) = IC \times TC \times TE \times N^{.5}$$

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

Breadth Calculation: Assumptions

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

Where:

$a(i) \sim N(0,1)$	$i = 1,n$	Alpha
$b(ij) \sim N(0,1)$	$j = 1,k$	Factor betas
$f(j) \sim N(0,\text{Var}(f))$		Factor returns
$sr(i) \sim \text{Lognormal}(\text{Avg}(sr),\text{Var}(sr))$		Specific risk
$e(i) \sim N(0,1)$		

n = # of securities in investment universe
k = # of risk factors

If all of the above variables are independent:

Breadth ~ n

Breadth Calculation (cont'd)

In reality:

Alpha(i) = a(i) + 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

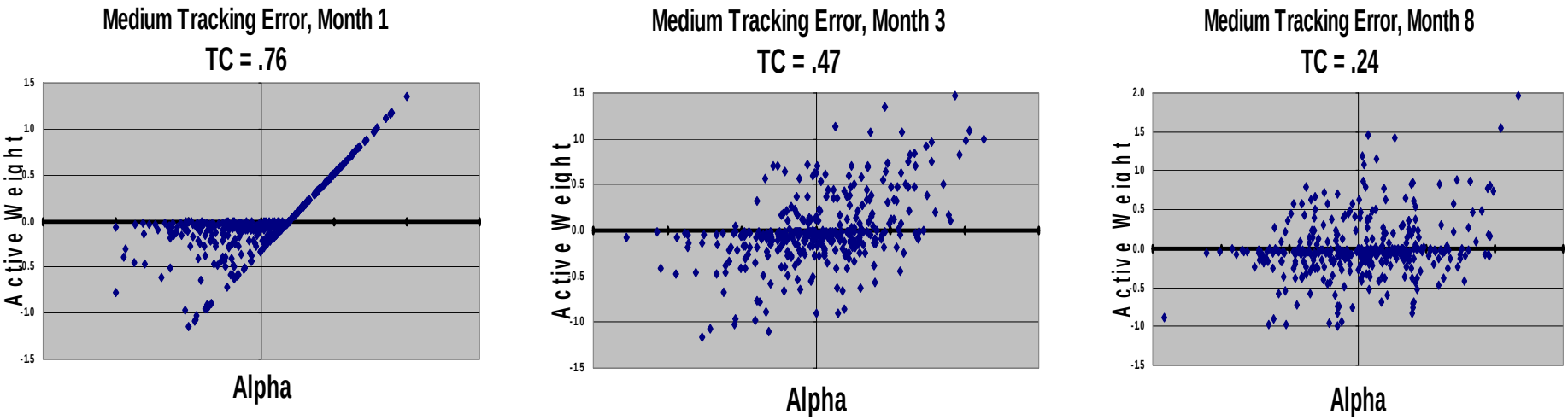
$$E(R) = IC \times TC \times TE \times N^{.5}$$

- 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(Unlimited T/O)
x TC(X% T/O) / TC(Unlimited T/O)

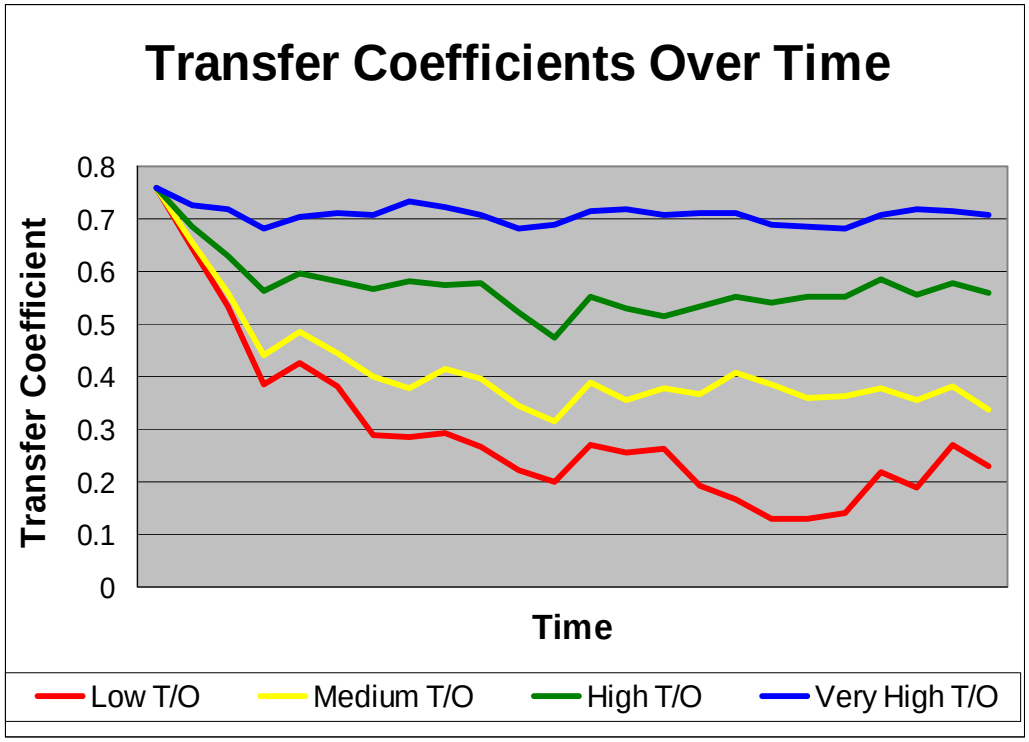
- Use “sustainable” TC

Turnover Constraint: Illustration



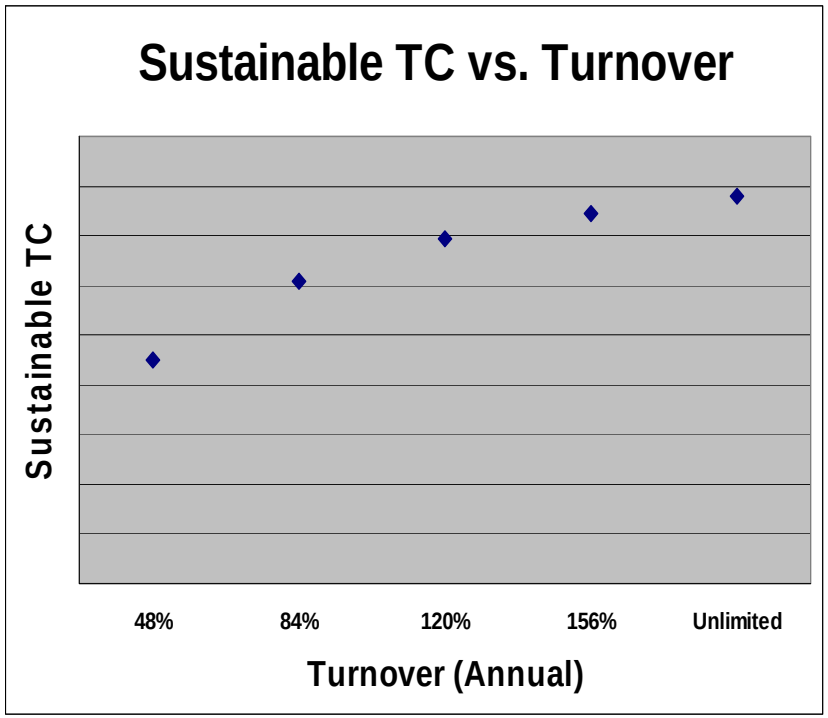
- Alphas have a limited shelf-life.
- If turnover is too low, relationship between alpha and active weights can deteriorate over time.
- Result: lower TC

“Sustainable” Transfer Coefficient



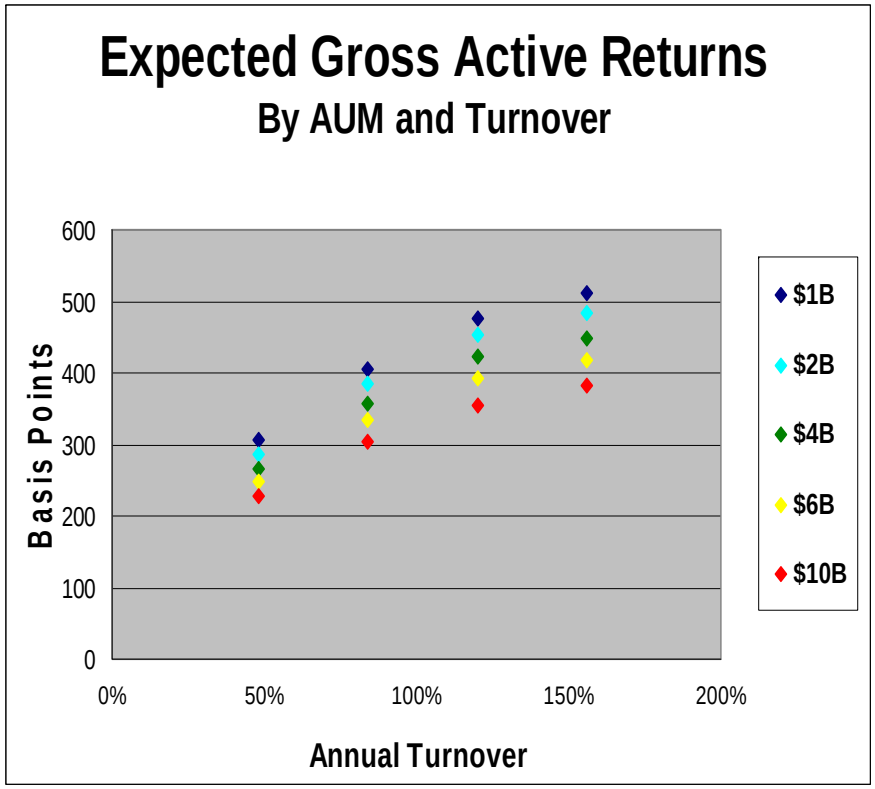
- TC will stabilize at a certain level, depending on:
  - Alpha shelf-life
  - Turnover
  - Tracking Error
  - # of securities
  - Other portfolio constraints

Sustainable TCs vs. Turnover



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

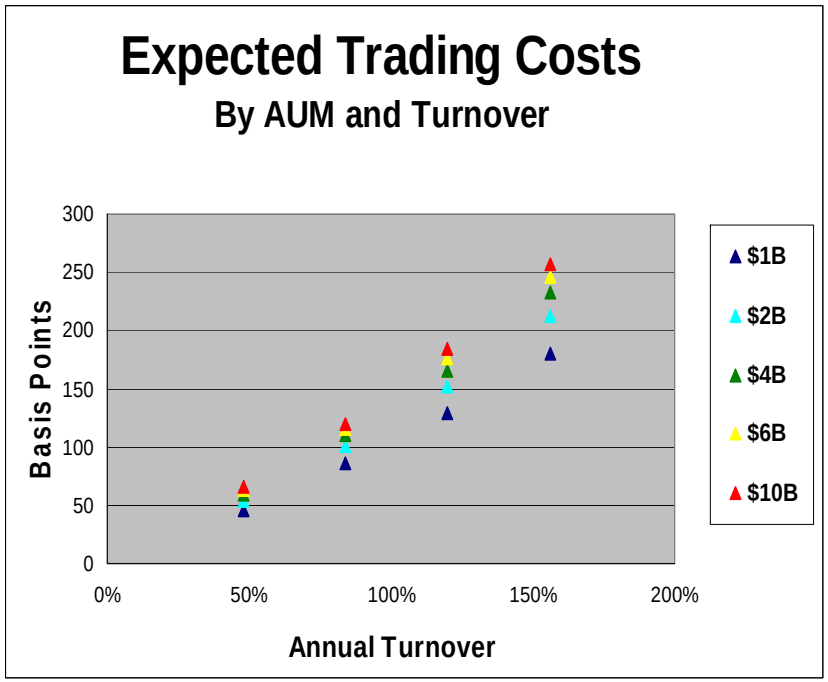
Expected Gross Active Return



EGAR(X%) = EGAR(~)
x sTC(X%) / sTC(~)

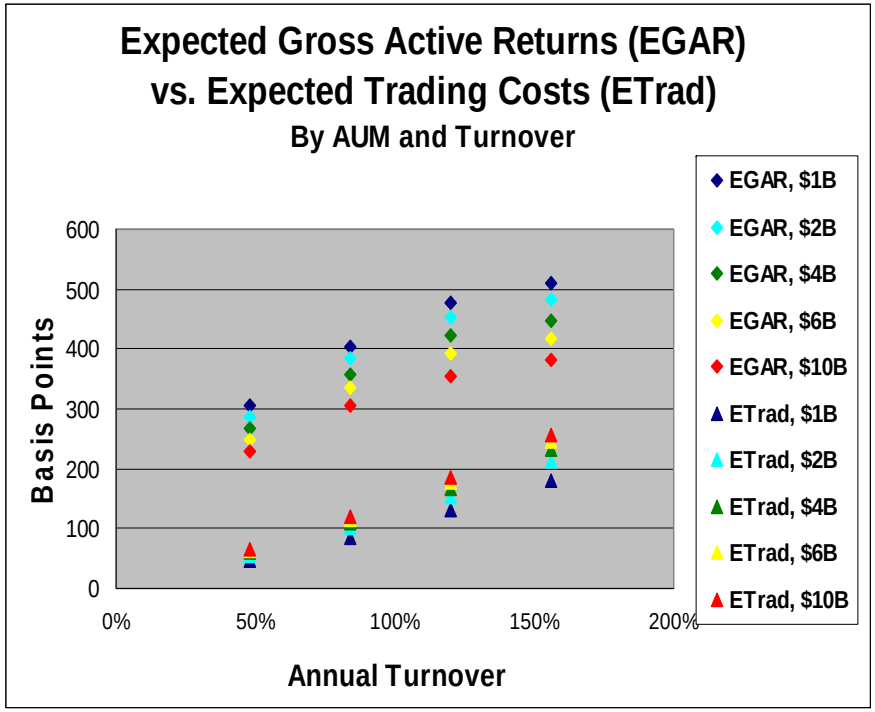
- We can now use the above formula to calculate expected gross active returns for each turnover level.
- Repeat for different levels of AUM.

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.

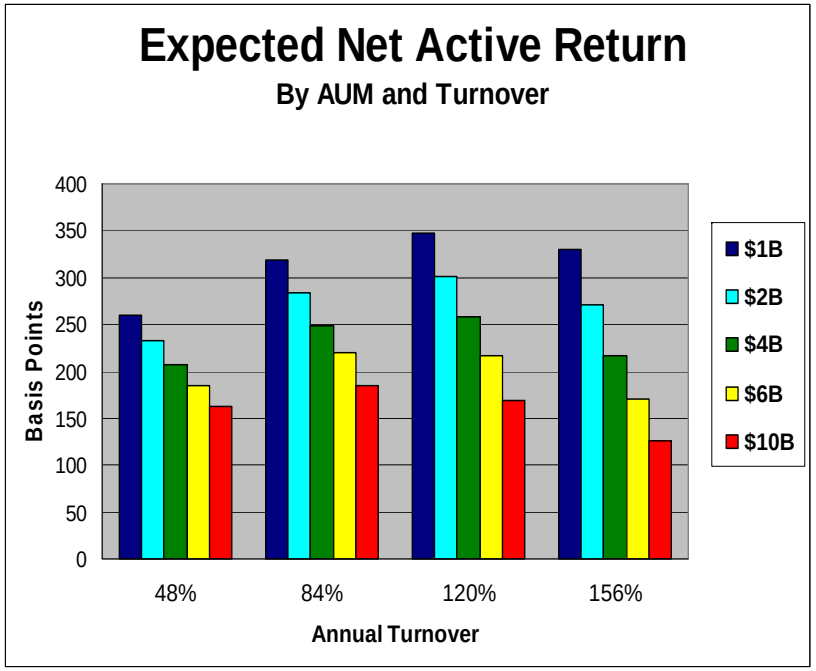
Expected Net Active Return



- 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