Strategy Design

and the

Fallacies of Breadth*

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Northfield Webinar
March 2021

*Journal of Asset Management, vol. 21, 2020: 626–635 (CQA Special Issue)

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Today

I. Why design strategies?

II. Model the investment strategy

III. The fallacies of breadth

IV. More applications

- Smart beta
- Industry controls
- Exploiting IC variation
- Integrating ESG

I. Why design strategies?

Alpha is scarce and fleeting: we need to make the most of it

Many ways to build a portfolio: which will maximize performance?

Grinold and Kahn: “The fundamental law … isn’t an operational tool … it will prove difficult in particular to estimate breadth accurately”

Simulations: useful; period-specific; can be time-consuming

Objective: provide a convenient way of obtaining more quantitative guidance for strategy design and related investment decisions

II. Model the investment strategy

Simple active strategy

Standard mean-variance utility $\boldsymbol{\alpha}'\mathbf{w} - (\lambda/2)\mathbf{w}'\mathbf{V}\mathbf{w}$

Active weights $\mathbf{w} = (\lambda\mathbf{V})^{-1}\boldsymbol{\alpha}$ can be positive or negative

Mimic constraint pairs with penalties

What determines performance?

$\lambda\mathbf{V}$, return forecasts $\boldsymbol{\alpha}$, and security returns $\mathbf{r}$

During design $\boldsymbol{\alpha}$ and $\mathbf{r}$ are unknown, so model them using plausible covariances Cov$\{\boldsymbol{\alpha}\}$, Cov$\{\mathbf{r}\}$, Cov$\{\boldsymbol{\alpha},\mathbf{r}\}$

How to forecast performance?

Start with return $= \mathrm{E}\left\{\mathbf{r}'\mathbf{w}\right\}$, tracking variance $= \mathrm{Var}\left\{\mathbf{r}'\mathbf{w}\right\}$, etc.

Evaluate them in terms of $\lambda\mathbf{V}$ and covariances

Result is set of formulae, e.g. return $= \mathrm{Tr}\left[\left(\lambda\mathbf{V}\right)^{-1}\mathrm{Cov}\{\boldsymbol{\alpha},\mathbf{r}\}\right]$

Also risk, alpha capture, factor exposures, IR

They tell us in advance the results of indefinitely long Monte Carlo simulations

Easily evaluated in R, MATLAB

We call these the **Design Formulae**

III. The fallacies of breadth

Different views

Based on concepts of breadth, **return correlation** is widely regarded as detracting from performance

Solnik & Roulet 2000, ETF.com 2007, Rothman 2010, Kolanovic et al 2010, Montagu et al 2010, Hatheway et al 2010, Patel 2011

Buckle 2004 presents a model where correlation *improves* active performance

Here we use the Design Formulae to resolve the disagreement

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Correlations and performance: results

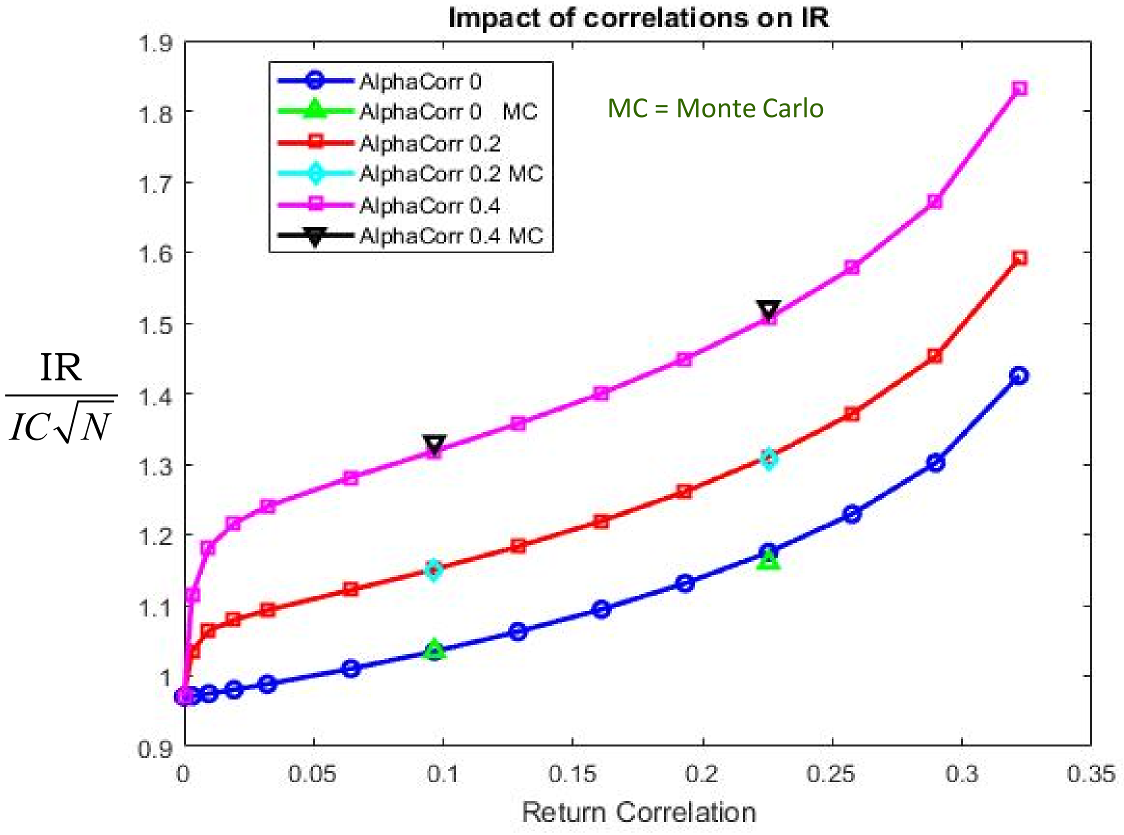
Left to right on a curve: correlation of return across securities

Curve to curve: correlation of return forecast (alpha) across securities

Both *increase* Information Ratio!

Monte Carlo confirms results

Supports Buckle, contradict consensus



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Intuition: why do return correlations improve IR?

It's a **risk** thing: portfolio return relies on correlations between $\boldsymbol{\alpha}$ and $\mathbf{r}$, not between $\mathbf{r}$ on different securities

Keep it simple: ignore biases $\left(\text{means}\right)$ in $\boldsymbol{\alpha}$ and $\mathbf{r}$, and ignore IC

Portfolio weights $\mathbf{w}$ come from $\mathbf{V}$ **inverse** so positive correlations in $\mathbf{V}$ cause **negative** correlations in $\mathbf{w}$

Tracking variance in this simple case is ...

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$$\text{TV} = \sum_{m,n} \text{E}\{w_m w_n\}\ \text{E}\{r_m r_n\}$$

Split the sums: TV $=$

$$\left\{ \begin{array}{c} \text{Single securities: } n = m \\ \text{No correlations across securities} \end{array} \right\} + \left\{ \begin{array}{c} \text{Security pairs: } n \neq m \\ \sum \text{E}\{w_m w_n\}\ \text{E}\{r_m r_n\} \end{array} \right\}$$

< 0 > 0

< 0: risk reduction!

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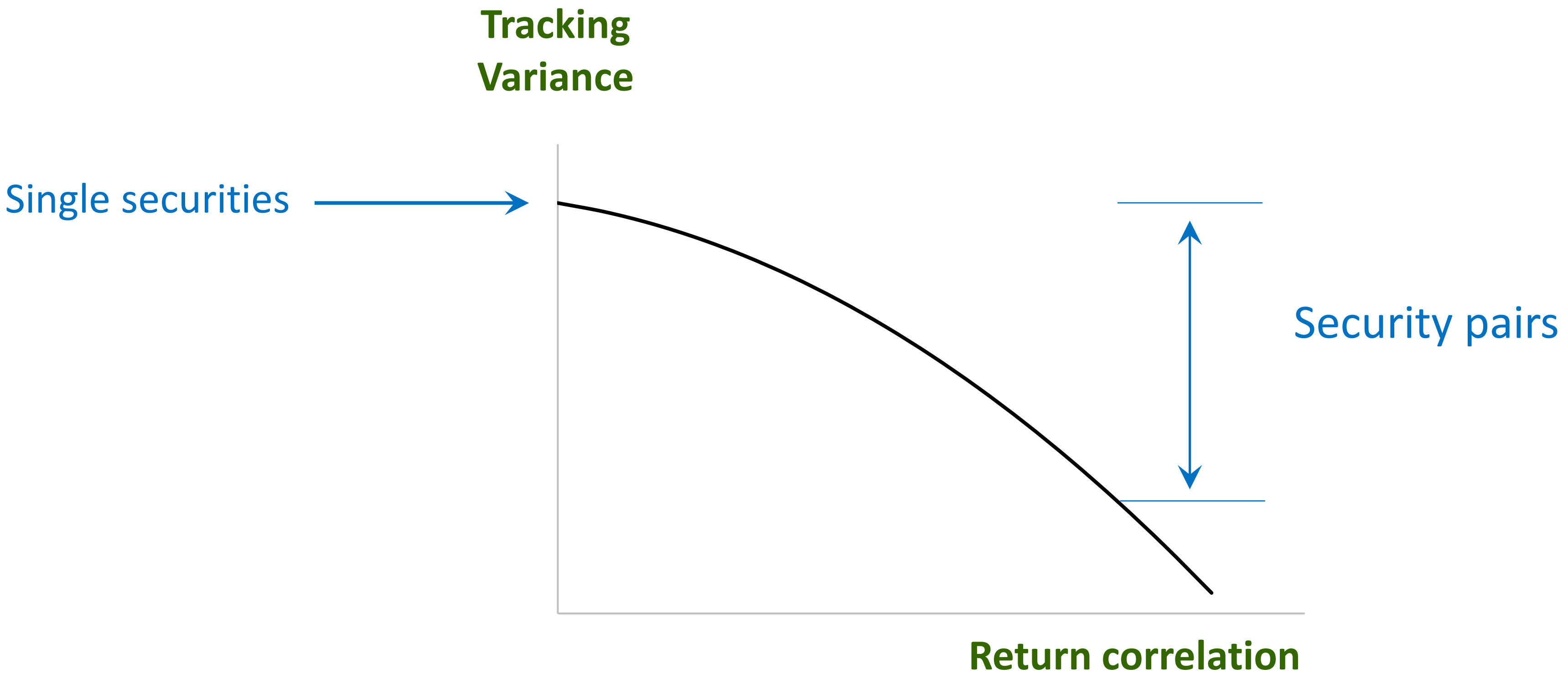
One way to think of it…



In our simplified case, the tracking variance consists of a positive contribution from single securities and a negative contribution from security pairs

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Return correlations summary

Portfolio construction creates negatively correlated security weights

Negatively correlated weights combine with positively correlated returns to causes risk reduction

Return is unaffected, so IR improves

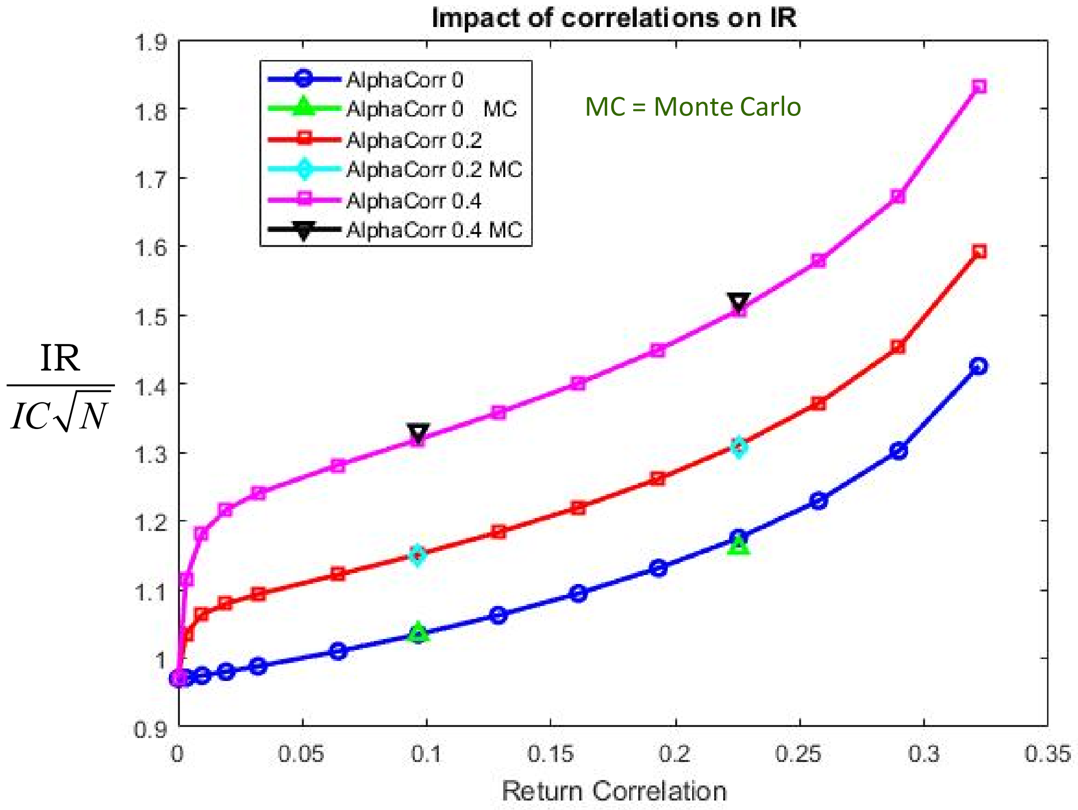
Alpha correlations

Breadth is number of **independent** forecasts per year

Popular belief: correlations across forecasts should decrease breadth and *IR*

Plot has Design Formulae and Monte Carlo results, and shows that alpha correlations *increase IR*

Popular belief is reversed here too



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Intuition: why does alpha correlation improve IR?

In $\mathbf{V}^{-1}\boldsymbol{\alpha}$ the negative off-diagonal elements of $\mathbf{V}^{-1}$ combine each asset's alpha with reversed portions of other assets' alphas

With positively correlated alphas, mixing in reversed versions of other alphas reduces the effective alpha magnitude

This reduces position size and so reduces risk

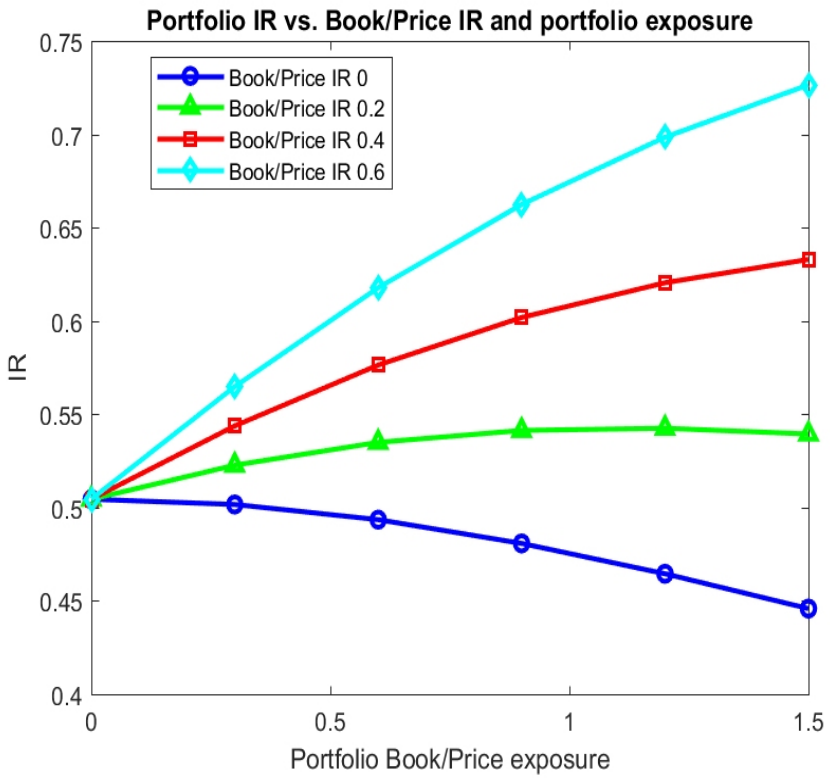
The subtracted alphas are from other stocks, so do not affect return

IR improves

IV. More applications

Smart Beta and active stock selection

How much capital should be deployed to Smart Beta?



Each curve is a **market scenario**

e.g. factor IR

A horizontal position is **implementation decision**

e.g. portfolio exposure to factor $\mathbf{f}$, $\mathbf{f}'\mathbf{w}$

Provides quantitative comparison of investment options in a variety of market scenarios

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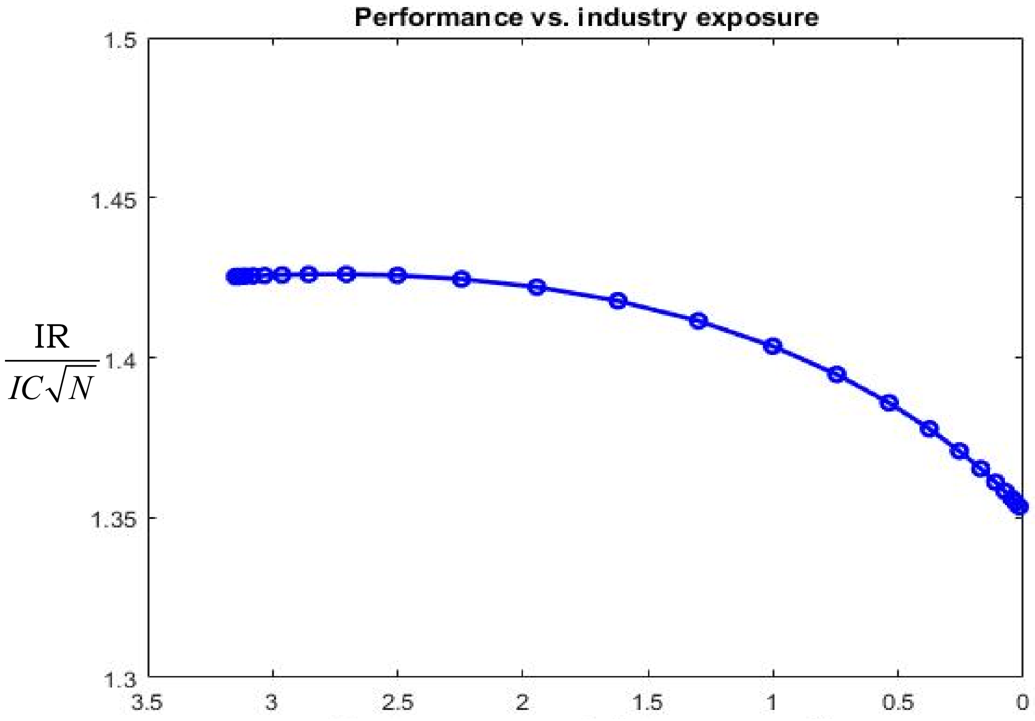
Custom risk management

An investor particularly averse to industry swings can impose penalty on exposure to each industry

Cut exposures in half with almost no performance cost

Eliminating industry exposures completely reduces IR by only 5% of its value

Reducing industry exposures is cheap



Average industry exposure %
Penalties tighten and exposures drop →

Exploiting IC differences across sectors

Alpha has

medium IC in some sectors

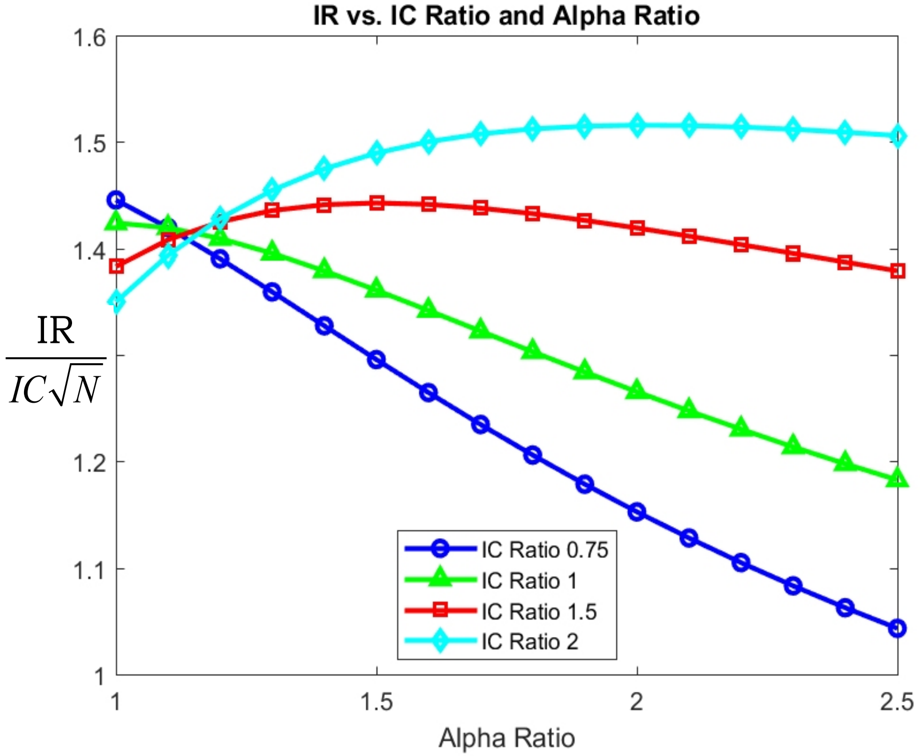
IC × IC Ratio in others

IC ÷ IC Ratio in the rest

Amplify alpha in high IC sectors, dampen it in the low

Each market scenario curve is a value of IC Ratio, the relative power of alpha in different sector groups

Each horizontal position is the alpha amplification, an implementation decision



IC: Energy Minerals, Non-Energy Minerals, Interest Rate Sensitive
IC × IC Ratio: Consumer, Health
IC ÷ IC Ratio: Industrial, Technology

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Exploiting IC differences across sectors, cont'd

Example

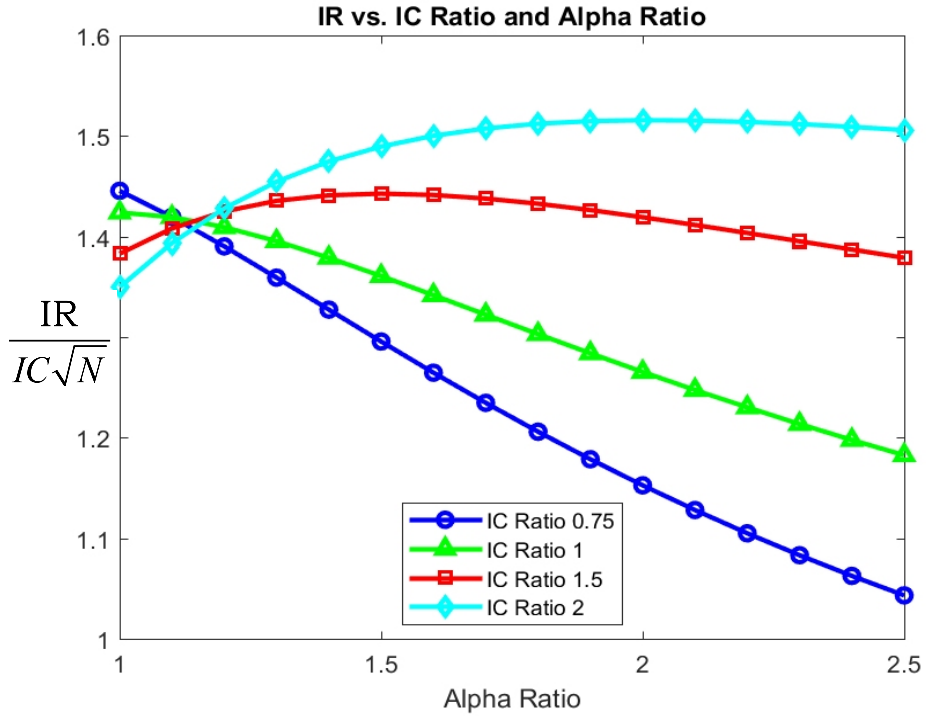
Investor believes IC Ratio will be 2, sets alpha ratio to 2

If correct: IR *increases* by 12%

If effect disappears IC Ratio is 1 and IR *decreases* by 11%

If effect reverses to IC Ratio 0.75, IR *decreases* by 20%

Quantitatively informed risk/return tradeoff shows that a less aggressive position makes more sense



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Incorporating ESG

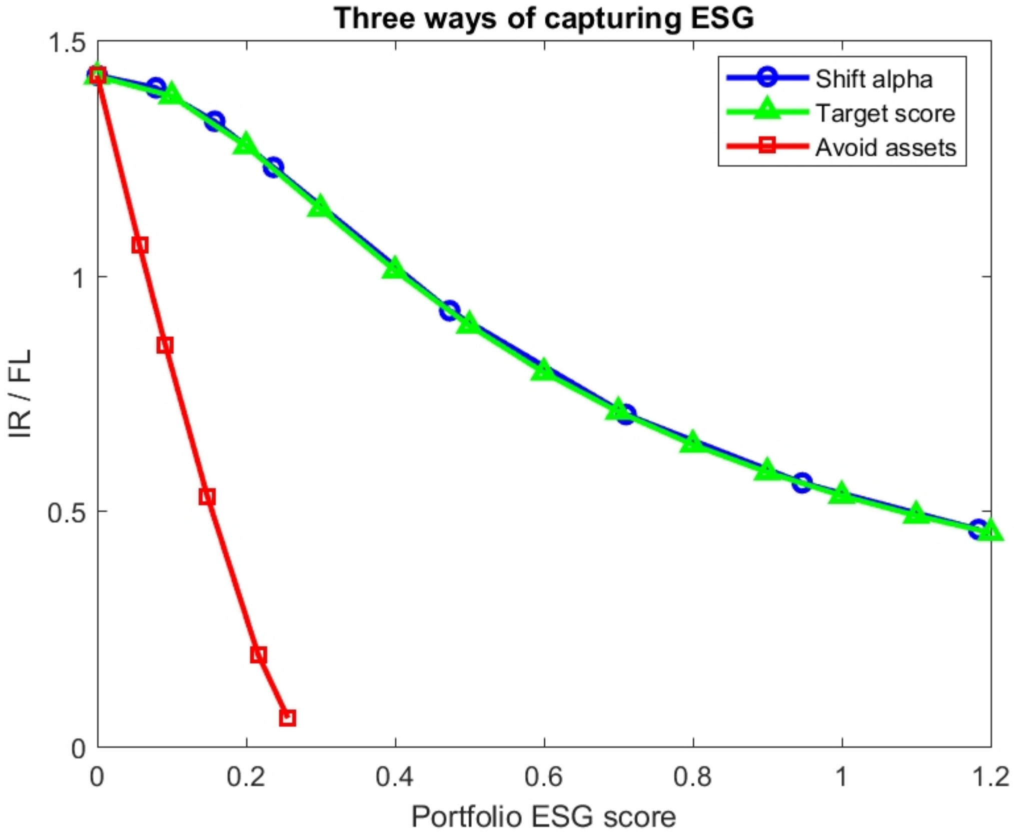
Compare different approaches

- ✓ Shift alpha using a multiple of the ESG score
- ✓ Use quadratic penalty to target the desired portfolio ESG score
- ✓ Avoid holding assets with poor ESG scores

Avoiding assets worst option: limited ESG capture, and very high performance cost

Shifting alpha requires trial and error to determine the multiplier

The winner: targeting the ESG score with a penalty gives top performance and is easiest to implement



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A more systematic approach

Assign a probability to each market scenario

Use probability-weighted average over scenarios as an objective function

Select implementation decision that maximizes the objective

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Summary

An easily evaluated design methodology that

- quantifies risk-return trade-offs
- enables optimal strategy design
- promotes higher Information Ratios

Shows that two breadth-based intuitions are fallacies: if *returns* or *forecasts* in active strategies are correlated, IR's improve. We have an opportunity, not a problem.

Intuition is simultaneously valuable and dangerous. Paraphrasing Einstein, it should be as simple as possible, but not more so.

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Appendices

Appendix: checking the return correlation intuition

The intuition requires correlations both

in the risk model $\mathbf{V}$ (construction correlation)

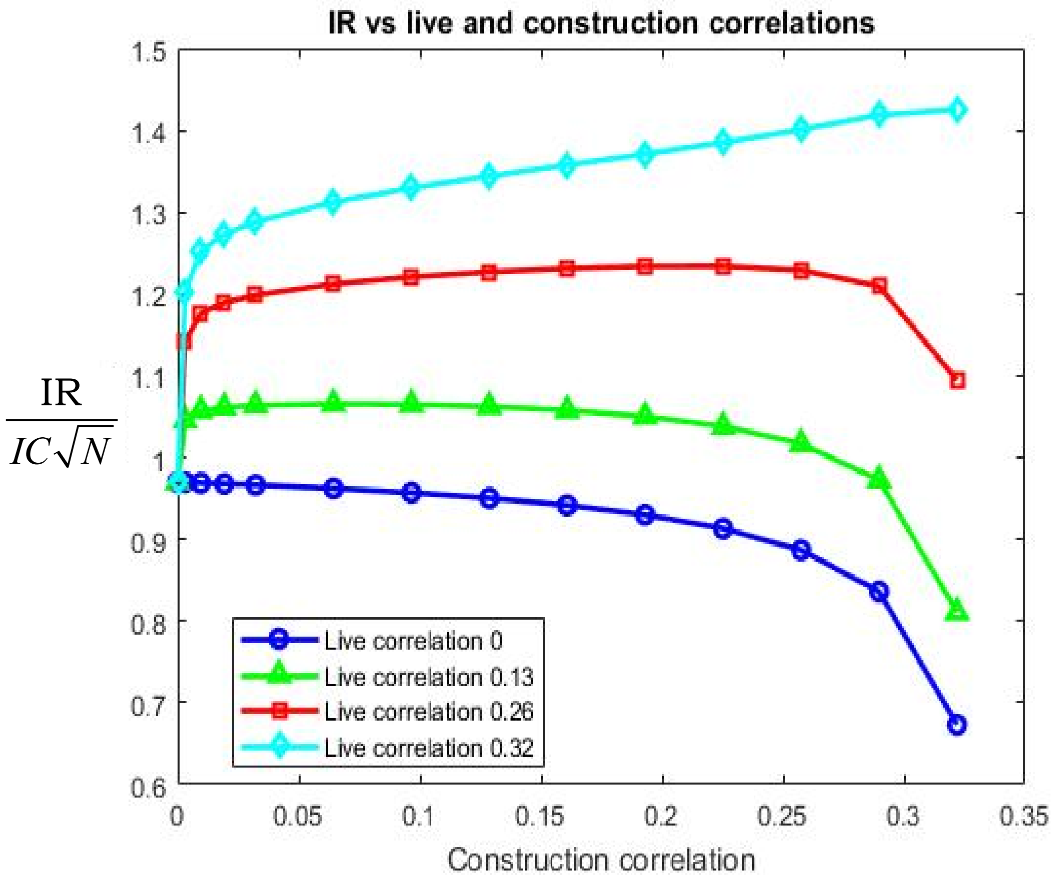
and

between the live returns (live correlation)

Chart confirms that performance improvement vanishes if either is not present

Neither works by itself: the effect is a collaboration between two correlations

Why do those curves start so steeply? With 500 stocks, construction correlation hits 125,000 pairs!



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Appendix: An Economic Information Ratio

Standard practice* uses an Information Ratio whose numerator is the portfolio's alpha capture, or return *forecast* $\mathrm{E}\{\boldsymbol{\alpha}'\mathbf{w}\}$

Return forecast no **economic impact** on the asset owner

The return, not the alpha capture, has economic impact

We use portfolio return $\mathrm{E}\{\mathbf{r}'\mathbf{w}\}$ as numerator for Information Ratio

* e.g. Grinold (1989), Grinold and Kahn (2000)

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Appendix: constraints

Two-sided, min/max constraint pairs represented as quadratic penalties on securities, factors. The model handles penalties.

Long-only constraint (LO) is one-sided and not handled by the model

For strongly binding LO strategies, use **differences** between non-LO versions

Model is most precise for strategies with weakly binding or no LO…

- ✓ Low active risk strategies
- ✓ market neutral
- ✓ market timing

Appendix: matrix-free formulae

Some simplifying assumptions allow us to develop quick estimates without using matrices

$\hat{\rho}$ is the risk model's forecast of the return correlation ρ

The assumptions are

- the universe is *large* and *correlated:* $\hat{\rho}(1-\rho)N >> 1$
- all correlations are *uniform* across the universe
- the risk model is comfortably positive definite

The formulae are not valid if $\hat{\rho} = 0$

$$\text{Return} \approx N \frac{IC}{\lambda\sigma\left(1-\hat{\rho}\right)}$$

$$\text{Risk} \approx \frac{\sqrt{N\left(1-\rho\right)}}{\lambda\sigma\left(1-\hat{\rho}\right)}$$

$$\text{Information Ratio} \approx IC\sqrt{\frac{N}{\left(1-\rho\right)}}$$

$$\text{Alpha} \approx \frac{N}{\lambda\sigma^2\left(1-\rho\right)}$$

$$\text{Average position size} \approx \frac{1}{\lambda\sigma^2\left(1-\hat{\rho}\right)}$$