The Fundamental Law of Mismanagement

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Prologue

- Active managers often claim superior performance because they
  - Invest in many securities
  - Use many factors to forecast
  - Trade frequently
  - Remove constraints

- Prescriptions are applications of Grinold’s (1989) “Fundamental Law of Active Management”

- Major proponents:
We Will Show

- All four prescriptions or “laws” are invalid and self-defeating

- This is because the formula treats asset management as if it were a casino game
  - Ignores estimation error in investment information
  - Role of constraints in practice

- Implications
  - Prescriptions unchallenged in academic curriculums and journal articles for more than twenty years
  - Often used to rationalize hedge fund strategies
  - Likely adversely impact many billions of dollars of assets under current management
Active Management Objective
The Information Ratio (IR)

- Excess return = return – index return

- Objective: Outperform index with greatest probability

- Information Ratio (IR):
  \[
  \frac{Average \, Excess \, return}{Standard \, Deviation \, of \, Excess \, return}
  \]

- Measure of active value for given level of active risk

- Note:
  - IR is the Sharpe ratio (SR) when index is mean-variance (MV) efficient
The Fundamental Law
Grinold’s Fundamental Law

- IR is approximately skill (IC) times breadth (BR)
  \[ IR \approx IC \times \sqrt{BR} \]

- IC: Skill -- correlation of forecast and outcome
- BR: Breadth -- number of independent decisions
- Formula assumes unconstrained MV optimization

- Implications:
  - IR is square root function of BR
  - Improve performance by enhancing: \( IC \times \sqrt{BR} \)
GK and CST Prescriptions
Grinold and Kahn Prescriptions

- GK state:
  - “It takes a modest amount of skill to win (the investment game) as long as that skill is deployed frequently and across a large number of stocks.”

- Prescriptions for adding value:
  - Increase trading frequency
  - Increase size of the optimization universe
  - Increase factors in forecasting return.
CST Transfer Coefficient

- Generalize the Grinold formula by introducing the “transfer coefficient” (TC).

- TC implications
  - Remove constraints to add performance

- Influenced marketing of many long-short, hedge fund, and unconstrained strategies.
Roulette and Investment Game
GK Roulette Wheel Rationale

- Roulette IC
  - Known, positive, constant
  - Each play additive
  - More plays greater breadth

- Note
  - No estimation error in inputs
  - Each play independent of prior one
Investment Game Similar?

- Investment IC
  - Has much estimation error
  - May be insignificant or even negative
  - Unstable: varies over time
  - More plays not necessarily additive

- Essential assumptions of the fundamental law inconsistent with investment practice
Review The Four Prescriptions
The Four GK and CST Prescriptions

1. Large optimization universe
2. Many factors
3. Frequent trading
4. Remove constraints
1. How Large Universe

- A larger universe may imply more breadth
  - Additivity assumes stable, homogeneous, positive IC
  - But size and IC are typically related

- Small universes may have homogeneous independent IC
  - But larger universes tend to lower average IC
  - IR may not increase

- Example: Analyst covering 20 stocks
  - Now asked to consider twice as many stocks.
  - Limitations of time and resources likely reduce average IC
  - Rationalizes why traditional managers generally have small numbers of stocks in portfolios
2. How Many Factors

- Quant portfolios typically have large universe benchmarks.
  - Individual stock analysis not feasible
  - Rely on factor frameworks for forecasting alpha

- Factors typically chosen from stylized categories
  - Value, momentum, quality, dividends, ddm, Fama-French

- How many factors to choose?
  - Finding uncorrelated positive factors no simple task
  - Adding factors may reduce IC while increasing volatility (Michaud 1990)
  - BR typically limited to little more than five useful independent positive factors that vary over time
3. How Frequent Trading

- Most strategies have natural trade frequencies
  - B/p or e/p monthly, quarterly limitations
  - Value strategies may trade no more than once a year
  - Growth stock managers may trade multiple times a year

- Increased trading frequency
  - May reduce IC and increase trading fees
  - Often requires increased resources and costs

- Note: Normal trading period does not imply calendar trading
4. How Many Constraints

- Financial institutions have leverage and regulatory limitations
- Long-only constraints limit liability risk
- Performance benchmarks mandate index related constraints
- Equal weight beats unconstrained (Jobson and Korkie 1981)
- Long-only may often be superior (Frost and Savarino 1988)
- Theoretical importance of constraints (Markowitz 2005)
Optimization Simulation: The Modern Way To Back Test
Why Simulation?

- Back tests are unreliable
  - Shows only how a procedure worked in some time period
  - Different periods likely different outcomes

- What is Monte Carlo simulation
  - A probabilistic technique based on generating a large number of random returns

- How used to evaluate an optimization strategy?
  - Compute simulated MV inputs from set of random returns
  - Compute MV optimized portfolios from simulated MV inputs
  - Collect set of simulated frontier data
  - Compute statistical summaries of results and alternatives
Optimization Simulation Test

- A referee is assumed to know the true mean-variance (MV) inputs
  - Simulate returns based on the referee’s data
  - Compute MV inputs from the simulated returns
  - Compute a simulated MV efficient frontier
  - Evaluate performance with referee’s inputs
    - How close simulated portfolios from true optimal
  - Repeat many times
  - Evaluate statistical properties of optimized portfolios

- Evaluate benefits of different optimization strategies
  - Widely used in professional statistical practice
  - Rare in finance
Jobson and Korkie (1981) Study

- Classic study of estimation error on unconstrained MV optimization
  - Referee uses 20 stock historical monthly returns as truth
  - Monte Carlo simulate 60 months of returns
  - Compute simulated MV inputs
  - Compute max Sharpe ratio (MSR) of simulated portfolios with referee’s truth
  - Repeat many times
  - Compute average of simulated MSRs
  - Compute MSR of equal weighted portfolio
  - Compute MSR of historical MV inputs portfolio
Jobson and Korkie (1981) Results

- Referee true MSR = .32
- Equal weighted portfolio MSR = .27
- Average simulated MSR MV optimized portfolios = .08
  - MV optimized average 25% of true MSR value!
  - Many simulated optimized portfolios buried in X axis!
  - Equal weighting far superior to MV optimized!

Note:
- Grinold framework assumes unconstrained MV optimization
- CST TC framework based on unconstrained optimization
- Unconstrained optimization unreliable investing
- Why was this result ignored?
A Generalized Simulation Framework
Simulation Objective

- **Purpose**
  - Evaluate the impact of estimation error on portfolio optimization relative to universe size
  - Testing the square root prediction of the Grinold law

- **Four cases**
  - Grinold theoretical formula
  - Unconstrained MV optimization
  - Long-only MV optimization
  - Equal weighting
Simulation Framework

- Historical risk-return MV inputs as the referee’s truth
  - Monthly returns of surviving Russell 1000 index stocks (2012-2013)

- Optimistic framework for GK and CST
  - Simulated returns maintain a consistent IC for the mean
  - IC assumption always additive as size increases
  - In practice IC unknown and often insignificant

- Assuming IR is SR
  - Best case for Grinold law and applications
  - Otherwise all optimized portfolios inefficient (Roll 1992)
Technical Issues (Wonkish)

- Avoiding covariance matrix ill-conditioning
  - Simulated variance parameters computed for the entire pool so that well-conditioning guaranteed up to 500.
  - Ledoit covariance estimation guarantees full rank
  - Each asset given some idiosyncratic variance in the model
  - Designed as best case results
  - See appendix and Esch (2015) for further details
  - Results can’t be explained as breadth leveling off as a function of portfolio cardinality
Simulation Displays:

- Four curves function of universe size
  - Dotted Grinold “theoretical max” (square root) curve
  - Unconstrained (purple)
  - Equal weighted portfolios (red)
  - Constrained long only portfolios (green)
  - Interval estimates represent 5% and 95% quantiles

- Figure 1: Asset allocation: IC = 0.1, 5 to 50 asset universe
- Figure 2: Asset allocation: IC = 0.5, 5 to 50 diversified assets
- Figure 3: Active equity: IC = 0.1, 50 to 500 stock universe
Figure 1: Asset Allocation: 50 Assets, IC = .1
Figure 1 Results:

- Jobson and Korkie (1981) result
  - Equal weight superior to unconstrained up to 30 assets

- Frost and Savarino (1986) result
  - Long-only superior to unconstrained

- Theoretical Grinold (1989) unrealistically optimistic
Figure 2
Asset Allocation: 50 Assets, IC = 0.5
Figure 2 Results: Impact of Higher IC

- Long-only and unconstrained similar results with high IC
  - Note less volatility with constrained

- Theoretical Grinold (1989) unrealistically optimistic
  - Independent of assumed information level
Figure 3
Equity Optimizing: 500 Assets, IC = .1
Figure 3 Results: Large Universe

- Frost and Savarino (1986) result robust
  - Long-only superior to unconstrained across universe
  - Note smaller level of variability relative to unconstrained

- Jobson and Korkie result
  - Equal weight superior up to 200 stocks

- Unconstrained rise gradually over horizon
  - Necessary condition for an additive simulation process

- Theoretical Grinold (1989) highly unrealistically optimistic
GK and CST a Definite Failure

- Results totally at odds with Grinold theory
  - No reliable prescriptions for asset management!
  - Overall inferiority of unconstrained case

- Estimation error limits out-of-sample value of
  - Adding assets
  - Adding factors
  - Increasing trading frequency
  - Eliminating appropriate constraints

- Sign and/or inequality constraints
  - Generally appropriate for realistic information levels
Summary

- **Consequence**
  - GK and CST prescriptions invalid
  - Transcendent importance of estimation error for optimized portfolio management ignored for nearly twenty-five years
  - A cohort of academic and practitioner research invalid
  - Affects 100s of billions or more of AUM

- **Necessary conditions for effective optimization in practice**
  - Resampling investment uncertainty
  - Economically meaningful constraints
  - Properly implemented estimation error sensitive optimization
Weisberg’s “Willful Ignorance” (2014)

- Modern science has inherited “a serious disconnect between quantitative research methodology and clinical practice.”
- Grinold just one example of the fundamental and ubiquitous fallacy of regarding probability models as the full measure of uncertainty
- Weisberg’s concerns touch nearly all of modern finance!
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