NORTHFIELD | modeling financial markets worldwide

Investment Performance Evaluation (Real and Simulated) Using the Effective Information Coefficient

Dan diBartolomeo
Webinar, February 2024

Problem Statement

- Whether evaluating live or simulated performance, one of the major difficulties in performance evaluation is determining the statistical significance of the results.

- Often practitioners simply ignore this issue and present results whether good or bad, that could have arisen from luck or skill. Generally, bad results are not presented at all.

- To make performance analysis useful for improvement of the investment process, understanding how to assess the significance of the results is of critical importance.

- Often systems simply revert to analyzing performance daily as opposed to weekly or monthly under the assumption that "more observations will always be more significant".
  - For a variety of statistical reasons (e.g. trading costs) presented in diBartolomeo (*Journal of Performance Measurement*, Spring 2003) that assumption is false.
  - We cannot manufacture statistical significance merely by dividing the sample period into a larger number of shorter intervals.

The Solution: The Effective Information Coefficient

- The job of an active manager is to make good predictions of security returns and use that information efficiently in composing their portfolio.
  - EIC measures the combined effectiveness of both aspects.
  - diBartolomeo (*Journal of Performance Measurement*, Fall 2008)

- A better way to get obtain results with statistical significance is to *evaluate the contribution of individual positions within the portfolio to risk-adjusted performance metrics.*
  - Since the number of active weights (benchmark relative) in an equity portfolio is typically in the hundreds, sample sizes are much larger compared to the traditional evaluation of portfolio level returns.
  - The EIC combines three ideas familiar to equity quant managers: information coefficients, breadth, and transfer coefficients, combining them into a unified metric.
  - Within firms, EIC can be used to evaluate live or simulated performance (i.e. backtests)

- Uniquely, EIC is structured to also be used by outside observers (e.g. clients, consultants) without requiring information known only to managers (e.g. alpha forecasts).

Two Old Greeks

- In his work the Nicomachean Ethics, Aristotle quotes Agathon as saying,

Even unto the Gods it is forbidden to change the past

- The implication is that the only reason to study the past is to use what we learn to make better decisions about the future.

- In that learning process we need to separate “what we know”, “what we think we know,” and “what we pretend to know because we don’t want to admit we don’t know”.

Required Sample Periods and Other Issues

- In Modern Portfolio Theory (Rudd and Clasing, 1982) describe the situation of a real-life equity yield tilt strategy.
  - They estimated that it would take many decades of live performance to determine whether the strategy was adding value to a statistically significant extent.
- In 1995 I gave a lecture at a CFA event at Northwestern University called "How to Blow a Back-Test"
  - The answer was simple "Believe the results".
  - I argued that many of the assumptions (unbiased data, stationarity, sufficient sample size) associated with back-tests were simply not realistic.
- In 2012 an influential paper was published entitled *"Pseudo Mathematics and Financial Charlantism"*, which provides a mathematical proof that the sample sizes needed for legitimate backtests are simply not achievable in most circumstances
  - While we only observe one path through time for live performance, researchers can "tweak" the parameters of a strategy until they find something that ***seems successful*** out of sample.
  - Bailey et al., 2014 (ams.org)

All Popular Metrics Are Impacted By Sample Size Issues

- Concepts like Sharpe Ratio, Information Ratio, Risk-Adjusted Return are almost always presented to investors without any conception of whether reported differences between one fund or strategy and another is statistically significant.
- This problem is made somewhat worse because estimating the confidence intervals on ratio measures (e.g. Sharpe Ratio) is algebraically complex, but it's all been solved.
  - Jobson, J.D. and Bob Korkie, "Performance Hypothesis Testing with the Sharpe and Treynor Measures", Journal of Finance, Volume 36-4, pp. 889-908, 1981.
  - Memmel, Christoph, "Performance Hypothesis Testing with the Sharpe Ratio", https://ssrn.com/abstract=412588
  - Lo, Andrew, "The Statistics of Sharpe Ratios", Financial Analyst Journal, Volume 58-4, pp. 36-52, 2002.
  - Bertrand, Philippe and Costin Protopopescu, "The Statistics of Information Ratios", SSRN Electronic Journal, 2010.
  - Ledoit, Olivier and Michael Wolf, "Robust Hypothesis Testing with the Sharpe Ratio", Journal of Empirical Finance, Volume 15, pp. 850-859, 2008.

The Effective Information Coefficient

- Instead of observing active portfolio returns in each period, we use a risk model to infer what alpha value an active manager must have forecast for each security for each time period.
  - These implied returns can be then be correlated with subsequent realized returns to describe whether the manager was able to predict security returns and use that information in forming an efficient portfolio.

- In effect we are asking, "were individual active positions optimal at each point in time"?
  - Depending on the strategy, the number of independent active positions can be dozens or hundreds for each time period, resolving the limitation on the number of observable portfolio returns in a sample period.

- By correlating the implied returns with the subsequent realized returns, we can evaluate skill inclusive of all constraints.
  - Multiplying through by the cross-sectional volatility (variety) of security returns yields the expected alpha.

EIC = IC * TC

- A manager knows their input alphas and their constraints so they can separately calculate "Information Coefficient" and "Transfer Coefficient"
  - Grinold (JPM, 1989)
  - Clarke, DeSilva and Thorley (FAJ, 2002)
- If you assume a risk model (e.g. Northfield), then an outside observer (investor, consultant) can compute the product of IC and TC without knowing either item separately.
  - You just need the portfolio and benchmark compositions for each observation, which is routine for "holdings-based attribution."
- You also have to assume how averse the investor is to active risk which you can infer from the portfolio tracking error
  - Derived from Rubinstein's utility function (JoF, 1976)
  - Practitioner version in our webinar, Estimating an Investor's Volatility/Return Tradeoff: The Answer is Always Six (northinfo.com).

Constraint Effects

- An important limitation on the use of "implied returns" is that the popular constraints such as "long only" portfolios will bias the implied returns for constrained positions.
  - If a manager's model predicts that the alpha on a stock will be very negative, they would underweight it relative to benchmark in such a large magnitude that they might be actually short the stock.
  - If shorting is not allowed in the portfolio, the inferred alpha will be upward biased, possibly making the predictive power seem less than it actually is.
- One way to avoid this problem is to simply not include any active position that is at a weight bound in the computation of the correlation of implied and realized security returns.
  - However, this can materially reduce sample size for concentrated strategies, although you still have a lot more sample than just one observation per period (i.e. the portfolio return)
- Another approach is to assume that IC is uniform over all securities, and the opportunity for alpha is a known proportion of factor and security specific bets.
  - See Active Portfolio Management (Grinold and Kahn, Second Edition, 2000), chapters 10 and 11
  - This is what we adopted for calculating EIC in the Northfield performance attribution process.

Portfolio Dynamics

- One obvious parallel to the EIC attribution method is the Portfolio Dynamics method proposed in Sneddon (Journal of Investing, 2006).
  - First proposed at the 2005 Northfield conference, Dynamics Of Active Portfolios (northinfo.com)
  - Like EIC, portfolio dynamics uses analysis at the individual position level of active strategies rather than looking at portfolio returns.
  - This method requires information only available to managers (e.g. alpha forecasts) so it cannot be used by "outsiders looking in" (e.g. investors, consultants).

- For managers, the Portfolio Dynamics method goes further than EIC in two aspects
  - You can analyze the separate impact of signals (i.e. sub-components) that make up your alpha estimates.
  - The tradeoffs between alpha decay and transaction costs are analyzed in detail, allowing for estimation of optimal turnover levels.

Do We Need Backtests at All?

- One of the intriguing aspects of the portfolio dynamics attribution method is the system of equations used can be *solved analytically for the expected value of the long-term information ratio* of a strategy.
  - All quantitative active strategies are predicted on the idea that security returns are to some degree predictable from past returns.
  - If we know (or think we know) that level of predictability, and the transaction costs of rebalancing our portfolio to reflect the mot recent information, we can project portfolio returns into the future if we act optimally.
  - Eventually, the cumulative impact of transaction costs and alpha decay are balanced, leading to a computable value of the expectation of the information ratio.

- A parallel (i.e. confirming) result is derived in a paper by Baldacci, Beneviste, and Ritter (see SSRN, 2022).

Conclusions

- Performance attribution cannot be used to improve active investment performance unless we understand the likelihood that past performance arose by luck rather than skill.
- There are many challenges associated with making evaluations of the statistical significance of active portfolio returns.
- In general, strategies are evaluated over periods that are not sufficiently long to meet the basic requirement that observed results (in sample) are a legitimate estimator of future (out of sample) active returns.
- For simulated results, the problem is even worse because of the positive bias associated with the ability to revise input parameters until success is reached (i.e. "overfitting).
- Methods such as EIC and portfolio dynamics invoke risk models and the assumption of optimal manager behavior to allow for analysis of individual position returns rather than portfolio level returns, massively increasing sample size over the sample period.

References

Sharpe, William F., "Mutual Fund Performance", Journal of Business, Volume 39-1, pp. 119-138, 1966.

Messmore, Tom, "Variance Drain", Journal of Portfolio Management, Volume 21-4, pp. 104-110, 1995.

Rudd, Andrew and Henry Clasing, Modern Portfolio Theory, Dow-Jones Irwin, Homewood, Illinois, 1982.

diBartolomeo, Dan, "Measuring Investment Skill Using the Effective Information Coefficient", Journal of Performance Measurement, Volume 13-1, pp. 45-52, 2008.

Levy, Haim, and Harry Markowitz, "Approximating Expected Utility a Function of Mean and Variance", American Economic Review, Volume 69-3, pp. 308-317, 1979.

Litzenberger, Robert and Mark Rubinstein, "The Strong Case for the Generalized Logarithmic Utility as the Premier Model of Financial Markets", Journal of Finance, Volume 31-2, pp. 551-571, 1976.

Wilcox, Jarrod, "Better Risk Management", Journal of Portfolio Management, Volume 26-4, pp. 53-64, 2000.

References

Wilcox, Jarrod, "Harry Markowitz and the Discretionary Wealth Hypothesis", Journal of Portfolio Management, Volume 29-3, pp. 58-65, 2003.

diBartolomeo, Dan, "Simplified Investment Performance Evaluation", Journal of Performance Measurement, Volume 25-3, 2021.

Jobson, J.D. and Bob Korkie, "Performance Hypothesis Testing with the Sharpe and Treynor Measures", Journal of Finance, Volume 36-4, pp. 889-908, 1981.

Memmel, Christoph, "Performance Hypothesis Testing with the Sharpe Ratio", https://ssrn.com/abstract=412588

Lo, Andrew, "The Statistics of Sharpe Ratios", Financial Analyst Journal, Volume 58-4, pp. 36-52, 2002.

Bertrand, Philippe and Costin Protopopescu, "The Statistics of Information Ratios", SSRN Electronic Journal, 2010.

Ledoit, Olivier and Michael Wolf, "Robust Hypothesis Testing with the Sharpe Ratio", Journal of Empirical Finance, Volume 15, pp. 850-859, 2008.

References

Lo, Andrew, Mila Getmansky and Igor Makarov, National Bureau of Economic Research, Working Paper 9571, March 2003.

Bolch, Ben, "More on Unbiased Estimation of the Standard Deviation", The American Statistician, Volume 22-3, pp. 27, 1968.

Brugger, Richard, "A Note on Unbiased Estimation on the Standard Deviation", The American Statistician, Volume 23-4, 1969.

diBartolomeo, Dan. "Applications of Portfolio Variety", in J. Knight and S. Satchell Editors, Forecasting Volatility, Butterworth-Heinemann. 2007.

References

Weisman, Andrew, "Informationless Investing and Hedge Fund Performance", Journal of Portfolio Management, Volume 28-4, pp. 80-91, 2002.

Bondarenko, Oleg, "Market Price of Variance Risk and Performance of Hedge Funds", SSRN Electronic Journal, March 2004.

Fung, William and David Hsieh, "Hedge Fund Benchmarks: A Risk Based Approach", Financial Analyst Journal, Volume 60-5, pp. 65-80, 2004.

Blackburn, Thomas, Dan diBartolomeo, and William Zieff, "Assessment of Cryptocurrency Risk for Institutional Investors", Global Commodity Applied Research Digest, Summer 2022.

Robertson, C.A. and J.G. Fryer, "Some Descriptive Properties of Normal Mixtures", Scandinavian Actuarial Journal, pp. 137-146, 1969.

Thode, Henry, Testing for Normality, CRC Press, 2002.

Jarque, Carlos M. and Anil K. Bera, "Efficient Tests for Normality, Homoscedasticity, and Serial Independence of Regression Residuals", Economics Letters, Volume 6-3, pp. 255-259. 1980.

References

Cornish, E.A. and Ronald Fisher, "Moments and Cumulants in the Specification of Distributions", Review of the International Statistical Institute, Volume 5-4, pp. 307-320. 1938.

Chernozhuckov, Victor, Ivan Fernadez-Val, and Alfred Galichon, "Rearranging Edgeworth-Cornish-Fisher Expansions", Economic Theory, Volume 42-2, pp.419-435, 2010.

Martin, Douglas and Rohit Arora, "Inefficiency and Bias of Modified Value at Risk and Expected Shortfall", Journal of Risk, Volume 19-6, pp. 59-84, 2017.

Liang, Bing, "Hedge Funds: The Living and the Dead", Journal of Financial and Quantitative Analysis, Volume 35-3, pp. 309-326, 2000.

Lo, Andrew. "Risk Management for Hedge Funds: Introduction and Overview", https://ssrn.com/abstract=283308, 2001.

Posthuma, Nolke and Pieter J. van der Sluis, "A Reality Check on Hedge Funds Returns", https://ssrn.com/abstract=438840, 2003.