Measuring the Efficiency of Portfolio Construction | December 2008

RESEARCH INSIGHTS

Portfolio managers may lose information in the process of constructing their portfolios because of constraints, costs, or other inefficiencies. The transfer coefficient can be used to measure and improve the information efficiency of a manager's portfolio. This article discusses various definitions of the transfer coefficient and to what extent they are equivalent.

Introduction

Managers strive to build portfolios that reflect their insights. Yet, often these ideas are not fully expressed in the portfolio because of externally (or internally) imposed constraints, transactions costs, or inefficient portfolio construction. Typical constraints include bounds on position sizes, limits on industry and styles exposures as well as the deeply entrenched "long only" constraint. Transactions costs are easy to understand (though not so easy to measure) and inefficiencies refer to suboptimal tradeoffs between return and risk.

To measure the slippage in going from thought to portfolio construction, researchers have proposed a measure known as the transfer coefficient (TC). The TC gauges how successfully the manager's ideas are transferred to his or her portfolio. Practitioners have employed several ways of calculating the transfer coefficient. The question often comes up – what are the differences between these various methods and does it make a difference which one is used in practice?

Comparing Different Definitions

Here the objective of the manager is to assess the opportunity cost of impediments. Within the active management framework, the basis of this comparison is the ratio of the forecast active return to the forecast active risk, commonly known as the ex-ante information ratio (IR). Other things being equal, the manager desires to maximize his IR.

To put this discussion in context, recall that in the active management framework (see Grinold and Kahn (1999)[1]), the portfolio that achieves the highest IR is the solution to the unconstrained active optimization problem:

$$\underset{h_A}{Maximize} \quad \alpha^T h_A - \frac{\lambda}{2} \underbrace{h_A^T \Sigma h_A}_{\sigma_A^2} \tag{1}$$

where $h_A = h_P - h_B$ is a vector of active weights (portfolio weights h_P minus benchmark weights h_B), α is a vector of the manager's forecast returns or alphas, Σ is the asset covariance matrix and λ is the aversion to residual risk. As usual, we assume the alphas are benchmark neutral (i.e. $\alpha^T h_B$=0).

The manager maximizes IR by finding the optimal tradeoff between his portfolio active alpha and the active risk of the portfolio. The IR of the optimal portfolio is just:

$$IR_{P^*} = \frac{\alpha^T h_{A^*}}{\sigma_{A^*}} \tag{2}$$

[1] Grinold, R., and R. Kahn. 1999, Active Portfolio Management, Second Edition (New York: McGraw Hill).

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Definition 1(A): The simplest and most intuitive definition of the TC is the ratio of the ex-ante information ratios of the manager's actual constrained portfolio P to the optimal portfolio $P*$:

$$TC = \frac{IR_P}{IR_{P*}} \tag{3}$$

The optimal portfolio is the set of weights in the absence of any constraints or costs. If the manager's information is well-mirrored in the portfolio, then the TC will be one. If constraints, costs or inefficiencies get in the way, the TC will be below one.

Definition 1(B): A second way portfolio managers often express the transfer coefficient is the forecast correlation between the active returns of the manager's portfolio P and the optimal portfolio $P*$. The intuition is straightforward: the more closely the two active returns are expected to track each other, the larger the transfer coefficient should be. Thus,

$$TC = \rho_{A,A*} = corr\left(r_A, r_{A*}\right) \tag{4}$$

While these first two definitions may appear to be different at first glance, the two definitions are in fact equivalent since the information in the alphas is embedded in the optimal portfolio $P*$'s weights, i.e.

$$\frac{IR_P}{IR_{P*}} = \rho_{A,A*} \tag{5}$$

Definition 2: A second representation is the cross-sectional correlation between risk-adjusted alphas and the active portfolio weights. A manager's alphas, which contain his information, should be as best reflected in the portfolio weights as possible.

If we denote the risk-adjusted manager's actual active weights as $\Sigma^{1/2} h_A$ and the risk-adjusted alphas as $\Sigma^{1/2}\alpha$, then the transfer coefficient is expressed as:

$$TC = corr\left(\Sigma^{-1/2}\alpha, \Sigma^{1/2} h_A\right) \tag{6}$$

Equation (6) is equivalent to the second definition in equation (4) assuming $\Sigma^{-1/2}\alpha$ and $\Sigma^{1/2} h_A$ have zero means. To see this, given $h_{A^*} = \frac{1}{\lambda}\Sigma^{-1}\alpha$ as the solution to the optimization problem, we can rewrite equation (4) as:

$$TC = corr\left(r_A, r_{A*}\right) = \frac{h_A^T \Sigma h_{A*}}{\left(h_A^T \Sigma h_A\right)^{1/2} \left(h_{A*}^T \Sigma h_{A*}\right)^{1/2}} = \frac{h_A^T \Sigma^{1/2} \Sigma^{-1/2} \alpha}{\left(h_A^T \Sigma h_A\right)^{1/2} \left(\alpha^T \Sigma^{-1} \alpha\right)^{1/2}} \tag{7}$$

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The term on the right of (7) is the just the correlation between the risk-adjusted active weights and alphas in equation (6) assuming they both have zero means. If the latter holds, this definition of the transfer coefficient is equivalent to the first two.

Definition 3: The third definition (see Clarke, de Silva, and Thorley, 2002), is perhaps the most well-known way of defining the transfer coefficient. It is the same as our previous definitions, assuming the manager's alphas are residual to the risk model's factors. Assume we have a covariance matrix Σ, based on a factor model so that:

$$\Sigma = XFX^T + \Delta \tag{8}$$

where X is the matrix of asset exposures to the model's factors, F is the factor covariance matrix and Δ is the diagonal matrix of specific variances, $\sigma_{sp,i}^2$, for each asset i. Then as long as the manager's alphas are orthogonal to the risk model factors in a "risk-adjusted" sense (i.e. $X^T\Delta^{-1}\alpha = 0$) and the active portfolio is factor neutral (i.e. $X^T\Delta^{-1}h_A = 0$), the covariances between assets will be zero.[2] In this case, equation (6) simplifies to the original and most popular form of the transfer coefficient:

$$TC = corr\left(\Delta^{-1/2}\alpha, \Delta^{1/2}h_A\right) = corr\left(\frac{\alpha_i}{\sigma_{sp,i}}, \sigma_{sp,i}h_{A,i}\right) \tag{9}$$

Here the transfer coefficient is defined as the cross-sectional correlation of the risk-adjusted holdings $h_i\sigma_{sp,i}$ with the normalized alphas, $\frac{\alpha_i}{\sigma_{sp,i}}$.

Definition 4: Lastly, some managers may simplify Definition 3 and calculate the transfer coefficient as the cross-sectional correlation between alphas and the active portfolio weights without any risk adjustment.

$$TC = corr\left(\alpha, h_A\right) \tag{10}$$

Transfer Coefficients for Factor Tilt Portfolios

When a manager's alphas are orthogonal to the risk factors, all definitions except the last one, Definition 4, will produce similar, and sometimes identical, results. However in practice, many portfolios are tilted, to some degree or another, towards one or several systematic factors. In this case, using Definitions 3 and 4 above can lead to misleading results.

To illustrate, look at portfolios based on factor bets as of June 2008 using both style factors from the Barra U.S. equity risk model and alpha signals from Barra Alphabuilder,[3] We benchmark the portfolio to the S&P 500, with an active risk of 2%. The Barra U.S. equity long-term (USE3L)

[2] In Clarke, de Silva, and Thorley (2002), alphas are orthogonal to a single factor, the market. Clarke. R, H. Silva and S. Thorley (2002), "Portfolio Constraints and the Fundamental Law of Active Management", Financial Analysts Journal, September/October 2002.

[3] For further details on the factors and signals, please refer to "United States Equity (V3) Risk Model Handbook", and "Alphabuilder Handbook," MSCI Barra.

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model is used as the risk input. We compute the transfer coefficient defined in one of the following ways:

$$TC = \frac{IR_P}{IR_{P*}} \qquad \text{(Definitions 1A \& 1B)}^4$$

$$TC = corr\left(\Sigma^{-1/2}\alpha, \Sigma^{1/2}h_A\right) \qquad \text{(Definition 2)}$$

$$TC = corr\left(\Delta^{-1/2}\alpha, \Delta^{1/2}h_A\right) = corr\left(\frac{\alpha}{\sigma_{sp,i}}, \sigma_{sp,i}h_A\right) \qquad \text{(Definition 3)}$$

$$TC = corr\left(\alpha, h_A\right) \qquad \text{(Definition 4)}$$

Table 1 (unconstrained portfolios) shows how using the more simplified versions of the transfer coefficient falls apart for portfolios with significant factor biases. Transfer coefficients should be 1 since there are no constraints. Transfer coefficients from Definition 3 are much smaller than 1 because the alphas are not orthogonal to risk factor exposures and the assumptions behind this definition are violated. Transfer coefficients are also substantially different from 1 for Definition 4, which does not take risk into account.

Table 1: Transfer Coefficients for Unconstrained Portfolios, June 2008

USE3 Style Factors					**U.S. Alphabuilder Signals**				
Definition	**1**	**2**	**3**	**4**	**Definition**	**1**	**2**	**3**	**4**
Volatility	1.00	1.00	0.57	0.46	Cash Plowback	1.00	1.00	0.93	0.75
Momentum	1.00	1.00	0.61	0.46	Dividend discount	1.00	1.00	0.96	0.82
Size	1.00	1.00	0.82	0.73	Estimated revision	1.00	1.00	0.94	0.79
Size Nonlinearity	1.00	1.00	0.78	0.63	Estimated change	1.00	1.00	0.86	0.72
Trading Activity	1.00	1.00	0.70	0.63	Relative strength	1.00	1.00	0.90	0.81
Growth	1.00	1.00	0.84	0.71	Neglect	1.00	1.00	0.96	0.92
Earnings Yield	1.00	1.00	0.78	0.58	Normalized E/P	1.00	1.00	0.97	0.90
Value	1.00	1.00	0.73	0.54	Residual reversal	1.00	1.00	0.94	0.82
Earnings Variability	1.00	1.00	0.74	0.57	Sector Momentum	1.00	1.00	0.82	0.71
Leverage	1.00	1.00	0.82	0.67	Earning Momentum	1.00	1.00	0.91	0.78
Currency Sensitivity	1.00	1.00	0.85	0.75	Predicted E/P	1.00	1.00	0.91	0.75
Yield	1.00	1.00	0.72	0.68					

Table 2 shows the results of the style factor tilts if we add a long-only constraint. Note that sometimes Definitions 1 and 2 deviate from each other because the cross-sectional means for $\Sigma^{1/2}h_A$ and $\Sigma^{-1/2}\alpha$ are no longer zero.

[4] Definitions 1A and 1B in the prior section were shown to be equivalent.

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Table 2: Transfer Coefficients for Constrained (Long-Only) Portfolios, June 2008

USE3 Style Factors					U.S. Alphabuilder Signals				
Definition	**1**	**2**	**3**	**4**	**Definition**	**1**	**2**	**3**	**4**
Volatility	0.65	0.82	0.44	0.37	Cash Plowback	0.80	0.80	0.74	0.56
Momentum	0.93	0.93	0.54	0.41	Dividend discount	0.71	0.72	0.69	0.59
Size	0.73	0.74	0.52	0.46	Estimated revision	0.69	0.69	0.64	0.50
Size Nonlinearity	0.23	0.24	0.19	0.12	Estimated change	0.71	0.72	0.60	0.46
Trading Activity	0.72	0.78	0.53	0.48	Relative strength	0.86	0.86	0.79	0.70
Growth	0.82	0.82	0.70	0.60	Neglect	0.98	0.98	0.94	0.92
Earnings Yield	0.73	0.73	0.52	0.33	Normalized E/P	0.25	0.25	0.24	0.11
Value	0.80	0.80	0.63	0.45	Residual reversal	0.84	0.84	0.83	0.71
Earnings Variability	0.91	0.91	0.69	0.52	Sector Momentum	0.97	0.97	0.82	0.70
Leverage	0.92	0.92	0.77	0.62	Earning Momentum	0.79	0.79	0.73	0.66
Currency Sensitivity	0.66	0.67	0.56	0.47	Predicted E/P	0.85	0.86	0.80	0.64
Yield	0.81	0.82	0.62	0.59					

In Table 2, the large disparities between the transfer coefficient definitions continue to appear when a simple long-only constraint is added. Here, the factors in question can also yield very different transfer coefficients. Thus in addition to the differences that may result from using different measures of the transfer coefficient, if the factors a portfolio is exposed to changes over time, a manager may see sizable changes in the transfer coefficient.

Conclusion

The transfer coefficient is widely used by quantitative portfolio managers as an ex-ante measure of the effectiveness of their portfolio construction process. In this article, we review several ways of computing the transfer coefficient and discuss the assumptions behind those methods

Using several familiar examples, we illustrate a basic lesson: A TC measure whose assumptions are not met may be misleading. Fortunately, the standard TC, the ratio of the ex-ante IR of the manager's actual portfolio to that of the unconstrained optimal portfolio, works all the time.

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