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Portfolio Strategy

Portfolio Concentration

For securities with similar return/risk expectations, the theoretically optimal information ratio (IR) is obtained through a broad diversification with equal active weights.

In practice, actual portfolio weightings are rarely this “flat.” For traditional funds and even most quantitative funds, the weightings typically follow some descending sequence. In a sample of mutual funds, 50% of the largest active weights ranged between 2.0% and 3.5%, with weights decreasing in a generally exponential fashion. These weighting structures imply alpha expectations that also follow an exponential-like descent.

Most portfolio managers identify the maximum weight they are willing to assign to any single security. This number is often under-utilized, especially given the valuable insights it can provide regarding a portfolio’s risk characteristics.

This Note moves forward from these observations to explore the portfolio characteristics obtained from applying various active weighting structures to different alpha patterns.

Assuming independent residuals, the optimal IR is reached with active weights proportional to the security alphas.

However, higher alphas and still near-optimal IR’s can be derived from portfolios that are significantly more concentrated than those providing the optimal IR.

Most funds have significant unused capacity for active risk. Assuming that the gross weightings maintain the desired beta control, more concentrated active structures could enhance the alpha prospects while sustaining tolerable levels of tracking error and yet having near-optimal IR’s.

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Portfolio Concentration

Summary

Our previous Notes used various alpha ranking and position weighting models to characterize the management process in active equity portfolios. In theory, with a constant residual volatility and zero correlation, the optimal weighting for each position should be proportional to its alpha ranking. With identical alpha expectations for all potential investments, this principle leads to a broadly diversified portfolio with equal weights. However, for other alpha situations and different correlation assumptions, portfolios that are more concentrated can also be optimal or at least near-optimal.

Another key point is that optimal solutions are usually defined in terms of a maximum information ratio (IR) of alpha to tracking error (TE). The IR ratio is an important metric but it does not provide a totally comprehensive description of a portfolio's benefits. Given the role that TE plays at the sponsor level, it is also important to separately consider the two components of the IR. There may be situations where a sponsor is willing to accept a greater alpha at the expense of a higher TE and a lower IR.

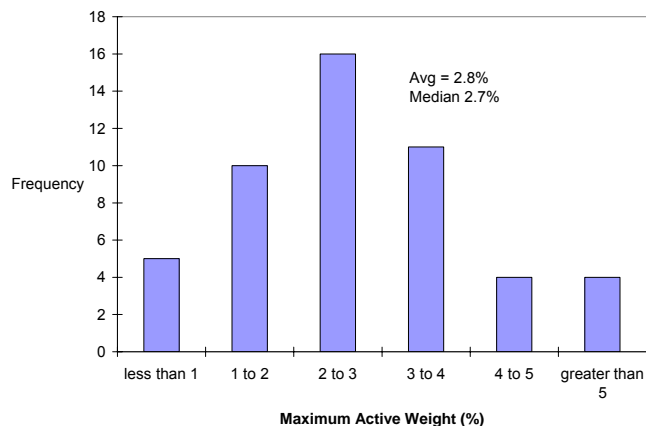
Weighting Models and Maximum Active Weights

Most portfolios identify the maximum active weight that they would invest in any one position. When transformed into a maximum percentage weight for any active position (MW), this number can provide valuable insights into the portfolio structure and its risk characteristics.

Exhibit 1 is a distribution of the maximum active weights for a sample of 50 long-only mutual funds, ranging from \$1B-\$20B in total market value. Although a few outliers exist, the majority of maximum active weights lie between 1-4%.

Exhibit 1

Maximum Active Weights for Sample Portfolios

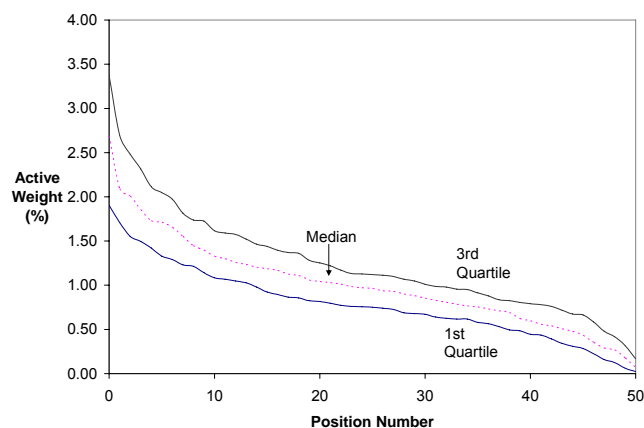


Source: Morgan Stanley Research

Exhibit 2 plots the median, 1st quartile and 3rd quartile of the active weights through the first 50 positions of the sample portfolios. The median maximum active size is 2.7% with a decline to 1.0% by the 25th position and 0.05% by the 50th position. These curves also show that there is little activity after the 50th position. Thus, it becomes reasonable to focus on the first 50 positions.

Exhibit 2

Active Weights for First 50 Positions for Sample Portfolios



Source: Morgan Stanley Research

By the nature of a long-only portfolio, all positive active weights must be funded by active underweights. However, in a typical

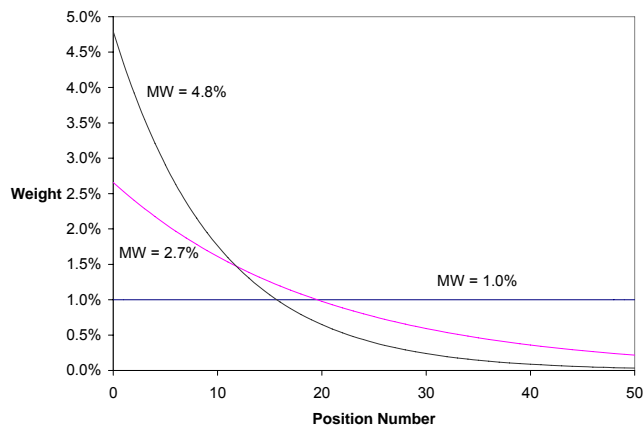
long portfolio, all but a few of the sizable active positions will be overweights, with the funding underweights scattered across many smaller positions. For a number of reasons, these fragmented underweights have a relatively minor impact on the expected alphas or the TE's that are the focus of this paper. Thus, in the interest of clarity, the following discussion will treat all active positions as if they were positive overweights.

Exponential Weighting Models

The portfolio weighting functions in Exhibit 2 can be roughly modeled with an initial MW and an exponential decline in the subsequent weights. Exhibit 3 displays three possible weighting functions, each specified to provide the total 50% active weight over 50 positions. With this requirement for a 50% activity level, the starting weight MW then fully determines the exponential weight curves shown in Exhibit 3. Exhibit 4 shows the cumulative weight for the three functions, with all curves ending at the total active weight of 50%.

Exhibit 3

Exponential Weighting Models

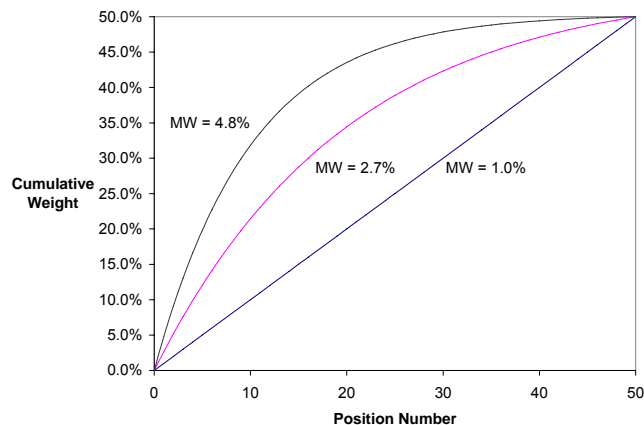


Source: Morgan Stanley Research

The middle curve in Exhibit 3 approximates the portfolio weightings for the sample funds in Exhibit 2. It begins at 2.7%, declines to 0.8% by the 25th position, and then drops to 0.2% by the 50th position. The higher curve represents a more concentrated weighting scheme with a maximum weight of 4.8% that declines to 0.4% by the 25th position and then reaches 0.03% at the 50th position. The bottom flat line represents a fixed 1% weight.

Exhibit 4

Cumulative Portfolio Weights



Source: Morgan Stanley Research

Tracking Errors

Given a constant 20% tracking error (TE) for each position, one can determine the TE associated with a starting MW and its associated weighting function. The formula for this calculation is provided in the Appendix.

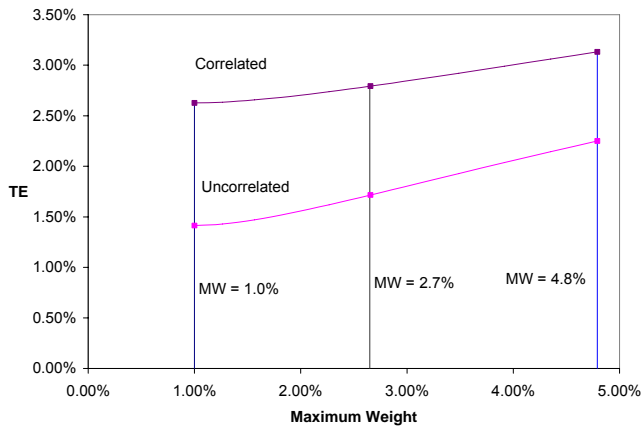
When each active position is assumed to be independent and uncorrelated, the TE calculation is quite simple. For MW's ranging from 1.0% to 4.8%, the TE's are shown on the lower curve in Exhibit 5. The lowest TE of 1.4% occurs with a MW of 1%, which is the most diversified portfolio with all 50 positions having the same 1% weight. With higher MW's, more of the total weight is concentrated in the earlier positions, leading to somewhat larger TE's. With a 4.8% MW, the uncorrelated TE reaches 2.25%.

However, in most long-only portfolios, there will be common factors that exist among the positions. These effects can be modeled by assuming that a positive correlation exists between any two positions. In Exhibit 5, the top line depicts the TE for a pairwise correlation of 0.05.

For a MW of 1%, the correlated TE is 2.6%. The TE then increases with higher MW's, reaching 3.1% for the most concentrated portfolio with an MW of 4.8%. It is interesting to note that Exhibit 5's curve for the correlated case is flatter than the uncorrelated case. This is because correlation in effect forces a certain "concentration" even across diversified weightings.

Exhibit 5

Correlated and Uncorrelated TE



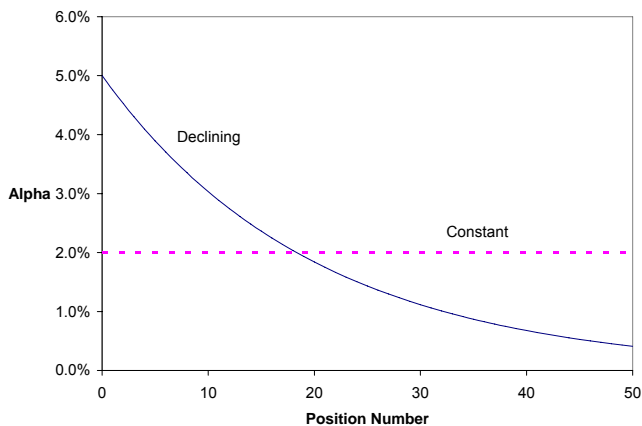
Source: Morgan Stanley Research

Alpha Ranking Functions

Portfolio managers generally have some formal way (in the case of quantitative funds) or informal way (in the case of fundamental managers) for sequencing their active investments in terms of expected excess returns. The declining curve in Exhibit 6 is an example of an alpha-ranking model that follows the same rate of exponential decay (0.05) as Exhibit 3's weighting function for an MW of 2.7%. In this example, the highest expected alpha is 5%, which then declines to 0.4% by the 50th position. Exhibit 6 also displays an alpha-ranking model that is constant at 2% for each position.

Exhibit 6

Alpha Ranking Models

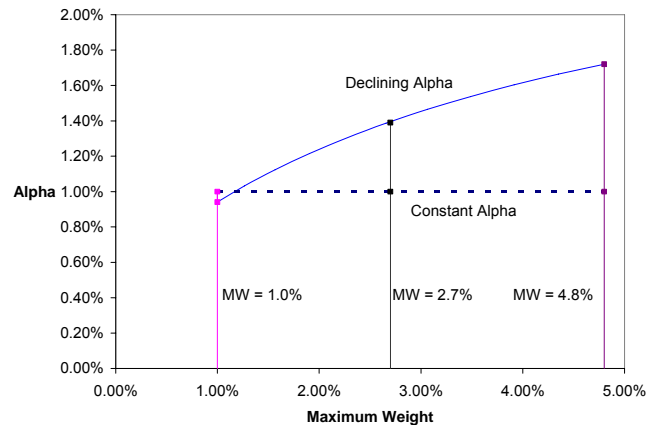


Source: Morgan Stanley Research

Exhibit 7 depicts the cumulative portfolio alpha from combining Exhibit 6's two alpha-ranking curves with the exponential weighting functions for MW's ranging continuously from 1.0% to 4.8%. For the constant alpha case, the portfolio alpha is also constant since all weighing functions are designed to accumulate to the same 50% activity level.

Exhibit 7

Portfolio Alphas



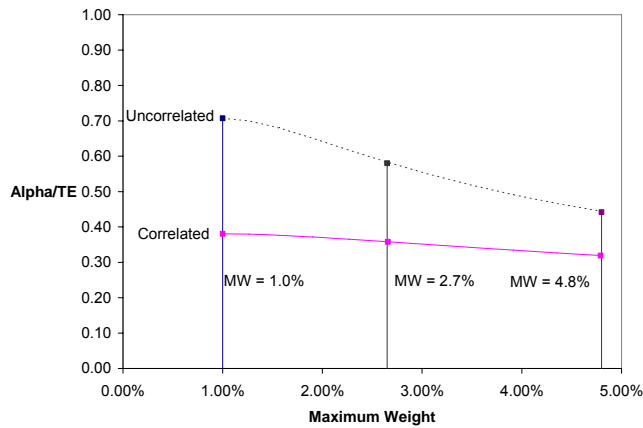
Source: Morgan Stanley Research

For the case of the declining alphas, the higher MW's assign greater weights to the larger alphas. This greater concentration in the more alpha-rich positions generates portfolio alphas that rise with higher MW's, as shown by the curve in Exhibit 7. Comparing Exhibit 7 with Exhibit 5, one sees that these higher portfolio alphas are associated with greater TE's. A standard approach for integrating these two measures is the information ratio (IR) comprised of the portfolio alpha divided by the corresponding TE.

The IR's for Constant Alphas

Focusing on constant alpha case, with the numerator being constant across all MW's, the IR value varies only with the TE in the denominator. As evident in Exhibit 5, for both the correlated and the uncorrelated cases, the TE rises with higher MW's, so the IR must always fall with higher MW's, as shown in Exhibit 8. Thus, for constant alphas, the most diversified portfolio, i.e., the one with all weights equal to 1%, provides the best IR.

Exhibit 8
IR's for Constant Alphas

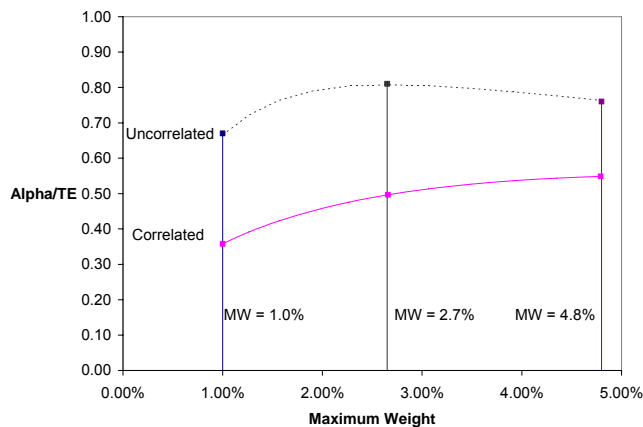


Source: Morgan Stanley Research

The IR's for Declining Alphas

For the declining alpha case, the IR story becomes more complicated. In contrast to the constant alpha case, the portfolio alpha now rises with higher MW's (Exhibit 7). The IR curve therefore depends on the specific relationship between the increasing alpha in the numerator and the increasing TE's in the denominator. Exhibit 9 plots the resulting IR curves.

Exhibit 9
IR's for Declining Alphas



Source: Morgan Stanley Research

For uncorrelated positions, the IR's rise with higher concentrations, reach a peak at an MW of 2.7%, and then decline slowly. It will be recalled that that declining alphas had the same (0.05) exponential rate of decay as the weighting function for a starting MW of 2.7%. This is, of course, no

coincidence. With all positions being independent and having the same residual error, it can be shown that each position's optimal (IR-based) weight must be proportional to its alpha value. Thus, the maximum IR will be achieved with an exponential weighting having the same 0.05 decay rate as the alpha function. Therefore, it is no surprise that the optimized IR is attained for a "decay-matching" MW value of 2.7%.

At the same time, it is interesting to note that the IR curve is relatively flat even beyond the 2.7% peak. This "near-optimality" of more concentrated weightings raises the question as to whether higher concentrations may be preferred under certain conditions. For example, some fund sponsors may be willing to tolerate somewhat greater TE's in exchange for materially higher alphas. The flat portion of the IR curve in Exhibit 9 suggests that such a tradeoff could lead to more concentrated portfolios with significantly higher alphas (Exhibit 7) but only slightly below-optimal IR's.

This alpha versus TE tradeoff becomes more compelling at the sponsor level. At this overall fund level, the alpha adds to the return while the TE can be shown to be largely submerged by the dominating beta risk. Thus, although moving from the IR-optimal point incurs higher TE in a component portfolio, the risk at the overall fund level will not significantly change.

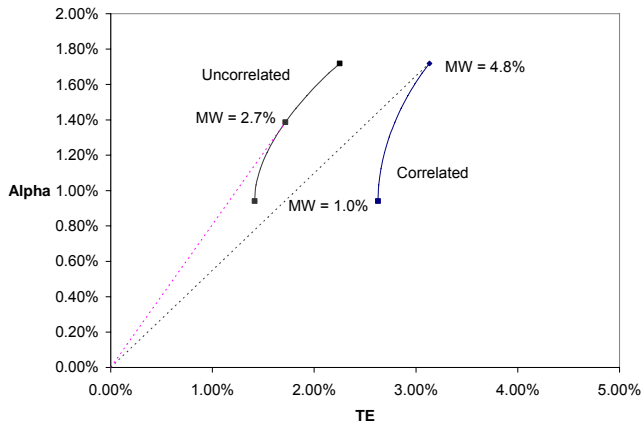
The correlated situation can lead us even further away from the diversified portfolio. In Exhibit 5, it was shown that correlation increased the overall TE's while flattening the TE curve. With this flatter TE, the rising alpha curve becomes more dominant. As shown in the lower curve in Exhibit 9, the net result is that the IR actually increases continuously with higher MW's. From a pure IR perspective, the highest IR value is only attained with an MW of 4.8%, i.e., the most concentrated portfolio considered in our example. Given the shape of this correlated IR curve, it might be that some TE limit would take precedence over reaching for the highest possible IR.

Efficient Frontiers for Declining Alphas

In Exhibit 10, the uncorrelated and correlated cases for the declining alphas are depicted as efficient frontiers in alpha versus TE space. The most diversified weighting, with MW of 1%, provides both the lowest TE and the smallest portfolio alpha. Consequently, an MW of 1% corresponds to the beginning point of the frontier for both the correlated and uncorrelated frontiers. With increasing MW's, the alphas and the TE's both rise continually. However, the optimal IR corresponds to the frontier point having the greatest slope for the line drawn from the origin. As seen earlier in Exhibit 8, this maximum slope for the uncorrelated case is reached at the

midpoint with an MW of 2.7%. In contrast, for the correlated case, the higher IR is only reached at an MW of 4.8%.

Exhibit 10
Alpha vs. TE: Uncorrelated and Correlated



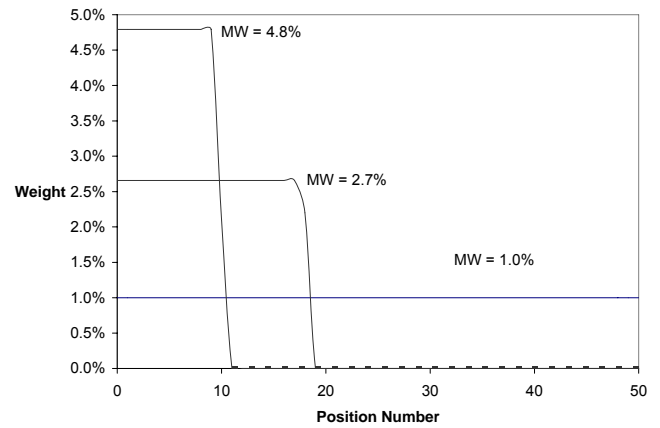
Source: Morgan Stanley Research

Simple Fixed Weights

All weighting functions thus far have assumed an initial MW followed by an exponential decline. The preceding discussion indicated that there might be situations when portfolios that are more concentrated may be preferred. Exponential weightings with higher starting MW's were explored as a way to achieve greater concentrations on the higher alpha investments. However, another approach to intensified concentrations is achieved by simply keeping the weight fixed at the starting MW until the 50% "activity budget" is exhausted.

Exhibit 11 provides three examples of these fixed weightings using the same maximum weights as in Exhibit 3 for the exponential weighting function. A 4.8% fixed weight covers slightly more than 10 positions, while a 2.7% fixed weight spans roughly 19 positions. The fixed 1% weight case obviously corresponds to 50 positions each having the same 1% MW.

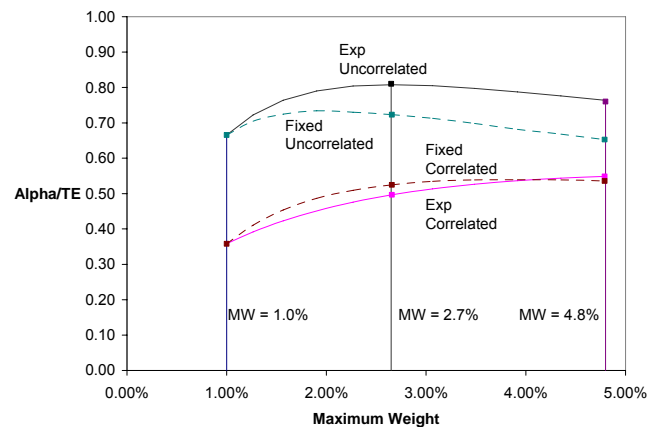
Exhibit 11
Fixed Weighting Function



Source: Morgan Stanley Research

Exhibits 12 and 13 compare the exponential and the fixed weighting approaches for the two correlation assumptions. The exponential weighting curves are the solid lines while the fixed weighting curves are shown as dashed lines.

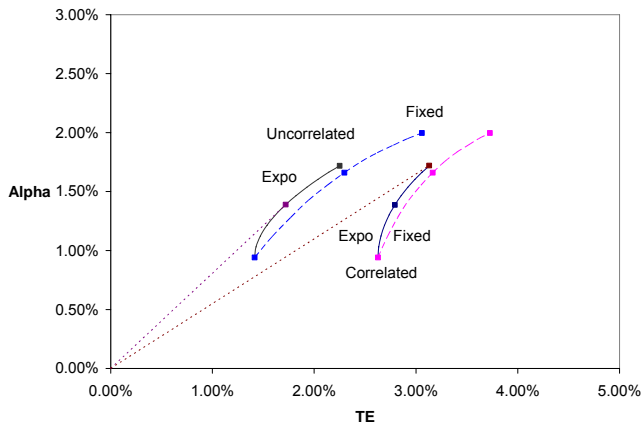
Exhibit 12
Alpha/TE: Four Weighting Scenarios



Source: Morgan Stanley Research

Exhibit 13

Alpha vs. TE Four Weighting Scenarios



Source: Morgan Stanley Research

It is interesting to note that in the uncorrelated case, the exponential IR curve in Exhibit 12 appears to significantly dominate the fixed weighting. However, with the 0.05 pairwise correlation, the IR curves become virtually coincident. In Exhibit 13's efficient frontiers, the fixed weights provide significantly higher alphas with near-optimal IR's, especially in the correlated case.

Of course, a key problem is that the alpha function, even if known, rarely fits any simple functional pattern. However, in practice, the actual weights assigned to various positions within a given portfolio do provide some indication of the presumed alphas. To the extent that these estimates allow higher-conviction investments to be at least classified into tiers, then similarly-clustered fixed weightings might provide a robust approach to higher-alpha portfolios that remain near-optimal in IR terms.

Appendix

Exponential Weightings

For a starting maximum weight MW, an exponential weighting model would assign active weight ω_i to the i th position,

$$\omega_i = (MW)e^{-\lambda(i-1)} \quad i = 1, N$$

where λ is the decay rate

In this paper, the total active weight accumulates to a level W so that λ can be determined as a function of MW from the implicit equation,

$$\begin{aligned} W &= \sum_1^N \omega_i \\ &= (MW) \sum_1^N e^{-\lambda(i-1)} \\ &= (MW) \left[\frac{(1 - e^{-\lambda N})}{(1 - e^{-\lambda})} \right] \quad MW > 1\% \end{aligned}$$

For $(MW) = 1\%$, we have constant weightings,

$$\omega_i = (MW) \quad i = 1, N$$

Uncorrelated Tracking Error and Exponential Weights

With a uniform residual error σ across all positions, the uncorrelated tracking error $TE(0)$ is given by

$$\begin{aligned} TE^2(0) &= \sum_1^N (\omega_i \sigma)^2 \\ &= \sigma^2 \sum_1^N (MW)^2 e^{-2\lambda(i-1)} \\ &= (MW)^2 \sigma^2 \left(\frac{1 - e^{-2\lambda N}}{1 - e^{-2\lambda}} \right) \quad MW > 1\% \end{aligned}$$

For $MW = 1\%$,

$$\begin{aligned} TE^2(0) &= N(MW)^2 \sigma^2 \\ &= N \left(\frac{W}{N} \right)^2 \sigma^2 \\ &= (W\sigma)^2 \left(\frac{1}{N} \right) \end{aligned}$$

Correlated Tracking Error and Exponential Weights

With a uniform pairwise correlation, the tracking error $TE(\rho)$ is given by

$$\begin{aligned} TE^2(\rho) &= \sum_{i,j} \omega_i \omega_j \rho_{ij} \sigma^2 \\ &= \sigma^2 \left[\sum_{i \neq j} \omega_i \omega_j \rho + \sum_{i=1}^N \omega_i^2 \right] \\ &= \sigma^2 \left\{ \left[\left(\sum_{i=1}^N \omega_i \right)^2 - \sum_{i=1}^N \omega_i^2 \right] \rho + \sum_{i=1}^N \omega_i^2 \right\} \\ &= \left[(W\sigma)^2 - TE^2(0) \right] \rho + TE^2(0) \end{aligned}$$

For the special case when $MW = 1\%$ and $\omega_i = 1\%$,

$$\begin{aligned} TE^2(\rho) &= \left[(W\sigma)^2 - (W\sigma)^2 \left(\frac{1}{N} \right) \right] \rho + (W\sigma)^2 \left(\frac{1}{N} \right) \\ &= (W\sigma)^2 \left\{ \left[1 - \frac{1}{N} \right] \rho + \frac{1}{N} \right\} \end{aligned}$$

and since $W = N(MW)$

$$\begin{aligned} TE^2(\rho) &= N^2 (MW)^2 \sigma^2 \left\{ \left[1 - \frac{1}{N} \right] \rho + \frac{1}{N} \right\} \\ &= (MW)^2 \sigma^2 \{ [N^2 - N] \rho + N \} \end{aligned}$$

Alpha Function

An exponential alpha function with a starting alpha α_0 and a decay rate μ will have position alphas,

$$\alpha_j = \alpha_0 e^{-\mu(j-1)} \quad j = 1, N$$

The portfolio alpha α_p with exponential weighing then becomes,

$$\begin{aligned} \alpha_p &= \sum_{j=1}^N \omega_j \alpha_j \\ &= (MW) \alpha_0 \sum_{j=1}^N e^{-(\lambda+\mu)(j-1)} \\ &= (MW) \alpha_0 \left[\frac{(1 - e^{-N(\lambda+\mu)})}{(1 - e^{-(\lambda+\mu)})} \right] \end{aligned}$$

for $(MW) > 1\%$ and $\mu > 0$.

For $MW = 1\%$ and/or $\mu = 0$ (the flat alpha case), the formula must be adjusted as shown earlier.

The Information Ratio

The information ratio is defined as

$$IR = \frac{\alpha_p}{TE(\rho)}$$

With exponential alpha ($\mu > 0$) and uncorrelated exponential weights ($\lambda > 0$), this ratio takes the form

$$IR = \frac{(MW)\alpha_o \left[\frac{(1 - e^{-N(\lambda+\mu)})}{(1 - e^{-(\lambda+\mu)})} \right]}{(MW)\sigma \sqrt{\left[\frac{(1 - e^{-2N\lambda})}{(1 - e^{-2\lambda})} \right]}}$$

When $\lambda = \mu$, this IR can be shown to reach a maximum value IR^* ,

$$IR^* = \frac{\alpha_o}{\sigma} \sqrt{\left[\frac{(1 - e^{-2N\lambda})}{(1 - e^{-2\lambda})} \right]}$$

Thus, for the numerical values used in Exhibit 9, with $MW = 2.7\%$, which implies an $\lambda = 0.05$, the optimal IR^* is given by

$$\begin{aligned} IR^* &= \frac{5}{20} \sqrt{\left[\frac{(1 - e^{-2(50)(.05)})}{(1 - e^{-2(.05)})} \right]} \\ &= 0.81 \end{aligned}$$

Fixed Weights

For a given fixed weight (MW), the position weightings can be approximated by

$$\omega_i = \begin{cases} (MW) & i = 1, \frac{W}{(MW)} \\ 0 & i > \frac{W}{(MW)} \end{cases}$$

so that the uncorrelated tracking error simply becomes

$$\begin{aligned} \text{TE}^2(0) &= \sigma^2 (\text{MW})^2 \frac{W}{(\text{MW})} \\ &= \sigma^2 (\text{MW})W \end{aligned}$$

while the correlated tracking error is again given by

$$\begin{aligned} \text{TE}^2(\rho) &= [\text{TE}^2(1) - \text{TE}^2(0)]\rho + \text{TE}^2(0) \\ &= [(W\sigma)^2 - \sigma^2 (\text{MW})W]\rho + \sigma^2 (\text{MW})W \\ &= \sigma^2 W \{ [W - (\text{MW})]\rho + (\text{MW}) \} \end{aligned}$$

The portfolio alpha under exponential weighting ($\lambda > 0$) is found from

$$\begin{aligned} \alpha_p &\cong \sum_{i=1}^{\left(\frac{W}{\text{MW}}\right)} \omega_i \alpha_i \\ &\cong \sum_{i=1}^{\left(\frac{W}{\text{MW}}\right)} (\text{MW}) \alpha_o e^{-\mu(i-1)} \\ &\cong (\text{MW}) \alpha_o \left[\frac{\left(1 - e^{-\mu\left(\frac{W}{\text{MW}}\right)}\right)}{\left(1 - e^{-\mu}\right)} \right] \end{aligned}$$

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	Count	% of Total	Count	% of Total IBC	% of Rating Category
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Equal-weight/Hold	1017	45%	320	44%	31%
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Overweight (O). The stock's total return is expected to exceed the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

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Equal-weight (E). The stock's total return is expected to be in line with the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

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More volatile (V). We estimate that this stock has more than a 25% chance of a price move (up or down) of more than 25% in a month, based on a quantitative assessment of historical data, or in the analyst's view, it is likely to become materially more volatile over the next 1-12 months compared with the past three years. Stocks with less than one year of trading history are automatically rated as more volatile (unless otherwise noted). We note that securities that we do not currently consider "more volatile" can still perform in that manner.

Unless otherwise specified, the time frame for price targets included in this report is 12 to 18 months.

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Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.

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