June 15, 2006

Portfolio Analysis
Correlation Effects in Short Extension “120/20” Strategies

Short extensions of active equity portfolios can improve both the cumulative alpha and the alpha/TEV ratio. The preconditions for productive short extensions include an efficient shorting procedure, an effective risk control discipline, and a credible prospect of being able to generate truly positive alpha values.

Short extension strategies can be designed to fit within a sponsor’s existing allocation space for active US equity management. With proper risk control, a short extension may entail tracking error that is only moderately greater than that of a comparable long-only fund.

Correlation effects materially increase the tracking error and lower information ratios of both long-only and short extension portfolios. It is therefore important to try to minimize any correlation effects.

Short extension portfolios can provide a natural offset to adverse correlations. This offset feature can be valuable across a wide range of alpha-ranking models.

Short extensions can be particularly productive in situations where the portfolio alpha is the primary consideration, as long as the associated tracking error falls within certain bounds.

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Correlation Effects in Short Extension “120/20” Strategies

Summary
With traditional equity long-only portfolios, the ability to take significant underweight positions is limited to those few stocks with very large market capitalizations. Short extension “120/20” strategies open the door to a fresh set of opportunities by allowing greater underweights (via shorting) to be taken in lesser-cap stocks.

These shorting/reinvestment strategies usually maintain the original long-only fund structure in terms of net market exposure, benchmark-centric management, and a high level of risk control. Rather than being viewed strictly as “alternative”, this risk discipline enables short extensions to be categorized in the same allocation space as traditional active equity portfolios.

The interest in 120/20-type strategies has grown significantly as both investment sponsors and asset managers have sought enhanced levels of positive alpha. There have been a number of theoretical studies on this topic, including follow-on articles from the early authors in this area, e.g., Jacobs and Levy, Grinold and Kahn, Clarke, de Silva and Thorley [1-20].

One of our previous Notes analyzed how different archetypal alpha-ranking models can be used to analyze the potential rewards and alternative structures of both long-only and long/short portfolios [21]. With extension portfolios, the alpha-ranking model can help determine the number of active short positions that should be taken. At some point, the incremental benefit in portfolio alpha falls below the increase in tracking error volatility (TEV). The marginal increase in the portfolio alpha/TEV ratio will then level out and decline as more positions are added to the portfolio.

In this Note, we explore how various correlation effects can also impact the potential rewards from short extensions. The earlier studies were based on the assumption that the active residual risks used in the TEV calculation were uncorrelated with one another. Even when dealing solely with long-only portfolios, projected TEVs fall in the range of 1-3%, well below the observed TEVs of 4% or higher seen in most actively managed portfolios (see “The Tracking Error Gap” [22]). This discrepancy between the observed TEVs and the theoretical uncorrelated values implies that there is typically some degree of correlation among the various positions. These correlations, even at a minimal level, can have a significant effect on the TEV and can therefore have a meaningful impact on portfolio performance.

In short extension portfolios, these correlations may lie within the long positions, within the short positions, and/or between the long and short positions. One of the benefits of a short extension is the opportunity to use the short positions to offset factor effects within the long portfolio. Such offsets can sharpen the intended exposures by removing extraneous risk factors, thereby leading to materially improved information ratios.

Long-Only Alpha Ranking Models
A basic assumption throughout this study is that the fund is able to maintain a strict benchmark-centric structure, i.e., that the portfolio is constructed so as to maintain a beta value of one relative to its benchmark. The active management then consists of choosing overweight and/or underweight positions that are expected to generate a certain alpha return.

Exhibit 1 displays three distinct alpha-ranking patterns for the long-only portfolio: 1) a simple flat pattern with all alphas fixed at 3.50%, 2) a moderately declining exponential ranking that begins with a 5% alpha for the position with the highest expected alpha and falls to 2% by the 25th position, and 3) a highly concentrated ranking, with an initial alpha of 13% but subject to a rapid exponential decay that reduces the alpha to 1% by the 15th position.

As shown in Exhibit 2, all three models were calibrated to have the same cumulative alpha of 1.75% for a portfolio with 25 long positions each having a 2% weight.
In an earlier Note [22], a basic formula was developed to show the TEV effect of pairwise correlations in the context of long-only portfolios. This same correlation model is used here for the current case of long portfolios with 2% position sizes, each with a residual volatility of 23%. As shown in Exhibit 3, it only takes a slight increase in pairwise correlation to generate significant increases in the TEV. For a 25-position portfolio, the TEV moves from 2% in the uncorrelated case to 3.5% at a 0.05 pairwise correlation and jumps to 4% for a correlation of 0.10.

At first glance, this leveling out of the alpha/TEV ratio after the 15th position may raise questions about whether the long portfolio should be structured to the full 25 positions. However, it should be noted that with a 0.05 pairwise correlation, the 25-position TEV is still well below 4%. At the same time, as shown in Exhibit 2, the portfolio alpha for this ranking model continues to rise with the higher position counts. In situations where such TEVs are quite tolerable, the investor may well opt for the higher alpha portfolio even without any corresponding improvement in the alpha/TEV ratio itself.

In the concentrated case (Exhibit 5), the alpha/TEV ratio peaks quickly at attractive levels for both the correlated and the uncorrelated cases. It is no surprise that, for the concentrated alpha ranking, a tight portfolio with only 5-8 positions appears optimal in terms of both the alpha/TEV ratio as well as the cumulative portfolio alpha.
In the flat case with a zero correlation, the alpha/TEV ratio increases as the alpha from each new position overwhelms the added tracking error. With a 0.05 or 0.10 correlation, the alpha/TEV curve still rises as more positions are added, but now at a decreasing rate.

Assuming a fixed 2% weight for all active positions, each short position will result in 2% cash proceeds that can be used to fund a new 2% long position. However, to be conservative, it is assumed that a maximum 2% constraint prevents further investment into the first 25 high-alpha long positions. The proceeds from the shorts therefore must be deployed into the lower-ranked long opportunities that lie beyond the 25th position.

Offsetting Long/Short Correlations
The basic long-only correlation model applies when all positions have a common pairwise correlation. Just as a uniform positive correlation can have a material TEV-increasing effect, so the opportunity for offsetting negative correlations can act as a major TEV-reducing factor. In theory, such offsets could be present within the long portfolio itself. However, for the sake of simplicity, only positive correlations are assumed to exist within the longs and within the shorts, while the offsetting negative correlations are assumed to occur only between the shorts and longs.

To analyze short extensions with such offsetting correlations, a more structured model is needed. The Appendix develops a theoretical formula for these more complex TEVs.
To demonstrate the impact of offsetting correlations, two Monte Carlo simulations were run for the case of a 20% short weight — one without correlation between the longs and shorts and another with a negative (-0.05) correlation. Both simulations contained positive 0.05 correlations within the longs and within the shorts. Exhibit 8 displays the resulting histograms. The top histogram with a zero correlation between the longs and shorts has a wider distribution of tracking errors and hence a larger TEV than the bottom histogram with an offsetting correlation. Exhibit 8 also shows that the simulated TEV results are generally in accord with the expected TEVs derived from the theoretical formula.

Exhibit 8
Tracking Error Simulation Results: 20% Short Weight

Exhibit 9 uses the results from the TEV formula to show the impact of various short-to-long correlations as the short weight increases. The three cases all assume a positive 0.05 correlation within the longs and within the shorts but differ in the short-to-long correlations. The TEV-reducing effect of these offsets is clearly evident.

Exhibit 9
TEV vs. Short Weight for Various Offset Correlations

Exhibit 10 focuses on short extension weights of 20% and 40% to show the TEVs as a function of the pairwise correlation between the longs and shorts. The solid curves reflect the theoretical expected values. The scatter points along the curve for the 20% case reflect a series of Monte Carlo simulations. The tightness of the fit provides comfort as to the robust quality of the “offset” TEV formula as developed in the Appendix.

Exhibit 10
Model Monte Carlo Simulations — TEV vs. Short-to-Long Correlations
Information Ratios for Short Extensions
The three alpha-ranking models can be combined with the TEV formula to develop alpha/TEV information ratios for short extensions.

Exhibit 11 presents the ratios for the moderately declining alpha ranking. With positive correlation of 0.05, the information ratio for the basic 25-position long-only portfolio ratio is 0.51. With varying short extensions added from that point, the long to short correlation can be seen to play a key role. With a zero offset correlation, the short extension provides only modest benefits. However, with an offsetting -0.05 correlation, the short extensions can raise the information ratio from the long-only’s 0.51 to a peak value of 0.90 for short weights in the 50-80% range. With the more moderate offset of -0.03, the ratio reaches a peak value of around 0.70 for short weights of 30-50%.

Exhibit 12
Alpha/TEV Ratio vs. Short Extension for Concentrated Alpha Case

As shown in Exhibit 12, for the concentrated case, the information ratio curves have a more pronounced maximum, ranging from 0.65 to 0.80, but with short weights falling in a much tighter range of 15-25%.

Finally, the less realistic flat alpha ranking (Exhibit 13) results in a continuously upward sloping ratio for the two offset cases. With a zero short to long correlation, the curve starts to flatten out around the 80% short weight and a ratio around 0.75.

Exhibit 13
Alpha/TEV Ratio vs. Short Extension for Flat Alpha Case

Alpha-Focused Investment
In practice, the alpha/TEV ratio may not always serve as a totally sufficient gauge of portfolio value. For typical asset allocations, the tracking error from any component portfolio is likely to have only a minimal impact on the overall fund volatility [23]. While the tracking error may be important for
other reasons, including as an informational signal relating to risk discipline, consistency, process reliability, etc., there certainly are situations where lower alpha/TEV ratios could be exchanged for higher returns as long as the TEV remained within some reasonable bound. In such situations, short extensions can lead to significantly enhanced alphas. Exhibit 14 illustrates the alpha enhancement for the declining alpha case. As an example, for a TEV limit of 4%, the alpha is increased by 1-2% depending on the degree of offset correlation provided by the short positions.

Conclusions
The key finding — which is perhaps best illustrated in the more realistic moderately declining alpha ranking — is that unproductive positive correlations can seriously elevate the TEVs and erode the alpha/TEV ratios for long-only portfolios. Consequently, there is a significant benefit to reducing any unintended or alpha-inefficient correlations. Improved alphas and better information ratios can then be obtained from appropriately sized short extensions — provided that the proper risk discipline is maintained, that the total shorting costs are sufficiently modest, and that the management can truly deliver credibly positive alphas. In addition, if the shorts can be selected so as to offset undesirable correlations within the long portfolio, then even further ratio improvement may be attained.

References:
### Appendix

In our Portfolio Note The Tracking Error Gap [22], the following algebraic expression was developed for the tracking error (TEV) of an N-position portfolio, with each position having a weight $\omega$, a residual volatility $\sigma$, and a pairwise correlation $\rho$,

$$\text{TEV}(\rho) = (\omega \sigma) \sqrt{N + N(N - 1)\rho}$$

For short extension portfolios consisting of $N_L$ long positions and $N_S$ short positions, a comparable model would require identifying three distinct correlations regimes,

1) $\rho_L$ within the $N_L$ longs

2) $\rho_S$ within the $N_S$ shorts

3) $\rho_{LS}$ between the short and the long positions

The correlations matrix would then have the following structure:

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<td>$\rho_{LS}$</td>
<td>$\rho_{LS}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Longs

1) $N_L$ with $\rho_L = 1$

2) $[N_L^2 - N_L] \text{ with } \rho = \rho_L$

3) $N_S$ with $\rho_S = 1$

Since all positions have a common variance $(\omega \sigma)^2$, the TEV ($\rho_L, \rho_S, \rho_{LS}$) for a short extension portfolio can be found by simply enumerating all the pairs:

1) $N_L$ with $\rho_L = 1$

2) $[N_L^2 - N_L] \text{ with } \rho = \rho_L$

3) $N_S$ with $\rho_S = 1$
4) \([N_S^2 - N_S]\) with \(\rho = \rho_S\)

5) \(2N_LN_S\) with \(\rho = \rho_{LS}\)

This enumeration leads to the expression,

\[
\text{TEV}(\rho_L, \rho_S, \rho_{LS}) = (\omega \sigma) \sqrt{N_L + N_L(N - 1)\rho_L + N_S + N_S(N - 1)\rho_S + 2N_LN_S\rho_{LS}}
\]

It is interesting (and comforting) to see that, when all the \(\rho\)'s are the same, the above formula devolves to the simple one for a "homogenous" portfolio, i.e.,

\[
\text{TEV}(\rho, \rho, \rho) = (\omega \sigma) \sqrt{N_L + N_L(N - 1)\rho + N_S + N_S(N - 1)\rho + 2N_LN_S\rho}
= (\omega \sigma) \sqrt{(N_L + N_S) + \rho[N_L^2 - N_L + N_S^2 - N_S + 2N_LN_S]}
= (\omega \sigma) \sqrt{(N_L + N_S) + \rho[(N_L + N_S)^2 - (N_L + N_S)]}
= (\omega \sigma) \sqrt{N + \rho[N(N - 1)]}
\]

where now \(N = N_L + N_S\).

Moreover, for extreme values of \(\rho\), the formula provides the well-known result, i.e.

\[
\text{TEV}(0,0,0) = (\omega \sigma) \sqrt{N}
\]

and

\[
\text{TEV}(1,1,1) = (\omega \sigma)N
\]
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