Morningstar Hedge Fund Operational Risk Flags Methodology

Morningstar Methodology Paper
January 22, 2010

Introduction

This document describes the rationale for, and the formulas and procedures used, to calculate the Morningstar Hedge Fund Operational Risk Flags, ("ORF".)

The light regulation and global availability of hedge funds create unique operational risk issues that are not found with regulated fund investments. Failure to monitor the operations of hedge funds and perform adequate due diligence are contributing factors that allow hedge fund managers and affiliates to perpetrate investment frauds.

The ORF evaluates the following components:

- Outside service providers, including administrator and auditor, are reviewed for suitability.
- Voluntary registration efforts are assessed.
- Returns are evaluated for unusual patterns.

Outside Service Providers

Many hedge funds operate as small businesses with few support personnel. Additionally, in many jurisdictions, including the United States, hedge funds are not required to have independent directors to approve the auditor and oversee the administrative functions.

Administrative functions of hedge funds can include many different operations, but generally include the verification of fund assets, verification of individual holdings' values, calculation of net asset value, and preparation of individual account statements. Although some hedge fund management companies have sufficient staff and operations to perform these duties effectively, independence of the fund administrator provides an additional investor protection.

The audit function provides assurance of the financial presentation and results. As such, it is important that the auditor be independent of the asset-management company. The auditor's responsibilities will generally require review of the administrator's operations and calculations. Therefore, we believe the audit function should be separate from that of the administrator.

Both administrators and auditors need to have the requisite expertise to evaluate hedge funds. This expertise can be tested in part by seeing if the service provider has an extensive customer list.

Introduction (Continued)

Voluntary Registration
Hedge funds as a global investment vehicle have the ability to house operations in a variety of jurisdictions with various regulatory requirements. Choosing to operate in an emerging market and avoiding the minimal regulation that accompanies registering a fund suggest that further due diligence is appropriate.

Return Patterns
Many hedge funds hold illiquid or difficult-to-price securities. The lack of readily available market prices may give hedge fund managers "flexibility" in how they value such positions when calculating returns that they report to hedge fund databases. Sometimes, this pricing flexibility manifests itself in monthly total returns that demonstrate serial correlation – that is, one month's returns are statistically correlated with the next month's. Such a signal does not directly indicate that a hedge fund has exhibited pricing flexibility, but it serves as an indication of the possibility. Funds with serial correlation that is higher than its peers are likelier than other funds to own assets that have unreliable prices.

Morningstar uses a standard statistical technique to estimate the level of serial correlation. Hedge funds with serial correlation higher than 90% of funds in a Morningstar Hedge Fund Category are deemed to have higher risk of understated risk or inaccurate pricing.

Calculations

Overview
There are four separate tests to calculate the ORF.

1. Administrator—Morningstar requires funds to have an independent administrator that serves at least five other hedge fund firms in the Morningstar database to pass this measure.
2. Auditor—In order to pass this measure, hedge funds must list an independent auditor and that auditor must also serve at least five other firms in the Morningstar hedge fund database.
3. Registration—Registration status is tested for all of the jurisdictions and regulatory bodies tracked by the Morningstar hedge fund database.
4. Return pattern—Serial correlation coefficients are calculated and compared with peers within the same Morningstar category.

The Operational Risk Flag Score is an equally weighted summation of these scores.

Service Providers—Administrator and Auditor
Each hedge fund has the option to provide service provider information when entering the Morningstar database, although these fields are not considered required disclosures for inclusion. Each hedge fund is responsible for keeping this information current.

Once a calendar quarter, Morningstar will generate a list of "Known" providers that service at least five separate hedge fund firms in the Morningstar hedge fund database. Global providers that operate separate subsidiaries based upon jurisdiction are evaluated at the global level. For example, if audit firm ABC, LLP operates in the United States and ABC BVI, Ltd. is an affiliated audit firm in the British Virgin Islands, both would be considered identical for purposes of provider qualifications.

Calculations (continued)

Individual funds' listed providers are tested quarterly against the Known provider list. Funds can fail the auditor test in three different ways:

1) Auditor information is not provided.

2) The auditor is not on the Known provider list.

3) The auditor is a related party.

Funds can fail the administrator test in four different ways:

1) Administrator information is not provided.

2) The administrator is not on the Known provider list.

3) The administrator is a related party.

4) The auditor and the administrator are the same provider or affiliated firms.

Registration Status
Each hedge fund has the option to provide registration status information when entering the Morningstar database, although these fields are not considered required disclosures for inclusion.

Individual funds are tested quarterly on their registration status. Funds that do not indicate they are registered with a regulatory body in a country deemed developed according to the Morningstar Regions methodology document do not pass the registration test.

Calculations (continued)

Serial Correlation
Morningstar uses the three-year adjustment coefficient from the technique presented by Okunev and White[1] as the measure of serial correlation. Rather than using the technique to unsmooth returns, we stop at the calculation of the adjustment coefficient c. Morningstar applies the technique to logarithmic returns rather than returns in level form because unsmoothing returns in level form can result in returns that are less than -100%.

Let:

TR_t	=	the observed return on the hedge fund in month t in decimal form
r_t	=	the observed logarithmic return on the hedge fund in month t
ru_t	=	the unsmoothed logarithmic return on the hedge fund in month t
RU_t	=	the unsmoothed return on the hedge fund in month t in decimal form

Morningstar calculates r_t as

[1] $$r_t = \ln(1 + TR_t)$$

Morningstar calculates ru_t as follows:

[2] $$ru_t = \frac{r_t - c r_{t-1}}{1 - c}$$

where c is a coefficient selected so that ru_t has a 1st order autocorrelation coefficient of zero. Okunev and White present a formula for c that makes r_{ut} have a 1st order autocorrelation coefficient of zero. Constraining the result of that formula to non-negative values, we have:

[3] $$c = \max\left(0, \frac{1 + \rho_2 - \sqrt{(1 + \rho_2)^2 - 4\rho_1^2}}{2\rho_1}\right)$$

[1] See John Okunev and Derek White, "Hedge Fund Factors and the Value at Risk of Credit Trading Strategies," October 2003.

MORNINGSTAR®

Calculations (continued)

where ρk is the kth order autocorrelation coefficient. Given a time series of T+k month observations on rt, we estimate ρk as follows:

[4] $$\overline{r} = \frac{\sum_{t=1}^{T+k} r_t}{T+k}$$

[5] $$\rho_k = \frac{\sum_{t=1}^{T} (r_t - \overline{r})(r_{t+k} - \overline{r})}{\sum_{t=1}^{T+k} (r_t - \overline{r})^2}$$

So, to calculate an unsmoothed series of T months, we need a time series of T+2 months. Hence, to calculate the three-year rating, we need 38 months of consecutive monthly returns, calculated using base currency returns. New funds that have not yet experienced 38 months of returns will receive a flag notifying investors that its history is too short for the serial correlation test. Other funds that lack 38 consecutive months of performance history ending on the calculation date will fail the serial correlation test..

The advantage of the Okunev-White procedure over using the 1st order autocorrelation for c is that it makes no assumptions about the higher orders of autocorrelation. However, we have found that, in some cases, the estimated value of $\rho 2$ using equation [5] implies that r is an explosive series so that equation [3] cannot be used to set c. In such cases, we set c to $\rho 1$.

To make the procedure more robust, we employ a statistical technique called Bayesian shrinkage. In the Bayesian approach, the researcher starts with some belief about one or more of the parameters of a model and combines those prior beliefs with what he learns from the data to develop a final estimate. The estimate from the data alone is said to be "shrunk" toward the prior belief. The amount of shrinkage depends on the strength of the prior belief relative to the strength of the evidence from the data.

In our case, we have a prior belief that the 2nd order partial autocorrelation coefficient is zero. The 2nd order partial autocorrelation is β2 in the regression equation

Calculations (continued)

[6] $$r_t = \alpha + \beta_1 r_{t-1} + \beta_2 r_{t-2} + \varepsilon_t$$

The theoretical values of β1 and β2 are related to the theoretical values of ρ1 and ρ2 as follows:

[7] $$\beta_1 = \frac{1-\rho_2}{1-\rho_1^2}\rho_1$$

[8] $$\beta_2 = \frac{\rho_2 - \rho_1^2}{1-\rho_1^2}$$

Note that if our prior assumption that $\beta_2 = 0$ held, $\rho_2 = \rho_1^2$.

If we are estimating the values of β1 and β2 from T observations and we have a prior belief that $\beta_2 = 0$, which we hold with a strength equivalent to N observations, the shrunken estimates for β1 and β2 are

[9] $$\beta_1^* = \frac{\omega-\rho_2}{\omega-\rho_1^2}\rho_1$$

[10] $$\beta_2^* = \frac{\rho_2 - \rho_1^2}{\omega-\rho_1^2}$$

where

[11] $$\omega = \frac{T+N}{T}$$

Let ρ_1^* and ρ_2^* denote the 1st and 2nd order autocorrelation coefficients implied by equations [7] and [8] when β_1^* and β_2^* are the beta coefficients in equation [6]. Substituting ρ_1^* for ρ1, ρ_2^* for ρ_2, the right-hand side of equation [9] for β_1, and the right-hand side of equation [10] for β_2, in equations [7] and [8], and solving for ρ_1^* and ρ_2^*, we find that $\rho_1^* = \rho_1$ and

[12] $$\rho_2^* = \frac{(\omega - \rho_2)\rho_1^2 + \rho_2 - \rho_1^2}{\omega - \rho_1^2}$$

Calculations (continued)

Replacing ρ_2 with ρ_2^* in equation [3], we have our revised formula for c:

[13] $$c = \max\left(0, \frac{1 + \rho_2^* - \sqrt{(1 + \rho_2^*)^2 - 4\rho_1^2}}{2\rho_1}\right)$$

However, if the expression inside of the square root symbol in equation [13] is negative, we set $c = \rho_1$.

Testing the relative level of c

When $c>0$, we test its statistical significance using the Wald statistic. The Wald statistic can be for the hypothesis that $c=0$ can be expressed as:

[14] $$W = \frac{c^2}{\sigma_c^2}$$

Asymptotically, W has a chi-squared distribution with one degree of freedom. The 90th percentile of chi-squared random variable with one degree of freedom is 2.71. So to do a test of size 10%, we would only reject the hypothesis that $c=0$ if $W>2.71$.

The Wald test is derived from the statistics that result from regression analysis. So the first step in deriving σ_c^2 is to express c as a function of β_1^* and β_2^* . From equations [9], [10], [11], and [12], we find that

[15] $$c = \frac{\gamma - \sqrt{\gamma^2 - 4}}{2}$$

where

[16] $$\gamma = \frac{1 - \beta_2^{*2}}{\beta_1^*} + \beta_1^*$$

Calculations (continued)

In order for equation [15] to be valid, we must have $\gamma^2 \geq 4$. This is equivalent to the condition that the expression inside of the square root symbol in equation [12] is non-negative. In that case, we set $c = \rho_1$ and $\sigma_c^2 = 1/T$.

Otherwise, we need to calculate σ_c^2 using a formula derived from the nonlinear functional relationship between c and $\begin{bmatrix} \beta_1^* & \beta_2^* \end{bmatrix}$. This is:

[17] $$\sigma_c^2 = \begin{bmatrix} \dfrac{\partial c}{\partial \beta_1^*} & \dfrac{\partial c}{\partial \beta_2^*} \end{bmatrix} \Sigma_\beta^{-1} \begin{bmatrix} \dfrac{\partial c}{\partial \beta_1^*} \\ \dfrac{\partial c}{\partial \beta_2^*} \end{bmatrix}$$

where Σ_β is the variance-covariance matrix for the estimator of $\begin{bmatrix} r_{t-1}, & r_{t-2} \end{bmatrix}$. This is

[18] $$\Sigma_\beta = T \begin{bmatrix} 1 & \rho_1 \\ \rho_1 & \omega \end{bmatrix}$$

So that

[19] $$\Sigma_\beta^{-1} = \frac{1}{T\left(\omega - \rho_1^2\right)} \begin{bmatrix} \omega & -\rho_1 \\ -\rho_1 & 1 \end{bmatrix}$$

By the chain rule of differential calculus, we have

[20] $$\frac{\partial c}{\partial \beta_1^*} = \frac{dc}{d\gamma} \frac{\partial \gamma}{\beta_1^*}$$

[21] $$\frac{\partial c}{\partial \beta_2^*} = \frac{dc}{d\gamma} \frac{\partial \gamma}{\beta_2^*}$$

Calculations (continued)

The derivatives on the right-hand sides of equation [20] and [22] are

[22] $$\frac{dc}{d\gamma} = \frac{1}{2}\left(1 - \frac{\gamma}{\sqrt{\gamma^2 - 4}}\right)$$

[23] $$\frac{\partial\gamma}{\partial\beta_1^*} = 1 - \frac{1 - \beta_2^{*2}}{\beta_1^{*2}}$$

[24] $$\frac{\partial\gamma}{\partial\beta_2^*} = -\frac{2\beta_2^*}{\beta_1^*}$$

From equations [18], [19], [20], and [21], we have

[25] $$\sigma_c^2 = \frac{\left(\frac{dc}{d\gamma}\right)^2 \left[\left(\frac{\partial\gamma}{\partial\beta_1^*}\right)^2 \omega + \left(\frac{\partial\gamma}{\partial\beta_2^*}\right)^2 - 2\frac{\partial\gamma}{\partial\beta_1^*}\frac{\partial\gamma}{\partial\beta_2^*}\rho_1\right]}{T\left(\omega - \rho_1^2\right)}$$

So the Wald statistic is calculated as follows:

1) If the expression inside of the square root symbol in equation [13] is negative, we set c $= \rho_1$ and $W = T\rho_1^2$. Stop.
2) Calculate c, β_1^*, and β_2^* using equations [13], [9], and [10], respectively.
3) Calculate γ using equation [16].
4) Calculate $\frac{dc}{d\gamma}, \frac{\partial\gamma}{\partial\beta_1^*}$, and $\frac{\partial\gamma}{\partial\beta_2^*}$ using equations [22], [23], and [24], respectively.
5) Calculate σ_c^2 using equation [25].
6) Calculate W using equation [14].

Calculations (continued)

Using the above calculations, funds are compared against funds within the same Morningstar Hedge Fund Category. Funds with a Wald statistic which is higher than 90% of the category fail the serial correlation test. Funds that have not existed for 38 months receive a flag warning notifying investors that this test was not performed.

Results

The Morningstar Hedge Fund Operational Risk Flag and Score

The ORF will be presented as a series of flags. In addition to the flags representing failures on the component tests investors can search filter hedge funds in the Morningstar database by the Operational Risk Flag Score., Funds that pass all the tests receive no flags and the lowest operational risk score of zero. Each failed test results in an operational risk flag also increasing the cumulative total, to the highest level of four. New funds with insufficient history for the serial correlation test receive 1/2 a point for the serial correlation flag. Therefore, a risk score of zero indicates that the hedge fund passed all four tests and a risk score of four indicates that the fund failed all of our operational risk tests.

Operational Risk Flag key: