MORNINGSTAR®

Morningstar Ownership Zone℠

Morningstar Methodology Paper
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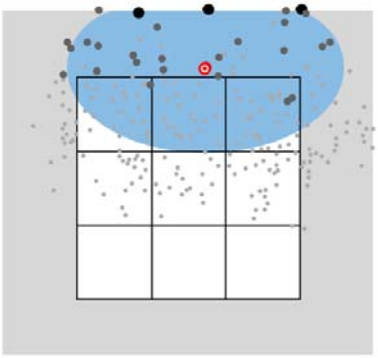
Introduction

The Morningstar Style Box™ was created in 1992 to provide a quick snapshot of a portfolio's overall style orientation. Morningstar classifies each equity portfolio into one of nine squares of the style box. The vertical axis distinguishes between large-, mid-, and small-capitalization holdings, and the horizontal axis separates portfolios into value, blend, and growth styles.

Very few portfolios contain stocks from only one of the nine squares of the style box. For example, a blend portfolio often contains both value and growth-oriented stocks, and a large-cap portfolio might contain some mid- and small-cap stocks. The Morningstar Ownership Zone℠ complements the style box to provide an additional layer of detail about an equity portfolio's investment style.



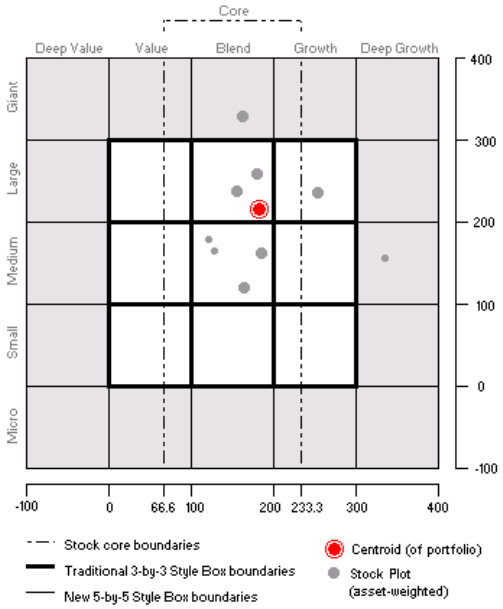
The ownership zone provides more detail by showing the range of stock sizes and styles represented in the portfolio. Because investment styles often have different levels of risk and return, it is crucial that investors have a tool to measure their style exposure and construct truly diversified portfolios. The ownership zone is derived by plotting each stock in the portfolio within the style box. Morningstar often uses a five-by-five box grid for the ownership zone to illustrate the full range of stock sizes (from giant-cap to micro-cap) and styles (from deep value to high growth).

The red "centroid" in the middle of the ownership zone represents the weighted average of all the holdings. The shaded area represents 75% of the assets in the portfolio and indicates the level of concentration in the holdings. A fund that is concentrated will have a small ownership zone relative to the area of the style box, and a broadly diversified fund will have an ownership zone that stretches across many sizes and styles.

Investors can use the ownership zone to differentiate between funds in the same Morningstar Category or to model how multiple funds complement each other in a portfolio.

Ownership Zone Methodology

Every month, Morningstar calculates raw size and value-growth scores for stocks. These scores are the coordinates that determine the stock's placement on the Morningstar Style Box. In order to provide visual equality when plotting these scores on the style box grid, the raw size and value-growth scores are rescaled. The graphic below shows rescaled scores.



More details about the style box and rescaling can be found in the document *The Morningstar Style Box Methodology,* which is available in the Research section (under Newsroom) at http://corporate.morningstar.com.

Style boxes for mutual funds and other investment portfolios are determined when Morningstar receives updated files of portfolio holdings from those asset-management firms. The ownership zones for funds and portfolios are drawn with the following methodology.

Given a fund that owns N stocks, let

w_i	=	The fraction of the fund's assets held in stock i
x_i	=	The raw value-growth score for stock i
y_i	=	The raw size score for stock i

By definition,

[1] $$\sum_{i=1}^{N} w_i = 1 .$$

A fund's location in the style box is determined by the asset-weighted averages of the raw value-growth and size scores of the stocks that it holds. Let

$\overline{x}$	=	The asset-weighted average of the raw value-growth scores of the stocks in the fund
$\overline{y}$	=	The asset-weighted average of the raw size scores of the stocks in the fund

By definition,

[2] $$\overline{x} = \sum_{i=1}^{N} w_i x_i$$

[3] $$\overline{y} = \sum_{i=1}^{N} w_i y_i$$

A fund's ownership zone is an ellipse drawn in $\hat{x} - \hat{y}$ space with the rescaled values of $\overline{x}$ and $\overline{y}$ as its center. See the rescaling rules in the style box methodology document for more detail.

$\hat{x}$	=	The rescaled value-growth score for stock i
$\hat{y}$	=	The rescaled size score for stock i
$\hat{\overline{x}}$	=	The rescaled value-growth score for the fund
$\hat{\overline{y}}$	=	The rescaled size score for the fund

The shape and tilt of the ownership zone are based on the asset-weighted standard deviations of $\hat{x}$ and $\hat{y}$ and the asset-weighted correlation of $\hat{x}$ and $\hat{y}$. Let

σ_x	=	The asset-weighted standard deviation of $\hat{x}$ (measures width)
σ_y	=	The asset-weighted standard deviation of $\hat{y}$ (measures height)
ρ	=	The asset-weighted correlation of $\hat{x}$ and $\hat{y}$ (measures tilt)

These ownership zone parameters are calculated as follows. First, we calculate a weighted average of the rescaled stock scores. These averages are only used for the standard deviations and correlation in equations 6-8.

[4] $$\mu_x = \sum_{i=1}^{N} w_i \hat{x}_i$$

[5] $$\mu_y = \sum_{i=1}^{N} w_i \hat{y}_i$$

[6] $$\sigma_x = \sqrt{\sum_{i=1}^{N} w_i \left(\hat{x}_i - \mu_x\right)^2}$$

[7] $$\sigma_y = \sqrt{\sum_{i=1}^{N} w_i \left(\hat{y}_i - \mu_y\right)^2}$$

[8] $$\rho = \frac{\sum_{i=1}^{N} w_i \left(\hat{x}_i - \mu_x\right)\left(\hat{y}_i - \mu_y\right)}{\sigma_x \sigma_y}$$

Define the function d(.,.) as follows:

[9] $$d\left(\hat{x},\hat{y}\right)=\frac{\left(\frac{\hat{x}-\hat{\bar{x}}}{\sigma_x}\right)^2-2\rho\left(\frac{\hat{x}-\hat{\bar{x}}}{\sigma_x}\right)\left(\frac{\hat{y}-\hat{\bar{y}}}{\sigma_y}\right)+\left(\frac{\hat{y}-\hat{\bar{y}}}{\sigma_y}\right)^2}{1-\rho^2}$$

Let d_p be a fixed value. The plot of all $\hat{x}-\hat{y}$ pairs in that satisfy the equation

[10] $$d\left(\hat{x},\hat{y}\right)=d_p$$

forms an ellipse. The value of d_p can be chosen so the ellipse contains a given fraction of the assets in the fund, say p (we use 0.75). To do this, we calculate

[11] $$d_i=d\left(\hat{x}_i,\hat{y}_i\right)$$

for each stock held by the fund and sort the resulting values in ascending order. Let $i_d(1)$, $i_d(2)$, …, $i_d(N)$, be index values such that

[12] $$d_{i_d(1)}\le d_{i_d(2)}\le\cdots\le d_{i_d(N)}$$

We find the smallest index value K that satisfies

[13] $$\sum_{j=1}^{K}w_{i_d(j)}\ge p$$

and set

[14] $$d_p=d_{i_d(K)}$$

d_p is the distance of any point on the ellipse from the centroid of the fund.

The fund's p percent ownership zone is the interior of the ellipse described by equation [10]. Points on the ellipse can be found by selecting values of $\hat{x}$ from the interval $\left[\hat{\bar{x}}-\sigma_x\sqrt{d_p},\hat{\bar{x}}+\sigma_x\sqrt{d_p}\right]$ calculating the corresponding values of $\hat{y}$ as follows:

[15] $$\hat{y}=\hat{\bar{y}}+\sigma_y\left(\rho\frac{\hat{x}-\hat{\bar{x}}}{\sigma_x}\pm\sqrt{\left[1-\rho^2\right]\left[d_p-\left(\frac{\hat{x}-\hat{\bar{x}}}{\sigma_x}\right)^2\right]}\right)$$

When drawing an ownership zone in the nine-square grid, the fund centroid is trimmed to the edges of the style box (0 or 300) and only the parts of the ellipse and its interior that fall within the central nine squares are shown, as displayed below.