Morningstar Factor Profile Methodology

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Introduction

A sizable literature exists identifying various "factors" that are believed to drive investment risk and return. Morningstar Style Box was an early adopter of factor identification, characterizing fund performance along two dimensions – size and value-growth. It has since become an invaluable tool for many investors in understanding fund and stock performance.

In recent years, additional factors have been proposed by academics and practitioners, driving a significant increase in factor-based investment strategies. Today, portfolios that target or tilt toward particular investment factors are widely offered by fund managers in both active and index products. More important, investors have learned that the returns of most portfolios can be largely explained by a certain combination of those distinct factors.

To help investors better analyze managed funds along the increasing number of factor dimensions, we introduce the Morningstar Factor Profile, a scientific and intuitive tool to capture the factor exposures of investment portfolios.
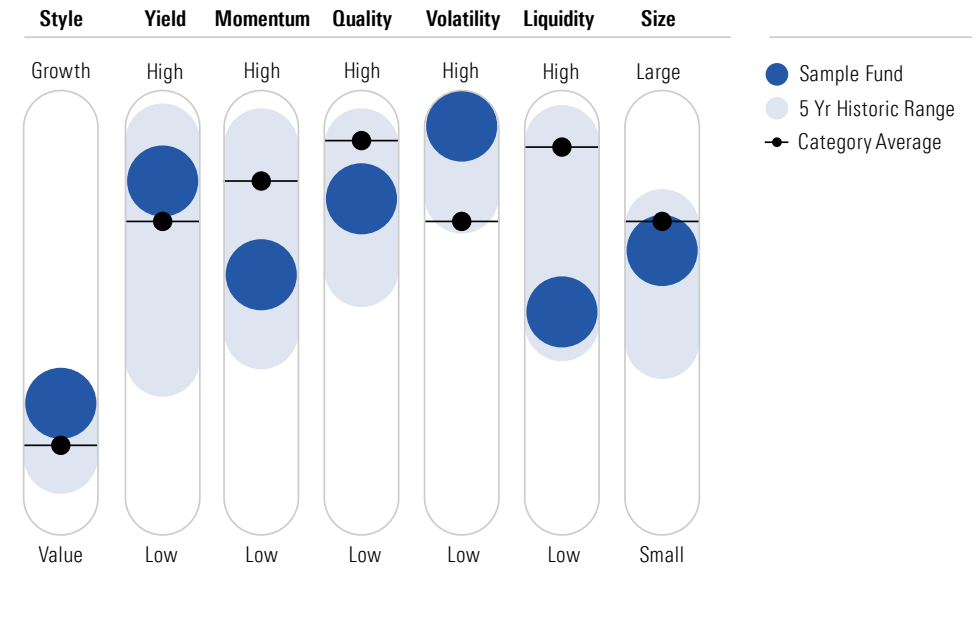
Morningstar Factor Profile includes seven factors that are widely accepted in the industry as reliable descriptions of the underlying drivers of market performance: size, style (or value-growth), quality, yield, liquidity, volatility, and momentum. The seven factors selected intend to strike a balance between the coverage of the most important factors and a reasonable level of complexity for investors.

Morningstar Factor Profile uses a bottom-up, holdings-based approach whereby a fund's factor exposure is based on the characteristics of the underlying securities. Morningstar first calculates a standardized score of stocks' factor characteristics, such as liquidity, value, and quality, within an asset class and region. This geographic framework ensures that stocks are compared with local peers and that factor characterizations are relevant to local investors. Stock-level factor scores are then aggregated to the fund level using portfolio holding weights. Lastly, fund-level factor scores are ranked and transformed to a scale between 1 and 100. As shown in Exhibit 1, the dark blue dot for each factor represents the position of a fund's ranking among all funds in the global universe.

In addition, Factor Profile also displays the average ranking of the funds in each Morningstar Category, shown as the black dot marker in Exhibit 1. This helps investors establish a relevant benchmark to evaluate a fund's positioning. Further, the light blue shaded area in Exhibit 1 shows the range (minimum

and maximum) of the fund's ranking over the past five years, which enables investors to assess the stability of a fund's factor exposures.

Exhibit 1 Factor Profile Visual

Leveraging Morningstar's unparalleled portfolio data, Factor Profile enables investors to rank and compare the factor exposure of a portfolio relative to the largest universe of funds. This includes newly created funds as Factor Profile is a holdings-based analysis. By contrast, the returns-based analysis provided by other vendors cannot be applied to funds with short periods of return history.

Factor Definition

In this section, we describe the definition of the seven factors included in Morningstar Factor Profile. These factors are widely studied and accepted among investors and are often the most popular strategies employed in factor investment and strategic-beta products.

Size

We use the raw size score from Morningstar Style Box as the input for calculating the size exposure of a stock. This ensures that the size ranking of Factor Profile is consistent with that of the Morningstar Style Box. The raw size score is calculated based on the natural logarithm of the market capitalization with a ranking and scaling scheme to ensure that each mid-cap stock has a raw score between 100 and 200. Small stocks have a score below 100 and large stocks above 200, according to the following formula:

$$Raw\ Size\ Score = 100 \times \left[1 + \frac{ln(market\ cap) - ln(cap_1)}{ln(cap_2) - ln(cap_1)}\right]$$

where cap_1 is the market capitalization that corresponds to the breakpoint between mid-cap and small-cap stocks for the stock's respective style zone and cap_2 is the market capitalization that corresponds to the breakpoint between large-cap and mid-cap stocks for the stock's respective style zone. For more details, refer to the Morningstar Style Box Methodology listed in the References section.

Next, to be consistent with the well-documented small size premium (Banz, 1981; Fama and French, 1993), we apply a negative transformation to the raw size score such that small-cap companies have high size scores:

$$Size\ Score = -\ Raw\ Size\ Score.$$

The interpretation of this high size score is that small stocks will have high exposures to the size premium.

Style
Similarly, to be consistent with the ranking from the Morningstar Style Box, we use the raw style score from the Style Box as the input for calculating the value-growth exposure of stocks. The raw style score is calculated as the difference between a stock's growth score and value score:

$$Raw\ Style\ Score = Growth\ Score - Value\ Score.$$

The value score is the weighted average of a stock's prospective earnings (E), book value (BV), revenue (R), cash flow (CF), and dividend (D), all scaled by the current price of the stock:

$$Value\ Score = \left[w_E \times \frac{E}{P_t} + w_{BV} \times \frac{BV}{P_t} + w_R \times \frac{R}{P_t} + w_{CF} \times \frac{CV}{P_t} + w_D \times \frac{D}{P_t}\right].$$

The growth score of a stock is the weighted average of the growth rates in a company's earnings (E), book value (BV), revenue (R), and cash flow (CF):

$$Growth\ Score = \left[w_E \times E_{growth} + w_{BV} \times BV_{growth} + w_R \times R_{growth} + w_{CF} \times CF_{growth}\right].$$

In this setting, a higher style score indicates a stronger growth orientation of a stock and a lower exposure to the value premium. For more details, refer to the Morningstar Style Box Methodology listed in the References section.

Momentum

It has been well documented that there is a momentum effect in stock markets, where stocks that have performed well recently tend to outperform in the future (Jegadeesh and Titman, 1993; Carhart, 1997). We calculate the momentum factor exposure as the log trailing 12-month return minus trailing one-month return. Higher values indicate larger, positive momentum exposure:

$$Momentum = \ ln(1 + \ r_{12}) - ln(1 + r_1)$$

where r_{12} and r_1 are trailing 12-month and one-month returns, respectively.

Liquidity

It has been shown both theoretically and empirically that the liquidity of stocks affects their expected returns (Amihud and Mendelson, 1986; Amihud and Mendelson, 1989; Amihud, 2002). Effectively, there exists an illiquidity premium to compensate investors for holding illiquid assets. In Factor Profile, we define the liquidity score of a stock as its average daily trading volume scaled by the number of shares outstanding over a month, assuming 21 trading days:

$$Liquidity = \frac{1}{21} \sum_{t=-20}^{0} \left(\frac{Trading\ volume_t}{share\ outstanding_t} \right).$$

Quality

Research has also shown that stocks of high quality tend to outperform those of low quality (Sloan, 1996; Asness, Frazzini, and Pedersen, 2019). We define a quality score of a stock as the equally weighted z-score of a company's profitability (trailing 12-month return on equity) and the z-score of its financial leverage (trailing 12-month debt/capital). The z-score is with respect to all the stocks in the global universe. Higher values indicate higher quality:

$$Quality = \frac{1}{2} \left[ROE_z + \left(1 - \frac{Total\ Debt_t}{Total\ Capital_t} \right)_z \right],$$

where ROE is the trailing 12-month return on equity and the subscript z indicates a z-score.

Yield

Stock yield is another important consideration for many investors, and it has been shown that the level of dividend yield is associated with expected stock returns (Blume, 1980). Factor Profile includes a total yield factor for stocks, which is the sum of trailing 12-month buyback and dividend yield of a company. Higher values indicate larger, positive yield exposure:

$$Total\ Yield = Buyback\ Yield_{ttm} + Dividend\ Yield_{ttm}$$

Volatility

The volatility of stock returns is a widely used measure of risk. Although theoretically stocks with higher risk should earn higher expected return, some research has shown that stocks with low volatility

outperform stocks with high volatility (Ang, Hodrick, Xing, and Zhang, 2006). As low- and minimum-volatility investment strategies have become more popular in recent years, we include a volatility score in Factor Profile. The volatility score is defined as the trailing 12-month volatility of daily returns of a stock, where higher values indicate higher volatility.

$$Volatility = \sqrt{\frac{\sum_{t=1}^{N}(r_t - \overline{r_t})^2}{N - 1}}$$

where r_t is the stock return at time t and $\overline{r_t}$ is the average return over N days.

Factor Profile Methodology

Morningstar Factor Profile applies a holdings-based analysis. It starts with calculating the factor scores for the stocks in our database each day and then produces the holdings-weighted scores for funds and portfolios. Next, the relevant funds' factor scores are transformed into a percentile ranking from 1 to 100. Lastly, a set of procedures is applied to transform the factor scores of individual stocks so that they are comparable to the funds' scores. The following section describes these steps in detail.

Factor scores for stocks and funds

Each day, we first produce the factor scores as defined in the previous section for all stocks in Morningstar's database. The current universe coverage is around 40,000 stocks globally. The following procedures are then performed for each of the raw factor scores.

▶ Factor score winsorization. The factor scores are winsorized at both the lower and upper ends to reduce the impact of extreme values. The specific thresholds are empirically tested and established separately for each factor score.

▶ Factor score standardization. The winsorized factor scores are then standardized so that the market-capitalization-weighted average value is zero and the standard deviation is one. This is to make sure that the factor scores are of the same scale and comparable. Note, this standardization process is applied within each of the seven regions: developed North America, developed Europe, developed Asia Pacific, emerging Latin America, emerging Europe, emerging Asia Pacific, and emerging Middle East and Africa. This ensures that stocks are compared with their closest peers within a region as companies from different regions may not be comparable in many aspects. For example, a large-cap company in a developing market may be considered as only a mid-cap stock in a developed market.

▶ The stock-level standardized factor scores are then aggregated to the fund level using a fund's holdings weights, based on the latest holdings of a fund in the Morningstar database.

Factor percentile ranking for funds

To make sure users of Factor Profile have intuitive measures, the standardized factor scores of funds are transformed to a percentile ranking between 1 and 100 with the following steps:

► Select the coverage of funds. To accurately measure factor exposures, sufficient coverage of a fund's holdings is required. The current coverage threshold is set at 90% of total portfolio weight, which includes over 40,000 portfolios. Note, the portfolio holdings in the Morningstar database are updated at different frequencies depending on the type of funds or specific agreements with fund managers. In Factor Profile, we propagate the holdings to daily level assuming the most recently reported holdings remain the same until the next update of the holdings. For the latest available holdings, we assume they are only applicable for the date of updating and no carryforward is performed.

► With the selected fund universe, for each factor score, sort the funds from highest to lowest scores and calculate a percentile ranking from 1 to 100 for each fund. This means funds with higher exposure scores will have lower percentile rankings. For example, when sorting on the size factor, funds with many micro-cap stocks should have a high size score, as they are most exposed to the small size premium. This means these funds should have a percentile rank near 1, while a fund of large-cap companies should have a percentile score closer to 100.

Factor Profile Visual

The percentile rankings of a fund's factor scores are then plotted within the Factor Profile capsules as displayed in Exhibit 1, where lower percentile rankings (high factor scores) are generally on the top of the capsules. For example, a portfolio with a style ranking of 1 would have a high growth tilt, while 100 would indicate an extreme value exposure. For each factor, we provide the percentile ranking and the associated characteristics of the portfolio in Exhibit 2. Note, for the size factor, the scale is flipped with 100 (large cap) on top and 1 (small cap) at the bottom; this helps simplify the Factor Profile visual by keeping all "high" or "large" indicators aligned at the top.

Exhibit 2 Factor Profile Visual Scores

Style	Yield	Momentum	Quality	Volatility	Liquidity	Size
Growth: 1	High: 1	High: 1	High: 1	High: 1	High: 1	Large: 100
Value: 100	Low: 100	Low: 100	Low: 100	Low: 100	Low: 100	Small: 1

Source: Morningstar, Inc.

Application of Morningstar Factor Profile

In this section, we illustrate the application of Factor Profile from two perspectives. We first examine the factor percentile rankings of several funds for three factors: size, volatility, and yield, as of October 2019. This demonstrates the effectiveness of the Factor Profile. Then, we consider how the factor rankings of funds changes over time.

Relative ranking of funds for different factors

As discussed above in the Factor Definition section and in the ranking methodology, funds and stocks of larger market capitalization should have a higher size percentile ranking. Exhibit 3 contains the size percentile rankings for a selected sample of Morningstar indexes. As shown, the output is consistent with expectation, where large-cap funds have higher size percentile ranks, while small-cap funds have lower size percentile ranks.

Exhibit 3 Morningstar Factor Profile Size Percentile for Selected Indexes

Index	Size
Morningstar US Small Cap Index	4.54
Morningstar US Mid Cap Index	22.92
Morningstar US Large Cap Index	97.97
Morningstar Wide Moat Index	98.53

Source: Morningstar Direct. Data as of October 31, 2019.

Next, we illustrate the percentile rankings of the volatility factor. The methodology is designed to give funds and stocks with higher volatility a lower percentile ranking and vice versa. Exhibit 4 shows the volatility percentile ranks for a selected sample of funds. As shown, the minimum-volatility funds tend to have the highest percentile rankings, while an ETF targeting high-beta stocks has a lower percentile ranking.

Exhibit 4 Morningstar Factor Profile Volatility Percentile of Selected Funds

Fund	Volatility
SPDR® S&P 500 Low Volatility ETF	100.00
Fidelity US Low Volatility ETF	98.49
iShares Edge S&P 500 Min Vol ETF	93.09
Russell 2000 High Beta ETF	31.51

Source: Morningstar Direct. Data as of October 31, 2019.

Lastly, we show the percentile rankings of the yield factor among a sample of selected funds in Exhibit 5. As expected, small and growth-oriented portfolios have high percentile rankings as they tend to have lower dividend yields. By contrast, funds that focus on dividends or buybacks have low percentile scores.

Exhibit 5 Morningstar Factor Profile Yield Percentile of Selected Funds and Indexes

Fund or Index	Yield
SPDR® S&P 500 Buyback ETF	2.31
Vanguard High Dividend Yield Index Fund	12.45
Morningstar US Dividend Composite TR USD	16.14
iShares U.S. High Dividend Equity ETF	20.22
Morningstar US Small Growth Index	99.98

Source: Morningstar Direct. Data as of October 31, 2019.

How factor percentile rankings change over time

In this section, we use Morningstar U.S. Large Cap Index, Morningstar U.S. Growth Index, and Morningstar U.S. Value Index to demonstrate how the factor percentile rankings change over time for typical funds.

In Exhibit 6, we can see that the size, style (value-growth), yield, and quality rankings of Morningstar U.S. Large Cap Index are relatively stable among the fund universe. This is not surprising as these factors tend to capture the fundamental characteristics of companies. These characteristics tend to change slowly over time, resulting in more-stable rankings among companies and funds.

Exhibit 6 Factor Percentile Rankings of Morningstar U.S. Large Cap Index – Size, Style, Yield, and Quality
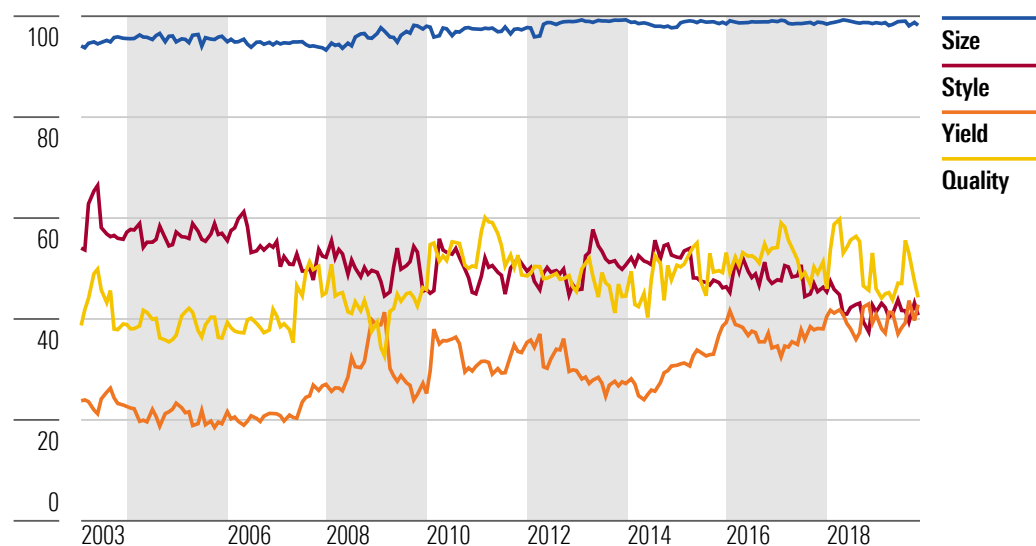
Source: Morningstar Direct. Data as of October 31, 2019.

By contrast, the momentum, volatility, and liquidity rankings of Morningstar US Market Index have been quite volatile, as shown in Exhibit 7. This is due to the fact that these factors tend to be influenced more by market conditions, which tend to change more rapidly.

Exhibit 7 Factor Percentile Rankings of Morningstar U.S. Large Cap Index –Volatility, Momentum, and Liquidity
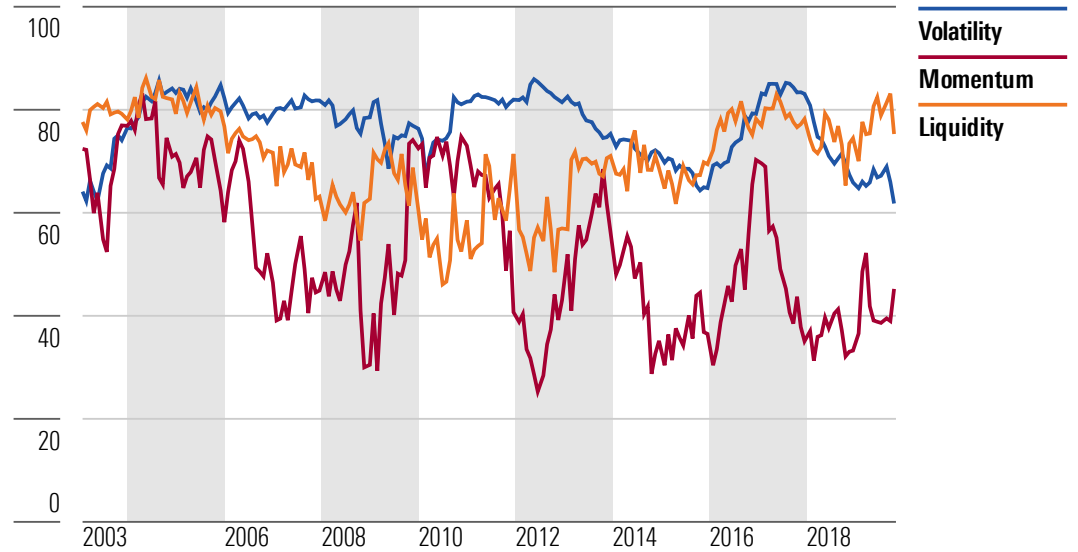
Source: Morningstar Direct. Data as of October 31, 2019

Exhibit 8 shows the relative ranking of the style (value-growth) factor of the Morningstar U.S. Growth Index and the Morningstar U.S. Value Index. As we can see, the Factor Profile factor ranking correctly placed the growth index at the top end of the percentile and the value index at the lower percentile.

Exhibit 8 Style Percentile Ranking of the Morningstar U.S. Growth Index and Morningstar U.S. Value Index
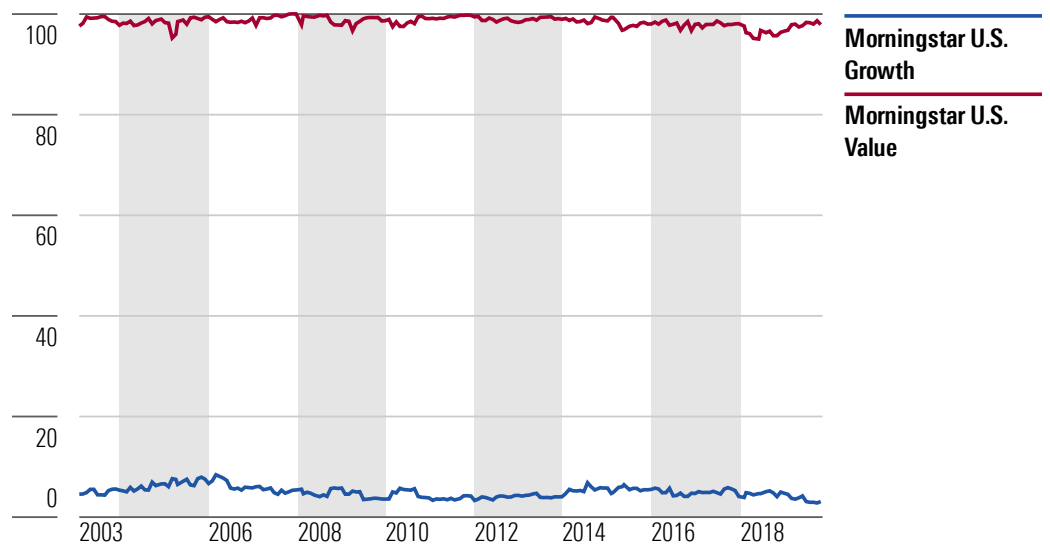
Source: Morningstar Direct. Data as of October 31, 2019.

References

Ang, A., Hodrick, R.J., Xing, Y., & Zhang. X. 2006. "The Cross-Section of Volatility and Expected Returns."
The Journal of Finance, Vol. 61, P. 259.

Amihud, Y., & Mendelson, H. 1986. "Asset Pricing and the Bid-Ask Spread." *Journal of Financial
Economics,* Vol. 17, No. 2, P. 223.

Asness, C.S., Frazzini, A., & Pedersen, L.H. 2019. "Quality Minus Junk." *Review of Accounting Studies,*
Vol. 24, No. 1, P. 34.

Amihud, Y. & Mendelson, H. 1989. "The Effects of Beta, Bid-Ask Spread, Residual Risk, and Size on Stock
Returns." *The Journal of Finance,* Vol. 44, No. 2, P. 479.

Amihud, Y. 2002. "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects." *Journal of
Financial Markets,* Vol. 5, No. 1, P. 31.

Banz, R.W. 1981. "The Relationship Between Return and Market Value of Common Stocks." *Journal of
Financial Economics,* Vol. 9, No. 1, P. 3.

Basu, S. 1977. "Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A
Test of the Efficient Market Hypothesis." *The Journal of Finance,* Vol. 32 No. 3, P. 663-682.

Blume, M.E. 1980. "Stock Returns and Dividend Yields: Some More Evidence." *The Review of Economics
and Statistics* 62(4): 567-577.

Carhart, M.M. 1997. "On Persistence in Mutual Fund Performance." *The Journal of Finance,* Vol. 52, No.
1, P. 57.

Fama, E.F., & French, K.R. 1993. "Common Risk Factors in the Returns on Stock and Bonds." *Journal of
Financial Economics,* Vol. 33, No. 1, P. 3.

Jegadeesh, N., & Titman, S. 1993. "Returns to Buying Winners and Selling Losers: Implications for Stock
Market Efficiency." *The Journal of Finance,* Vol. 48, No. 1, P. 65.

Morningstar. 2018. Morningstar Style Box Methodology.
https://www-prd.morningstar.com/content/dam/marketing/shared/research/methodology/678263-
StyleBoxMethodolgy.pdf

Morningstar. 2019. Morningstar Risk Model Methodology.
https://www-prd.morningstar.com/content/dam/marketing/shared/pdfs/Research/885571.pdf

Sloan, R. 1996. "Do Stock Prices Fully Reflect Information in Accruals and Cash Flows About Future Earnings?" *The Accounting Review,* Vol. 71, No. 3, P. 28.

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Morningstar Quantitative Research is dedicated to developing innovative statistical models and data points, including the Morningstar Quantitative Rating, the Quantitative Equity Ratings and the Risk Model.

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