Step-by-step guide to Vanguard's factor construction

Vanguard's differentiated approach to factor investing, developed by our Quantitative Equity Group (QEG), is designed to deliver the most focused exposure to targeted factors possible in a low-cost, transparent, and flexible way.

Our active implementation process aims to achieve and consistently maintain this strong level of factor exposure.

The following illustrates QEG's step-by-step single-factor methodology approach.

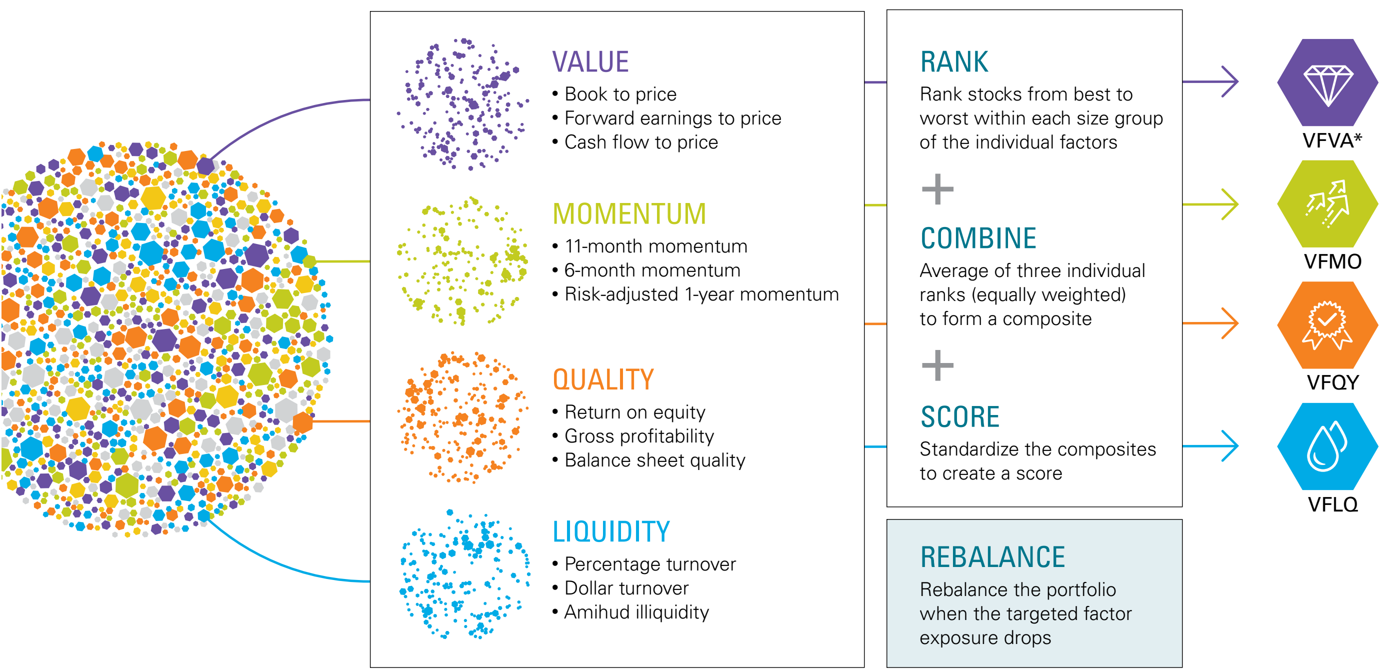
The high-level view

With our factor ETFs targeting value, momentum, quality, and liquidity, we rank each stock in the selection universe broadly using three underlying characteristics to isolate the given factor. We then compile an equally weighted composite ranking for each stock and convert that ranking into a factor score.

Each portfolio is constructed by including the stocks with the highest scores until we reach one-third of the market cap of the initial selection universe, weighting each qualifying stock based on its factor score (see **Figure 1**).

Additionally, our active implementation allows us to rebalance whenever we deem it appropriate so your factor exposures remain as targeted as possible.

Figure 1. Three broad signals are used to determine factor exposure



Source: Vanguard.

* VFVA is the ticker for Vanguard U.S. Value Factor ETF, VFMO for Vanguard U.S. Momentum Factor ETF, VFQY for Vanguard U.S. Quality Factor ETF, and VFLQ for Vanguard U.S. Liquidity Factor ETF.

Taking a deep dive

A further look under the hood to understand our security-selection methodology illustrates the transparency that is at the center of QEG's factor methodology. QEG uses a nine-step security-selection process that we believe distinguishes Vanguard's factor suite and may help concentrate factor exposure.

Table 1. How we build the single-factor portfolios, step-by-step

1	Screen out any stocks with less than $2 million in average daily trading volume over a rolling 12-month period.	• Avoids thinly traded stocks. • Helps steer clear of securities that could be relatively expensive to trade.
2	Divide the Russell 3000 Index into three market-cap buckets: Russell Top 200 Index:[1] large-cap stocks | Russell Midcap Index:[2] mid-cap stocks | Russell 2000 Index: small-cap stocks	• Enhances diversification. • Yields several hundred stocks in each strategy, reducing concentration risk. • Provides meaningful exposure to mid- and small-cap stocks, which have historically tended to deliver much larger premiums across all factors. • Allows us to maintain similar market-cap exposure across all our factor strategies, regardless of each individual factor's particular market-cap bias.
3	Rank the stocks in each market-cap bucket using three underlying characteristics.	• We believe that using three broad underlying characteristics to locate stocks exhibiting a given factor strikes the right balance between robustness and complexity. • While combining multiple characteristics may yield more robust portfolios that target factors with high precision, combining too many variables can lead to a level of complexity that increases portfolio-monitoring costs and due diligence efforts.
4	Combine the three rankings into one equal-weighted ranking.	• We rank stocks with scores to clearly determine their particular weighting in the portfolio. • A score-weighted approach ensures that stocks with the strongest factor attributes have greater weighting in the portfolio. • We use a percentile-based score, instead of a z-score,[3] because the percentile approach ensures greater diversification. • The percentile approach avoids very large weightings for individual stocks. • Shifting scores downward by 0.5 ensures that stocks with low factor strength, between 0.0 and –0.5, won't be included in the portfolio. • Only stocks with positive factor scores are considered for inclusion.
5	Convert the ranking into a percentile score, e.g., the 95th percentile = 0.95, with all stocks between 0 and 1.	
6	Adjust scores downward by 0.5 so all factor scores are between –0.5 and +0.5.	

1 The Russell Top 200 Index measures the performance of the 200 biggest companies in the Russell 3000 Index.

2 The Russell Midcap Index measures the performance of the 800 smallest companies in the Russell 1000 Index.

3 A z-score is a statistical method of rescaling and standardizing data to enable easier comparison. The standardization process takes a characteristic, such as a price-to-book ratio, subtracts the average computed across companies, and divides this difference by the standard deviation of the characteristic computed across companies. The outcome is a normally distributed variable with a mean of 0 and a standard deviation of 1. A positive z-score indicates the observed value is above the mean of all values, while a negative z-score indicates the observed value is below the mean of all values.

7	Select the highest-scoring stocks until one-third of the market cap of the bucket is reached or until all positive-scoring stocks are included.	• This step entails selecting the strongest-scoring stocks. • Selecting stocks by factor strength, rather than market-cap weight, provides greater exposure to the targeted factor. • We also want to avoid stocks with negative scores because they are relatively unattractive from a factor-exposure perspective.
8	Weight each stock in a given bucket by dividing its factor score by the total of all factor scores in that bucket.	• Using this approach, the stocks with the highest factor scores will have the largest weighting for that particular bucket. • While each bucket is based on a market-cap range, the smallest stock in a given bucket could get the largest weighting of any stock in that bucket.
9	Multiply each stock's weighting by one-third to determine its weighting in the combined portfolio.	• We multiply the weighting determined in step 8 for each stock in its market-cap bucket by one-third so that its weighting is scaled in the combined portfolio. • A significant benefit of this approach is that we end up with hundreds and hundreds of stocks in our factor portfolios with a natural position-size limit of around 1% to 2% based on the math behind the construction. • This avoids too great a weighting in a single stock, and therefore, our approach has very little idiosyncratic stock risk. • Instead, this overall approach gives broad exposure to the factor we are targeting. • Finally, our construction methodology enables us to maintain similar market-cap exposure across all our factor strategies.

Source: Vanguard.

The table below identifies and defines the three initial characteristics we use to isolate stocks exhibiting the targeted factors in each of our single-factor strategies.

Table 2. Definitions of Vanguard factor characteristics

	BROAD LEVEL	UNDERLYING CHARACTERISTICS
Value: VFVA	Book to price	Book value/price
	Forward earnings to price	Forward earnings/price
	Cash flow to price	Operating cash flows/price *nonfinancials only*
Momentum: VFMO	11-month momentum	Total returns from month T-12 to month T-1
	6-month momentum	Total returns from month T-7 to month T-1
	Risk-adjusted 1-year momentum	Intercept from a 1-year regression of stock returns on their regional benchmark

	BROAD LEVEL	UNDERLYING CHARACTERISTICS
Liquidity: VFLQ	Percentage turnover	1-year average (% of shares traded)
	Dollar turnover	1-year average dollar volume
	Amihud illiquidity[4]	1-year average (absolute value of % price change/dollar volume)
Quality: VFQY	Operational quality	Return on equity (ROE) Gross profitability *nonfinancials only*
	Balance sheet quality	Equity issuance *financials only* Leverage *nonfinancials only* Change in net operating assets *nonfinancials only*

Source: Vanguard, as of March 31, 2019.

4 Yakov Amihud, 2002, *Illiquidity and stock returns: Cross-section and time-series effects. Journal of Financial Markets*, Vol. 5(1):31-56.

The value of active implementation

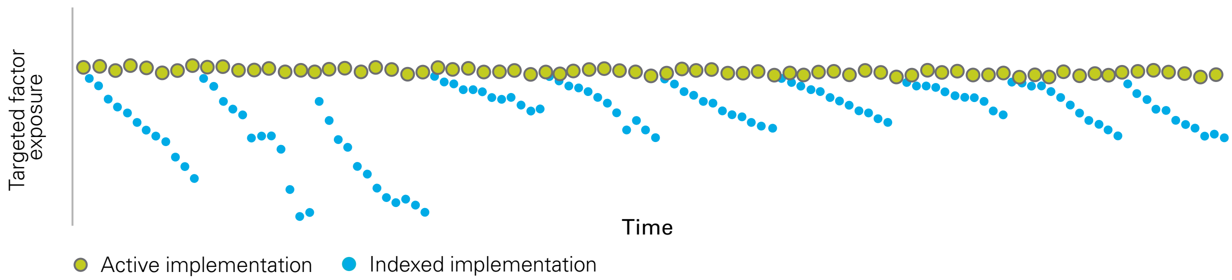
Since we actively manage our factor portfolios instead of relying on an index provider, we can score the stocks in the universe daily and rebalance those portfolios as necessary, rather than on a fixed schedule. We can even change our methodology to more accurately reflect the latest research.

Of crucial importance is that active management allows us to adjust factor exposure more dynamically, which might give a portfolio less factor decay than an index-based solution would.

Factor decay can represent a headwind for factor-based strategies. For example, a stock that exhibits, say, strong value characteristics at one point may lose those characteristics as the market shifts. Active implementation means we can change a stock's weighting in a portfolio—even daily—to enhance or de-emphasize the stock's effect on the portfolio's return as its factor-based characteristics shift.

Figure 2 shows how factor decay can dilute exposure and, in turn, how active implementation offactor-based investing can minimize factor decay.

Figure 2. Active equity factor implementation can maintain more consistent exposure



Source: Vanguard

Note: The green dots show how active rebalancing can help maintain more consistent exposure to factors. The blue dots show how factor exposure "decays" when employing an index approach and is brought back in line through periodic rebalancing.

For more information on Vanguard's factor-based funds, please connect with us at 800-997-2798.

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Funds that concentrate on a relatively narrow market sector face the risk of higher share-price volatility. Factor funds are subject to investment style risk, which is the chance that returns from the types of stocks in which the fund invests will trail returns from the stock market. Factor funds are subject to manager risk, which is the chance that poor security selection will cause the fund to underperform relevant benchmarks or other funds with a similar investment objective.

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