Craftsmanship Alpha: An Application to Style Investing

Ronen Israel
Ronen.israel@aqr.com
Principal, AQR Capital Management

Sarah Jiang
Sarah.jiang@aqr.com
Managing Director, AQR Capital Management

Adrienne Ross
Adrienne.ross@aqr.com
Vice President, AQR Capital Management

Abstract

Successful investing requires translating sound investment concepts into actual trading strategies. We study many of the implementation details that portfolio managers need to pay attention to; such choices range from portfolio construction to execution.

While these kinds of decisions apply to any type of investment strategy, they are particularly important in the context of style investing. Consider two managers who both intend to capture the value factor in a long/short context: each manager might make a number of decisions, many of which can lead to meaningfully different outcomes. These choices can often explain why one value manager outperforms another.

Ultimately, what may seem like inconsequential design decisions can actually matter a lot for style portfolios. In fact, the skillful targeting and capturing of style premia may constitute a form of alpha on its own — one we refer to as "craftsmanship alpha."

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Introduction

Today, many investors are looking to take advantage of alternative sources of return, specifically those that are uncorrelated with traditional assets. In doing so, they have turned their attention to style premia. Style premia are a set of systematic sources of returns that are well researched and have been shown to deliver long-run returns that are uncorrelated with traditional assets.[1] Styles have been most widely studied in U.S. equity markets, but have been shown to work consistently across markets, across geographies, and over time. There is a logical, economic rationale for why they work and are likely to continue to do so.

The growing popularity of style investing has also given rise to a variety of investment options for investors. There are variations in the types of style portfolios, but also — importantly — in how different managers choose to build those portfolios. While practitioners might define styles with similar "labels," actual portfolios can differ significantly from one another. Even a single style such as value has variations that an investor should consider: for example, it can be applied as a tilt to a long-only portfolio, or it can be applied in a "purer" form through long/short strategies; it can be based on multiple measures of value, or a single measure; it can be done in isolation, or combined with other styles in a synergistic way. Investors should consider these differences and also recognize that there is potentially value-added (or subtracted) in every step of the investment process: signal choice, portfolio construction, risk management, and cost-effective trading.

Our paper focuses on the craftsmanship required to build effective style portfolios. That is, the kind of decisions that happen *after* we have already agreed on the type of style portfolio that we want to build. We start with a brief discussion of the types of style portfolios an investor may choose; we then go into more detail on design decisions related to building style portfolios; and finally, we address other considerations for style investing, such as trading and risk management. We will share our thoughts on a number of enhancements that can be made without deviating from the main thesis. While many of these enhancements reflect our opinions on better ways to build portfolios, the main point is that these choices need to be made consciously. Certain design choices may improve the risk/return characteristics of the overall portfolio, by enhancing returns, reducing risk, or a combination of both. We call the sources of alpha that involve implementation choices "craftsmanship alpha."

What Kind of Style Portfolio?

While style premia investing has certainly grown in popularity, there still remains considerable disagreement over which styles drive returns — which styles one should believe in. Generally, the most widely accepted and utilized styles relate to value (the tendency for cheap assets to outperform expensive ones), momentum (the tendency for outperformers to continue to outperform), defensive (the tendency for low-risk, high-quality assets to outperform high-risk, low-quality assets on a risk adjusted basis), and carry (the tendency for higher-yielding assets to outperform lower-yielding assets). However, there are also other styles, such as size or liquidity. While the efficacy of the latter two styles has generally been more challenged,[2] it is outside the scope of this paper to present the merit of each style. Instead, we aim to highlight that even general agreement on *which* style to include does not map as directly to a portfolio as many think.

[1] Asness, Moskowitz, and Pedersen (2013); Asness et al. (2015a). Past performance is not a guarantee of future performance.

[2] Some of the challenges related to the size anomaly relate to its lack of pervasiveness (only applicable in equities), the limited economic intuition behind its efficacy, and its weak in-sample evidence. Even though Asness et al. (2015b) show that the size premium may be resurrected when you control for quality, we believe the size anomaly may be better thought of as a subset of illiquidity, which is more robust, more pervasive, and accompanied by better theory (but comes at a cost which is that it is less liquid, so more costly to trade).

To illustrate this point, consider, just as a starting point, all the different ways to take advantage of a single style such as value. Arguably, the most popular expression is the long-only (or "smart beta") approach, which applies tilts within equities to overweight stocks that are relatively cheap.[3] This approach results in deviations from market capitalization weights that in practice imply certain systematic style tilts.[4] Relative to other forms of value investing, long-only style tilts are typically easier for many institutions to adopt because they involve less peer risk (they have lower tracking error to conventional portfolios and benchmarks), have greater capacity, and do not require the use of leverage, shorting or derivatives. But for investors who are more comfortable with less traditional implementations, a "purer" expression of value would be a long/short approach, which seeks to capture the entire style premium and none of the traditional beta. Such an approach may be valuable for investors who want to add uncorrelated sources of return.[5] Both long-only and long/short approaches can have merit, sometimes even for the same investor.

While single-style (long-only or long/short) investing may be beneficial on its own, we believe that investors may do better by combining styles in a multi-style portfolio. Relative to a single-style approach, multi-style approaches may produce more robust portfolios.[6] Investing in styles that are lowly correlated with each other can have attractive diversification benefits as the styles tend to pay off at different times.[7] In particular, combining value with momentum, for example, allows investors to take advantage of two different potential sources of returns. Importantly, however, how they are combined matters (we will come back to this point later).

It's also worth mentioning that if investors are comfortable with a long/short approach, they may also apply styles across a broader range of asset classes. In a similar vein to how combining styles may offer greater diversification, so does combining asset class portfolios.[8] Regardless of the implementation choice, we believe investing in styles will continue to produce positive long-run excess returns, but it is critical to implement them efficiently. We now turn to a discussion of portfolio construction.

How to Build Style Portfolios?

Once an investor has decided on the type of style portfolio they are most comfortable with (e.g., long/short value), there are a number of choices that can be made in actually building that portfolio. Put differently, two long/short strategies that rely on the same style may have different exposures and performance over time, likely a result of different design decisions in portfolio construction. While certain design decisions may result in better investment outcomes, these choices may not materialize in every period (or even over a 5-10 year period). However, to the extent they are based on sound economic logic

[3] In the case of value in equities, the portfolio is typically constructed by tilting a market portfolio according to some fundamental measure. For example, a manager might overweight high book-to-price (B/P) stocks and underweight low B/P stocks. The resulting portfolio will have both market and "pure" style exposure. It is the long-only equivalent of Fama and French's famous HML factor, the return spread between a diversified portfolio of high book-to-price and low book-to-price stocks.

[4] See Ilmanen, Israel, and Villalon (2014); Asness et al. (2015c); Arnott, Hsu, and Moore (2004) for more on this.

[5] For more on long-only versus long/short style investing, see Ilmanen, Israel, and Villalon (2014). And for more on multi-asset style investing, see Asness et al. (2015a). While we do not get into "130/30" (also called relaxed constraint or active extension) implementation in any detail here, it's worth mentioning that it can be considered a hybrid between long-only and long/short approaches.

[6] We do see a standalone role for some risk-reducing styles (such as defensive equity or trend-following) when an investor's focus is on downside protection for their total portfolio.

[7] Novy-Marx (2012, 2013); Asness, Frazzini, and Pedersen (2013); Asness et al. (2015a); Frazzini et al. (2013). Diversification does not eliminate the risk of experiencing investment losses.

[8] In order to fully embrace this multi-asset approach, however, investors need to adopt the long/short framework. There are certain asset classes where a long-only style portfolio wouldn't apply, such as currencies where there is no real benchmark.

and empirical evaluation over longer histories, we do expect them to pay off over the long-run. We now focus on a number of the portfolio construction decisions that may improve the targeting and capturing of style premia; we focus mostly on long/short value portfolios in U.S. equities, but where relevant, may use a long-only approach or a different style to illustrate our point.

Smarter Style Measures

Typically value portfolios sort stocks based on some measure of fundamental value relative to price, such as book value relative to price or earnings relative to price. While these concepts might seem simple, practitioners may vary the inputs that they use or the adjustments that they make in defining each measure. For example, whether or not to include intangible assets and/or non-operating assets[9] can differ among managers in calculating the book value of a company. For earnings calculations, managers may also treat unusual or infrequently occurring items differently.

Surprisingly, even the choice of market price can also vary by manager: the price used can be the latest figure or a lagged one. The standard academic approach, HML ("High Minus Low"), uses the price that existed contemporaneously with the book value, which due to financial reporting can be lagged by 6 to 18 months. To illustrate why this decision is important and why using lagged price might differ from using the latest price, consider a company that looked expensive based on its book value and price from six months ago, but whose stock price has fallen over the past six months. Holding book value constant,[10] this stock should now look better from a valuation perspective (since the price is lower). Yet, in a traditional definition (using lagged prices) the stock is viewed the same way irrespective of the price move. As a result, HML can be viewed as an incidental bet on both value and momentum.

To correct for this "noisy" combination of value and momentum, Asness and Frazzini (2013) suggest replacing the 6- to 18-month lagged market price with the current market price to compute valuation ratios that use more updated information. Measuring HML using current price (what they refer to as "HML Devil") seeks to eliminate any incidental exposure to momentum, resulting in a better proxy for true "value," while still using information available at the time of investing. While such an adjustment may seem inconsequential, it can actually make a big difference — ultimately, the devil is in the details (as we will show again and again throughout this paper!).

Multiple Style Measures

While stocks selected using the traditional academic measure of value (discussed above) perform well in empirical studies,[11] there is no theory that says book-to-price is the best measure for value. In fact, we believe other measures can be used and applied simultaneously to form a more robust and reliable view of a stock's value.[12] In addition to the fact that no theory exists for why you would use only one measure, there is actually a strong theoretical argument for why you *would* want more than one: regardless of whether you believe style returns comes from capturing a risk premia or a mispricing, a multiple-measure approach can reduce the measurement noise associated with any one measure. Utilizing multiple measures can help

[9] Penman, Richardson, and Tuna (2006).

[10] While such an assumption may be unrealistic, Asness and Frazzini (2013) show that moves in book value are generally smaller than market moves.

[11] Fama and French (1992).

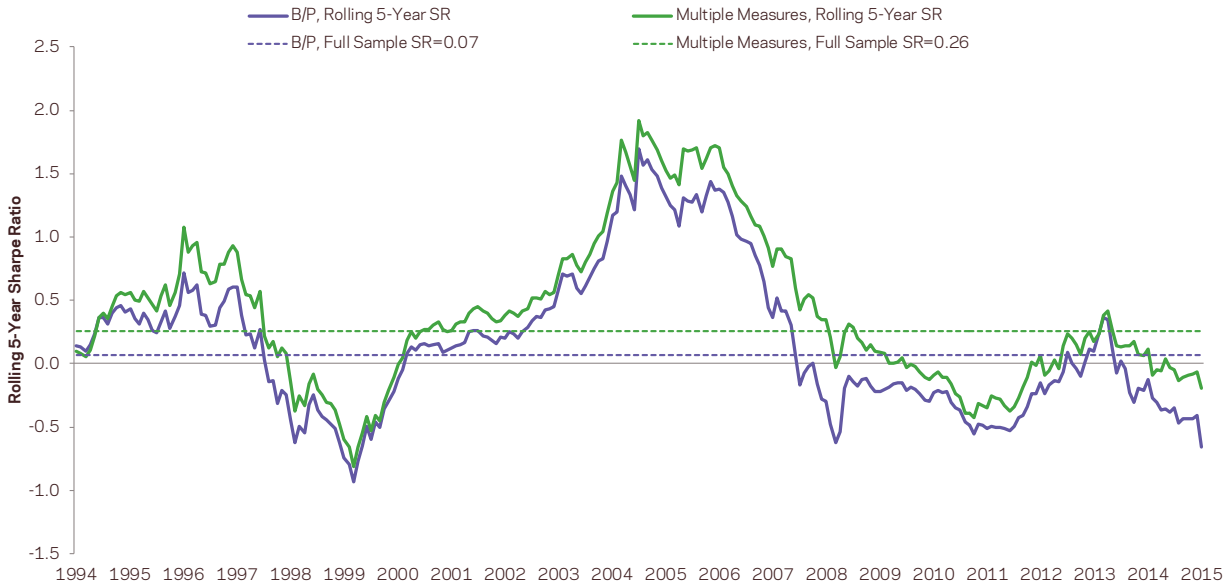
[12] Frazzini et al. (2013); Asness et al. (2015c).

isolate the common component (the "true" measure of value), which is the core of what we're trying to capture. As such, investors can relate prices to a variety of other reasonable fundamentals, including, but not limited to, earnings, cash flows, and sales. To understand the potential benefits of a multiple-measure approach, **Exhibit 1** looks at rolling 5-year Sharpe ratios for two value portfolios: one based on just book-to-price, and another based on a composite of five different value indicators.[13]

The results show that both book-to-price and multiple value measures provide positive risk-adjusted returns on average (0.07 and 0.26, respectively),[14] and are highly correlated with each other (roughly 0.9 correlated based on monthly returns). However, the multiple-measure value portfolio outperforms book-to-price in almost every 5-year period since 1990.[15] The same multiple-measure approach can be applied to other styles too: for example, momentum portfolios that include both earnings momentum and price momentum may be more robust. It is important to note that using multiple measures is not a form of factor proliferation, which can lead to concerns about data mining; instead, using additional measures leads to a more robust version of the ideas behind the factors as there isn't a single, perfect definition of each style.

Exhibit 1 | *Diversified Signals May Improve Risk-Adjusted Performance*

5-Year Hypothetical Sharpe Ratios: Book-to-Price vs. Multiple Value Measures
U.S. Stocks Long/Short, January 1990 – December 2015



[13] Here we use book-to-price, earnings-to-price, forecasted earnings-to-price, cash flow-to-enterprise value (an adjusted measure of price), and sales-to-enterprise value.

[14] Book-to-price was the worst performer within the multiple-measure value composite; however, the composite still outperformed three out of the five standalone measures on a risk-adjusted basis over this period.

[15] Hypothetical performance data has certain inherent limitations, some of which are discussed in the disclosures.

Source: AQR, Russell 1000. For illustrative purposes only and not representative of an actual portfolio AQR manages. For all measures, we use current prices. The multiple measures include book-to-price, cash flow-to-enterprise value, earnings-to-price, forecasted earnings-to-price, and sales-to-enterprise value. Value portfolios are formed every month by ranking all U.S. stocks in the Russell 1000 universe on these metrics. Portfolios are formed by going long the top half (cheap) and short the bottom half (expensive) of stocks; stocks are weighted by market capitalization. Hypothetical returns are gross of estimated transaction costs. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures. Please read important disclosures at the end of this paper.

Stock Selection and Weighting Schemes

Another portfolio construction design choice that can result in different exposure to a given style, and thus different performance, is how to select and weight stocks within a portfolio. A common approach among academics is to set a cutoff and weight stocks in a style portfolio via their market capitalization. The standard academic approach — in Fama French's HML, for example — is to rank stocks based on book-to-price, go long the top 33% of stocks with the highest book-to-price and short the bottom 33% with the lowest book-to-price, and then weight those stocks based on their market capitalization. However, the 33% cutoff is just one choice a manager can make; as is the choice of weighting by market capitalization.

To illustrate this point, let's go back to our hypothetical value portfolio based on multiple measures from Exhibit 1. Here we are creating a portfolio based on the top 50% of stocks with the highest "composite" value rank across five different value measures. Every month we rank stocks based on each value measure, and go long the top 50% of stocks with the highest aggregate score and short the bottom 50% with the lowest score; we then weight the stocks in the resulting portfolio by their market capitalization (i.e., market-cap weight). The 50% cutoff is one choice we made; if, however, we had decided to restrict the portfolio to the top 33% (as per the standard academic approach), the portfolio would end up having more concentrated value exposure and slightly better performance, but also higher risk, and therefore virtually the same Sharpe ratio.

An alternate weighting choice that can result in even more value exposure is to account for relative cheapness within stocks held long and short. This approach assigns larger positive (negative) weights to the stocks that rank most (least) favorably on its value rank (i.e., signal-weighting). While weighting stocks in a value portfolio based on signal strength results in the highest exposure to the desired style (and therefore potentially higher returns and Sharpe ratios), it tends to result in exposure to smaller, less liquid stocks, effectively foregoing some of the potential liquidity benefits of a market capitalization weighting scheme. As such, an approach that blends market capitalization and signal strength may provide a good balance between liquidity and higher expected gross return.[16]

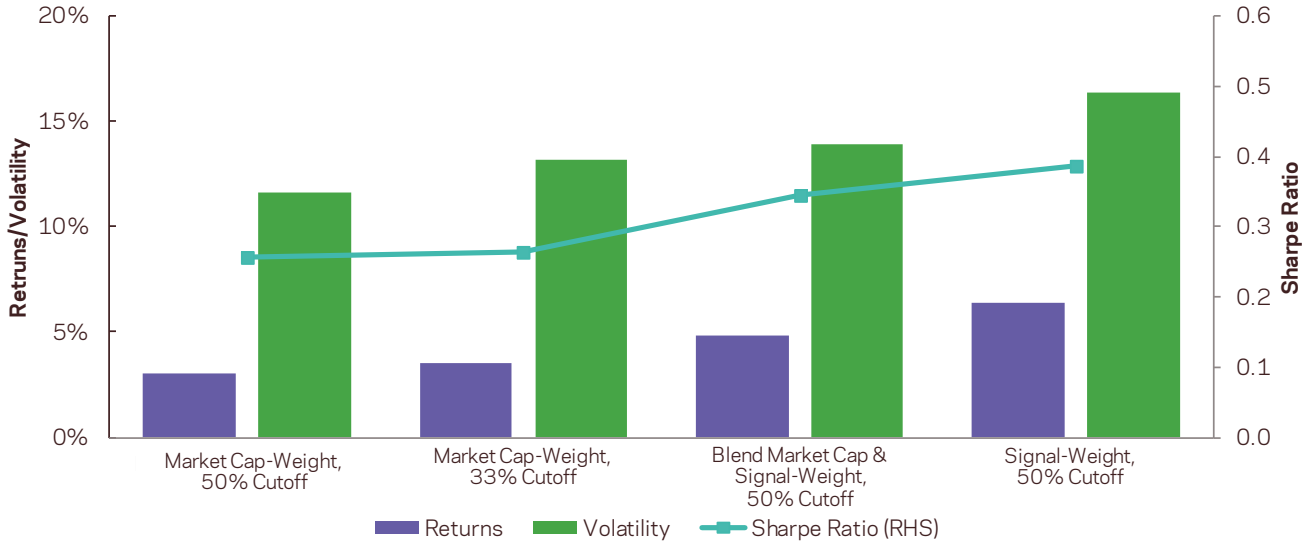
The results for all these weighting choices are shown in **Exhibit 2**. The point here, again, is not to argue for specific choices, though we of course have and will share our favorites. The broader point is that even after substantial agreement on the basic styles, there are many important choices to be made.

[16] Note that these results are gross of transaction costs.

Exhibit 2 | *Different Selection and Weighting Schemes Produce Varying Performance*

Weighting Stocks in a Hypothetical Value Portfolio

U.S. Stocks Long/Short, January 1990 – December 2015



Source: AQR, Russell 1000. For illustrative purposes only and not representative of an actual portfolio AQR manages. The portfolio is constructed every month by first sorting stocks on multiple measures including book-to-price, cash flow-to-enterprise value, earnings-to-price, forecasted earnings-to-price, and sales-to-enterprise value. The long/short portfolio is formed by going long (short) the cheap (expensive) stocks. Value portfolios are formed every month by ranking all U.S. stocks in the Russell 1000 universe. We test two cutoffs: top third minus bottom third and top half minus bottom half. The portfolio weights stocks either by the market capitalization of the stocks, the relative ranking of the stocks, or a blend of the two measures based on a 50/50 weight. Throughout, we use current prices. Hypothetical returns are gross of estimated transaction costs. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures. Please read important disclosures at the end of this paper.

Unintended Risks

There are also specific choices managers may make to help mitigate poorly rewarded or unintended risk exposures. Even if the manager has the intention of capturing the purest form of a risk premium, certain design choices can result in other embedded risks. These risks might be unintentional, or even worse, unwanted and perhaps uncompensated.

To illustrate this point, let's examine the Fama-French HML portfolio, but constructed using current prices as done in HML Devil.[17] Recall that this portfolio follows an academic methodology: ranking stocks based on book-to-price and selecting the top 33% stocks to go long and the bottom 33% to short.[18] This simple ranking results in a portfolio that implicitly takes style bets both within industries and across industries, without any explicit risk controls on the relative contributions of each. In addition, even though this portfolio is constructed with $1 long and $1 short, it can still have varying market beta over time.[19]

[17] For the remainder of this paper we will utilize current (rather than lagged) prices, as done under the HML Devil approach as discussed earlier. However, for simplicity we will refer to this portfolio as book-to-price.

[18] Fama and French utilize current prices and also construct their portfolios over the entire CRSP universe (large - and small-cap stocks, including many micro-cap stocks).

[19] See Israel and Ross (2017) for more on how HML's market exposure varies over time.

The average risk exposures of this portfolio are shown in the pie chart in **Exhibit 3** where we use portfolio holdings to breakdown risk exposures. The results show that the majority of risk is coming from market exposure and industry selection (value across industries), with only 32% of the risk coming from stock selection (value within industries).

To understand how a long/short value portfolio can have such significant market (and industry) risk, consider what happened during the technology bubble: technology stocks were expensive based on book-to-price ratios and were generally higher risk as well, which meant that they exhibited higher market beta. Because these stocks fell on the short side of a naïve $1 long/$1 short value portfolio, that portfolio would have been net short the technology sector and effectively the market as well (i.e., higher beta on the short side than the long side). A key question here is whether timing the market and technology sector is intentional. In general, we believe that if an exposure is intentional and believed to be compensated, it's better to separately and explicitly gain said exposure, rather than let it fall out of a naïve implementation. If exposure is neither intentional nor compensated, we believe that risk should be eliminated.

So how should managers deal with these risks? One way may be to "hedge" out these risks and build a value portfolio that isolates style exposure. For market risk, that might mean constructing a portfolio with a beta of zero (i.e., the long side beta is equal to the short side beta), effectively hedging out market risk.[20] For industry risk, one might apply style measures (book-to-price, for example) on a within-industry basis (i.e., focus on comparisons relative to industry peers).[21] Managers may then avoid unintended industry bets but also make explicit inter-industry bets where deemed beneficial. However, for styles in general, we believe it makes sense to assign more risk to within-industry comparisons given the greater breadth (i.e., more securities within industries than industries to compare). In addition, at least when it comes to value, industry selection may not be as well compensated over the long-run.[22]

To understand the potential benefits of constructing a "pure play" value portfolio, the right hand side of **Exhibit 3** compares the risk-adjusted performance for a book-to-price portfolio with significant market and industry risk to one that eliminates any incidental industry and market risk.[23] The book-to-price portfolio that isolates value exposure has delivered higher risk-adjusted returns. Overlaying an industry neutrality constraint on value strategies often reduces volatility while keeping long-run returns broadly unaffected, which implies higher portfolio Sharpe ratios.[24] But the tradeoff is that this adjustment typically results in higher turnover.[25] We are not saying these choices and trade-offs are easy or obvious, just that they're real and should be made consciously.

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[20] For a long-only portfolio, the analogous concept is to target a beta of 1 to the benchmark; such an approach ensures that active returns are not driven by the market.

[21] Note that industries are just one way to define peers; an additional craftsmanship refinement may be to define peer groups th rough additional economic and statistical linkages, for example.

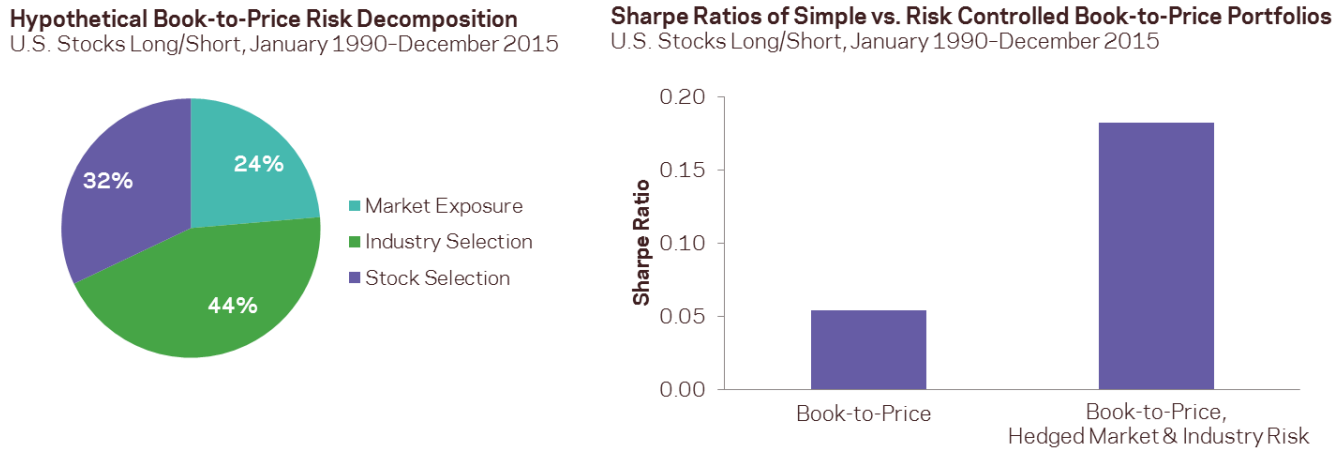
[22] For momentum there is more evidence that it is effective across industries. Moskowitz and Grinblatt (1999); Asness, Porter, a nd Stevens (2000).

[23] Managers can also seek to mitigate these risks by explicitly hedging them, separating comparisons of stocks within industries from comparisons across industries, or diversifying across multi-style portfolios. For instance, in the case of industry exposure, combining value and momentum may provide offsetting industry exposure. Think of the tech bubble — during this period a value portfolio would be underweight "expensive" tech stocks, while a momentum portfolio would be overweight "increasing in price" tech stocks. The combination of these two styles may help mitigate industry exposure.

[24] Specifically, portfolios that are long high within-industry B/P stocks and short low within-industry B/P stocks should have about the same to slightly higher expected return, but less variance, than portfolios long high market-wide B/P stocks and short low market-wide B/P stocks (Asness, Porter, and Stevens, 2000).

[25] In general, when portfolio adjustments result in higher turnover, investors need to consider transaction costs and taxes. The higher costs associated with additional turnover may be mitigated through efficient trad ing – more on this to come. The tax efficiency of a portfolio is a complicated function of turnover, short- and long-term gain and loss realizations and dividend income. See Israel and Moskowitz (2012) and

Exhibit 3 | *Naïve Approaches Result in Significant Market and Industry Exposure*



Source: AQR, Russell 1000, MSCI BARRA. For illustrative purposes only and not representative of an actual portfolio AQR manages. We form our value portfolio every month by ranking all U.S. stocks in the Russell 1000 universe on book-to-price. The portfolio is formed by going long the top third (cheap) and short the bottom third (expensive) of stocks; stocks are weighted based on market capitalization. The risk decomposition (on the left) is computed by analyzing of the holdings of the hypothetical long/short value portfolio. Using the BARRA USE3L risk model, we decompose holdings into three components: 1) a market portfolio based on the value portfolio's market beta multiplied by the Russell 1000 index, 2) an industry portfolio, based on the value portfolio's beta to each industry multiplied by the respective cap-weighted industry portfolio, and 3) the residual portfolio that is free of market and industry biases. The Sharpe ratios (on the right) use the long/short value portfolio compared to the residual portfolio that is free of market and industry biases. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures. Please read important disclosures at the end of this paper.

It's also important to note that these risks are not just present in value portfolios. A momentum portfolio that simply ranks stocks based on past 12 month price returns and overweights the relative winners may result in a portfolio that implicitly makes market bets. For example, during a bull market, the stocks that tend to outperform are typically higher beta names; so by going long these stocks, the momentum portfolio will have significant market beta. Put differently, the momentum portfolio construction implicitly times the market: generally overweighting the market after an up market and underweighting after a down market. This may or may not be desired, but it should be consciously chosen!

Lastly, while we have focused on market and industry risk, there are also other unintended risks that may be hedged from portfolios. For example, in international equity portfolios, a manager can have stock, industry, country and currency risks.[26] For instance, in creating a portfolio, if one just ranked all global stocks on valuation, part of the risk would come from buying cheap stocks within each country, part from country tilts, and perhaps even odder, part from currency bets. You may or may

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Sialm and Sosner (2017) for more information on the after-tax performance, tax exposure, and tax efficiency of equity styles.

[26] Aghassi et al. (2011).

not desire all those bets, but you certainly may desire them at different levels of risk/confidence than what falls out of this simple ranking approach. We believe a better approach to building style portfolios separates and manages these risks independently. This approach may improve the comparability of stocks by controlling for differences across industries and countries, and allows the manager to better allocate and control risk to each source of return (i.e., capture and target risk to each return source *independently*).

Volatility Targeting

Typically, investors understand that they must periodically rebalance their portfolios to maintain a strategic asset allocation. Yet, many investors commonly let their portfolio volatility fluctuate with market volatility, which can result in large time-varying portfolio risk where returns tend to be dominated by certain periods of higher volatility. Volatility (or risk) targeting is an approach that seeks to yield more consistent risk-taking over time, by adjusting nominal position sizes dynamically in response to these portfolio volatility changes. Such an approach may lead to more stable portfolios and better diversification across time periods. Similarly, volatility targeting each style within a multi-style portfolio can lead to better diversification at all times. As a result, volatility targeting is a technique that practitioners may use when constructing long/short style portfolios. In long-only portfolios, the analogous concept is targeting tracking error.

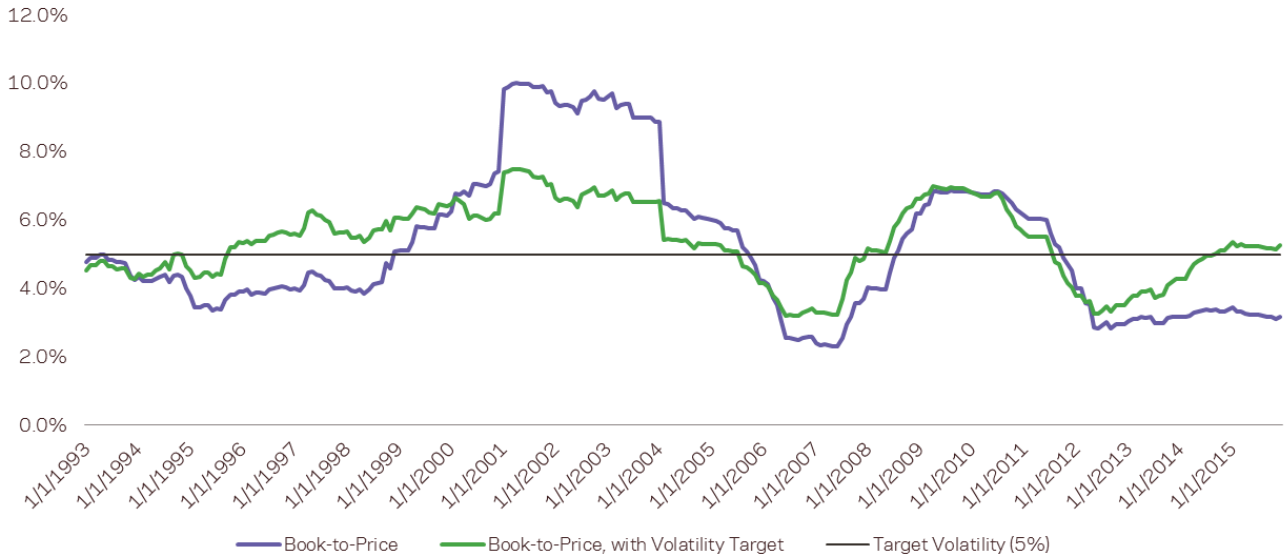
Of course, targeting a more consistent level of volatility only makes sense if investors believe that it is forecastable (one needs forecastable volatility in order to target it), and also that the trading costs of doing so do not eliminate the benefits. To understand if this approach is realistic and beneficial, **Exhibit 4** looks at the realized volatility over time for two hypothetical value portfolios, a long/short value portfolio where the volatility is not controlled, and one where the portfolio is scaled to target a fixed volatility. The volatility targeted portfolio has realized volatility that is more stable and closer to the target volatility over time.

It is also worth noting that there could be a case for allowing volatility to fluctuate, for example, if higher volatility is associated with higher Sharpe ratios. But without a view on attractiveness, taking a consistent level of risk (i.e., being diversified across time) seems to be a defensible approach.

Exhibit 4 | *Diversification Through Time*

Hypothetical Three-Year Rolling Volatilities of Book-to-Price Portfolios

U.S. Stocks Long/Short, January 1990 – December 2015



Source: AQR, Russell 1000. For illustrative purposes only and not representative of an actual portfolio AQR manages. Volatilities above are computed on 3-year rolling returns of long/short book-to-price portfolios. Value portfolios are formed every month by ranking all U.S. stocks in the Russell 1000 universe on book-to-price. The long/short portfolio is formed by going long the top half (cheap) and short the bottom half (expensive) of stocks; stocks are weighted by value signal strength. Both volatility-adjusted and non-volatility-adjusted portfolios are designed to be market and industry neutral ex-ante. The volatility adjusted portfolio targets 5% volatility at each rebalance; this level was chosen since it was the average volatility of the book-to-price portfolio. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures. Please read important disclosures at the end of this paper.

Integrating Styles in a Multi-Style Portfolio

Similar to weighting stocks in a single style portfolio, there are also different ways to weight styles in a multi-style portfolio. There are two popular approaches that are often considered as potential starting points for investors: the "portfolio mix" that builds a style portfolio by investing in separate, standalone style portfolios (effectively an "a la carte" approach to style investing) and the "integrated approach" that endogenously integrates styles directly in the portfolio construction process. The portfolio mix approach may be used by individual investors building their own portfolios (perhaps diversifying across managers), or by managers building a multi-style portfolio for them.

To understand how these approaches can differ, consider two portfolios that aim to take advantage of two historically lowly correlated styles, value and momentum: the portfolio mix first picks the "best" value stocks and the "best" momentum stocks and then combines them to form a portfolio; in contrast, the integrated approach first blends each stock's value and momentum scores and then forms a portfolio with the stocks that look best in combination (i.e., it considers the exposure to both styles before investing). The two approaches can actually end up holding very different stocks (especially when investing in lowly correlated styles, such as value and momentum). To see why this may be the case, the top half of **Exhibit 5**

shows a simple example of how 16 representative stocks (as represented by the boxes) map to different portfolios based on their value and momentum scores or "grades."

Focusing first on the top left long-only example, we see that stocks that score highly based on value and momentum make it into both the mix and the integrated portfolios, but those that look excellent on one style (e.g., "A" on value) and terrible on the other (e.g., "F" on momentum) are those that make it into the portfolio mix only. Notably, the integrated approach avoids these stocks (e.g., "A/F" value/momentum combinations) and instead focuses on stocks that look 'good' on *both* value and momentum (e.g., "B/B" combinations).

Now, consider how the same 16 stocks map to different long/short portfolios (top right of the Exhibit). The ability to go short means that we can now take advantage of stocks that are unattractive based on value and momentum.[27] For both the portfolio mix and integrated portfolios, stocks that look excellent (terrible) on value and momentum make it into the long (short) side, while the integrated portfolio also focuses on stocks that look good (bad) in combination for the long (short) sides. There is one subtle nuance with the long/short approach that is worth highlighting: the "A/F" stock does not actually make it into the mix portfolio (as it did for long-only); this is due to the offsetting nature between the "A" stock long and the "F" stock short, which can be expressed in the long/short example.[28]

It turns out these kinds of distinctions have implications when it comes to returns. Stocks that look excellent on one style, but horrible on the other (e.g., "A/F" stocks) have mediocre expected returns, while those that look good on each style (e.g., "B/B" stocks) have higher expected returns. The long-only integrated portfolio correctly avoids the former types of stocks and instead focuses on the latter, underscoring the importance of an integrated approach for long-only investing (a point which is discussed at length in Fitzgibbons et al., 2016). However, integration is also important for long/short portfolios as the types of stocks that make it into the mix still tend to underperform those in the integrated. The bottom half of Exhibit 5 examines the performance differences between various groupings of stocks. It shows that the stocks that are unique to the integrated portfolio tend to outperform those that are unique to the portfolio mix — for *both* long-only and long/short portfolios.

[27] Note that a long-only portfolio can take advantage of unattractive stocks by holding them at a weight less than the benchmark (i.e., underweight these stocks). However, for simplicity, we choose to represent pure longs and shorts here.

[28] Such a stock actually "makes it" into both the long and short side, but it would not appear in the implemented portfolio due to position netting. If the long/short value and momentum portfolios were run separately it would indeed appear in the long portfolio of one and in the short portfolio of the other.

Exhibit 5 | *Comparing Portfolio Mix and Integrated Approaches, Long-Only and Long/Short*

Long-Only Portfolio Mapping
Hypothetical Example of 16 Stocks

Momentum "Grade" \ Value "Grade"	A	B	C	F
A	Both	Both	Portfolio Mix Only	Portfolio Mix Only
B	Both	Integrated Only		
C	Portfolio Mix Only			
F	Portfolio Mix Only			

Long/Short Portfolio Mapping
Hypothetical Example of 16 Stocks

Momentum "Grade" \ Value "Grade"	A	B	C	F
A	Both	Both	Portfolio Mix Only	
B	Both	Integrated Only		Portfolio Mix Only
C	Portfolio Mix Only		Integrated Only	Both
F		Portfolio Mix Only	Both	Both

Stocks Not in Any Style Portfolio

Hypothetical Performance of Various Groups of Stocks
U.S. Stocks, January 1990 – December 2015

	Long-Only			Long/Short		
	Stocks in Both	Stocks in Integrated Only	Stocks in Portfolio Mix Only	Stocks in Both	Stocks in Integrated Only	Stocks in Portfolio Mix Only
Alpha*	1.9%	1.6%	0.7%	6.5%	5.4%	4.2%
t-statistic	2.88	2.11	0.73	3.63	2.94	2.15
Example Stocks Long: Val/Mom "Grade"	A/A	B/B	A/C & A/F	A/A	B/B	A/C
Example Stocks Short: Val/Mom "Grade"	-	-	-	F/F	C/C	B/F

* Alpha is measured relative to an equally-weighted composite of Russell 1000 stocks. The stocks in each respective group are also equally-weighted.
Source: AQR, Russell 1000. For illustrative purposes only and not representative of an actual portfolio AQR manages. The long-only "portfolio mix" is constructed by equally weighting standalone value (book-to-price) and momentum (past 12-month price return, excluding the recent month), each with a 15% cutoff based on the Russell 1000 universe. The long-only "integrated" portfolio is constructed by first combining value and momentum scores and then selecting a cutoff so that it has the same tracking error as the portfolio mix. The long/short portfolio is constructed using a similar approach, with the portfolio mix using a 15% cutoff and the cutoff for the integrated portfolio determined so that it has the same leverage and volatility as the portfolio mix. These simple portfolios are neither market- nor industry-neutral. Returns are gross of transaction costs. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures. Please read important disclosures at the end of this paper.

While we have focused on performance differences, an additional benefit of an integrated approach is the potential reduction in transaction and other costs. Forming a portfolio of multiple styles in an integrated way allows managers to net positions and trades, which may allow for a reduction in turnover of the portfolio.[29] However, the tradeoff is that allocation and attribution may not be as straightforward.[30]

Strategic or Tactical

A bigger picture question when it comes to investing in styles is whether to tactically time or to simply maintain strategic allocations. Tactical timing means owning more (less) of a particular style when its expected return is higher (lower) than normal. Practitioners use a variety of ways to determine whether a style is conditionally attractive; for instance, timing may be based on valuation metrics (increasing/decreasing the weight of a style when the spreads in valuation between the long

[29] There are also potential tax benefits to an integrated approach. See Israel and Moskowitz (2012) for more information on the tax efficiency of standalone and integrated equity styles.

[30] For an integrated approach, allocating to styles is done in the portfolio formation process and therefore the attribution process is not as straightforward as allocating to standalone style portfolios. See Fitzgibbons et al. (2016) for more on the benefits of an integrated approach.

and short sides are wide/tight), momentum measures (increasing/decreasing the weight of a style when recent performance has been better/worse), or macroeconomic conditions (identifying the best market environments for each style). While several studies have looked at the efficacy of tactical timing (whether for markets or styles, based on a variety of measures), the evidence shows that timing is very difficult in practice.[31] Valuation timing tends to have slightly more predictive power for long-horizon factor returns, particularly for slower turnover factors (like the market itself and, to a lesser extent, the value factor) versus faster ones.[32] Still, the evidence shows that the benefit of timing strategies has been weak historically, and some tests of the long-term power of timing may even be exaggerated and/or inapplicable.[33]

Specifically, for factors the evidence on timing is further complicated by the fact that timing styles based on valuation is highly correlated with having direct value factor exposure in the portfolio. As such, value timing may not add much to a portfolio that already has a strategic allocation to value. These results are addressed in Asness et al. (2017), who show that the bar is raised further for contrarian style rotation when the relevant benchmark is a strategically diversified multi-style strategy with direct value exposure. Thus, contrarian tilting across style premia is potentially even harder to do successfully than contrarian market timing.

To further understand the high bar to timing styles, we ask the question of how good (or skilled) you would need to be at timing to justify tactical tilts. We do so relative to a diversified baseline portfolio, an equally-weighted 50/50 combination of value and momentum,[34] and for a timing strategy that is based on valuation metrics (i.e., one that is correlated with strategic value exposure).[35] For simplicity, we ignore the (weak) empirical evidence on the efficacy of value timing, and instead, define timing 'skill' by assumed standalone strategy Sharpe ratios. The results in **Exhibit 6** show that the amount of timing (or how large the tactical tilt should be) varies as a function of skill: modest timing skills merit modest tilts. Importantly, timing skills need to be better than a 0.1 Sharpe strategy to merit any weight at all; that is, when the timing strategy has a 0.1 Sharpe ratio, it may be better to stick with the strategic value/momentum weights. But even when timing skills are very large (the standalone timing strategy Sharpe ratio is 0.5), the results show that the size of the tilt should *still* be modest, at +/- 12%. More extreme tactical tilts require higher levels of skill to justify the concentration. Timing skills must be good enough to overcome not only the hurdle of a good starting point (such as a well-diversified portfolio of multiple styles), but also the transaction costs of doing so as tactical allocators often face higher turnover than their strategic counterparts. Finally, the results shown here have looked at a timing strategy that is positively correlated with the strategic baseline exposure, but if instead such a strategy were lowly correlated to the baseline portfolio (i.e., the baseline portfolio did *not* already have value

[31] Asness, Ilmanen, and Maloney (2017) focus on valuation-based market timing and show that correlation evidence (in-sample and over long horizons) make contrarian market timing look promising, yet when an actual contrarian trading rule is applied, the performance improvement is weak.

[32] There may also be a case for timing at extremes: when the spread between 'cheap' and 'expensive' assets is particularly wide. One period in which value timing was at extremes was during the tech bubble (1999-2000). While a value investor was ultimately rewarded handily after the tech bubble burst, she would have lost a lot before making anything, highlighting another example of how value timing may be difficult in practice.

[33] Timing strategy backtests can be vulnerable to look-ahead biases. In particular, the use of in-sample spreads may over-fit the past and under-deliver in the future (see Asness, Ilmanen, and Maloney, 2017) and attempts to increase the sample size by using overlapping data or performing multiple regressions over different horizons do not improve inference about long-horizon return predictability (see Boudoukh, Israel, and Richardson, 2017).

[34] Given assumed volatilities of 5% and expected Sharpe ratios of 0.5 for each style, the equally-weighted combination has a Sharpe ratio of around 1.0, due to diversification. These styles are diversifying to each other as they are -0.5 correlated. The 1.0 strategic baseline Sharpe ratio is consistent with long-run empirical evidence on an equally-weighted value (HML) and momentum (UMD) portfolio.

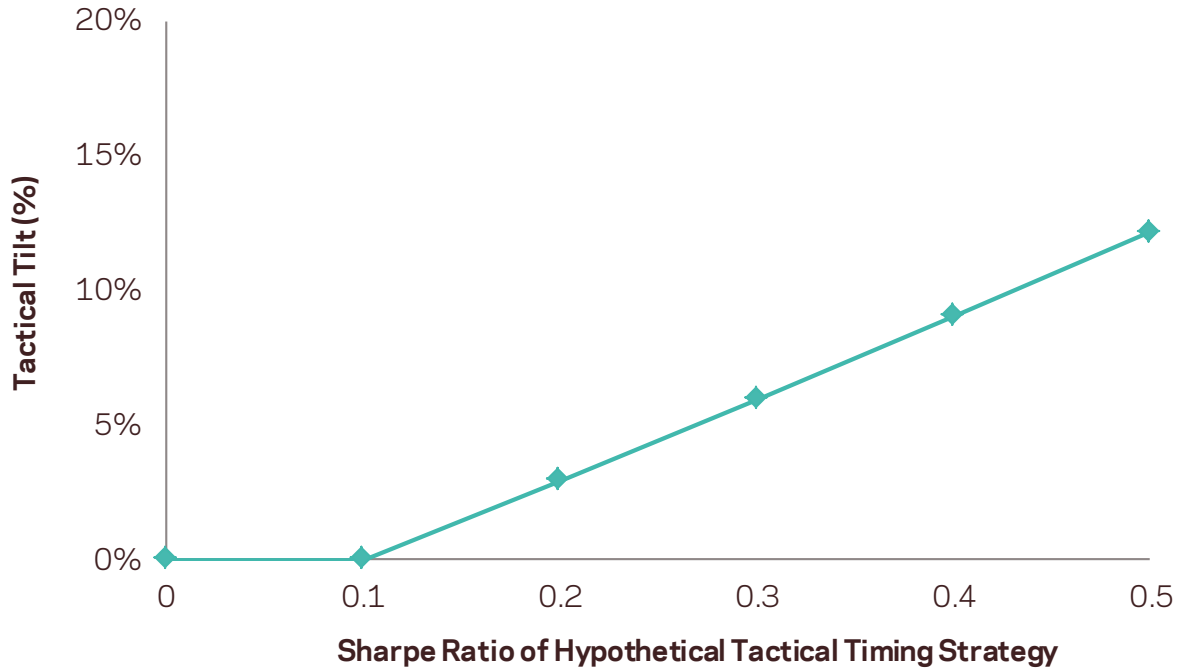
[35] Historically, the contemporaneous correlations between the returns to value timing (difference between the value-timed multi-style portfolio and the non-timed multi-style portfolio) and returns to value and momentum are +0.7 and -0.6, respectively (see Asness et al., 2017).

exposure)[36] there could be a case for higher tilts. Similarly, a lower baseline strategic Sharpe ratio could also merit higher tilts.[37]

The decision of whether to time styles (and by how much!) should ultimately depend on how skilled you are at timing, combined with what is already in your portfolio. We believe that strategic diversification generally beats extreme tactical tilts (i.e., tactical concentration) and that if you are to try to time factors (or the market) you should do so on the margin (i.e., "sin a little").[38] The positive craftsmanship choice here is resisting the temptation to sin a lot.

Exhibit 6 | *The Bar for Tactical Timing*

Size of Optimal Tactical Tilt as a Function of Skill
Given a Strategic Baseline Portfolio with a Sharpe Ratio of 1.0



Source: AQR. The example above is provided for illustrative purposes only. The baseline portfolio is a simple equal-weighted 50/50 combination of value and momentum, assuming the two styles are lowly correlated (-0.5 correlation). For value and momentum, we assume arithmetic Sharpe ratios of 0.5 and volatilities of 5%, such that the combination of value and momentum (the strategic baseline portfolio) has a Sharpe of 1.0. We then evaluate the inclusion of a timing strategy with a correlation of +0.7 with value and -0.6 with momentum, and solve for optimal risk allocation to the timing strategy at different Sharpe ratios. That is, given a Sharpe assumption for a timing strategy, how much risk would you want to take in it; we then translate that risk to a tilt. Transaction costs will likely further penalize tactical strategies. Please read important disclosures in the Appendix. The Sharpe ratios and volatility assumptions used are meant to be illustrative and not based off of any actual underlying data. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures.

[36] For example, if an investor does not have value exposure in their strategic portfolio, then value timing may be potentially additive. However, compared to an explicit risk-targeted strategic allocation to value, value timing provides an intermittent and sub optimal amount of value exposure; Asness et al. (2017).

[37] In our example, we have assumed a baseline portfolio that has a Sharpe of 1.0. If, however, the baseline portfolio had a lower Sharpe ratio, the results would imply higher tactical tilts.

[38] Asness, Ilmanen, and, Maloney (2017); Asness et al. (2017).

In this section we have focused on design decisions and choices that managers can make when constructing style portfolios — each choice has the opportunity to add value or subtract if done poorly, but may also require sophisticated portfolio construction techniques. These individual choices may result in more modest Sharpe ratio improvements than, say, the large gains to diversifying across factors. But, while these improvements may seem incremental, they are still worth pursuing as every little bit counts. At the end of the day, it is up to the manager to decide how to construct her style portfolio; we aim to highlight how various craftsmanship choices can affect exposures and performance of style portfolios.

How To Execute Style Portfolios?

While portfolio construction decisions may allow managers to more-efficiently harvest the underlying risk premia through enhanced signals or better weighting schemes, it is important to ensure that trading and risk management decisions do not erode the value added from other steps of the process.

Portfolio Implementation

The previous section outlined some choices managers need to make when designing their theoretical style portfolios. So far, the discussion has focused on portfolio construction in a world without real-world costs, such as the cost to trade toward that theoretical, ideal portfolio. Effective portfolio implementation is about achieving high returns net of those costs. A simplistic implementation is to build theoretical portfolios, and trade directly to them, without weighing the expected benefit of trading to the ideal portfolio against the expected trading cost of doing so. Style investing requires active portfolio rebalancing: what was considered cheap yesterday may no longer be trading cheap today. Because of this dynamic nature of style investing, it's very important to think about execution and implementation.

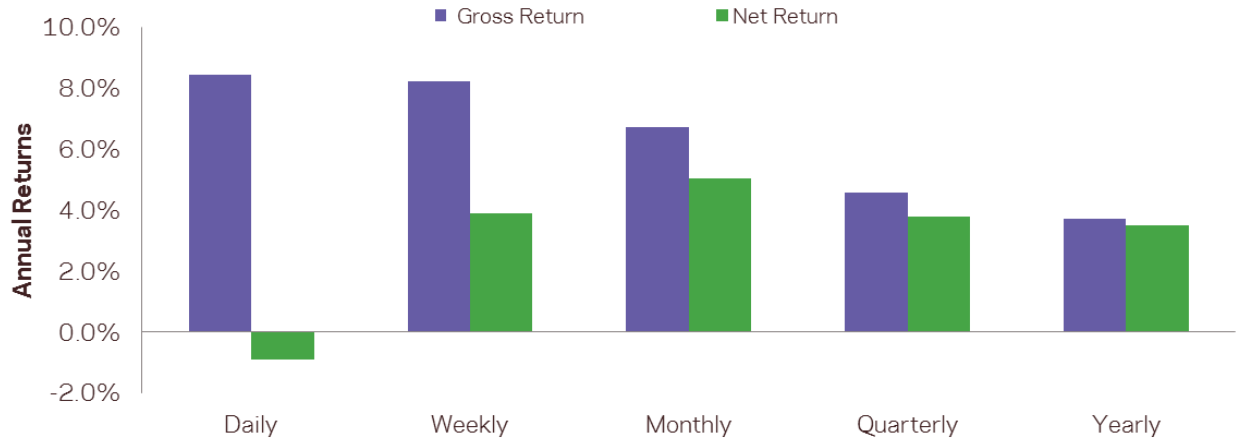
To illustrate this point: consider a style portfolio that rebalanced at different frequencies. A portfolio that is rebalanced daily may result in the "freshest" portfolio (with the highest correlation with the ideal portfolio) and the highest gross-of-transaction-costs performance; while a portfolio that is rebalanced annually will likely be "stale" (further away from the ideal portfolio) and therefore have worse gross performance. But these comparisons don't take transaction costs into account.[39] A better point of comparison is to focus on net-of-transaction-costs performance. Obviously the daily rebalanced portfolio will incur high transaction costs, thereby reducing the gross performance benefits. And the annual rebalanced portfolio will have much lower transaction costs, but applied against lower gross returns. Ultimately, the transaction costs savings of rebalancing at a lower frequency needs to be weighed against the performance degradation of trading a more stale portfolio (i.e., there is a tradeoff between the cost of trading vs. the opportunity cost of not trading). **Exhibit 7** looks at a simple long/short momentum portfolio and shows the impact that different rebalancing frequencies can have on gross and net performance. We focus on momentum because of its higher natural turnover, relative to other styles. As a result of its higher turnover, rebalance decisions may have a larger impact for momentum portfolios.

[39] See Israel and Moskowitz (2012) for more information on taxes and style investing, and Frazzini, Israel, and Moskowitz (2012) for more on trading costs.

Exhibit 7 | *The Tradeoff Between Rebalancing Frequency and Performance*

Performance at Different Rebalance Frequencies for Hypothetical Price Momentum Portfolios

U.S. Stocks Long/Short, January 1990 – December 2015



Turnover	58X	22X	9X	4X	1X
Correlation to the "Ideal" Portfolio*	1.00	1.00	0.98	0.95	0.75

* The "ideal" portfolio reflects the model based on past 12-month price returns, excluding the most recent month, rebalanced daily. Source: AQR, Russell 1000. For illustrative purposes only and not representative of an actual portfolio AQR managed. We vary the rebalance frequency on a long/short momentum portfolio. Returns are shown gross of cash. The momentum portfolio is formed at various frequencies, as shown along the x-axis, by ranking all U.S. stocks in the Russell 1000 universe on past 12-month price returns, excluding the most recent month. A long/short portfolio is formed by going long the top half (outperformers) and short the bottom half (underperformers); stocks are weighted by momentum-signal strength. Reported are returns gross and net of transaction costs. All numbers are also gross of cash and financing costs. Transaction costs are calculated using a propriety trading cost model. Turnover is quoted as total buys and sells over total short-side notional. Please read important disclosures in the Appendix. Hypothetical performance data has certain inherent limitations, some of which are discussed in disclosures.

Another way to potentially reduce transaction costs is to allow for some deviation from the ideal (or "freshest") portfolio through an optimization. Given that a manager has decided to rebalance daily, for example, they may still reduce trading costs by allowing some deviation to the ideal portfolio. It turns out that varying the deviation can have a similar effect as changing the rebalance frequency: a higher deviation induces greater style drift and therefore greater performance degradation, but also less turnover and therefore, lower transaction costs.

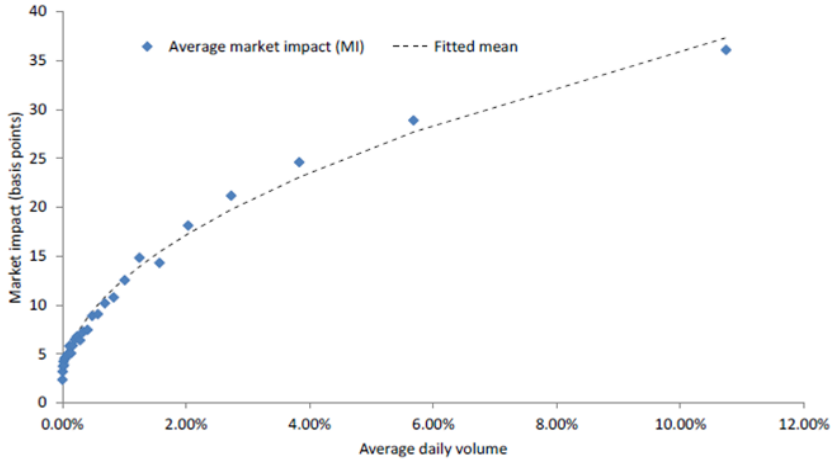
This exercise is not meant to suggest that there is one magic turnover level that works for all style portfolios. The behavior of style portfolios constructed by different managers can vary greatly (we've already shown several design decisions in this paper that can lead to vastly different portfolios); as a result, it may not be informative to compare turnover or transaction costs in isolation across different products or managers. Low, or high, turnover by itself should not be seen as a virtue. Ultimately, net returns, judged over a long enough sample period, is a better way to compare different strategies.

Cost-Effective Execution

We have discussed the tradeoff between expected returns and rebalance frequency and how transaction costs play a crucial role in that determination. But it's also important that once the rebalance frequency or turnover is set, managers utilize smart trading techniques to minimize costs incurred per dollar traded. A big portion of trading costs for large investors is price impact,[40] or how different the execution price is relative to the price at the time the manager enters the market. Price impact often dwarfs explicit costs like commissions. Interestingly, however, many managers and investors focus on the explicit, rather than the implicit, costs of trading.

One way that managers may reduce their market impact is by being patient. Using real world execution data, Frazzini, Israel, and Moskowitz (2012) observe that the greater the participation rate (shares traded/market trading volume) the costlier it is to trade. **Exhibit 8**, extracted from their paper, shows that trading 2% of a stock's daily volume results in roughly 17 basis points (bps) of market impact; in contrast, trading 6% costs roughly 28 bps per dollar traded on average. An implication of this is that if a manager wants to trade 6% of a stock's daily volume, there needs to be a decision on how best to do so. In the case of style investing, trades are generally based on slower signals (rather than higher frequency ones), so a manager may choose a patient trading approach. Rather than completing the trades in one day, they may spread them out across 3 days (utilizing roughly 2% of trading volume per day). A patient trading approach such as this may reduce trading costs.[41] A similar logic can apply to intra-day trading: spreading out trades over the course of a day, rather than trading in a short period (e.g., around market close), will likely lead to lower market impact.

Exhibit 8 | *Smarter Trading Can Reduce Transaction Costs*
Market Impact by Fraction of Trading Volume
August 1998 – September 2013



Source: Frazzini, Israel, and Moskowitz (2012). The data through 2013 is an extension of data from 2011 using the same methodology. For illustrative purposes only. Plotted is the average market impact for actual live trades from AQR's proprietary database, as in Frazzini, Israel, and Moskowitz (2012). The authors sort all trades in their dataset into 30 bins based on their fraction of daily volume and compute average market impact for each bucket. This includes all available developed market equity transactions (cash equities and equity swaps) in their data between August 1998 and September 2013. See Appendix A for more detail. Market Impact is in basis points (annualized) and

[40] See Frazzini, Israel, and Moskowitz (2012) for additional information on explicit (commissions, bid-ask spread) and implicit (price impact) trading costs.

[41] In our example, the trading cost savings could be 11bps (28 bps-17bps), but this is likely an overestimate as we cannot assume the cost functions over three days are independent. That is, trading 2% on the last day might be costlier than trading 2% on the first day, since you've been trading in the same direction for consecutive days. However, this estimate of reduced trading costs should be directionally correct.

defined as the difference between trade-weighted average execution price and the price at the time the manager enters the market. Please read important disclosures in the Appendix.

Risk Management

Another important aspect of running a style portfolio is being intentional in the type of risks the portfolio takes on and managing those risks through time. We have already touched on hedging out unintended risks (such as market or even industry risk) and volatility targeting, but there are other dimensions of risk investors need to be mindful of as well; these include leverage, illiquidity, solvency (i.e., adequate free cash levels), left tail risk, and correlation risk (i.e., styles becoming more correlated). For long/short portfolios, leverage is an important risk dimension, which can be managed by varying exposures as volatilities move around (e.g., reducing leverage when volatility increases), limiting leverage at some absolute level, trading liquid instruments, and maintaining comfortable levels of cash to support that leverage.

Even with thoughtful risk management, there can be painful times for style portfolios. Having a pre-specified plan for how to handle a crisis is of paramount importance, especially for long/short levered portfolios. One alternative is doing nothing, but it is unlikely a manager can actually stick to that in all circumstances. The reality is that in a crisis, risk aversion tends to increase; eventually risk appetite and risk levels diverge enough such that they have to be brought back in line, which is typically accomplished via deleveraging. This behavior often means that investors capitulate at the bottom or worst possible time, and then are averse about putting risk back on.

To help avoid this type of situation, investors can benefit from having a systematic plan in place on how to handle a crisis. This type of plan begins cutting risk when the portfolio experiences a drawdown, or if the short-term tail risk of the portfolio goes up. It then systematically adds back risk as the returns improve and the left tail risk subsides.[42] In other words, mechanical drawdown rules may dial down risk if pre-specified loss levels are reached (and dial risk exposures back up when performance recovers). A pre-specified planned drawdown control system may be beneficial in times of panic; underscoring the importance of having a plan before you need one. Such an approach may allow investors to maintain diversification and stay invested in tough times.

Conclusion

Throughout this paper we have discussed many of the craftsmanship choices that can be made when constructing style portfolios. While there may be broad agreement on the major styles that drive asset returns, we have shown that when it comes to style investing, many details matter — from how to transform signals into portfolio weights to risk control to optimization to trading. In the design of style portfolios, craftsmanship choices are present again and again, explicitly or implicitly, and these are the kinds of decisions that can impact investment success.

While there may not always be a clear right or wrong with some of these design decisions, managers should be able to defend their choices and understand their implications. We believe design choices that are based on economic principles and empirical evidence should lead to better investment outcomes – even if not in every period (over the short-term, randomness can trump an ex-ante edge!). Ultimately, what may seem like inconsequential decisions can lead to a meaningful edge over time.

[42] Our view is that such a plan is likely unnecessary in long-only implementations but becomes more helpful in long/short portfolios with leverage.

Appendix A: Trade Execution Data from Exhibit 8, Summary Statistics

Panel A: Amount Traded (Billion USD)		By region		By size		By portfolio type	
Year	Total	U.S.	International	Large Cap	Small Cap	Long short	Long only
1998*	2.96	1.29	1.67	2.96		2.96	
1999	5.29	1.99	3.30	5.29		5.29	
2000	1.99	0.76	1.23	1.99		1.86	0.13
2001	1.08	0.55	0.53	1.08		1.00	0.08
2002	4.21	0.71	3.50	4.21	0.00	1.40	2.81
2003	5.43	2.69	2.75	5.43	0.00	4.17	1.26
2004	10.00	2.95	7.05	9.99	0.01	6.38	3.62
2005	16.16	8.06	8.10	15.75	0.41	11.45	4.71
2006	67.01	34.79	32.22	64.23	2.78	44.69	22.31
2007	129.46	50.70	78.76	125.21	4.25	96.65	32.81
2008	108.29	25.06	83.24	104.27	4.02	69.30	38.99
2009	111.12	18.58	92.54	108.12	2.99	85.50	25.62
2010	117.17	29.15	88.02	113.78	3.38	91.94	25.23
2011	146.50	56.62	89.88	141.93	4.58	115.69	30.81
2012	179.09	121.39	57.70	173.41	5.68	141.97	37.13
2013**	141.18	92.87	48.31	136.04	5.14	95.21	45.98
Total	1,046.94	448.15	598.79	1,013.69	33.25	775.46	271.48

*Indicates partial year from August 31, 1998. **Indicates partial year up to September 30, 2013. Source: This table shows summary statistics of the trade execution database used in Exhibit 8. See Frazzini, Israel, and Moskowitz (2012) for more detail. The data through 2013 is an extension of data from 2011 using the same methodology as detailed in this paper. For illustrative purposes only.

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