When equity factors drop their shorts

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Abstract

This paper makes a breakdown of common equity factor strategies into their long and short legs, and finds that (i) most added value tends to come from the long legs, (ii) the long legs of factors offer more diversification than the short legs, and (iii) the performance of the shorts is generally subsumed by the longs. These results hold across large and small caps, are robust over time, carry over to international equity markets, and cannot be attributed to differences in tail risk. Moreover, we do not even account for the substantially higher implementation costs involved with the shorts compared to the longs. We also challenge recent claims that the value and low-risk factors are subsumed by the new Fama-French factors, as we find that this result is entirely driven by the short legs of these factors and breaks down for the longs. Altogether, our findings show that decomposing factors into their long and short dimensions is crucial for understanding factor premiums and building efficient factor portfolios.

Keywords: asset pricing, factor premiums, factor investing, short selling, limits to arbitrage, low volatility, value, momentum, profitability, investment, quality.

JEL Classification: G11, G12, G14

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1. Introduction

In this paper we examine the long and short sides of equity factor premiums, and show that the added value of common factors is generally concentrated in the longs. There is abundant evidence for the existence of various factor premiums in the equity market, such as the value, momentum, and low-risk premiums; see, for example, Fama and French (1992, 1993, 2006, 2008, 2012, 2015, 2016), Jegadeesh and Titman (1993, 2001), Asness, Moskowitz, and Pedersen (2013), and Blitz and van Vliet (2007), Frazzini and Pedersen (2014). Standard academic factor portfolios take hypothetical long positions in stocks with attractive characteristics, combined with short positions in stocks with unattractive characteristics. As such, factor premiums can be disentangled into a long-leg premium and a short-leg premium. For example, the Fama and French (1993) value factor (HML) assumes a long position in large value and small value stocks, combined with a short position in large growth and small growth stocks, as illustrated in Figure 1. In this way, the portfolio captures not only the outperformance of value stocks, but also the underperformance of growth stocks. The Fama-French momentum (WML), profitability (RMW), and investment (CMA) factors are constructed using the same approach, which ensures that factors are (more or less) orthogonal to the broad equity market and to the performance of small versus large stocks.

INSERT FIGURE 1 HERE

The long-short approach assumes that both legs contain information that is relevant for investor portfolios and for understanding asset prices. However, long and short legs contain different stocks and may be subject to different dynamics and asset pricing implications. In fact, several studies suggest that the importance of long and short legs differs and that their relation is not symmetric; see, for example, Jegadeesh and Titman (1993), Ang et al. (2006), and Fama and French (2018). Furthermore, Chu, Hirshleifer, and Ma (2017) show that short-sale constraints have an asymmetric effect on the two legs of equity factor premiums.

In practice, shorting individual stocks is not without frictions. One consideration is that short positions involve additional costs, in particular borrowing fees. Investors also face various implementation hurdles, since many stocks can only be sold short to a limited extent, other stocks cannot be shorted at all, and existing short positions may unexpectedly be recalled; see, for example, D'Avolio (2002), and Geczy, Musto, and Reed (2002). Short selling also brings along additional risks, such as (a) the potential for unlimited losses, (b) "short squeeze" scenarios in which investors are unable to close their short positions, (c) counterparty risk, and (d) reputational risk, as the media can take a critical stance towards short sellers. Finally, there can be legal impediments. For instance, many countries either have a partial or full ban on short selling.

In light of these theoretical and practical considerations, we argue that it is important to examine the long and short dimensions of factor premiums separately, for a proper understanding of factor premiums and building efficient factor portfolios. The issues involved with shorting individual stocks can be solved effectively by hedging the market beta of a long-only factor portfolio with (liquid derivatives on) broad market indices. With this approach one captures the performance of the long legs of factor premiums. The performance of the short legs can be isolated in a similar fashion, i.e. by considering the short portfolio in combination with an offsetting long position in broad market indices that brings the market beta to zero. How both legs contribute to factor premiums depends on the relative

contribution of each leg to total performance, and also on the correlation between the two legs. To our best knowledge, this analysis has not been documented in the empirical asset pricing literature yet.

Breaking down commonly studied equity factor premiums over the 1963-2018 period, we find that the long-minus-market approach has typically been more powerful than the full-fledged long-short approach for individual factors, and even more so for a multi-factor combination. This key result is summarized in the first three bars in Figure 2, which shows that Sharpe ratios have been highest for the long legs of factors, and lowest for the short legs. We find that individual factors have close to zero correlation on their long sides, while being positively correlated on their short sides. The better diversification on the long side is a key driver of the higher risk-adjusted returns when factors are combined. Moreover, we find that the short legs of factors typically have zero to negative alpha after controlling for their long legs. By contrast, long legs generally have a significantly positive alpha that cannot be explained by the shorts. In other words, factor premiums generally originate on the long side, and the short legs of factor premiums are subsumed by their long-leg counterparts.

INSERT FIGURE 2 HERE

Figure 2 confirms the result of, amongst others, Fama and French (1992, 1993, 2006, 2008, 2012, 2015, 2017) and Israel and Moskowitz (2013), that factor premiums tend to be larger in the small-cap space than in the large-cap space. The Fama-French 2x3 methodology gives fifty percent weight to both, which helps to boost the magnitude of their factor premiums. We find that the long side of factor strategies exhibits stronger performance and subsumes the shorts both in the large-cap space and in the small-cap space. Moreover, starting from the long side of factors in the large-cap space, a bigger gain can be made by adding the long side in the small-cap space than by adding the short side in the large-cap space.

From a theoretical perspective these results imply that it is important to understand the long and short sides of factor premiums separately. The practical investment implication is that since there is no unique alpha in the short legs, an efficient approach to factor investing is to simply concentrate on the longs and hedge out the market beta with liquid market index derivatives. We note that the above findings are without considering shorting costs and the feasibility of shorting, and that incorporating such information would most probably lead to even stronger conclusions (as shorting costs tend to be substantial and shorting is difficult for smaller stocks). We show that these results are robust over time and generally also present internationally across different regions and for global versions of the factor strategies. In another robustness test we show that our results cannot be explained by tail risk, because, if anything, accounting for tail risk in various ways only strengthens our conclusions. We do acknowledge that our analysis is limited to the standard academic factors, and do not necessarily carry over to the hundreds of other factors that have been proposed in the asset pricing literature. Such an extensive approach is beyond the scope of our study however.

Finally, our breakdown of factor strategies into their long and short legs also allows us to provide a fresh perspective on the value and low-risk premiums. The low-risk premium, documented in studies such as Blitz and van Vliet (2007), Baker, Bradley and Wurgler (2011) and Frazzini and Pedersen (2014), is the finding that low-risk stocks earn high risk-adjusted returns, while high-risk stocks earn low risk-adjusted returns. This results in a significant alpha which is not explained by classic factors such as the market, size, value, and momentum.

However, Novy-Marx (2014) argues that the low-risk premium is explained by the profitability factor introduced in Novy-Marx (2013). Similarly, Fama and French (2016) find that the low-risk anomaly is subsumed by their recently introduced profitability and investment factors. Fama and French (2015) show that also their classic value factor based on book-to-market (HML) is rendered redundant by these two new factors. However, neither study makes a distinction between the long legs and the short legs of the low-risk and value factors.

Breaking down factor portfolios into their long and short legs, we find that the conclusions of Novy-Marx (2014) and Fama and French (2015, 2016) regarding the low-risk and value factors are entirely driven by the short sides of these strategies. The short sides of low-risk and value are indeed subsumed by the other factors, in particular (low) profitability and (high) investment. In other words, the poor performance of high-risk and growth stocks can be explained by their 'junk' resemblance. However, the performance of the long sides of low-risk and value cannot be explained by the long sides of other factors, including (high) profitability and (low) investment. This asymmetric result implies that low risk and value are distinct factors on the long side, and that the long-short results for these factors are dominated by their different behavior on the short side.

2. Data and methodology

Most of our data is sourced from the online data library of professor Kenneth French, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. In particular, we obtain monthly returns for the 2x3 portfolios behind the value (HML), momentum (WML), profitability (RMW), and investment (CMA) factors for the US market over the period July 1963 until December 2018. We do not include the size (SMB) factor in our analyses, as it is already constructed in a long-minus-market fashion. We augment the Fama-French factors with a low/high volatility (VOL) factor, which is closely related to the Betting-Against-Beta (BAB) factor of Frazzini and Pedersen (2014). The main difference is that the VOL factor stays close to the Fama-French factor construction methodology, which prevents the issues identified by Novy-Marx and Velikov (2018), who find that a large part of the BAB premium stems from dynamic hedging and shorting highly illiquid micro caps. We note that our preference for volatility over beta has no material impact on our conclusions in this study.

The VOL factor is based on 2x3 portfolio sorts similar to the other long-short Fama-French equity factors. Every month, all stocks in the CRSP database are classified as either large or small, using the NYSE median market capitalization as breakpoint. Next stocks are sorted on their past 36-month volatility within both of these size groups and assigned to low-, mid-, and high-risk portfolios using the NYSE 30th and 70th percentiles as breakpoints. All portfolios are value-weighted. Each leg is levered up or down to a market beta of 1 in order to make the VOL factor market neutral. For simplicity, market betas are estimated full-sample against the Fama-French market portfolio, but we note that the results do not change if a rolling-window estimate method is used instead. The 30-day T-bill rate is taken as borrowing and savings rate. This beta-adjustment is the only departure from the standard Fama-French factor construction methodology. The VOL factor is created by taking a fifty-fifty long position in large-cap low-volatility and small-cap low-volatility stocks, combined with a fifty-fifty short position in

large-cap high-volatility and small-cap high-volatility stocks. Data for this VOL factor is taken from http://www.robeco.com/data.

Based on the underlying 2x3 portfolios we can break down all long-short factors in two ways. One breakdown is into the large-cap and small-cap components. Taking value as an example, the full-fledged long-short value strategy is the Fama-French HML portfolio, which is long 50% large-cap value and 50% small-cap value, and short 50% large-cap growth and 50% small-cap growth. The large-cap component is the long large-cap value and short large-cap growth portfolio, and the small-cap component is the long small-cap value and short small-cap growth portfolio. Note that if we take a fifty-fifty average of these large-cap and small-cap components we get back the original HML factor.

Another breakdown of the standard long-short factors is into their long and short legs, where, again, we strive for consistency with the Fama-French methodology. Taking value as an example again, we construct the long-minus-market leg by going long the H component of the HML portfolio, i.e. 50% large-cap value and 50% small-cap value, and short 50% large-caps and 50% small-caps. For the market-minus-short leg we go long 50% large-caps and 50% small-caps, and short the L component of the HML portfolio, i.e. 50% large-cap growth and 50% small-cap growth. Note that with the long and short legs defined in this way we get back the original HML factor when taking the sum of the two legs. We use the same approach for the other factors. This is visually illustrated in Figure 1, where the top arrows represent the long leg and the bottom arrows the short leg.

The large-cap and small-cap portfolios used to construct the long and short legs are the large-cap (B) and small-cap (S) components of the Fama and French (2015) SMB factor. Their large-cap and small-cap portfolios are derived from the 2x3 size-value, 2x3 size-profitability, and 2x3 size-investment sorted portfolios, with the large-cap portfolio being the simple average of the 9 large stock portfolios and the small-cap portfolio being the simple average of the 9 small stock portfolios. By defining the market as 50% large-cap (B) plus 50% small-cap (S), instead of simply taking the actual capitalization-weighted market portfolio, we ensure that the long-minus-market and market-minus-short portfolios are size neutral. Although we have confirmed that this choice does not drive our results, we believe it is important to account for a potential size bias, as size is a factor affecting stock return variability. In order to obtain pure value exposure, the large-cap value portfolio should be hedged with a broad large-cap portfolio, and the small-cap value portfolio should be hedged with a broad small-cap portfolio. Note that, in practice highly liquid and cost-efficient derivatives such as S&P 500 index futures and Russell 2000 index futures can be used to this end.

3. The long and short side of factor premiums

Panel A of Table 1 shows the performance of the long-legs of the five factors based on the standard Fama-French methodology. The individual Sharpe ratios range from 0.40 to 0.61. For an equally weighted portfolio of the five long legs the Sharpe ratio increases to 1.10 due to diversification effects. In Panel B of Table 1 the short legs of the five factors are shown. For three out of the five factors (value, momentum, and investment) the long legs have a higher Sharpe ratio than the short legs. For the two other factors (profitability and low-risk) the short side appears to be a bit stronger. The individual Sharpe ratios vary between 0.37 and 0.54. When all five factors are combined, however, the long side clearly emerges as the winner,

with a Sharpe ratio of 1.10, versus only 0.69 for the short legs. This indicates that the long legs diversify each other better than the short legs. Panel C shows the combination of the long and short legs, i.e. the standard long-short factors. The results are in between, with Sharpe ratios for the individual factors varying between 0.40 and 0.58, and a combined Sharpe ratio of 0.86.

INSERT TABLE 1 HERE

Table 2 provides further insight into factor diversification on the long side versus the short side, by reporting for each factor its average correlation with the other factors. For example, value stocks (long leg of HML) have an average correlation of 0.04 with the other long factor legs. By contrast, growth stocks (short leg of HML) have an average correlation of 0.38 with the other short legs. In other words, growth stocks co-move with risky-unprofitable-loser stocks, while value stocks are virtually uncorrelated with stable-profitable-winner stocks. The average correlation among all long legs is a negative -0.04, while the corresponding number for the short legs amounts to a positive 0.31. Thus, the diversification benefits of factors are asymmetric, being much stronger on the long side than on the short side.

INSERT TABLE 2 HERE

Although the 0.35 difference in correlation between long legs and short legs might not seem that large, it compounds to sizable risk-adjusted return differences when multiple factors are combined. Figure 3 shows that the average Sharpe ratio for single factors is about 0.5, both on the long side and on the short side. However, when three factors are combined this goes up to 0.8 on average for the long-legs, versus only 0.6 for the short legs. This number increases further to 1.1 when all five long-leg factors are combined, while the resulting number for the short legs stays below 0.7.

INSERT FIGURE 3 HERE

The results so far indicate that factors are better rewarded on the long side than on the short side, driven by lower correlations between the long legs of factors. However, it might still be that investors leave some performance on the table by ignoring the short-leg portfolio altogether. In order to address this concern, we directly examine the added value of factors on the long and short sides. We start by examining the correlations between the long and short legs, as shown in the top row of Table 3. Correlations are generally high, ranging between 0.59 and 0.85 for individual factors. This number increases to 0.87 for the multi factor combination, which also explains why the volatilities of the long-leg portfolio (2.2%) and short-leg portfolio (3.7%) almost fully add up to the volatility of the long-short portfolio (5.7%) in Table 1. These numbers show that long and short legs offer closely related factor exposures, especially when multiple factors are combined.

This raises the question what the long and short legs contribute when controlling for the 'other' leg? To this end, we separately regress each individual factor leg on the flip-side legs of all the factors. The t-value of the resulting alphas closely relates to a test on the best factor model, as outlined in Fama and French (2018). The results are shown in the first columns of Table 3. The alpha of the long leg of each factor is positive and mostly significant at the 5% level. By contrast, the alpha of the short leg is zero to significantly negative. In other words, short leg factor exposures do not add significant value when controlling for the long legs.

We further examine the robustness of this conclusion by constructing the maximum Sharpe ratio portfolio based on the 2x5 factor legs. The weights are required to be non-negative and

to sum to 100%. The lower part of Table 3 shows that the optimal portfolio with the highest return per unit of risk contains positions in each of the five long legs. Weights vary between 11.0% and 31.0%, while only 2.6% would be invested in a single short leg (high volatility). This finding provides additional confirmation that virtually none of the short sides of factors is able to offer any value on top of the performance that can be obtained with investing in just the long side of factors.

Finally, we consider the multi factor portfolio and regress its long leg on its short leg, and vice versa. As expected, we find that the alpha of the long-leg portfolio, i.e. the performance that remains after adjusting for the exposures to the short-leg portfolio, is positive (1.09%), and statistically significant (t-stat 7.44). By contrast, the short-leg portfolio has a statistically significantly negative alpha of -1.00% (t-stat -3.89). The explanation for this result is that the short legs have a weaker performance than the long legs, and, on top of that, barely provide any diversification to the long legs. All these tests show that the long-leg portfolio is superior to the short-leg portfolio, and that nothing essential is lost by ignoring the short side of factors altogether. In sum, short legs offer no value add once controlling for the long legs, as the factor exposure of short legs is fully subsumed by the long legs.

INSERT TABLE 3 HERE

4. Factor premiums in large and small caps

Several studies show that factor premiums tend to be larger in smaller cap stocks; see, amongst others, Fama and French (1992, 1993, 2006, 2008, 2012, 2015), and Israel and Moskowitz (2013). Consequently, size is an important dimension in factor premiums. This is addressed in the standard academic factors, such as HML, by averaging over a large-cap and a small-cap leg in order to mitigate potential size effects. This means that standard factors can not only be broken down into long and short legs, but also consist of a large-cap and a small-cap component. In this section we examine these large-cap and small-cap parts of factors separately.

Table 4 contains the results. Consistent with the literature we find that Sharpe ratios are generally higher among small-caps than among large-caps. In other words, the value, momentum, profitability, investment, and low-risk factors are more powerful in the small-cap space than in the large-cap space. On average, the difference in Sharpe ratios is approximately a factor 2. For instance, the equally-weighted portfolio of the five factors has a Sharpe ratio of 1.08 in the small-cap space versus just 0.53 in the large-cap space. The long legs of the five factors have a higher combined Sharpe ratio than the short legs for both large caps and small caps. For large caps the Sharpe ratio is 0.72 versus 0.36 and for small caps this is 1.13 versus 0.94. For all caps the Sharpe ratios are 1.10 and 0.69 as already shown in Table 1 and Figure 3. Again, the correlations of the long legs are lower than the correlation of the short legs.

INSERT TABLE 4 HERE

These results imply that theoretical factor strategies obtain a major part of their performance in the small-cap segment of the market. It is questionable, however, if these returns are attainable in practice, in particular because shorting stocks in the small-cap space can be expensive, and difficult or even impossible to implement on a large scale. Regressing the long factor legs on the short factor legs we again find a significantly positive alpha for the long legs.

In order to examine whether the small-cap short legs perhaps still contain some unique alpha we again optimize for the maximum Sharpe ratio portfolio. We find that 100% is allocated to the long legs, divided between 21% for large caps and 79% for small caps. In other words, adding large-cap long legs adds more to factor premiums than small-cap short-legs. This is quite a remarkable finding in a theoretical setup without any frictions or costs, both of which are generally high for short legs in general and for small cap shorting in particular. Note that the long-leg portfolios involve lower implementation frictions, since shorting market indices is generally cheaper and more scalable than shorting individual small-cap stocks.

5. Subperiods, risk analysis, and international results

All analyses so far were based on the US stock market over the full 1963-2018 period. In this section we analyze if our results are robust across subsamples, to using asymmetric risk measures, and on international data. First, we conduct a decade-by-decade analysis. Figure 4, Panel A shows the Sharpe ratio of the combined five long-legs and the combined five short-legs for six sub-periods. In each of the six sub-samples the long legs have higher Sharpe ratios than the short legs. The differences vary, being smaller in the 1970s and 2000s and bigger in the 1960s and 2010s, but without any clear trend over time. Panel B of Figure 4 shows the t-statistic of the alpha of the long (short) portfolio regressed on the short (long) portfolio. Confirming our full-sample results, the added value of the long leg is consistently positive and significant, while the shorts consistently do not add alpha over the long legs.

INSERT FIGURE 4 HERE

A potential explanation of the results so far might be that risks are asymmetric (see for example Bawa and Lindenberg, 1977) and that the long legs are perhaps less attractive than the short legs from a tail risk perspective. Figure 5 depicts tail risk, measured in terms of cumulative drawdowns, of the long and short legs over time. The long legs exhibit a consistently lower drawdown risk compared to the short legs. The short legs are often twice as risky as the long legs, and experience significantly deeper drawdowns. Factor performance was generally weak during the dotcom bubble of the late 1990s, but the losses on the shorts (risky, unprofitable, growth stocks) exceeded the losses on the longs (stable, profitable, value stocks). Also in the aftermath of the Global Financial Crisis (GFC) most factors underperformed, and momentum in particular. But again, the losses of the shorts (risky, unprofitable, losers) were up to three times larger than the losses of the longs (stable, profitable, winners) during 2009. In other words, when factors fail, the shorts tend to be hit harder.

INSERT FIGURE 5 HERE

Table 5 further reports various non-symmetric risk statistics for the multi-factor combination of the long and short legs, providing additional confirmation of this result. The shorts exhibit a more negative skewness and a higher excess kurtosis than the longs. They also have a higher semi-deviation (2.4% versus 1.3%) and a much higher 95%VaR. Some of this downside risk is idiosyncratic, but also the systematic contribution to downside risk is higher for shorts, witness the higher tail betas. In sum, a downside risk perspective only strengthens our conclusion that the long side of factors dominates the short side.

INSERT TABLE 5 HERE

Several papers document the existence of factor premiums in international samples; e.g. Fama and French (1998, 2012, 2017), and Asness, Moskowitz, and Pedersen (2013). To examine the robustness of our findings we consider the international evidence. We follow the same testing approach as before, now applied to the international 2x3 portfolios from the Kenneth French data library and again a self-constructed volatility factor. We consider four regions (North America, Europe, Japan, Asia ex Japan), akin to Fama and French (2012), as well as a global portfolio. We use the maximum available sample period, which is from July 1990 to December 2018. Table 6 shows the results. Consistent with our findings for the US, we find that for North America, Europe, Asia Pacific ex Japan, and Global the long legs tend to have higher Sharpe ratios than the short legs. Only for Japan, the shorts legs appear to be slightly better. If we focus on the global sample, the long legs have a Sharpe ratio of 1.19 versus 0.66 for the short legs. For this sample the correlation between the long and short legs is 0.80, indicating very similar exposures, and limited diversification between longs and short legs. Further, long legs consistently add value over the short legs, while the reverse does not hold true. For example, the alpha of the global long legs is significantly positive (1.56%, t-value = 5.75) and cannot be explained by the short legs, while the short alpha is significantly negative (-0.89%, t-value = -2.37), again in line with the results for the US.

INSERT TABLE 6 HERE

The global results are also consistent over time. Figure 6, Panel A shows that in each of three sub-periods (i.e. decades) in our sample the longs have higher Sharpe ratios than the shorts. Similarly, Figure 6, Panel B shows the longs add consistent alpha over the shorts during each decade in the international sample, while shorts consistently do not add alpha over the long legs. As for the US, we note that these results are before transaction or shorting costs. Since shorting individual stocks in international markets tends to be more expensive than shorting stocks in the US, these results would be even stronger on an after-cost basis. To summarize, across time and markets, long legs of factor consistently dominate short legs, and short legs are subsumed by exposures to the long legs.

INSERT FIGURE 6 HERE

6. Growth is junk, but value is not quality

Recently, Fama and French (2015) find that their classic value factor (HML) is rendered redundant by the two new quality factors in their 5-factor model, profitability (RMW) and investment (CMA). We reevaluate this result in light of the findings above that factor premiums predominantly originate in the long side. In fact, correlations of HML with the other factors are materially lower in the long legs (0.04) than in the short legs (0.38) or the long-short combination (0.26; see Table 2). Panel A in Table 7 shows that the HML factor has a highly significant CAPM-alpha over the 1963-2018 period. The multi-factor regressions show that this alpha of 4.91% indeed falls to an insignificant -0.13% when controlling for the loadings of HML on the other four factors that nowadays comprise the Fama-French 5-factor model. The biggest hit comes from a very high loading on the CMA factor, which has a coefficient of almost 1 and an associated t-statistic of over 20. This finding is robust to adding WML and VOL as additional control factors to the Fama-French model.

INSERT TABLE 7 HERE

Our breakdown of factors into their long and short sides enables us to provide a fresh perspective on the HML factor. Panel B of Table 7 shows that the alpha of the long leg of HML remains strong (+1.98%) and highly significant when controlling for the long legs of all other Fama-French factors. One reason for this is that the loading on the CMA factor becomes much lower, and another reason is that the loading on RMW goes from positive to negative. Panel C shows the results for the short leg, or 'growth' part of HML. For this short leg, the alpha vanishes completely (-0.22%) after adjusting for exposures to the short side of other factors. Especially the exposure to the short leg of CMA (Aggressive) is very significant, with a t-statistic of over 30. Again, this result is robust to including the WML and VOL factors additionally in the analysis, as shown in the 7-factor analyses in Table 7.

In other words, the poor performance of growth stocks can be fully explained by the 'junk' resemblance of these stocks, but the strong performance of value stocks cannot be attributed to a 'quality' resemblance of these stocks. Thus value is not the simple inverse of growth. Altogether we find that the finding of Fama and French (2015) is entirely driven by the short leg of HML, and that their conclusions do not hold for the long leg of HML. The long side of value holds its ground as a distinct factor that is not subsumed by the long sides of other factors.

In order to examine the robustness of our findings we repeat all tests over the July 1963 to December 1990 and January 1991 to December 2018 subperiods. The first subperiod is the exact same period that was used in the seminal Fama and French [1992] study. Panel D of Table 7 shows the corresponding alphas and t-statistics. Full-sample we found that although the standard value premium is explained by the new Fama-French factors, the long side of the value premium is not explained by the long sides of the other factors. Over the first subperiod, however, the standard value premium already remains significant after controlling for the other Fama-French factors. This is fully driven by the long leg again, as the short leg is subsumed by the short legs of the other factors. Over the second subperiod the raw value premium is not even significant. The long side again appears to be stronger than the short side, but both are not significantly different from zero during this period. These results imply that if the value premium manifests itself, then the unique alpha is coming from the long side, while if the value premium does not materialize there is also not much left to salvage.

7. High-risk is junk, but low-risk is not quality

Novy-Marx (2014) finds that the low-risk anomaly is subsumed by the profitability factor of Novy-Marx (2013). In a similar spirit, Fama and French (2016) find that the low-risk anomaly is explained by their 5-factor model that includes profitability and investment factors. By contrast, Blitz and Vidojevic (2017) find that the low-risk anomaly is not explained by the current Fama-French factors in cross-sectional (Fama-MacBeth) regressions. Similar to our analysis for value, we reevaluate the VOL factor premium using a long leg and short leg decomposition of factors, as Table 2 revealed that correlations of VOL with other factors are again materially lower in the long legs than in the short leg or long-short combination. Table 8 contains the results for the 1963-2018 period. Panel A of Table 8 shows that the highly significant CAPM-alpha of the long-short volatility factor is reduced to 0.58% when controlling for exposures to the current five Fama-French factors, in particular due to highly significant loadings on the RMW profitability, CMA investment, and HML value factors.

However, as for HML, a different picture emerges when we break down the VOL factor into its long and short legs and analyze low risk and high risk separately.

INSERT TABLE 8 HERE

Panels B and C of Table 8 show that low risk and high risk each have a highly significant CAPM-alpha, with t-statistics above 3. Panel B shows that although the alpha of the long leg of the volatility factor becomes somewhat smaller when controlling for the long legs of the other Fama-French factors, it remains highly significant. One reason for this is that the loading on the long leg of the CMA factor (Conservative) becomes small and insignificant, and another reason is that the loading on RMW hurts less because the RMW premium is rather small on the long side (1.0%, Table 1). For the short leg of the volatility factor, however, the alpha vanishes completely and even turns negative after adjusting for exposures to the short side of other factors, as shown in Panel C. The high volatility portfolio loads heavily on the short legs of the RMW, CMA and WML factors. In other words, the poor performance of high-risk stocks can be fully explained by the 'junk' resemblance of these stocks, but the strong performance of low-risk stocks cannot be attributed to 'quality' features of these stocks. We note that these results also hold when WML is dropped from the regression.

This analysis implies that the findings of Novy-Marx (2014) and Fama and French (2016) are driven by the short legs of the strategies, and that their conclusions do not hold for the long legs. Novy-Marx (2014) observes that the high-risk portfolio is strongly tilted towards small, unprofitable, and growth firms, and our results confirm this finding. However, the long-short results are fully driven by this relation on just the short side of the factor. The long-leg results show a completely different picture. Put differently, the high-risk anomaly may not be a distinct phenomenon, but the time-series regression evidence indicates that the low-risk anomaly is.

In order to examine the robustness of our findings we repeat all tests over the July 1963 to December 1990 and January 1991 to December 2018 subperiods. Panel D of Table 8 shows the corresponding alphas and t-statistics. The results for the low-risk factor are very robust over the two subsamples. In the first subsample the standard low-risk factor is not even explained by the Fama-French factors, with the unique alpha again coming from the long side. In the second subperiod the standard factor is explained, but the long side remains unexplained. Thus, the long side of the low-risk factor offers a consistent unique alpha.

7. Conclusion

Factor portfolios are typically constructed by combining a long leg and a short leg, assuming that the two legs are complimentary drivers of factor premiums. We critically examine this assumption for equity factor portfolios. By decomposing portfolios of the common factors into their long and short legs we find that factor premiums typically reside in the long legs. The short legs generally do not add any value to the longs, as they are weaker and offer less diversification benefits. These results hold across large and small caps, with long legs in the large-cap space and small-cap space providing most contribution to factor premiums. We also show that these results are robust over time, cannot be attributed to differences in tail risks, and also hold internationally across different regions. In sum, factor premiums tend to be most attractive on the long side, and no essential information is lost by dropping the short legs.

These findings suggest that the long legs are crucial for understanding factor premiums, as the short legs offer essentially the same exposure but with lower rewards. The practical implication of this is that investors can capture the premiums offered by common factors efficiently by focusing on the long legs of factors and using highly liquid market index futures to hedge out the market exposure. We note that the above findings are without considering shorting costs and the feasibility of shorting, and that accounting for such practical considerations would most likely only strengthen our conclusions further (shorting costs tend to be substantial and shorting is difficult outside larger cap stocks).

Our analysis focuses on the standard 'Fama-French' style factors. Although these are widely considered to be the most important drivers of stock returns, we are aware that hundreds of alternative factors have been documented, and that it is well possible that some of these do obtain most of their performance on the short side. Future research could examine whether efficient short stock portfolios can be constructed that offer value add over the long legs of the factors that we study, as well as the long legs of other market anomalies.

Our approach also sheds a new light on previous findings regarding the value and low-risk factor premiums, as their correlation structure is materially different on the long and short sides. Some recent studies argue that these factors are subsumed by the new Fama-French factors, profitability and investment, but we show that these results are entirely driven by the short legs of these factors. The long legs of both value and low-risk offer distinct premiums, which cannot be explained by the long legs of other factors.

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Table 1: Breakdown of factor premiums

This table shows the annualized return and volatility statistics for the value (HML), momentum (WML), profitability (RMW), investment (CMA) and volatility (VOL) factors and an equal weighted combination (All) over the period July 1963 – December 2018. All factors are market neutral. Panel A and B contain the long and short leg of the 5 equity factors. Each leg is an equal 50/50 combination of the large and small leg, minus the market (50/50 large/small portfolios), to neutralize market and size tilts. Panel C is the sum of Panel A and B and the classical way of presenting long-short factors.

Panel A: Long leg of factors

	long-minus-market					
	HML	WML	RMW	CMA	VOL	All
Return (%)	2.1%	3.6%	1.0%	1.6%	3.7%	2.4%
Volatility (%)	5.3%	5.9%	3.3%	3.2%	6.9%	2.2%
Sharpe ratio	0.40	0.61	0.31	0.49	0.53	1.10

Panel B: Short leg of factors

	market-minus-short					
	HML	WML	RMW	CMA	VOL	All
Return (%)	1.8%	4.4%	2.1%	1.8%	2.7%	2.5%
Volatility (%)	4.8%	9.5%	4.8%	4.6%	4.9%	3.7%
Sharpe ratio	0.37	0.46	0.43	0.40	0.54	0.69

Panel C: Long-Short factors

	long-minus-short					
	HML	WML	RMW	CMA	VOL	All
Return (%)	3.9%	8.0%	3.1%	3.4%	6.3%	4.9%
Volatility (%)	9.7%	14.5%	7.5%	6.9%	11.0%	5.7%
Sharpe ratio	0.40	0.55	0.41	0.49	0.58	0.86

Table 2: Diversification benefits of factors

This table shows the average pairwise correlation for the value (HML), momentum (WML), profitability (RMW), investment (CMA), and volatility (VOL) factors and the average (All) for the long leg, short leg and long/short legs over the period July 1963 – December 2018.

Average correlation	HML	WML	RMW	CMA	VOL	All
Long leg	0.04	-0.16	-0.09	-0.05	0.08	-0.04
Short leg	0.38	0.12	0.32	0.42	0.34	0.31
Long/Short	0.26	-0.03	0.14	0.25	0.31	0.19

Table 3: Added value long- and short-legs

This table shows the added value of the long legs and short legs of the value (HML), momentum (WML), profitability (RMW), investment (CMA), and volatility (VOL) factors and the combined factor portfolio (All) over the period July 1963 – December 2018. Panel A shows the correlation and alphas of the long and short legs with accompanying standard t-values. For the individual factors we regress the long or short leg returns on the returns on the other factors of the opposite leg. For the combined factor portfolio we regress the returns on a leg on the other leg returns. Panel B shows the optimal % weights in each of the 2x5 legs in the maximum Sharpe ratio portfolio.

Panel A: Correlation and alphas	HML	WML	RMW	CMA	VOL	All
Corr. long with short legs	0.85	0.75	0.70	0.59	0.74	0.87
Alpha long leg over short legs	0.70%	2.70%	0.51%	1.19%	0.39%	1.09%
t-value	(1.82)	(6.44)	(2.21)	(3.83)	(0.76)	(7.44)
Alpha short leg over long legs	-0.57%	-3.07%	-0.70%	-0.94%	0.15%	-1.00%
t-value	(-1.86)	(-4.04)	(-2.07)	(-2.91)	(0.33)	(-3.89)

Panel B: Max Sharpe portfolio	HML	WML	RMW	CMA	VOL
Weight long leg	11.0%	23.7%	20.6%	31.0%	11.0%
Weight short leg	0.0%	0.0%	0.0%	0.0%	2.6%

Table 4: Small versus large caps

This table shows the risk and return statistics of the combined factor portfolio for large caps and small caps separately over the period July 1963 – December 2018. Panel A shows the Sharpe ratios for the long leg and short leg for large caps and small caps separately. Panel B shows the alphas, standard t-values and optimal % weights in the maximum Sharpe Ratio (SR) portfolio, as defined in Table 3.

Panel A: Sharpe ratios	Long leg	Short leg	Long-Short
Large caps	0.72	0.36	0.53
Small caps	1.13	0.94	1.08
All caps	1.10	0.69	0.86

Panel B: Alphas and weights	Long leg		Short leg	
	Large caps	Small caps	Large caps	Small caps
Alpha over other legs	0.83%	1.34%	-1.93%	0.51%
t-value	(3.78)	(5.62)	(-5.97)	(1.81)
Weight max. SR port.	21.1%	78.9%	0.0%	0.0%

Table 5: Downside risk perspectives

This table shows the risk and return characteristics of the long leg and short leg of the combined factor portfolio over the period July 1963 – December 2018. Panel A shows volatility and various downside risk characteristics. Tail betas are computed following the lower-partial-moments (LPM) beta, or 'tail beta', of Bawa and Lindenberg (1977). Panel B shows the return/risk statistics including measures which account for non-normal returns. The Adjusted Sharpe ratio corrects for the skewness and kurtosis (Pézier and White, 2008) and the Sortino ratio uses downside volatility as risk measure.

Panel A: Risk	Long leg	Short leg	Long-Short
Volatility	2.2%	3.7%	5.7%
Skewness	-0.1	-0.3	-0.2
Excess Kurtosis	7.0	10.1	8.9
Semi-deviation	1.3%	2.4%	3.5%
VaR (95%)	-2.7%	-4.9%	-7.3%
Max. drawdown	-10.5%	-15.5%	-24.2%
LPM beta (1 sigma)	-0.02	-0.07	-0.09
LPM beta (2 sigma)	-0.01	-0.04	-0.05

Panel B: Return/risk	Long leg	Short leg	Long-Short
Sharpe ratio	1.10	0.69	0.86
Adjusted Sharpe ratio	0.69	0.52	0.60
Sortino ratio	1.88	1.07	1.39
Return/VaR	0.90	0.52	0.68

Table 6: International results

This table shows the annualized Sharpe ratio and alpha statistics for the international combined factor portfolio over the period July 1990 – December 2018. The table includes results for North America, Europe, Japan, Asia Pacific and Global markets. All factors are market neutral. Panel A shows the Sharpe of the long leg, short leg and long-short portfolios. Panel B shows the alphas of the long leg and short leg per sample with accompanying standard t-values, as defined in Table 3.

Panel A: Sharpe ratio	N.America	Europe	Japan	Asia Pac.	Global
Long leg	0.88	1.19	0.33	1.10	1.19
Short leg	0.50	0.92	0.35	0.99	0.66
Long-Short	0.69	1.12	0.39	1.14	0.94

Panel B: Alphas	N.America	Europe	Japan	Asia Pac.	Global
Alpha long leg over short leg	1.44	1.21	0.39	1.28	1.56
t-value	(5.14)	(3.91)	(0.89)	(3.02)	(5.75)
Alpha short leg over long leg	-1.15	0.11	0.53	0.86	-0.89
t-value	(-3.34)	(0.28)	(1.12)	(1.76)	(-2.37)

Table 7: HML and long versus short legs

This table shows the CAPM and multi-factor model alphas of HML and its long and short legs for the period July 1963 – December 2018. Panel A shows the long/short results (HML), Panel B the long leg (H: Value) results, Panel C the short leg (L: Growth) results, and Panel D the robustness over the July 1963 – December 1990 and January 1991 – December 2018 subperiods. All panels show the alphas and betas with accompanying standard t-values.

Panel A: HML	Alpha	Mkt-Rf	SMB	RMW	CMA	WML	VOL
CAPM	4.91%	-0.16					
(t-value)	(3.87)	(-6.88)					
5-Factor	-0.13%	0.02	0.03	0.14	1.00		
(t-value)	(-0.13)	(1.00)	(1.08)	(3.50)	(23.66)		
7-Factor	0.66%	-0.07	0.11	-0.03	0.76	-0.11	0.28
(t-value)	(0.73)	(-3.42)	(4.08)	(-0.67)	(16.64)	(-6.63)	(8.99)

Panel B: Long (H)	Alpha	Mkt-Rf	SMB	Robust	Conserv.	Winner	Lowvol
CAPM	2.49%	-0.06					
(t-value)	(3.51)	(-4.52)					
5-Factor	1.98%	-0.05	0.00	-0.23	0.44		
(t-value)	(2.89)	(-3.64)	(-0.14)	(-3.60)	(6.39)		
7-Factor	1.21%	-0.04	0.10	-0.32	0.31	-0.16	0.35
(t-value)	(2.00)	(-3.78)	(5.65)	(-5.49	(5.19)	(-5.20)	(12.44)

Panel C: Short (L)	Alpha	Mkt-Rf	SMB	Weak	Agress.	Loser	Highvol
CAPM	2.41%	-0.10					
(t-value)	(3.98)	(-9.08)					
5-Factor	-0.22%	0.03	0.02	0.06	0.90		
(t-value)	(-0.59)	(3.80)	(1.54)	(2.26)	(34.25)		
7-Factor	0.11%	0.00	0.02	0.03	0.85	-0.06	0.09
(t-value)	(0.31)	(0.31)	(1.87)	(1.11)	(27.51)	(-5.39)	(2.93)

Panel D: Subperiods		1963-1990			1991-2018	
	HML	Long	Short	HML	Long	Short
CAPM alpha	6.12%	3.36%	2.76%	3.48%	1.44%	2.04%
(t-value)	(3.82)	(3.75)	(3.54)	(1.78)	(1.36)	(2.15)
5-Factor alpha	2.76%	3.24%	0.24%	-2.52%	0.60%	-0.84%
(t-value)	(2.31)	(4.43)	(0.47)	(-1.76)	(0.50)	(-1.56)
7-Factor alpha	1.80%	1.80%	0.48%	-1.20%	0.12%	-0.36%
(t-value)	(1.49)	(2.43)	(0.88)	(-0.91)	(0.11)	(-0.73)

Table 8: Volatility and long versus short legs

This table shows the CAPM and multi-factor model alphas of HML and its long and short legs for the period July 1963 – December 2018. Panel A shows the long/short results (HML), Panel B the long leg (low volatility) results, Panel C the short leg (high volatility) results, and Panel D the robustness over the July 1963 – December 1990 and January 1991 – December 2018 subperiods. All panels show the alphas and betas with accompanying standard t-values.

Panel A: VOL	Alpha	Mkt-Rf	SMB	HML	RMW	CMA	WML
CAPM	6.35%	0.00					
(t-value)	(4.26)	(0.00)					
7-Factor	0.58%	0.26	-0.28	0.40	0.60	0.40	0.03
(t-value)	(0.54)	(11.72)	(-9.14)	(8.99)	(13.95)	(6.36)	(1.22)
Panel B: Long (Lowvol)	Alpha	Mkt-Rf	SMB	High	Robust	Conserv.	Winner
CAPM	4.10%	-0.07					
(t-value)	(4.46)	(-4.05)					
7-Factor	3.12%	0.02	-0.24	0.54	0.53	0.07	-0.19
(t-value)	(4.16)	(1.30)	(-11.50)	(12.44)	(7.54)	(0.94)	(-5.08)
Panel C: Short (Highvol)	Alpha	Mkt-Rf	SMB	Low	Weak	Agress.	Loser
CAPM	2.24%	0.07					
(t-value)	(3.46)	(5.75)					
7-Factor	-0.82%	0.22	-0.05	0.14	0.40	0.42	0.11
(t-value)	(-1.87)	(21.71)	(-3.97)	(2.93)	(13.10)	(7.78)	(7.53)

Panel D: Subperiods		1963-1990			1991-2018	
	VOL	Long	Short	VOL	Long	Short
CAPM alpha	6.12%	3.48%	2.64%	7.20%	5.04%	2.16%
(t-value)	(3.76)	(3.26)	(3.92)	(2.96)	(3.43)	(1.98)
7-Factor alpha	4.20%	4.56%	0.96%	-0.48%	3.00%	-1.68%
(t-value)	(3.10)	(5.26)	(1.64)	(-0.30)	(2.61)	(-2.37)

Figure 1: Factor portfolios

This figure illustrates how the long legs and the short legs are constructed. The value portfolio, also referred to as 'High Minus Low', or HML, is used as an example. The long leg, "L" depicted in black, consists of two parts, the Big Value portfolio and the Small Value portfolio. The long leg of value invests 50%-50% in both portfolios and hedges out the average of the Big All and Small All portfolios. The short leg, "S" depicted in grey, mirrors the long leg.

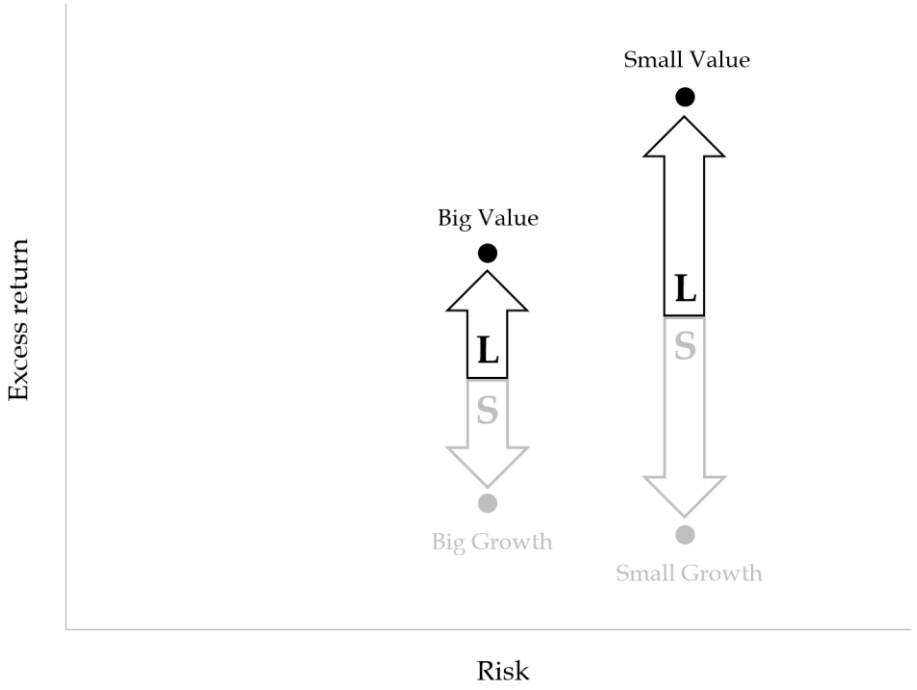


Figure 2: The long and short of equity factors

This figure summarizes the Sharpe ratios of the long leg ('Long'), long/short ('L/S'), and short leg ('Short') of the equal-weighted combination of HML, WML, RMW, CMA and VOL factor portfolios for the sample period July 1963 – December 2018. The sample is further split into Large and Small cap stocks, following the standard Fama-French definition.

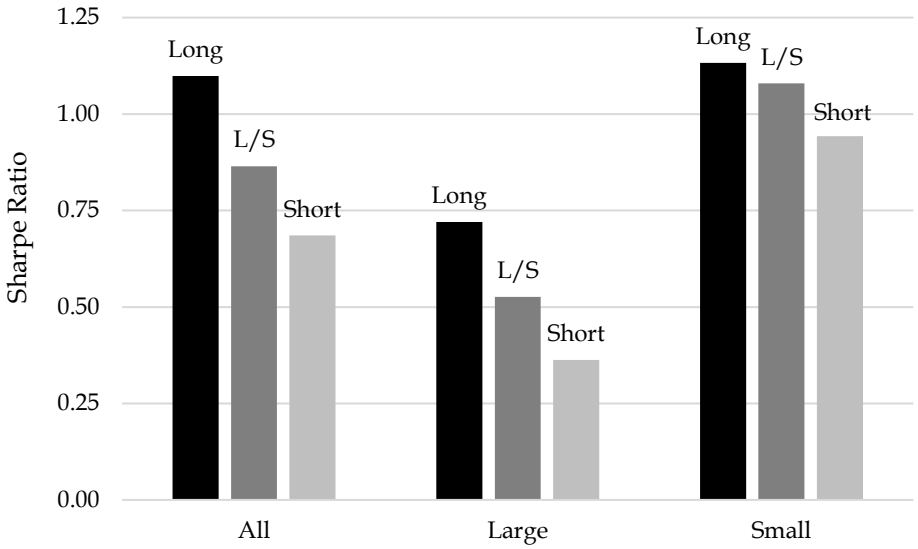


Figure 3: Diversification benefit of equity factors

This figure shows the Sharpe ratio of factor portfolios when increasing the number of factors. Shown are the Sharpe ratio of the average portfolio over all possible single or multi-factor portfolios for 1-2-3-4-5 factor combinations. The long leg ('Long'), long/short ('L/S'), and short leg ('Short') results are depicted for the sample period July 1963 – December 2018.

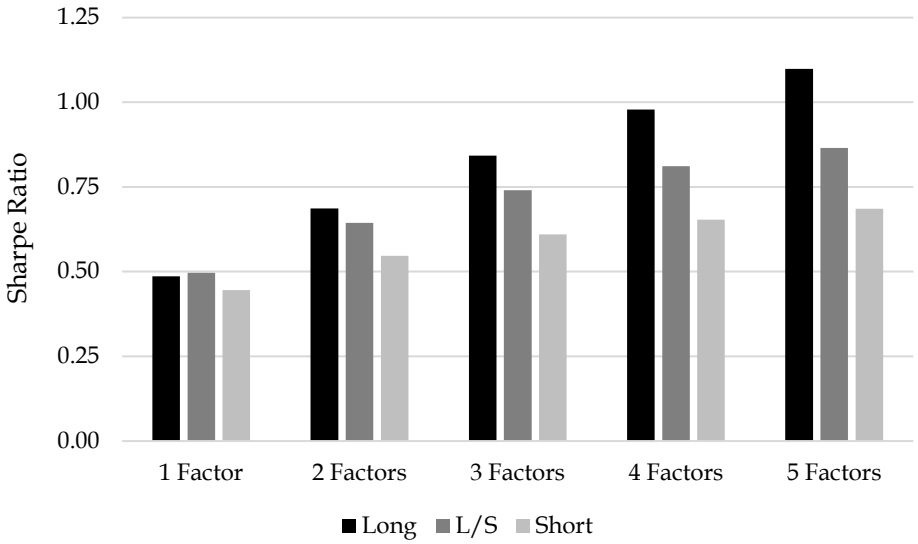
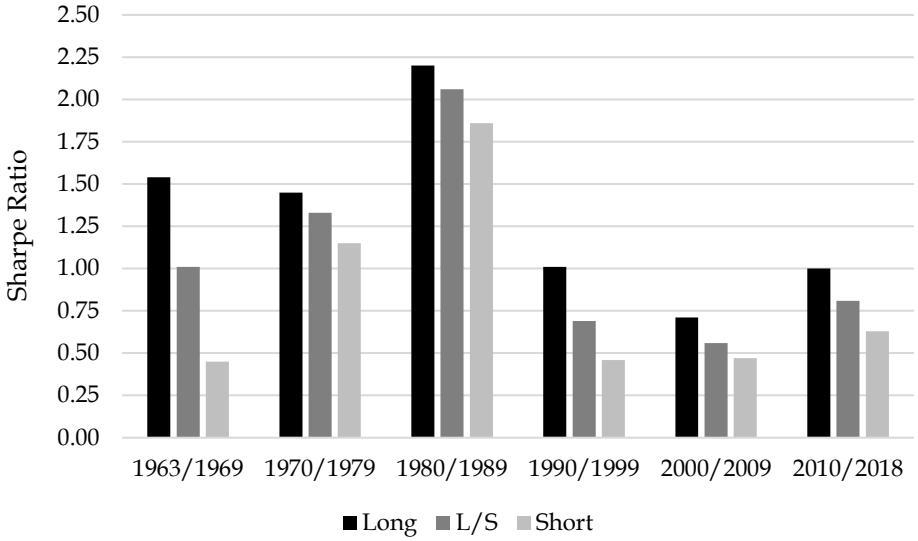


Figure 4: Subperiod results

This figure shows the Sharpe ratio (Panel A) and t-value of the spanning alpha (Panel B) of the combined factor portfolio for the long leg ('Long'), long/short ('L/S'), and short leg ('Short') portfolios over the decades in our sample of US stocks (July 1963 – December 2018).

Panel A: Sharpe ratios



Panel B: Spanning alphas

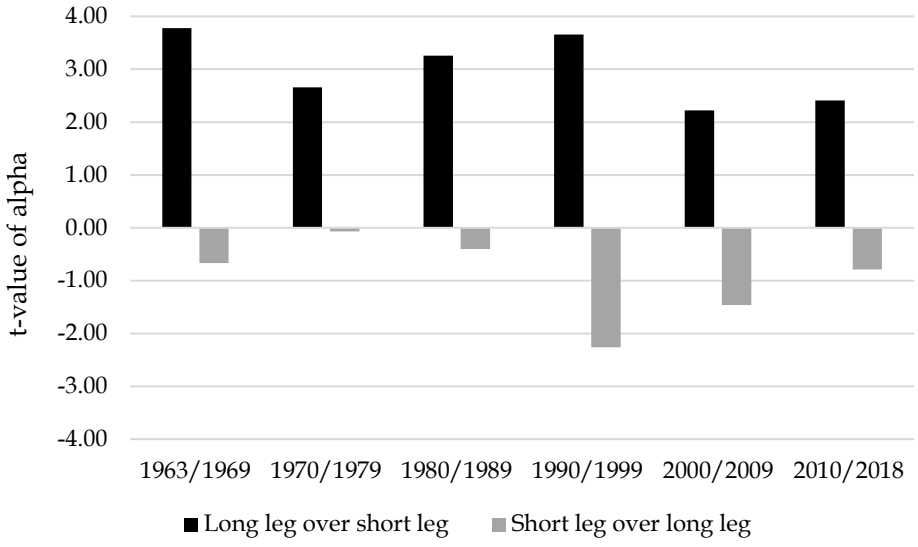


Figure 5: Drawdowns of factor portfolios

This figure shows the cumulative drawdowns of the long leg and short leg of the combined factor portfolio through time.

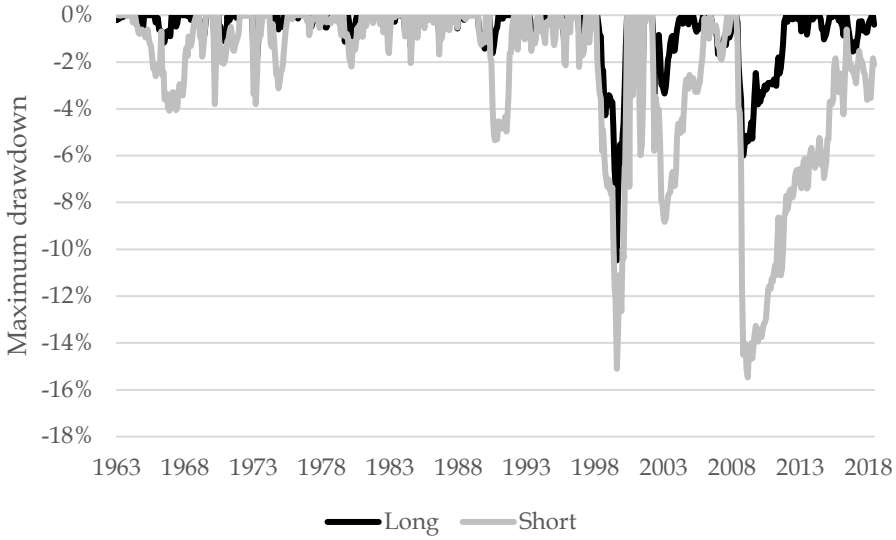
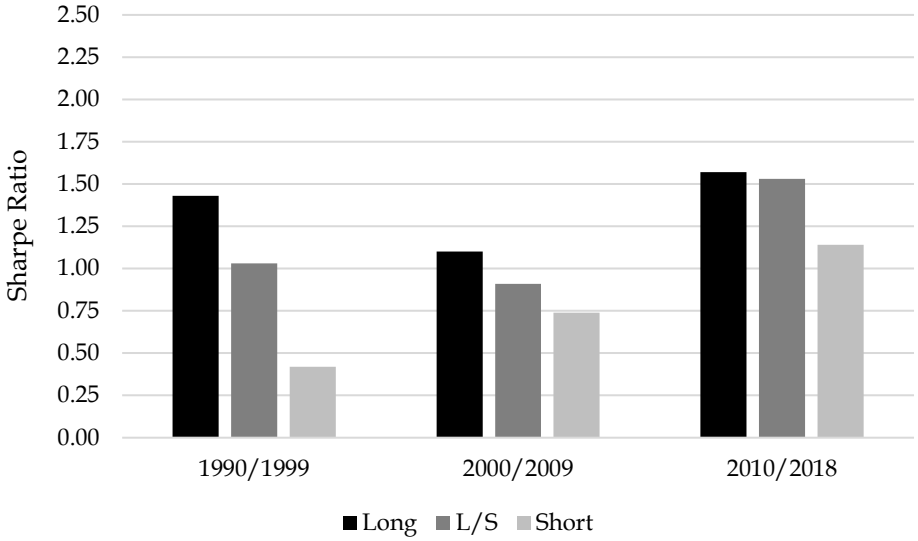


Figure 6: Global sample subperiod results

This figure shows the Sharpe ratio (Panel A) and standard t-value of the spanning alpha (Panel B) of the combined factor portfolio for the long leg ('Long'), long/short ('L/S'), and short leg ('Short') portfolios over the decades in our sample of global stocks (July 1990 – December 2018).

Panel A: Sharpe ratios



Panel B: Spanning alphas