# What Is a Factor?

## Part 2: The Impact of the Long-Only Constraint

Our recent paper "What, Exactly *Is* a Factor?"[1] examined various ways of constructing a portfolio used to calculate factor returns. We demonstrated that the absence or presence of a number of common constraints—such as a universe limitation—could have a large impact on a portfolio's exposures and returns. We also showed how some methodologies, such as using just the top and bottom quintiles based on the chosen factor, can have a particularly distorting effect, since returns are no longer driven by the factor alone, but also by other exposures.

In this follow up we drill down into the impact of a long-only constraint. Many managers cannot short in their portfolios, yet their returns are measured against a "factor" that can. As in our earlier paper, we find that difference can have a substantial impact.

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[1] Click here to download the paper

The traditional and commonly used "factor-mimicking portfolio" (FMP)[2] may reflect the "ideal" for the factor, but it may not represent the actual return that a manager using the factor could expect to see. Notably, the FMP may overstate the achievable return, compared with a factor portfolio that can only be short up to the benchmark weight. In contrast, an FMP constructed exactly like the traditional version, but with a constraint that the portfolio cannot be short a stock more than its weight in the benchmark (a so-called "long-only" FMP), is likely to look more like a factor-based long-only manager's and may provide a more-realistic picture of what the factor investor might hope to earn. This is particularly true if the factor gains most of its return from the short side, as the long-only portfolio return would likely be considerably less than the FMP suggests, and the difference would show up as residual, or unexplained return in attribution[3].

But a long-only factor portfolio is not a panacea. Even when it otherwise is modeled after the FMP—that is, it seeks to have exposure to the desired factor while eliminating exposure to other style factors, industries, and countries and currencies in the case of a multi-country portfolio—there are a few caveats.

- The inability to short will also impact the long side in order to maintain the neutrality to the other factors, and the more concentrated the benchmark the bigger the impact, because, with the exception of a few very large stocks, any underweights would have to be quite small.
- The inability to short will also impact the long positions and create a more concentrated portfolio.
- The higher the tracking error the larger the impact from the no-shorting constraint.
- It is more difficult to diversify away all of the stock-specific risk.

## Methodology

To illustrate the impact of the constraint on the portfolio structure and performance we used Axioma's optimizer to create a series of "long-only" portfolios that tilt on some of Axioma's Worldwide model (WW4) factors, while constraining all other styles, industries, countries and currencies. The portfolios used the Axioma Global Developed Markets All-Cap Portfolio[4] as the investment universe and benchmark. The daily-rebalanced portfolios targeted four different levels of tracking error. There were also no trading or liquidity constraints. In other words, the portfolios are meant to be as close as possible to the FMP but eliminate the ability to short. Note that our analysis is based on **active** holdings and returns, and most of this report will focus on the Profitability[5] factor.

[2] A long-short portfolio with unit exposure to the factor in question, and no exposure to any other model factor. The portfolio encompasses the model's full investment universe, is rebalanced daily, and has hundreds or thousands of small positions.
[3] Of course, other factors may drive the residual as well, most notably the stock-specific risk in the portfolio.
[4] Axioma's Market Portfolios (AMPs) are rules-based universes of sufficiently liquid securities, which cover 99% of investible equities and can be sliced and diced into country, regional and size-based portfolios, with a daily history of 20+ years.
[5] Profitability is based on a company's return on equity, return on assets, cash flow to assets, cash flow to income, gross margin and sales to assets. Speak to your Axioma representative for more information.

## Portfolio Impact of the Long-Only Constraint

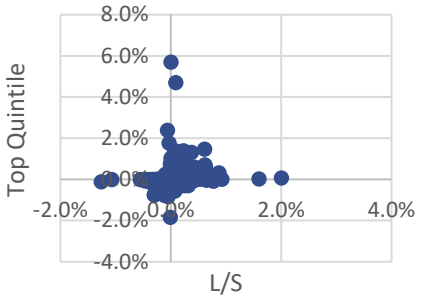
As noted, we tested our portfolio at four different levels of target tracking error: 10, 50, 100 and 300 basis points. At low levels of tracking error, the optimizer only wants to take very small positions. Therefore, even if a stock is, say, just 5 basis points of the index, the optimizer may not want to have a bigger short position if it *could* short. However, at 300 bps, if the optimizer could short it may want to short a lot more of an unattractive stock than it is able to, since it has a bigger risk budget to work with, but in the case of the no-short constraint it can't. In order to maximize exposure to the factor, it may therefore have to take bigger long positions in attractive stocks than it otherwise would, thereby creating a more concentrated portfolio.

Exhibit 1 shows scatter plots for the portfolios as of 31 December 2018, with the active weights of the four long-only portfolios on the Y axes and the weights of the long-short portfolio constructed the same way on the X axes[6]. As expected, it is clear that the no-short constraint has very little impact on the very low tracking error portfolio vis a vis the long-short portfolio (that is, their active weights are proportionally almost the same), but as the target tracking error rises, the active weights become much less correlated.

The red circle on the 100 and 300 bps scatterplots illustrates this point. These two stocks (they are the same for each portfolio) had very negative Profitability scores, and were the two biggest short positions in the long-short portfolio (-1.26% and -1.07%). However, while one had a weight of 0.11% in the index (and a short position of that size in the active long-only portfolios), the other was tiny, about 0.3 basis points, so could only have that very small active weight, clearly much less than in the long-short portfolio. *If the long-short portfolio is the "ideal" representation of the factor, the inability to short moves the portfolio farther away from that ideal as the target level of risk increases. In addition, in the pursuit of alpha, it may also then have to take larger positions on the long side, creating a more concentrated portfolio.*

**Quintile Portfolios**

Another common way of using a factor, especially in some smart beta products, is to sort the universe and buy only the most attractive stocks. This methodology creates a portfolio that may have big bets on other factors, a point we noted in the prior paper. As of 31 December 2018, the active bets of the capitalization-weighted top quintile of stocks based on Profitability included a 13% underweight in Financials, offset by a 10% overweight in Consumer Discretionary, a 3.4% overweight in the US but a 2.5% underweight in Canada and 2% in France. In addition, the portfolio had a bias toward high volatility and richly valued stocks. As a result, the active top-quintile portfolio had a quite low holdings correlation with the "ideal" long/short portfolio.

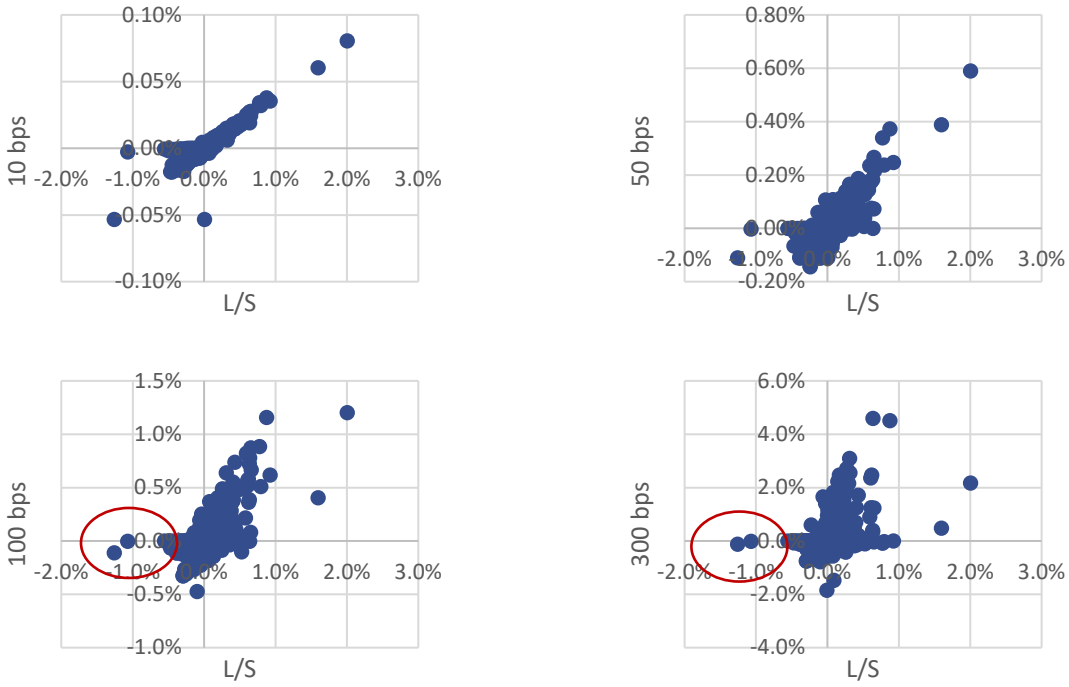



Data as of 31 December 2019

Source: Axioma

[6] See the original paper for more details

**Figure 1. Active Weights, Long-Only Portfolios vs. Long-Short, 31 December 2018**




Source: Axioma

## Performance

If a factor were only to work as a buy signal, but not effectively identify stocks to short, then we would expect the traditional FMP to have a return similar to, or lower than, the long-only factor portfolio, as we have described above. On the other hand, if a signal really only identifies stocks to avoid, then return to the FMP might be quite misleading to a manager intending to use it in a long-only portfolio.

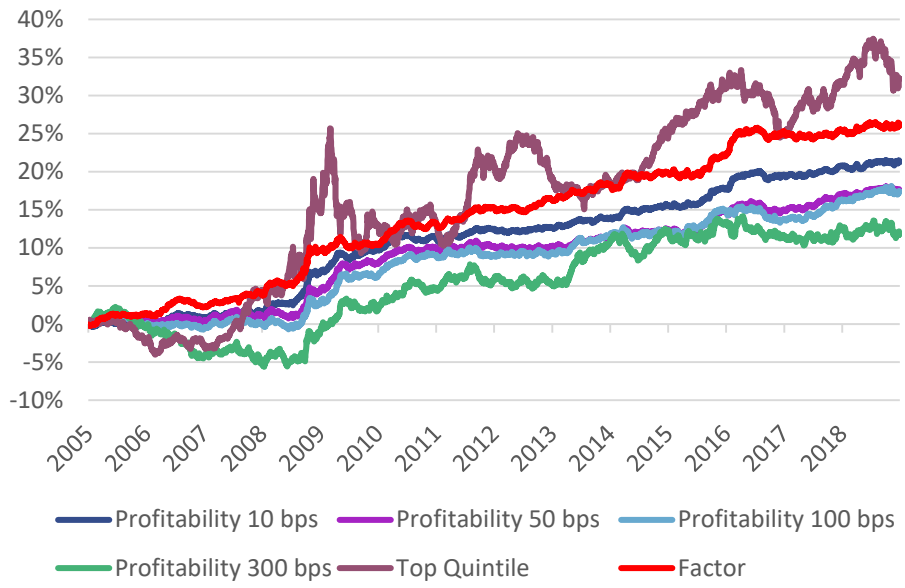
If we were to just separate the return to the long side from the short side to determine the efficacy of each, we would again have the issue of other exposures; the FMP is industry, style, country and currency neutral because of offsetting positions on each side. Therefore, we believe a better approach is to compare performance of the long-only portfolios to the FMP, and make the assumption that at least some, if not most, of the difference in return would be the result of the factor having better performance on one side of the trade.

These long-only portfolios would obviously have very different performance from the underlying factor, and given the weight differences, also from each other. Figure 2 shows the cumulative return to the long-only portfolios (including the one that invests in the top quintile and does not have any other exposure control), along with the underlying factor. Note that to have a valid comparison we had to scale each portfolio to have an exposure of "1" to the Profitability factor, as does the FMP.

Over time we observe that all of the long-only portfolios underperformed the factor, with the magnitude of returns decreasing more-or-less monotonically on a cumulative basis as target tracking error went up.

This chart suggests that a long-only investor is likely to see a lower-than-expected return from investing in the Profitability factor, and that the factor seems to derive a fair amount of its strong return from the short side.

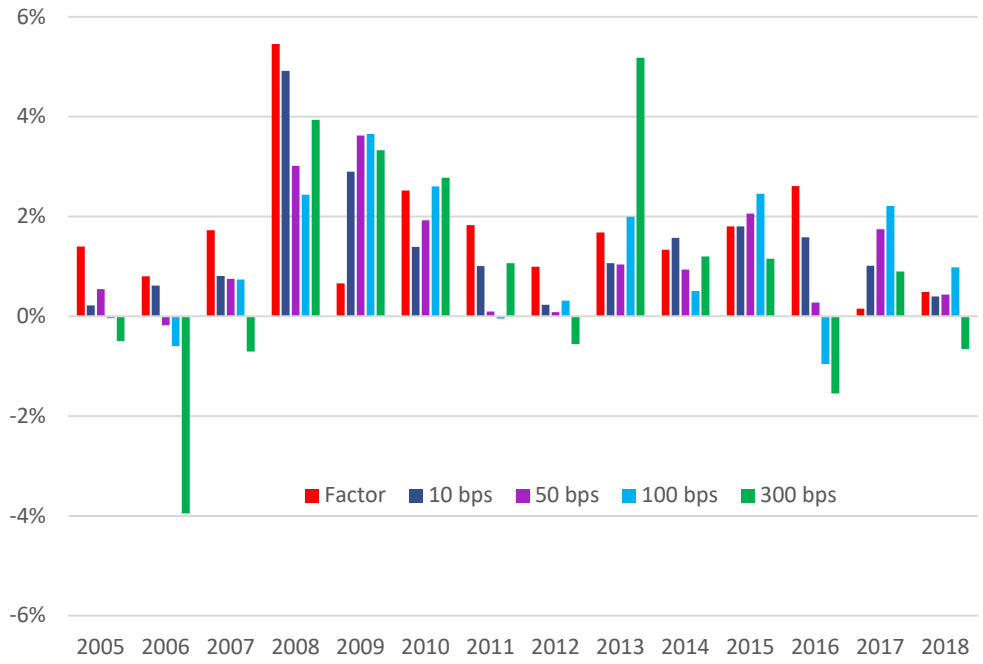
**Figure 2. Cumulative Active Return, Profitability Long-Only Portfolios vs. FMP**




Note: Returns are scaled to a Profitability exposure of 1
Source: Axioma

Of course, sometimes the factor works equally well on the short and long sides, or even better on the long side (in other words, highly profitable stocks fare well, but less profitable or unprofitable stocks do not necessarily tank). When we examine year-by-year returns (scaled to a Profitability exposure of 1) we see that the 300-basis point tracking error occasionally outperforms the others and the factor (see 2013 in Figure 3, for example).

**Figure 3. Annual Active Returns, Long-Only Portfolios vs. Factor**




Note: Returns are scaled to a Profitability exposure of 1
Source: Axioma

Even with these longer-term differences, the portfolios' daily returns are positively correlated, although the correlations decrease as target tracking error increases. But note the Top Quintile portfolio's correlations. The portfolio's returns are *uncorrelated* with the factor, and they are only slightly correlated with the other long-only portfolios. The return differences driving the correlations down are largely the result of the other factor exposures, and they suggest that this construction methodology may not really be giving the investor the desired exposure to the factor. We do note that over the full 14-year period of our study, this portfolio outperformed the other versions, but clearly with significantly more volatility.

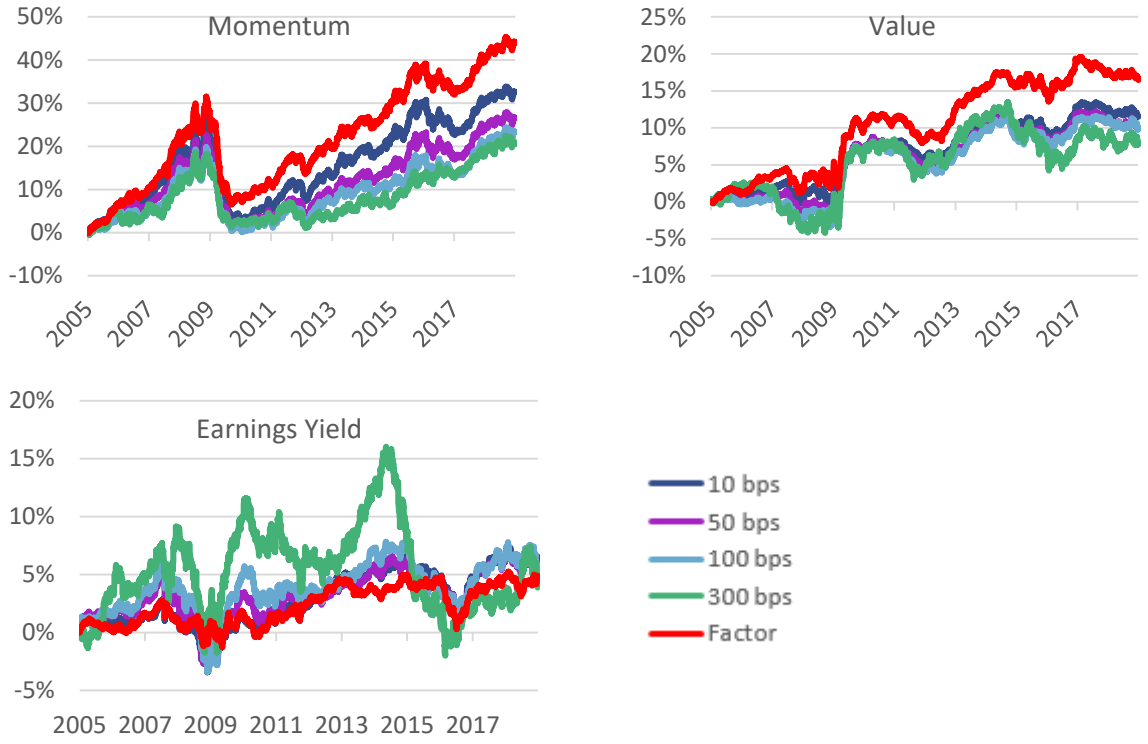
**Table 1. Correlation Matrix of Daily Active Returns, 2005-2018**

| | Factor | 10 | 50 | 100 | 300 | Top Quintile |
|---|---|---|---|---|---|---|
| **Factor** | 1 | | | | | |
| **10** | 0.80 | 1 | | | | |
| **50** | 0.64 | 0.82 | 1 | | | |
| **100** | 0.51 | 0.63 | 0.88 | 1 | | |
| **300** | 0.30 | 0.31 | 0.46 | 0.61 | 1 | |
| **Top Quintile** | -0.01 | 0.04 | 0.10 | 0.14 | 0.14 | 1 |

Source: Axioma

As noted in the beginning of the paper, we looked at several factors in Axioma's WW4 model, not just Profitability. It seems that the spread between long-short and long-only is quite inconsistent across strategies. Whereas the long-only Momentum[7] FMPs substantially lag their long-short factor counterpart, the difference based on tracking error is not nearly as big for Value[8] (where the factor return is much lower than that of Momentum or Profitability). Earnings Yield had the most curious results. Here 1) the factor is not a consistent source of excess return, 2) there is very little difference in cumulative return of the various long-only portfolios, 3) the 300-basis-point portfolio is extraordinarily volatile, suggesting it is badly impacted by the portfolio concentration driven by the no-shorting constraint and (perhaps most notably) 4) the return seems to be stronger on the long side, as the long-only portfolios fairly consistently outperform the factor.

**Figure 4. Cumulative Active Return, Profitability Long-Only Portfolios vs. FMP**




Note: Returns are scaled to a factor exposure of 1
Source: Axioma

[7] Axioma's Medium-Term Momentum factor, which is based on the first 11 of the last 12 months' returns.
[8] Book/Price

## Conclusion

Although we hope to have illustrated the impact a long-only constraint can have on a factor portfolio, this analysis is not firmly conclusive about the efficacy of a factor for long-only managers. We want to be clear that even if a manager has a perfectly calibrated factor portfolio on which to attribute performance, he or she may still see a significant impact from stock-specific (aka residual) returns, because the portfolio most likely has stock-specific risk contained within. In addition, none of these returns includes transaction costs, which could be significant. However, we chose to leave them off because the standard factor returns in most models similarly ignore those costs and we were merely trying to compare different ways of creating a portfolio that could be used to attribute returns.

We still believe, however, that the closer a factor portfolio is to a manager's process, the better it is likely to accurately describing the manager's returns. In our earlier paper, we discussed the impact of changing the investment universe or rebalancing frequency and constraining other factors exposures or not when using an optimizer to create variations on a factor portfolio, as well as the pitfalls of using simple quintile spreads as measures of factor returns. Here we attempted to zero-in on the mismatch between long-short and long-only factor portfolios and showed that differences in active holdings can have significant implications on the returns a portfolio—managed or just used to define a factor—can realize.