January 2018

When It Comes to Momentum, Don't Cramp My Style

An In-Depth Look at Sample Factor Portfolios

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This year Axioma introduced Sample Factor Portfolios as a way to gauge the possible performance impact of various constraints on portfolios that target exposure to specific risk factors, such as Momentum or Value. In addition, we wanted to show returns that might be more attainable than those implied by our factor-mimicking portfolios (FMPs)[2]. Results show that certain constraints can have significant impact, and the returns of these portfolios can differ substantially from those of the underlying factor that the portfolio tilts on, as well as from each other.

[1] Substantial thanks go to Axioma's Olivier d'Assier, Dieter Vandenbussche and Diana Rudean for their thoughtful comments and suggestions.

[2] A factor-mimicking portfolio is a long-short portfolio that has unit exposure to the factor in question and no exposure to any other factor. It is created based on the large estimation universe used to generate our risk models. It typically has hundreds or thousands of long and short positions, and is rebalanced daily with no regard to turnover. It is therefore difficult, if not impossible, to invest in. However, it represents the "purest" exposure to the factor, which the model user aspires to achieve.

In this series of reports, we dig deeper into the portfolio differences, as well as the longer-term performance impact generated by even simple constraints. This initial report focuses on portfolios tilting on Axioma's Medium-Term Momentum factor (henceforth just called Momentum). We show that adding constraints to an optimization (like wearing a belt and braces to hold up your trousers) may lead to portfolios that have unwanted characteristics and poorer results. A long-only constraint is likely to be unavoidable, but others are not.

For this analysis, we created three portfolios. Each is long-only and fully invested, maximizing active exposure to Momentum, while targeting 3% tracking error relative to the Russell 1000 index, which also forms the investable universe. Portfolios were fully invested and rebalanced monthly at month end. There were no constraints other than those mentioned below. There were no asset-level constraints, but active weights in most cases remained below 3%. With no liquidity or turnover constraints, they are also not really investable, but we also avoid the issues of path dependency. Of course, there are infinite choices we could have made in constructing these portfolios, but the three we illustrate below represent some of the major ways systematic managers construct their portfolios.

The three versions of our Momentum portfolio are:

- "Unconstrained" does not constrain styles or industries, thereby allowing the optimizer to find Momentum wherever it can.
- "No Style" eliminates active exposure to all style factors except Momentum, but allows industry exposures.
- "No Style, No Industry" also disallows both active industry exposures and style factor exposures (other than Momentum).

Before we discuss the performance and attribution of these portfolios, let's examine some of their major holdings and risk characteristics, and compare and contrast them.

Varying constraints clearly led to portfolios that were quite different from one another, even though they all had a strong Momentum tilt and 3% tracking error. Some major risk characteristics as of Nov. 30, 2017, are detailed in Table 1.

Portfolios Are Different Along a Number of Dimensions. The major components of active risk were quite different. Even the number of names (not explicitly targeted) varied, with the Unconstrained portfolio holding nearly twice as many stocks as the style-constrained version. (The historical range of number of names is detailed in Appendix 1.) Of course, the industry-constrained portfolio did not have active industry risk, but more than half its risk was stock specific[3]. Constraining style exposures also curtailed style risk relative to the Unconstrained portfolio, which had a higher proportion of style and industry risk than the other two, but less specific risk. At the end of November 2017, industries had a negative contribution to risk, meaning they diversified the risk from the other factors. Historically, however, industries have more often been a positive contributor to risk. In Appendix 2 we show the time series of these risk decompositions, which varied widely.

Overall, the Unconstrained portfolio had the highest Momentum exposure, the least specific risk (in both absolute and percent-of-total terms), and the lowest concentration in total weights, active overweights

[3] This breakdown distributes the factor covariance across the components, so their risk adds up to 100.

and percent contribution to risk. We note later how it also had the best performance over the long term (although not necessarily recently), and more frequently had the best annual performance of the three.

Only one stock was among the five biggest risk contributors in all three portfolios (ALGN), GOOG and GOOGL were among the biggest underweights in all three, and AAPL was one of the top three weights in all three, but otherwise there was little commonality across all three portfolios. Interestingly, many of the biggest underweights were in the so-called FAANG[4] stocks, where Momentum scores are generally slightly positive, but not among the top ranks of stocks based on this measure. As of the end of November these underweight bets served as good diversifiers. The turnover in these portfolios is fairly high (average monthly two-way turnover ranged from 51% to 68% this year), so these comparisons change quite a bit from month to month.

We also see how different the portfolios are, and how big a difference we might expect to see in performance by looking at the correlation matrix of total and active weights (Table 2). The Unconstrained and No Style portfolios are more similar to each other than either is to the No Style, No Industry variant in terms of correlation of both total and active weights, suggesting the industry constraint drives bigger changes in the portfolio than the style constraints. Still, in all cases, the correlations are relatively low. The tracking error between the portfolios is also lowest between the No Style and Unconstrained versions, but all are fairly large suggesting we would be likely to see performance differences. Active return correlations are fairly high, but we note later that while the *direction* of returns may be the same (that is, what the correlation measures), the *magnitudes* can be quite different.

A key point here is that many investors put constraints on their optimizations as a kind of "belt and braces" approach to managing active portfolio risk. But these statistics show that constraints actually hurt the risk profile by concentrating risk in possibly unintended ways. Of course, many constraints are unavoidable, driven by client requirements or regulations. However, to the extent possible, managers should limit self-imposed constraints to get higher exposures and better risk characteristics in their portfolios.

Sector Weights May Diversify Factor Risk. Both the Unconstrained and No Style portfolios allow sector active weights, which may offset some of the Momentum risk. The active sector weights for the No Style portfolio were generally bigger than those in the Unconstrained version (which could also use other factors to offset risks), and both versions had a high tilt toward Financials (Figure 1). For a few sectors—Consumer Discretionary, Energy and Health Care—the portfolio bets were in the opposite direction (although fairly small), and the Unconstrained portfolio was underweight Technology, while the No Style took no active weight there.

Finally, the Unconstrained portfolio ended up with exposures to most of the other factors, with (not surprisingly) negative exposures to Dividend Yield and Value, but also a more possibly unexpected underweight in Exchange Rate Sensitivity. It was also positively exposed to Leverage, Liquidity, Market Sensitivity, MidCap, Profitability and Volatility, suggesting stocks with positive exposures to those factors have had better Momentum of late.

[4] Facebook, Apple, Amazon, Netflix and Google

Table 1 . Portfolio Characteristics

	Unconstrained			No Style			No Style, No Industry		
Number of Names	153			76			83		
Total Risk (Benchmark 6.5%)	7.2%			7.0%			6.8%		
Predicted Beta	1.01			0.97			0.96		
Factor vs. Specific									
Factor	6.95%			6.64%			6.38%		
Specific	1.87%			2.09%			2.42%		
% Contribution to Risk									
Specific	31.8%			35.5%			54.7%		
Style	70.2%			63.1%			45.3%		
Industry	-1.9%			1.4%			0.0%		
Active Momentum Exposure	0.92			0.80			0.63		
Average Monthly 2-Way T/O, 2017	51%			52%			68%		
Top 5									
Weights	AAPL	4.46%	5.39%	AAPL	5.67%	7.56%	C	6.65%	9.32%
Weight/	BA	3.48%	4.13%	BA	4.48%	5.73%	XOM	4.11%	1.58%
% of Total Risk	HD	2.45%	1.33%	JPM	4.06%	5.26%	AAPL	4.00%	5.15%
	C	2.37%	3.15%	C	3.21%	4.55%	PFE	3.94%	2.45%
	EL	2.34%	1.18%	ALGN	3.15%	5.00%	PYPL	3.54%	4.80%
	Total	15.10%	15.19%	Total	20.56%	28.11%	Total	22.24%	23.29%
Overweights	BA	2.86%	4.74%	BA	3.86%	6.59%	C	5.82%	-3.53%
Active Weight/	EL	2.23%	2.44%	ALGN	3.08%	14.45%	PYPL	3.22%	6.95%
% of Active Risk	ALGN	2.08%	8.99%	NLY	3.00%	-0.08%	LRCX	3.19%	9.15%
	FNF	1.92%	2.23%	JPM	2.55%	-0.40%	PFE	3.10%	0.93%
	PYPL	1.86%	3.87%	AXP	2.40%	-0.18%	TRCO	2.75%	2.54%
	Total	10.96%	22.27%	Total	14.89%	20.37%	Total	18.07%	16.04%
Underweights	MSFT	-2.42%	-1.34%	FB	-1.59%	-1.89%	JPM	-1.50%	1.89%
Active Weight/	FB	-1.59%	-1.86%	BRK/B	-1.51%	0.15%	JNJ	-1.49%	-0.01%
% of Active Risk	BRK/B	-1.51%	0.44%	GOOG	-1.20%	-0.68%	GOOG	-1.20%	-0.83%
	GOOG	-1.20%	-0.64%	GOOGL	-1.20%	-0.68%	GOOGL	-1.20%	-0.83%
	GOOGL	-1.20%	-0.64%	WFC	-1.03%	0.92%	BAC	-1.14%	1.73%
	Total	-7.92%	-4.02%	Total	-6.52%	-2.18%	Total	-6.53%	1.94%
Contributors to Risk	ALGN	8.99%	3.26	ALGN	14.45%	3.26	ALNY	20.09%	3.41
% Risk Contribution/	IPGP	5.21%	2.56	BA	6.59%	1.25	ALGN	9.53%	3.26
Momentum Score	SQ	5.15%	3.41	IPGP	5.74%	2.56	LRCX	9.15%	1.88
	NRG	5.11%	2.67	ANET	4.46%	2.58	PYPL	6.95%	1.62
	BA	4.74%	1.25	PYPL	3.66%	1.62	TTWO	6.95%	2.70
	Total	29.19%		Total	34.89%		Total	52.67%	

Total risk is based on Axioma's US4 Medium-Horizon Fundamental Model
Data as of Nov. 30, 2017
Source: FTSE Russell, Axioma

Table 2. Correlations and Tracking Error

	No Style	No Style or Industry
Total Weight Correlation		
No Style or Industry	0.62	
Unconstrained	0.80	0.54
Tracking error		
No Style or Industry	2.10%	
Unconstrained	1.61%	2.45%

	No Style	No Style or Industry
Active Weight Correlation		
No Style or Industry	0.48	
Unconstrained	0.72	0.40
Active Return Correlation		
No Style or Industry	0.82	
Unconstrained	0.92	0.78

Figure 1. Sector and Style Exposures

Data as of Nov. 30, 2017. Only Unconstrained portfolio had active style exposures (right-hand chart).

Source: FTSE Russell, Axioma

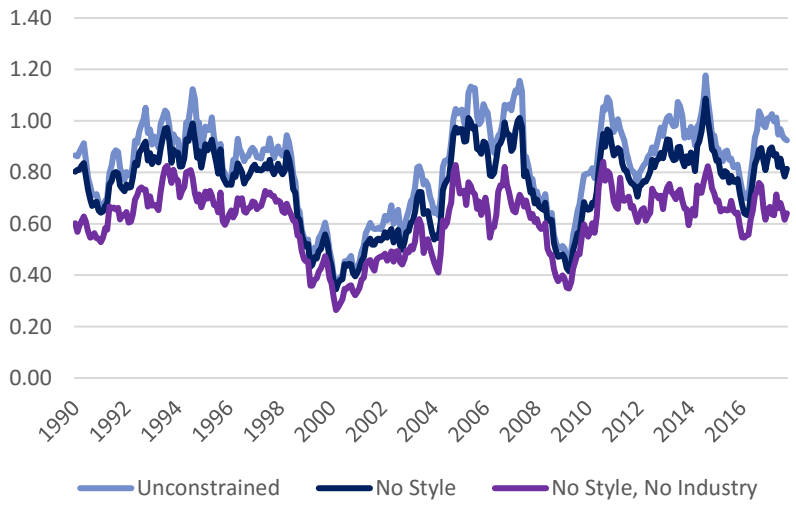
Time Series Analysis of Momentum Exposure and Risk Contribution. Time series analysis can give us a sense of how many of these factors have varied over time, and therefore what variation we might see going forward.

One presumably tilts on Momentum because it should pay off in positive active returns, so it follows one would want to maximize the factor exposure. The Unconstrained portfolio consistently had the highest exposure to the desired factor and the No Style, No Industry portfolio had the lowest. There were some points in time when the exposures were very similar despite the different construction methodologies, but those were periods when the factor's volatility and, indeed, overall market volatility were unusually high, and it took much less exposure to reach the target tracking error. Importantly, in those times, when one might be most concerned about outsized performance, the added constraints did not make much of a difference.

How much risk budget was used by the Momentum tilt also varied widely over time for all three sample portfolios. Momentum's contribution to risk ranged from about 29% to almost 82% for the

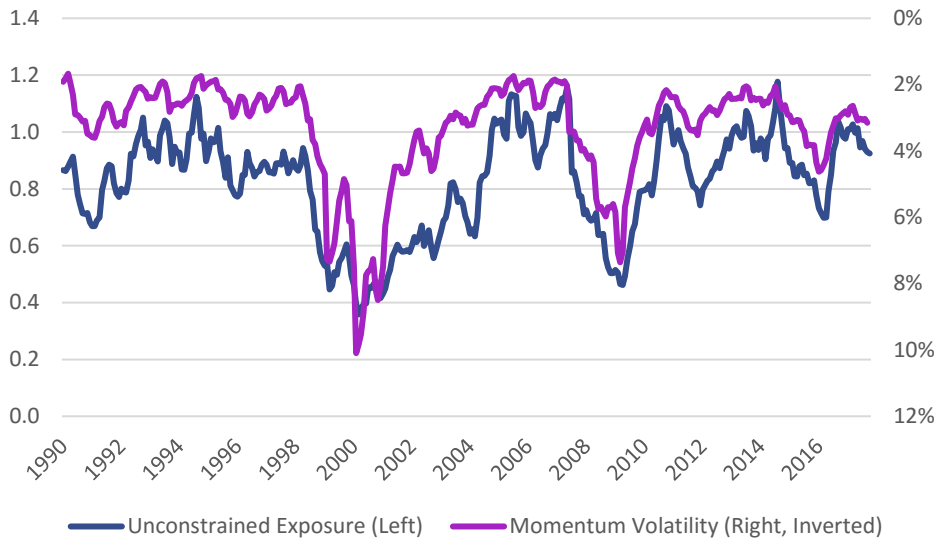
Unconstrained portfolio, 22% to 81% for the No Style version, and 12% to 85% for the No Style, No Industry portfolio—in all cases quite a wide range. Peaks tended to be around 2000 (the height on the internet bubble), autumn of 2008 and June of 2016, whereas the lowest contributions to risk fell in mid-1998 (right before the Russian debt crisis), spring 2006 and autumn 2014—all periods corresponding to higher and lower levels of volatility of the Momentum factor. Managers tilting on Momentum should be aware of this broad range of factor volatility driving contribution to risk. If the risk budget is not used by the desired factor, it is being used by some other factor (note that in the Unconstrained and No Style versions the optimization always reached the desired 3% level of active risk, but in the No Style, No Industry variant there were a few periods in which risk fell short of the goal, most notably in early-to-mid 2007).

Figure 2. Momentum Exposure Through Time



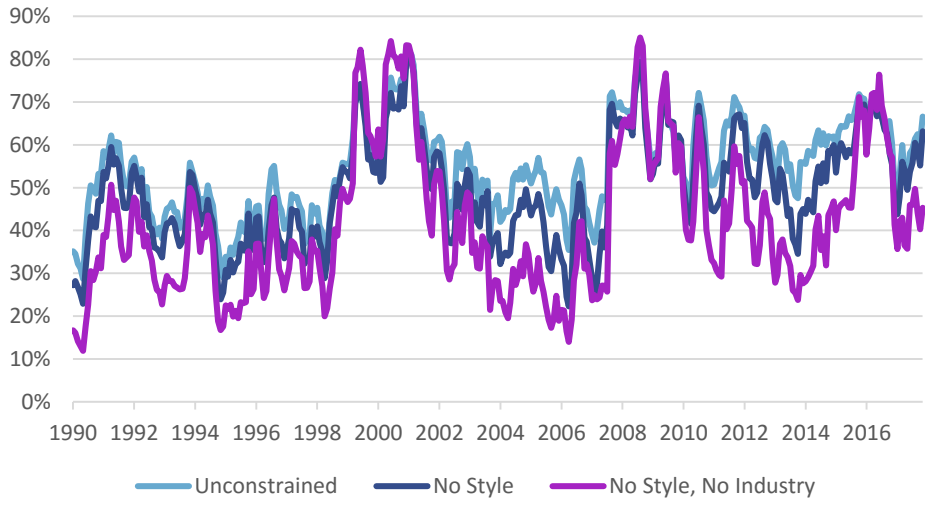
Source: FTSE Russell, Axioma

Figure 3. Momentum Exposure (Unconstrained) vs. Factor Volatility



Source: FTSE Russell, Axioma

Figure 4. Momentum Contribution to Risk



Source: FTSE Russell, Axioma

Performance Differences Were Occasionally Large. Although all three portfolios produced positive active returns for expanding periods ended November 2017, constraints had a clear impact on performance, especially in certain years. The most constrained portfolio had the worst performance among our three versions for every expanding-window period from the last 12 months to the last 25 years, and for the five-, 10- and 15-year periods the active return would probably not have covered transaction costs and fees (Table 3). The other two portfolios produced much better returns, but this year and last year, as well as for the last three and five years, the style-constrained portfolio fared better than the Unconstrained, which was dragged down by some of its other style exposures.

Since managers generally don't have the luxury of proving their mettle over extended periods of time, in Table 4 we show the year-by-year comparison of active returns, highlighting the best and worst performer for each year. A few things stand out from this table:

- The range of outcomes can be extremely wide. For example, in 2010 the Unconstrained portfolio beat the index by more than 6%, whereas the industry-constrained portfolio slightly underperformed. (The yearly spread between the best and worst performer is also noted on the table.)
- It was more typical, however, for active returns to follow the same direction, and in many years they were of a similar magnitude.
- The Unconstrained portfolio beat the benchmark in 21 of the 26 years from 1991 to 2016 and the No Style portfolio had positive active returns in 19. The industry-constrained portfolio only outperformed in 16.
- In half the years the Unconstrained portfolio had the highest return, and it was only the worst performer in five. In contrast, the industry-constrained portfolio was only the highest in four of the years, and the lowest in 16.
- While all three portfolios had their worst year ever in 2009, the No Style, No Industry portfolio did have the "least-bad" year (although the constraints clearly did not help it very much).
- The magnitude of active returns for all three portfolios seems to be generally declining, although 2017 has been a stellar year through November.
- We often think of Momentum strategies as "up market" strategies. In other words, performance tends to be better when markets are up. The correlations between annual active and market returns are indeed positive, but not as high as one might expect (0.21, 0.26 and 0.20 for Unconstrained, No Style, and No Style, No Industry, respectively).
- It theoretically follows that constraints could help more in down years, but in all four down years of our study the Unconstrained portfolio had the highest return, and only lagged the market in one.
- It was quite interesting that the Unconstrained and No Style portfolios actually fared better than the underlying factor in each of the expanding-window periods, although that was not true for the No Style, No Industry portfolio. This outcome is a bit surprising given the added constraints on our Sample Factor Portfolios[5].

[5] Other than because of the style and industry, there are two major reasons the portfolios' active returns could differ substantially from the return of the Momentum factor: (1) the selection universe in the portfolios' case only includes large-cap (Russell 1000) stocks, whereas the factor-mimicking portfolio (FMP) spans a much broader universe, and (2) these portfolios are long-only. Although the active portfolio is effectively long-short it can only be short up to benchmark weight. So, if Momentum fares better because stocks with poor Momentum underperform, our active portfolio would be hurt relative to the FMP.

Table 3. Performance Data

Returns for Periods Ended November 2017 (%)									
	YTD 2017	2016	Last 12 months	Last 3 years	Last 5 years	Last 10 years	Last 15 Years	Last 20 Years	Last 25 Years
Unconstrained	27.2	12.2	28.4	14.2	17.9	10.6	12.0	10.4	13.0
No Style	29.8	13.4	32.2	16.1	18.0	10.0	11.6	10.2	12.9
No Style or Industry	24.3	10.8	26.3	13.5	16.4	8.7	10.4	8.7	11.4
Russell 1000	20.3	11.9	22.6	10.7	15.6	8.4	9.7	7.4	9.7

Active Returns for Periods Ended November 2017 (%)									
	YTD 2017	2016	Last 12 months	Last 3 years	Last 5 years	Last 10 years	Last 15 Years	Last 20 Years	Last 25 Years
Unconstrained	6.87	0.22	5.86	3.54	2.27	2.21	2.31	2.99	3.24
No Style	9.48	1.43	9.63	5.37	2.41	1.62	1.97	2.77	3.17
No Style or Industry	3.96	-1.14	3.70	2.80	0.73	0.34	0.75	1.26	1.70
Momentum Factor	4.80	-3.36	4.07	2.35	2.03	0.67	1.68	2.47	2.81

Source: FTSE Russell, Axioma

Active Return

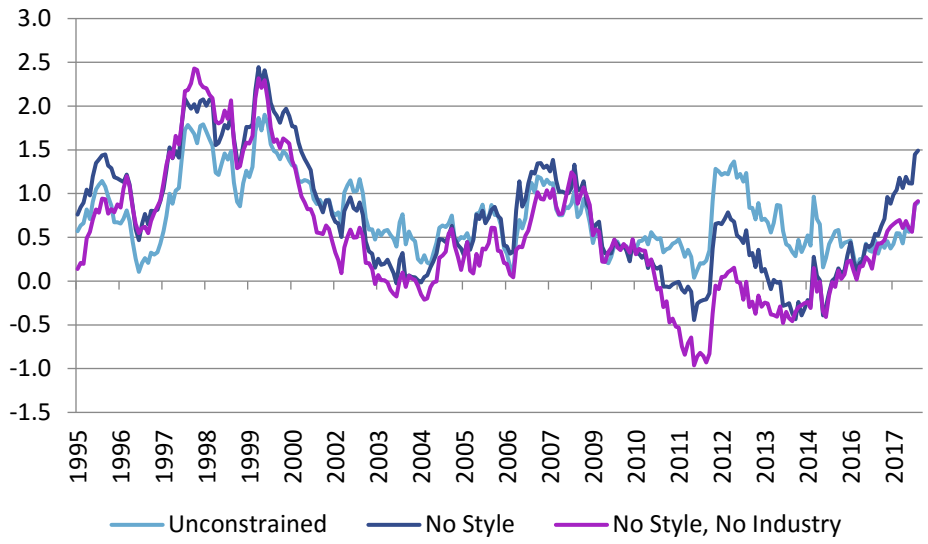
	Unconstrained	No Style	No Style or Industry
1991	15.47%	16.17%	9.49%
1992	5.36%	4.33%	1.50%
1993	9.93%	9.35%	5.29%
1994	-5.55%	-4.83%	-4.79%
1995	9.89%	15.48%	10.73%
1996	0.95%	0.60%	2.28%
1997	8.69%	7.61%	7.71%
1998	6.86%	12.89%	6.49%
1999	10.01%	11.99%	7.77%
2000	4.20%	3.44%	1.00%
2001	-0.93%	-2.53%	-2.14%
2002	4.93%	3.39%	3.21%
2003	0.48%	-1.74%	-2.83%
2004	1.45%	2.26%	1.14%
2005	6.27%	5.73%	2.77%
2006	-2.36%	-0.30%	-0.87%
2007	7.00%	7.75%	7.25%
2008	2.56%	1.97%	1.42%
2009	-6.42%	-7.11%	-6.14%
2010	6.54%	2.07%	-0.43%
2011	1.80%	1.61%	-1.72%
2012	3.50%	1.43%	2.35%
2013	0.73%	-3.54%	-4.18%
2014	-0.79%	-0.50%	-0.95%
2015	4.61%	5.86%	6.14%
2016	0.22%	1.43%	-1.14%

	Unconstrained	No Style	No Style or Industry	Spread
1991	15.47%	16.17%	9.49%	6.68%
1992	5.36%	4.33%	1.50%	3.86%
1993	9.93%	9.35%	5.29%	4.64%
1994	-5.55%	-4.83%	-4.79%	0.76%
1995	9.89%	15.48%	10.73%	5.59%
1996	0.95%	0.60%	2.28%	1.67%
1997	8.69%	7.61%	7.71%	1.08%
1998	6.86%	12.89%	6.49%	6.40%
1999	10.01%	11.99%	7.77%	4.22%
2000	4.20%	3.44%	1.00%	3.20%
2001	-0.93%	-2.53%	-2.14%	1.60%
2002	4.93%	3.39%	3.21%	1.71%
2003	0.48%	-1.74%	-2.83%	3.31%
2004	1.45%	2.26%	1.14%	1.12%
2005	6.27%	5.73%	2.77%	3.50%
2006	-2.36%	-0.30%	-0.87%	2.06%
2007	7.00%	7.75%	7.25%	0.75%
2008	2.56%	1.97%	1.42%	1.14%
2009	-6.42%	-7.11%	-6.14%	0.98%
2010	6.54%	2.07%	-0.43%	6.97%
2011	1.80%	1.61%	-1.72%	3.52%
2012	3.50%	1.43%	2.35%	2.07%
2013	0.73%	-3.54%	-4.18%	4.91%
2014	-0.79%	-0.50%	-0.95%	0.45%
2015	4.61%	5.86%	6.14%	1.53%
2016	0.22%	1.43%	-1.14%	2.57%
2017 (Through 11/30)	6.87%	9.48%	3.96%	5.53%

Best Performer Worst Performer Spread >5%

Source: FTSE Russell, Axioma

Figure 5. Rolling Three Year Realized Information Ratio



Source: FTSE Russell, Axioma

To sum up this section, the choice of constraints can be critical in driving the portfolio's risk profile, exposure to the relevant factor and performance. We presented just a few examples, using portfolios in which it would still be difficult to invest because there were no constraints related to turnover or liquidity, among other possibilities. But it is clear from this analysis that constraints can make a huge difference.

Where's the Momentum?

Another way to use this analysis is to see exposures to the other style factors and to sectors for the Unconstrained portfolio, to see where the Momentum is and is not. We would expect when a factor or sector is strong it would get higher weight in the Unconstrained portfolio, which looks for Momentum wherever it may be, and weaker returns should lead to underweights. So, for example, if the Value *factor* is faring poorly or the return to Volatility is negative (as expected), we would also expect our Momentum portfolio to have negative exposure to those factors, and that is what we see in the examples in Figure 5. Given that Momentum tends to beget more Momentum, this can also be helpful in estimating future factor performance—if Momentum has turned, perhaps the factor will, too[6] (Figure 5). One can also see how these unintended exposures could potentially impact performance. Although, in general, exposures are fairly low, we will show some big impacts from small exposures later, in year-to-date attribution.

Some observations:

- Momentum's exposure to Dividend Yield is usually negative, with the occasional slightly positive reading. The Unconstrained portfolio's active Dividend Yield exposure turned positive in August 2016, but has since backed off, re-entering negative territory in June and continuing to fall since then as Dividend Yield has been a poor investment strategy.
- The exposure to Earnings Yield trended up for much of this year before dropping back down in the last few months, as lower-growth and cheaper stocks took a back seat to high flying tech shares. This decrease in Earnings Yield, along with lower Value scores mentioned below, suggests Momentum may be getting a bit expensive.
- Stocks with positive exposure to Exchange Rate Sensitivity (they go up when the dollar appreciates) have experienced a sharp downturn in Momentum since mid-2012. The exposure hit an all-time low in December 2016, inched up for a while before falling back down in the last few months, approaching its five-year low. This steady drop suggests a secular change more than a short-term cyclical variation.
- The portfolio's Growth exposure has hovered at slightly negative for much of the past year, after dropping sharply from mid-2015. The only time the exposure to Growth had been lower in our portfolio's history was a brief period in 1994. Since May, however, exposure to Growth has ratcheted up, but remains right around zero as of this writing.
- The portfolio's exposure to Liquidity has trended upward and almost always been positive since the late 1990s. The exposure reached a peak in March of this year. And, in fact, the magnitude of the portfolio's current exposure to Liquidity is higher than that of any other factor (except Momentum, of course). Clearly the more liquid stocks have had the Momentum with them for much of the time since the Global Financial Crisis, potentially the result of the flow of money into Momentum "Smart Beta" ETFs. We will continue to track this factor for other strategies as well.
- The Momentum portfolio has almost always been tilted toward stocks with higher exposures to Market Sensitivity (i.e., higher beta stocks). That exposure reached an all-time peak earlier this

[6]Note that looking at the Momentum exposure of, say, a Value portfolio, would accomplish a similar goal more directly, but this report is limited to analyzing Momentum portfolios.

year and has since backed off, meaning that the Momentum in higher beta stocks, although positive, is starting to fade.

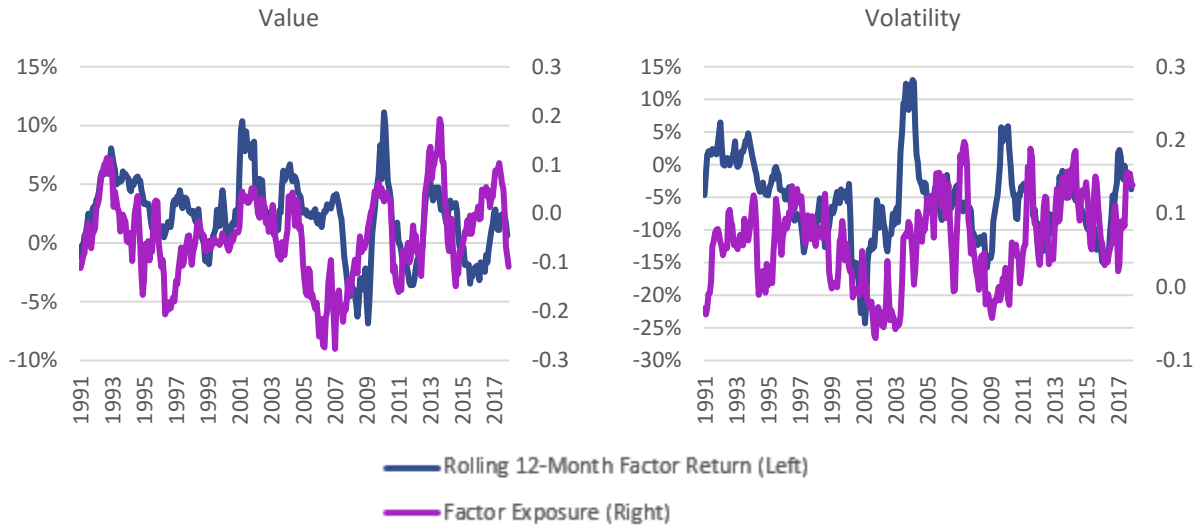
- Profitability's exposure in the Momentum portfolio had been trending down since 2015, but has picked up since May of this year and is now ever-so-slightly positive.
- The Size exposure in our Momentum portfolio has always been negative. This is not surprising in an optimized portfolio targeting a specific level of tracking error.[7] While it is difficult to sort out whether this means the momentum in Size is changing, it has been in a general downtrend for the past five years.
- Investors sometimes believe that Value and Momentum are negatively correlated, suggesting a Momentum portfolio would always have a negative exposure to Value, but that isn't the case. In fact, the Value exposure in our Momentum portfolio steadily increased from the summer of 2014 through mid-2017, but then retreated as Value started to get a drubbing[8] and was clearly not where the Momentum in the market was.
- Finally, Volatility's exposure is currently near its all-time high level, meaning that higher volatility stocks currently have Momentum. Given that to outpace one's stock peers and gain Momentum a stock may very well have to have higher Volatility. This can work against a Momentum portfolio, as we know the return to the Volatility factor is most often negative, and often of higher magnitude than a positive Momentum return. One implication, therefore, is that constraining Volatility exposure may help the performance of a Momentum portfolio.[9]

[7] In a long-only portfolio, stocks with negative expected returns can only be "short" up to their weight in the benchmark. This means that the portfolio is more likely to get a positive exposure to a factor in its long positions, particularly of smaller stocks, hence a general small-cap bias. This is true for any factor (or combination of factors), not just Momentum.

[8] See our recent paper "Giving a Boost to Value Performance – with a Little Factor Awareness (and Luck), http://go.axioma.com/WP201708-Giving-a-Boost-to-Value-Performance.html, and our blog post "The Momentum Ball Remains in Growth's Court" http://www.axioma.com/blog/post/the-momentum-ball-remains-in-growths-court/for more on this topic.

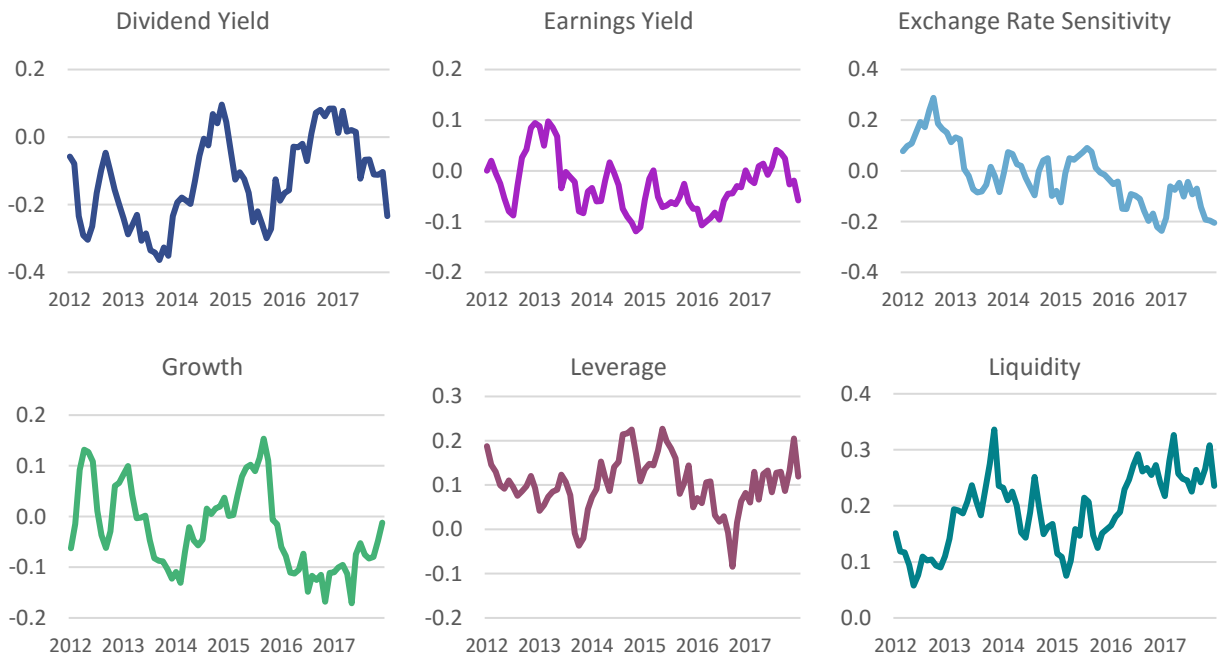
[9] Although it would not have this year, as the return to Momentum has been unusually strong, while Volatility's returns have been close to zero in the US.

Figure 6. Factor Return vs. Exposure in Unconstrained Portfolio



Source: FTSE Russell, Axioma

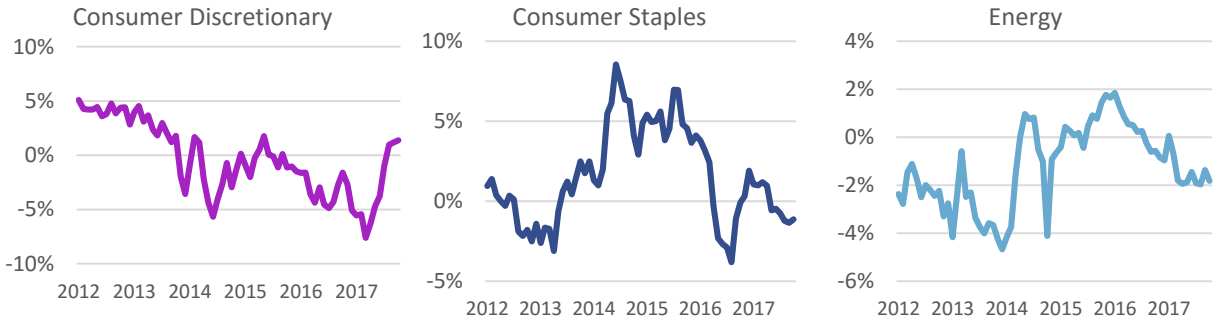
Figure 7. Unconstrained Portfolio Exposures to Other Risk Factors

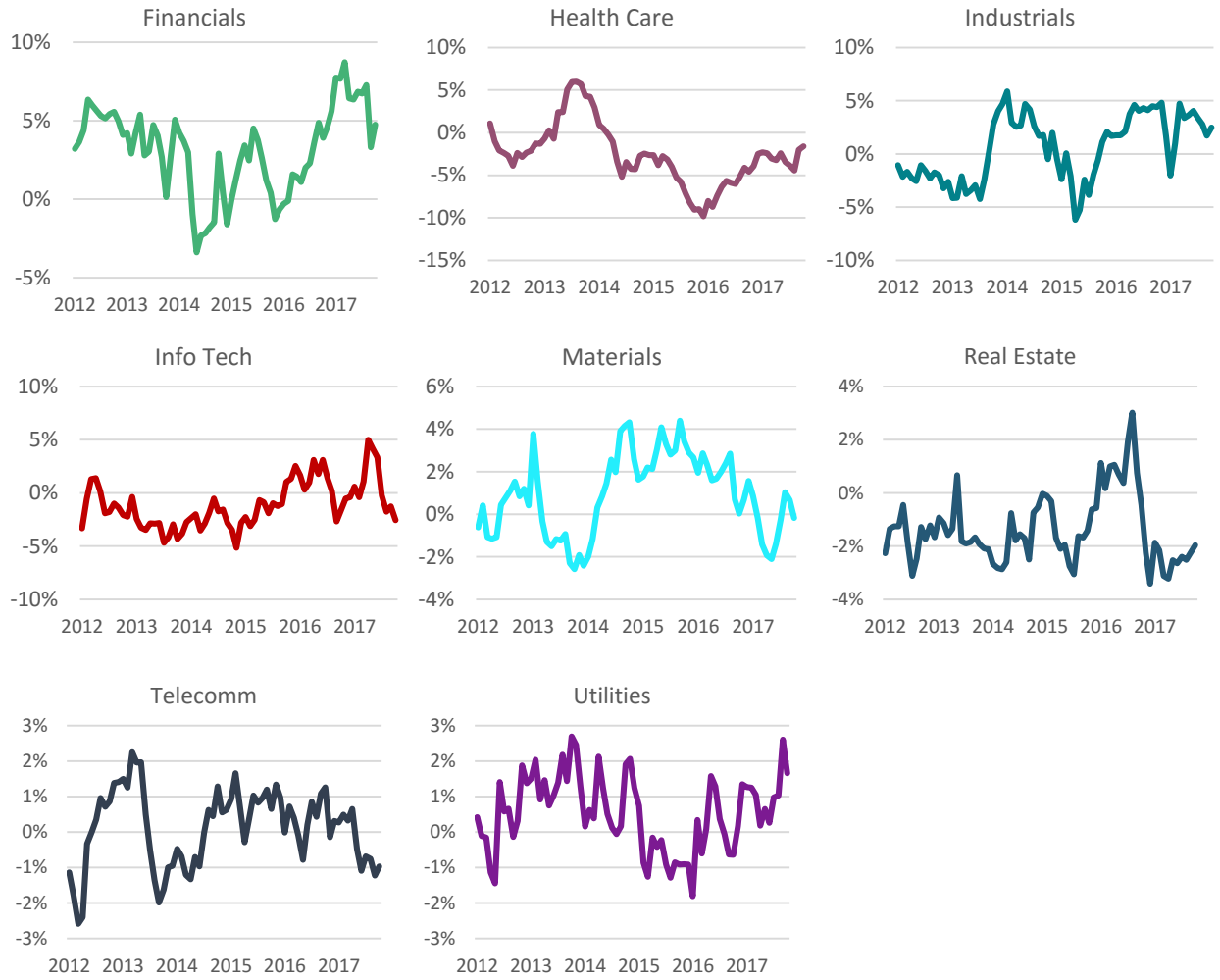


Source: FTSE Russell, Axioma

Similarly, we can look at the sector exposures of our unconstrained Momentum portfolio to see which sectors may be gaining or losing Momentum (Figure 7). As of November 2017, we note some sharp reversals in sector exposures from 2016. Most notably, as the economy seems to be running full steam ahead, the most cyclical sectors—Consumer Discretionary and Materials—seem to be gaining Momentum, whereas Information Technology's exposure surprisingly seems to have lost steam since May, possibly more for risk management reasons than because they have seen their Momentum fall.

Figure 8. Active Sector Exposures: Unconstrained Portfolio





Source: FTSE Russell, Axioma

Finally, we calculated **factor-based performance attribution** for the year-to-date period. This analysis shows some interesting results, not to mention unusually high active returns.

The Momentum factor has had a strong year, and has therefore been a major contributor to return in each of the portfolios, obviously contributing just about all of the total style factor return for the portfolios in which the other style factors were constrained. The Unconstrained portfolio saw a drag on performance from its small-cap bias this year, while most other factors had a fairly benign impact. The No Style portfolio had the highest active return, which was driven even more by specific return than by return from Momentum exposure. This is a bit unusual, as we more often see specific return as a drag on performance when an underlying factor works as well as Momentum has this year.[10] There was considerable overlap in the industry contributions for the portfolios that allowed industry exposures, but there were some relatively large differences in industry contribution (e.g. Commercial Services

[10] See our paper "Turning Negative Into Nothing: Ax explanation of "adjusted factor-based performance attribution", http://go.axioma.com/WP-TurningNegativeIntoNothing.html, for more detail.

detracted 25 basis points from the No Style portfolio, the third biggest negative contribution, but just 2 basis points from the Unconstrained version).

Table 4. Attribution, January-November 2017

Momentum Portfolios	No Style	No Style, No Ind	Unconstrained	
Portfolio	29.82%	24.29%	27.19%	
Benchmark	20.34%	20.34%	20.34%	
Active	**9.48%**	**3.95%**	**6.85%**	
Specific Return	5.45%	0.74%	3.38%	
Factor Contribution	4.03%	3.21%	3.46%	
Style	4.54%	3.32%	3.59%	
Dividend Yield	0.02%	0.01%	0.04%	-
Earnings Yield	-0.01%	-0.01%	0.00%	+
Exchange Rate Sensitivity	0.00%	-0.01%	-0.05%	-
Growth	0.01%	0.01%	-0.22%	-
Leverage	-0.05%	-0.06%	-0.25%	+
Liquidity	0.01%	0.04%	0.10%	+
Market Sensitivity	-0.03%	0.00%	-0.20%	+
Medium-Term Momentum	**4.58%**	**3.36%**	**5.28%**	**+**
MidCap	0.01%	0.02%	0.27%	+
Profitability	0.01%	0.01%	-0.03%	-
Size	0.01%	-0.02%	-1.03%	-
Value	0.01%	-0.01%	0.17%	+
Volatility	0.00%	0.00%	-0.48%	+
Industry	-0.49%	-0.09%	-0.11%	

Top 4 Industries	Aerospace & Defense 0.28%(+)	NA	Machinery 0.33%(+)
	Food & Stap Retailing 0.26%(-)	NA	Food & Stap Retailing 0.25%(-)
	Road & Rail 0.26%(+)	NA	Div Telecomm Svcs 0.20%(-)
	Pharmaceuticals 0.21%(-)	NA	Road & Rail 0.17%(+)
Bottom 4 Industries	Internet Soft & Svcs -0.39%(-)	NA	Internet Soft & Svcs -0.39%(-)
	Biotechnology -0.38%(-)	NA	Biotechnology -0.28%(-)
	Comm Svcs & Supp -0.25%(+)	NA	Insurance -0.21%(+)
	Hlth Care Prov&Svcs -0.22%(+)	NA	Banks -0.18%(+)

*Attribution is based on daily returns, although the portfolios are rebalanced monthly. Therefore, there may be a small contribution from styles or industries in the constrained portfolios as exposures drift intra-month.
Note: "+" or "-" next to the factor indicates an overweight or underweight position in the Unconstrained portfolio.
Source: FTSE Russell, Axioma

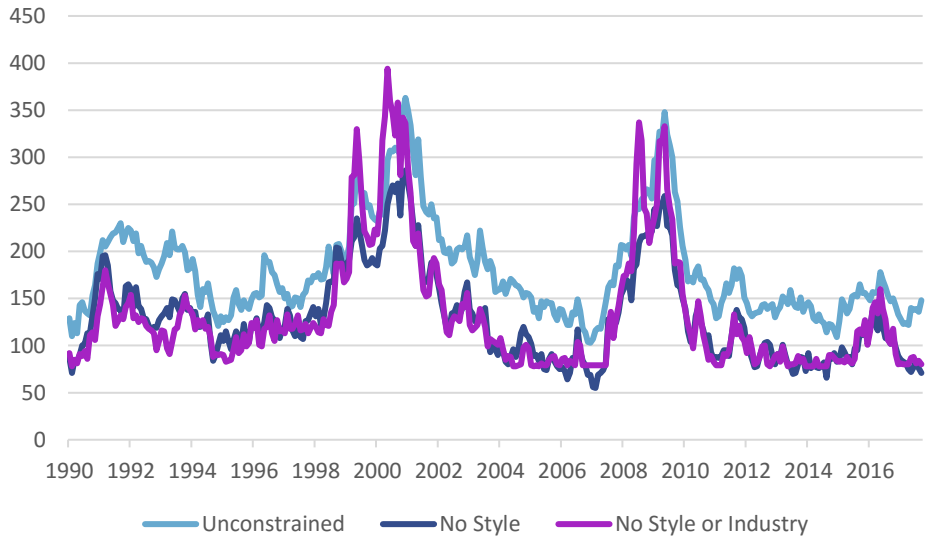
Conclusion

Imposing relatively simple constraints can considerably change the nature of a portfolio relative to an unconstrained version[11]. We have demonstrated how constraining industry and/or style exposures can drive big disparities in risk contribution, active weights and contributions to risk, portfolio beta and total risk, even the number of names. The amount of Momentum exposure for a given level of risk also declines as constraints are added. Investors who want to maximize Momentum exposure should be very careful about the constraints they impose. Finally, the Momentum exposure and its contribution to risk varies substantially over time based on market conditions, and an investor in this type of strategy may not even realize it.

These differences, in turn, are likely to drive sometimes substantial variation in performance. Most institutional portfolios add additional constraints, such as limits on liquidity and trading, on top of the few we illustrated, which likely serve to drive even bigger differences in returns. And as constraints move the portfolio away from the desired factor, that risk vacuum may be filled with specific risk, which is not what the factor-based manager intends.

Examining the characteristics of an unconstrained strategy can also help us understand performance drivers—past and possibly future—of a factor-tilted portfolio. Our unconstrained Momentum portfolio has seen its Earnings Yield and Value exposures drop, suggesting this strategy may be moving toward being overvalued. At the same time, it is increasing in Profitability and Growth, so perhaps those factors can offset some of the potential drag from valuation. We have also seen what appears to be a secular decline in exposure to Exchange Rate Sensitivity, going from positive to negative, suggesting that we may be seeing a shift from importers to exporters having Momentum. These may all be influences of which a typical model user is unaware of, but perhaps should be.

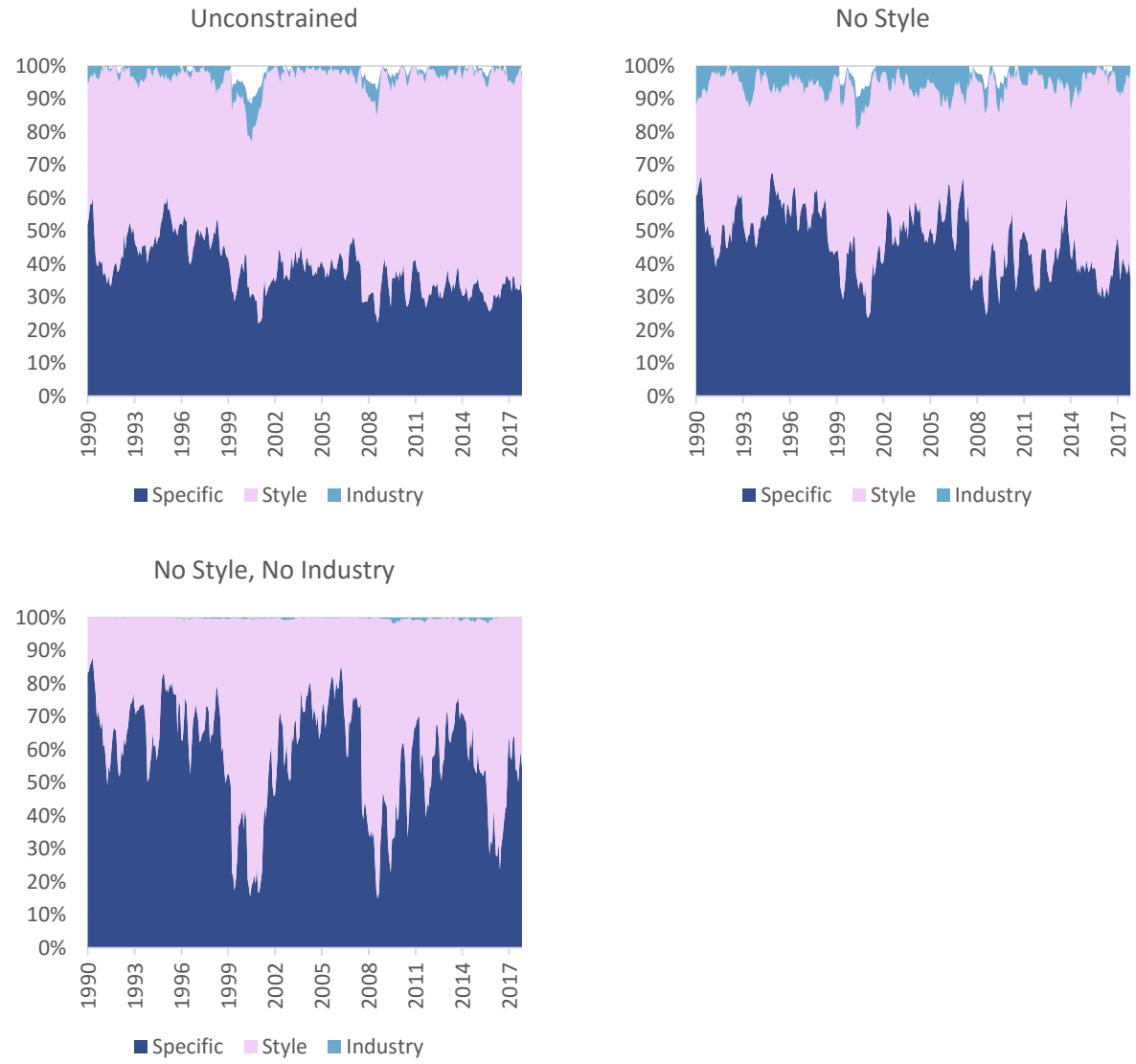
Appendix 1: Number of Names Through Time



Source: FTSE Russell, Axioma

[11] Of course, one of the biggest drivers of difference relative to a Factor-Mimicking portfolio, the "purest" expression of a factor, is a long-only constraint, but we do not cover the impact of that constraint in this paper.

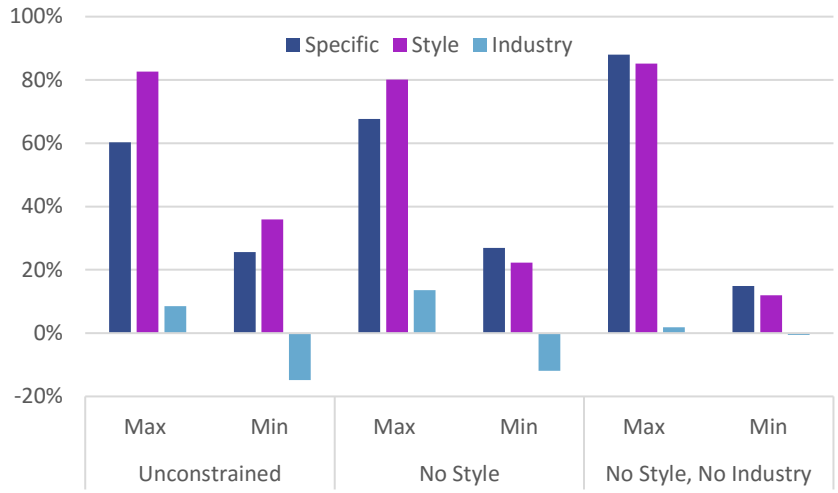
Appendix 2: Decomposition of Risk Through Time



Source: FTSE Russell, Axioma

These charts represent the time series of the factor block's overall contribution to overall portfolio risk, with the covariance between the factors distributed across them. Note that when these area charts do not add to 100 it is the result of a negative contribution to risk, or the diversifying impact, of a factor block. For these portfolios, only industry risk served to diversify the risks from the other factors.

Appendix 3. Range of Risk Contributions from Each Block



Source: FTSE Russell, Axioma