Deutsche Bank
Markets Research

Global

Quantitative Strategy
Factor Monitor

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Introducing our Global Factor Monitor

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Looking Under the Hood of Rewarded Equity Factors

This note introduces our factor monitor which will provide ongoing updates on the state of quantitative equity factors that are typically present in multi-factor equity models. By bringing together various threads of research, we are able to provide a differentiated perspective on prospective factor performance enhanced by novel and proprietary metrics. This multifaceted approach reflects the variety of risks that may impact factor performance and should help paint a more detailed picture for investors.

We monitor the following factors which are constructed as composites of a number of underlying metrics as follows:

- **Value:** Earnings Yield, Book to Market, and Dividend Yield
- **Quality:** Return on Equity, Accruals, Asset Turnover, Gross Margin, and Leverage
- **Momentum:** First 11 Month and First 5 Month
- **Low Beta:** 252D Beta to MSCI World
- **Size:** Market Cap

Motivated by our past research, this note will provide an introduction to the various concepts and link to our past papers at the beginning of each section. In the future, this monitor will take the form of an easily digestible chart pack which will evolve with new research and reader feedback.

DB Quant Strategy: Linear Signal Blending (2017)

Building on our recent research on signal blending, these composite factors combine the underlying metrics listed above such that each metric has an equal risk contribution in the composite signal using the asset by asset covariance matrix. We track the performance and characteristics of long – short quintile portfolios constructed on a region- and sector-neutral basis. In addition to recent factor performance, we draw on our past research to highlight key risks and opportunities for each global factor portfolio using a number of relevant

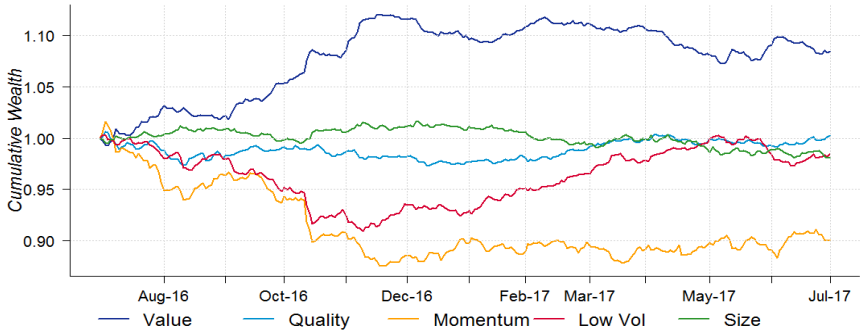
indicators. In each case, the indicators are constructed on a historical-relative basis to facilitate comparisons across factors in a manner devoid of structural biases (e.g. Value almost always looking cheap relative to Quality). We measure the historical relationship between these indicators and near-term future factor performance using regression- as well as regime-based analysis. This helps to potentially capture both linear and non-linear relationships between our indicators and factor performance. We look across the following dimensions:

- **Factor Performance:** the past 12 months has been a tale of two halves. The first half saw investors looking for opportunistic entry points in undervalued names. However, this trend has reversed over the past 6 months with Quality and Low Volatility outperforming, while Value has stagnated.
- **Valuations:** we find informative relationships between valuations and future 1-month performance. Currently, Size is the only factor that appears to be slightly expensive when compared to its 36-month average. However, we find this to be supportive of performance as extreme Valuations for risk based factors may represent things that are "cheap for a reason". Quality's performance has been the least sensitive to valuations over the period, but it has typically performed best while fairly priced.
- **Crowdedness and Liquidity:** Measures of crowdedness and liquidity showed strong non-linear relationships with future performance. In the near to medium term, mild crowding may enhance the performance of some strategies. Factors have generally performed best when they were within normal bands (within 1 standard deviation of their 36-month average).
- **Macroeconomic Environment:** We are currently in a period characterised by positive growth expectations. This has been particularly supportive of pro-cyclical factors such as Value and Size. Though, with the exception of Momentum, all of our factors performed well in similar periods.
- **Market Risk Sentiment:** We are currently in a Low Risk regime as indicated by the DB Global Sentiment Indicator. This regime has been generally supportive of factor based strategies, particularly of Low Volatility and Value, whilst Quality has struggled. Given the Risk On/ Risk Off nature of Value and Quality, we also look at the performance of double sorted tertile portfolios across the different risk sentiment regimes. We find that in the current environment Quality greatly benefits from conditioning on Valuations (i.e. avoiding the most expensive names in a Quality strategy).

Factor Performance Update – Last Twelve Months and Quarter to Date

Value has been the strongest performer over the past twelve months. However, this performance was largely concentrated in the first half of the period with gains flattening out following the "Trump surge" and shifting investor expectations around central bank policy. In 2017, we have seen a return to the more defensive strategies like Low Volatility and Quality which have benefited from slower than anticipated interest rate adjustments and increasing macroeconomic risks globally. Momentum has struggled overall as it has been caught wrong footed by the strong rotation in performance around the start of the year for Value and Low Volatility stocks. For example, Momentum had a daily return correlation with Low Volatility of 55% in 2016, which has reversed to -33% in 2017, just as Low Volatility rallied.

Figure 1: Long-Short Quintile Performance - Last Twelve Months



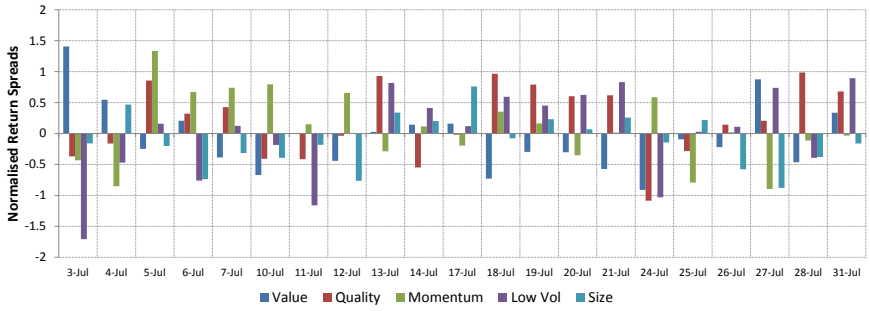
	12M Return	Sharpe Ratio	Hit Rate (%)	Turnover (%)	3M Return	1M Return
Value	8.4%	1.22	58.3%	57.2%	-2.0%	-0.6%
Quality	0.3%	0.11	41.7%	68.6%	0.4%	1.0%
Momentum	-10.0%	-1.38	41.7%	137.9%	0.9%	1.0%
Low Vol	-1.5%	-0.21	50.0%	40.2%	0.7%	0.1%
Size	-2.0%	-0.76	50.0%	32.4%	-1.8%	-0.9%

* Turnover is calculated as two-way turnover

Source: Deutsche Bank, Factset, Worldscope

Looking more closely at the past month of July, we saw that it largely reflected the trends over the entire first half of the year. It was largely a risk off month for investors with Value and Size underperforming Quality. However, it was quite mild in terms of return swings with none of the factors experiencing a return greater than 2 standard deviations relative to their long term history. In the below figure, we look at the normalised return spreads for each strategy. These are the z-scored long-short quintile return spreads relative to their entire history. This makes comparisons across factors with different volatilities more representative.

Figure 2: Standardised Long-Short Quintile Performance - Last Month



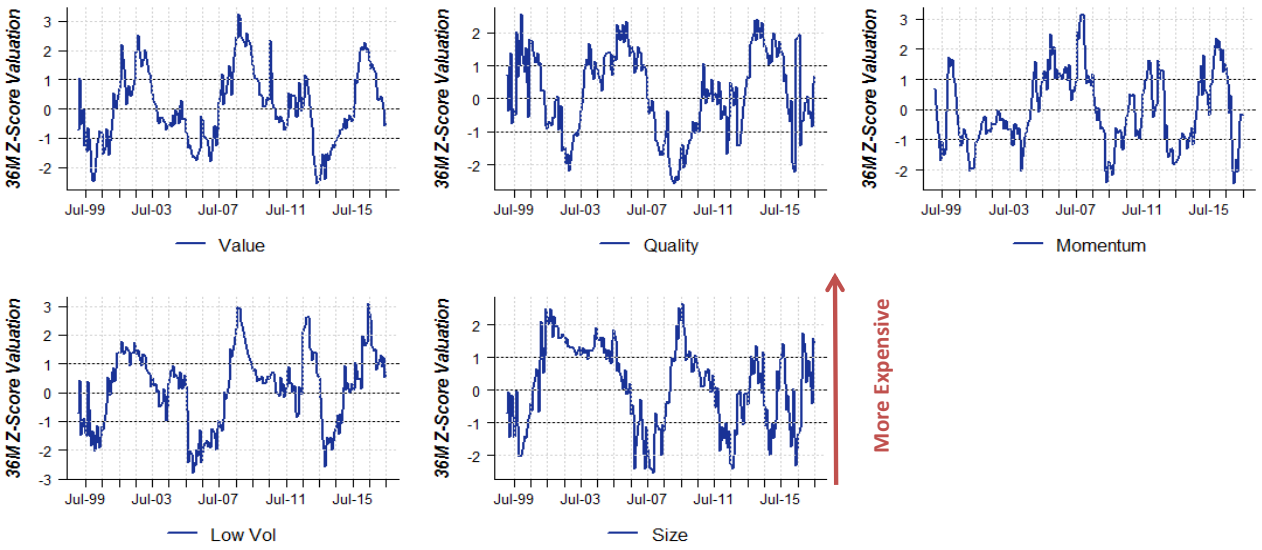
Source:Deutsche Bank, Factset, Worldscope

Factor Valuations

DB Quant Strategy: Strategy Crowding (2016)

Factor valuation analysis helps build a case for possible entry and exit points for the various strategies. We define factor valuations as the spread in median Price-to-Book between the top and bottom quintiles. However, this spread will have structural biases when comparing factors against each other (e.g. Value will almost always look cheap and Quality will almost always look expensive). We convert these to historical relative series by taking the 36-month rolling z-score for each factor to facilitate comparison. We chose 36-months as an intuitive horizon to strike a balance between adaptability to changing investor preferences and stability. We define Cheap/Expensive periods as periods with historical relative valuations of <-1 and >+1 standard deviations respectively from the 36 month mean valuation.

Figure 3: Historical Factor Valuations - 36M Z-Score of Median Price-to-Book Spreads



Source:Deutsche Bank, Factset, Worldscope

The table below shows how the various factors performed relative to their valuations. However, this will be the common framework with which we assess the various indicators. The first section of the table show the current 36-month relative valuation for each factor as well as in which percentile the current value falls versus its entire history. The second section evaluates the linear relationship between valuations and forward 1-month returns. We show the beta and t-statistic from the regression of 1-month forward return spreads on the historical relative valuation spreads. In this case, a negative number indicates that the cheaper a factor is the better its future performance. The following the sections look at the relationship using regime analysis. We consider the annualised average return, annualised Sharpe Ratio, and Hit Rate (defined as the percent of months in the subperiod where the factor generated a positive quintile return spread). Finally, we include the number of periods classified in each regime. The current regime for each factor is highlighted.

For Valuations, we find that Low Volatility exhibits a strong relationship between its valuation and forward 1-month performance ; the cheaper the factor the better it tends to perform going forward. In contrast, we see a similarly strong but inverted relationship for Size and Value; the more expensive the factor the better the forward performance (at least over short horizons such as 1 month). This is consistent with our previous work looking at factor valuations linked above (2016).

Figure 4: Factor Performance and Valuation Spreads

	Value	Quality	Momentum	Low Vol	Size
Current Z-Score Valuations	-0.49	0.70	-0.17	0.73	1.47
Current Z-Score Valuations Percentiles	34%	65%	42%	66%	85%
1-Month Fwd Return Beta to Z-Score Valuations	0.20%	-0.06%	0.04%	-0.21%	0.28%
1-Month Fwd Return T-Stat to Z-Score Valuations	1.69	-1.03	0.20	-2.63	2.75
Annualised Average Return Expensive	11.11%***	1.80%	3.67%	-1.99%	11.41%***
Annualised Average Return Fair	6.37%***	6.98%***	-1.47%	8.76%***	4.93%**
Annualised Average Return Cheap	5.85%	3.59%	12.93%***	7.58%***	-0.73%
Annualised Sharpe Ratio Expensive	1.33	0.55	0.27	-0.28	1.60
Annualised Sharpe Ratio Fair	1.02	1.75	-0.10	1.97	0.73
Annualised Sharpe Ratio Cheap	0.60	0.68	1.54	1.87	-0.12
Hit Rate Expensive	63%	55%	53%	53%	69%
Hit Rate Fair	59%	68%	58%	72%	57%
Hit Rate Cheap	51%	68%	70%	71%	50%
Count of Expensive Periods	54	71	49	58	68
Count of Fair Periods	122	103	125	112	99
Count of Cheap Periods	45	47	47	51	54

Hit Rate = % of Months with Positive Return in Sub-Period
Z-Score Valuations = 36M Z-Score of Median Price-to-Book Spread
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Z-Score versus whole history of Z-Scores
Regimes defined as periods with Z-Score greater than 1 or less than -1

Source:Deutsche Bank, Factset, Worldscope

This divergence, though unintuitive on first look, makes sense in the context of risk and behavioral rationales for each strategy. Size and Value are traditional risk premia that provide exposure to distress and business cycle risk. In certain cases, companies can become "cheap for a reason" as the market enters periods of distress where these strategies typically underperform. This is also reflected in the risk-adjusted performance in the various valuation regimes, which declines as we move from Expensive to Cheap regimes for the Value and Size factors. The relationship between Valuations and forward returns for Value and Size reverses over longer horizons, 18 to 24 months.

On the other hand, Low Volatility is more anomalous with explanations that do not typically appeal to compensation for risk. This implies that divergences in valuation are not likely to be driven by risk and thus should be more transient, making for a better short term indicator. This is evident from positive and statistically significant returns of the Low Volatility factor in the Cheap and Fair regimes.

We see that Quality has historically performed best when fairly priced. As far as Momentum is concerned, whilst Valuations haven't been strong indicators of performance across the whole time-series, we find that Momentum has outperformed on average when it has been relatively cheap compared to its history.

Crowding & Liquidity

DB Quant Strategy: Strategy Crowding (2016)

DB Quant Strategy: Building a Liquidity based Toolkit (2016)

Crowding is a concept that is often ill-defined, despite being a common concern. In our experience, investors often have trouble articulating what exactly they mean by crowding. Though, many claim to "know it when they see it" (often with hindsight). That isn't to say we don't believe that crowding is a risk. However, it is important to have a clear notion of what one is trying to measure.

- **Investor Preferences:** grassroots measures of crowding such as short interest provide direct measures of crowding that reflect investor positioning. We believe these types of measures most closely align with the fundamental intuition of a crowding definition (concentrated positioning by investors with similar preferences).
- **Statistical Measures:** heightened asset correlations within a portfolio are often assumed to be a symptom of crowding. For example, this can be driven by investors trading stocks based on exposure to exogenous shocks (e.g. macro trades) or the proliferation of quant managers buying lists of stock with similar attributes. This potentially leads to higher risk by eroding the benefits of diversification.
- **Herding:** describes the phenomenon where investors move to similar investments because others are investing in those stocks. This can cause a positive feedback loop leading to trend chasing that may ultimately destabilize the price setting process. We measure the saturation of each strategy via the overlap in positions with the long and short legs of Momentum which may be at a higher risk of herding.
- **Strategy Liquidity:** Investors commonly conflate crowding and liquidity. This is because the likelihood of a "crowded" exit may increase if there is not sufficient liquidity for participants to easily close positions. This can be thought of as resulting from individual stock characteristics or symptomatic of market level liquidity shocks.

While these are distinct concepts, we find it useful to consider them in tandem given the possible interaction between metrics, particularly crowding and

liquidity. The use of multiple metrics helps to build a more informative mosaic about the prospects of each factor.

Crowding measures can be defined for our measures of investor preference using a cross sectional regression of the following form:

Figure 5: Incremental Crowding Regression

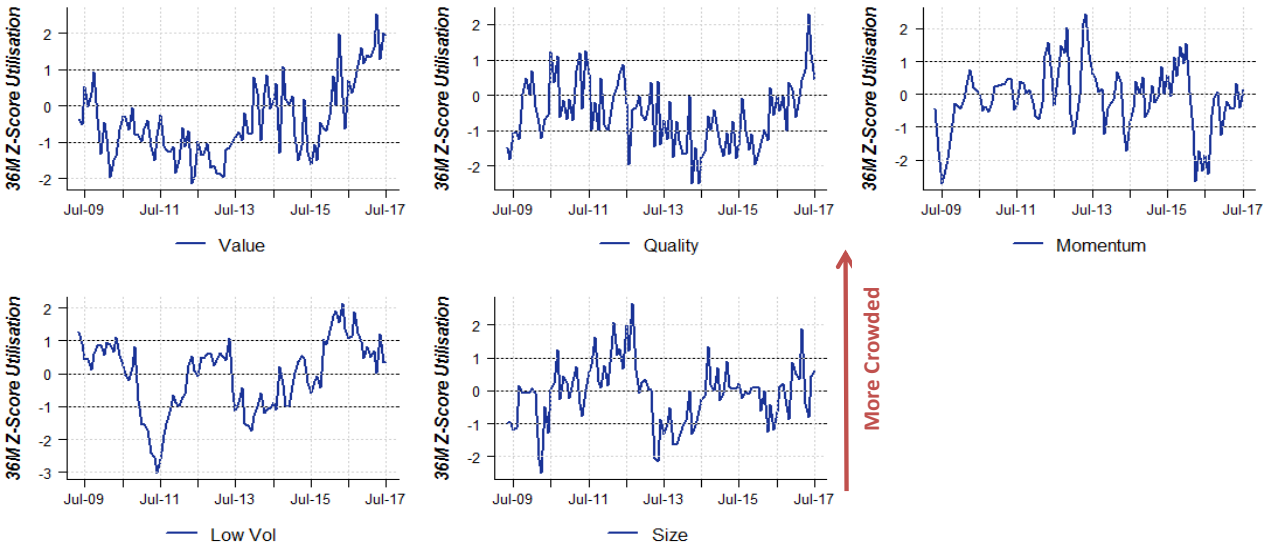
$$C_{i,t} = c + \sum_{j=1}^{J}\sum_{Q=2}^{Q} \beta_{t,j,q} D_{i,t,j,q} + \sum_{Q=2}^{Q} \beta_{t,size,q} D_{i,t,size,q} + \sum_{Q=2}^{Q} \beta_{t,vol,q} D_{i,t,vol,q}$$

Source: Deutsche Bank

where Ci,t is the crowdedness score (e. g., short interest) for stock i at time t. Di,t, j,q is a dummy variable that indicates whether stock i is in the q -th quantile of factor j at time t. Di,t,size,q and Di,t,vol,q are dummy variables indicating whether stock i is in the q -th quantile of the size and volatility factors at time t. In our analysis, we omit the lowest quantile from the dummy variables. Hence by tracking the beta coefficient for our short quintile over time, we can measure the spread between the long and short legs of our factor on the crowdedness variable (short interest, ownership, etc..) after controlling for other quant factors (e.g. size, volatility, etc.).

For this exercise, we employ data from the securities lending market as in the literature (Hanson and Sunderam 2011). We use the active utilisation ratio as our crowdedness metric of choice. This is a useful metric as it takes into account both the supply and demand for shorting in a given security. It is defined as the percentage of short interest compared to the lendable supply. In our case, the beta coefficient on Di,t, j,q thus represents the spread between the qth quintile (eg, Expensive quintile for Value factor) and the top quantile of Value (eg. cheap Value quintile). Thus, if expensive stocks are more heavily shorted than cheap stocks at a given point in time, then this might indicate that institutional investors (who are more likely to short) are heavily invested in Value.

Figure 6: Historical Active Utilisation- 36M Z-Score of Utilisation Regression Coefficient



Source: Deutsche Bank, Factset, Markit, Worldscope

Currently, we find Value to be historically crowded in terms of elevated Active Short Interest Utilisation (at the 98th percentile of the 36-month z-score over the whole history) . However, we find mixed evidence as to the relationship of this type of crowding with future 1-month performance . For Size, Momentum, and Low Volatility factors, crowdedness - as defined above - leads to lower expected short-term performance (over the following month) compared to periods when the factors do not appear to be crowded. For Value and Quality the evidence is more mixed, and consistent with our work in 2016 which found the relationship to be non-linear such that, in the near to medium term, mild crowding may in fact enhance the performance of some strategies.

Figure 7: Factor Performance and Active Utilisation

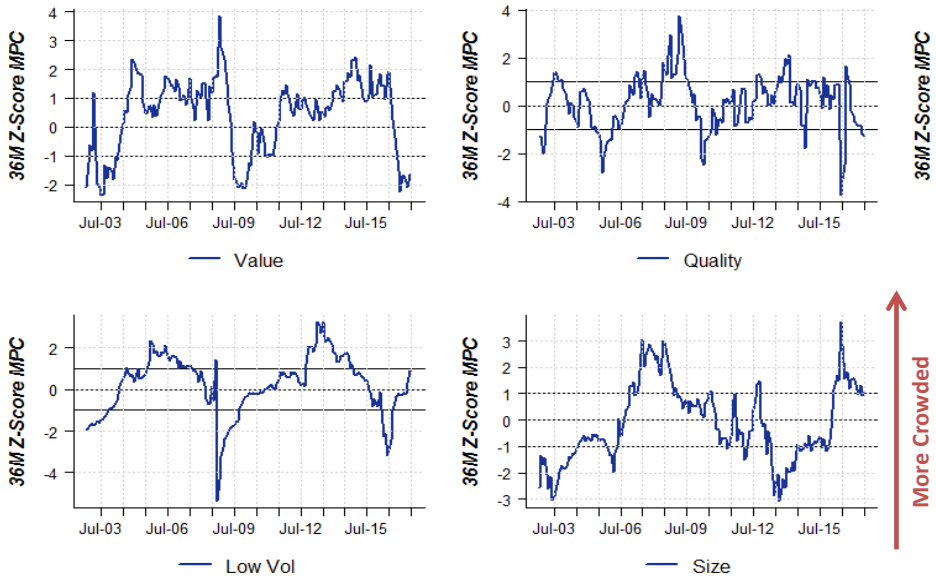
	Value	Quality	Momentum	Low Vol	Size
Current Z-Score Utilisation	1.95	0.46	0.12	0.34	0.60
Current Z-Score Utilisation Percentiles	98%	76%	63%	71%	81%
1-Month Fwd Return Beta to Z-Score Utilisation	0.08%	0.09%	0.05%	-0.01%	-0.18%
1-Month Fwd Return T-Stat to Z-Score Utilisation	0.62	0.82	0.18	-0.04	-1.42
Annualised Average Return Crowded	2.39%	2.59%	-2.16%	3.71%	-4.61%
Annualised Average Return Normal	2.95%	3.11%*	3.74%	7.08%***	2.09%
Annualised Average Return UnCrowded	1.51%	0.05%	4.37%	6.36%*	6.92%*
Annualised Sharpe Ratio Crowded	0.41	1.01	-0.27	0.54	-1.54
Annualised Sharpe Ratio Normal	0.70	0.90	0.44	1.66	0.52
Annualised Sharpe Ratio UnCrowded	0.34	0.02	0.37	1.41	1.59
Hit Rate Crowded	45%	50%	36%	53%	40%
Hit Rate Normal	55%	60%	63%	69%	53%
Hit Rate UnCrowded	47%	50%	69%	67%	61%
Count of Crowded Periods	11	6	11	15	10
Count of Normal Periods	55	58	71	62	70
Count of UnCrowded Periods	32	34	16	21	18

Hit Rate = % of Months with Positive Return in Sub-Period
Z-Score Utilisation = 36M Z-Score of Incremental Active Utilisation
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Z-Score versus whole history of Z-Scores
Regimes defined as periods with Z-Score greater than 1 or less than -1

Source: Deutsche Bank, Factset, Markit, Worldscope

Mean Pairwise Correlation (MPC) is the average of all pairwise correlations between the stocks that comprise a portfolio at each point in time. The correlations are calculated using a rolling 5-year window with an EWMA half-life of 2 years. This measure captures the tendency of stocks to move together. If the MPC for a particular strategy is much higher than its history, it could indicate that investors are trading these stocks as a "group" instead of differentiating between them based on stock-level information. We look at the MPC for each factor on a long – short basis.

Figure 8: Historical Mean Pairwise Correlation- 36M Z-Score of Mean Pairwise Correlation Spread



Source:Deutsche Bank, Factset, Worldscope

With the exception of Value, we see that all factors have generated positive and statistically significant returns in "normal periods". We have seen Mean Pairwise Correlations for Value stay subdued since the start of the year with higher crowding on the short side. We have seen two similar periods for Value, the period following the Early 2000s recession and the period following the Global Financial Crisis. Value has performed particularly well in these periods with a strong Information Ratio and a Hit Rate % of around 75%. Quality has just fallen into the crowded short regime. However, like with its Valuations, it has performed best when it isn't extremely sought after or ignored. Size is the only factor which currently appears crowded on the long side by this measure. This has been a strong indicator for the Size factor historically both over the full time series and in terms of regime specific performance. Small cap names tend to provide alpha opportunities because they are less informationally efficient. However, these are masked when they are traded as a group which has led to underperformance.

Figure 9: Factor Performance and Mean Pairwise Correlation

	Value	Quality	Momentum	Low Vol	Size
Current Z-Score MPC	-1.63	-1.25	0.92	0.88	1.08
Current Z-Score MPC Percentiles	11%	16%	71%	69%	75%
1-Month Fwd Return Beta to Z-Score MPC	-0.01%	-0.09%	0.43%	0.03%	-0.22%
1-Month Fwd Return T-Stat to Z-Score MPC	-0.11	-1.23	2.00	0.37	-2.45
Annualised Average Return Crowded	7.59%***	-0.21%	5.51%	5.59%**	-3.26%
Annualised Average Return Normal	-0.87%	3.75%***	5.54%**	6.81%***	6.62%***
Annualised Average Return UnCrowded	7.49%**	1.55%	-10.79%	4.65%	7.93%***
Annualised Sharpe Ratio Crowded	1.10	-0.04	0.85	0.97	-0.50
Annualised Sharpe Ratio Normal	-0.16	1.21	0.66	1.45	1.03
Annualised Sharpe Ratio UnCrowded	1.60	0.49	-0.48	0.72	1.45
Hit Rate Crowded	60%	55%	63%	67%	47%
Hit Rate Normal	40%	65%	63%	71%	60%
Hit Rate UnCrowded	74%	48%	45%	66%	58%
Count of Crowded Periods	72	38	32	52	43
Count of Normal Periods	70	113	111	95	81
Count of UnCrowded Periods	34	25	33	29	52

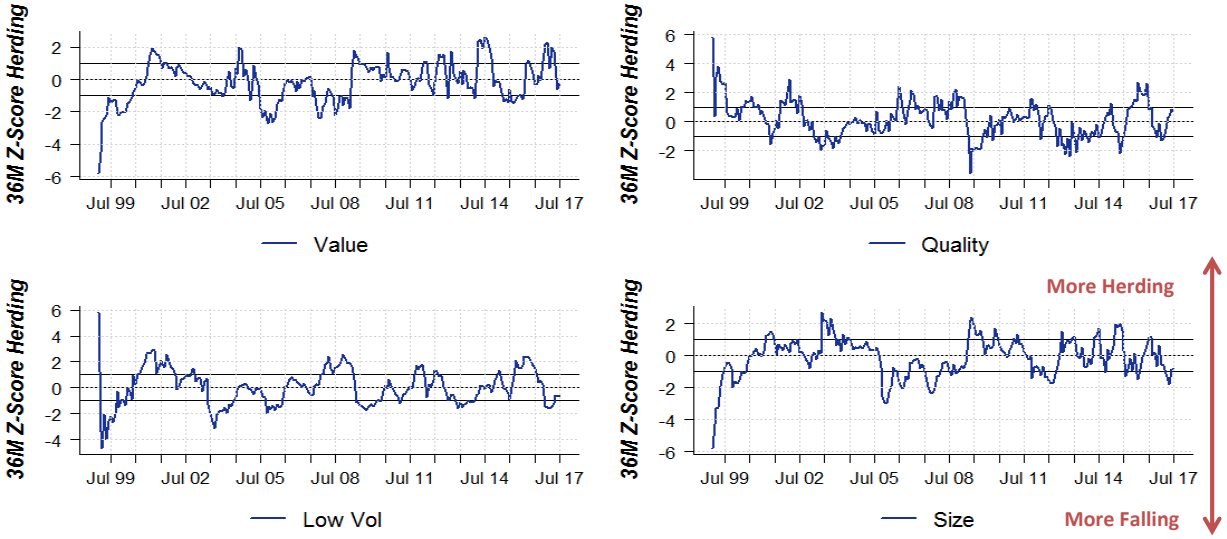
Hit Rate = % of Months with Positive Return in Sub-Period
Z-Score MPC= 36M Z-Score of Mean Pairwise Correlation
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Z-Score versus whole history of Z-Scores
Regimes defined as periods with Z-Score greater than 1 or less than -1

Source:Deutsche Bank, Factset, Worldscope

Investor Herding describes the phenomenon where investors behave in a similar manner and tend to invest in stocks already held by their peers. This can cause a positive feedback loop that may ultimately destabilize the price setting process and lead to unwarranted and rapid price appreciation, followed by crashes. Measures of herding often look at the behavior of institutional investors by comparing the number of net buyers and net sellers in the preceding period. However, we take a slightly broader definition taking into account price pressures from all market participants by looking at momentum saturation.

We define momentum saturation for a portfolio of stocks as the percentage of names in the portfolio that also appear in the Long Momentum quintile minus the percentage of names found in the Short Momentum quintile at a given point in time. This reflects that stocks can "herd" both positively or negatively if investors are buying or selling the stock in unision. We calculate this measure for both the long and short legs of a factor respectively. Finally, we take the 36-month z-score of the long minus short difference in momentum saturation. This gives us a view if a factor has a higher exposure to positive (herding) or negative (falling) herding names.

Figure 10: Historical Herding - 36M Z-Score of Excess Momentum Portfolio Overlap



Source:Deutsche Bank, Factset, Worldscope

Returns are positive and statistically significant in periods for all factors in "normal" periods. We find that Quality outperforms when it has a higher exposure to names that are positively herding. This can be seen in the regime analysis where it produces the highest risk-adjusted returns in the herding regime (36-month z-score of herding > 1 standard deviation from the mean). We see Size also benefits from positive herding at more extreme levels generating a Sharpe Ratio nearly twice that of periods where it is not herding. On the other hand, Value performs best when it is not influenced by positive or negative herding. In essence, Value is able to exploit mispricings when the stocks in each log of the portfolio are more likely exhibiting mean reverting behaviour rather than trending.

Figure 11: Factor Performance and Investor Herding

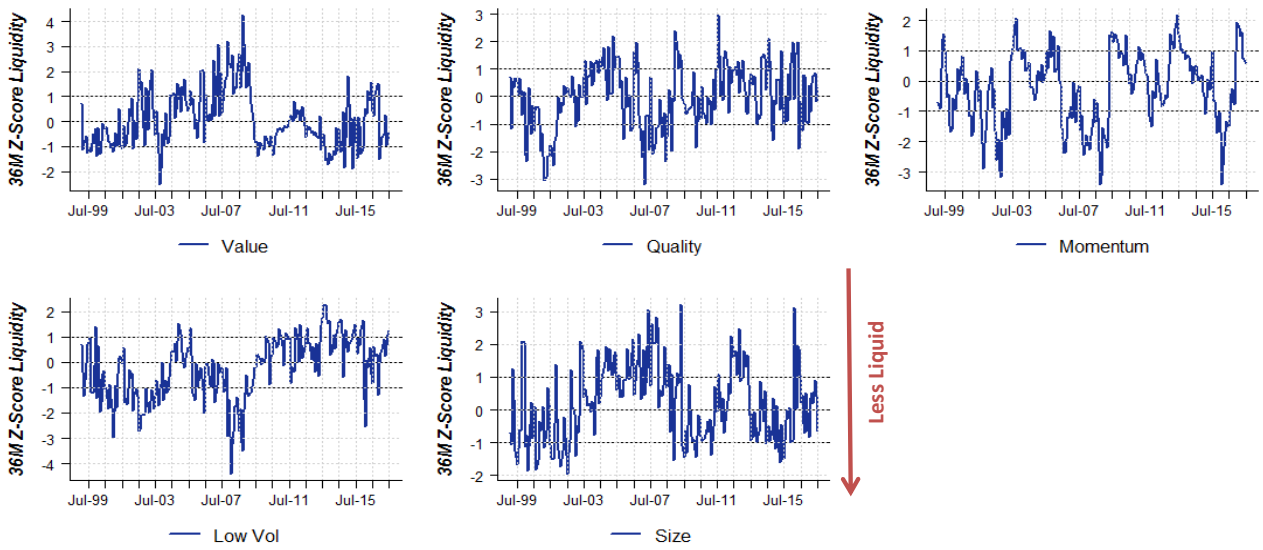
	Value	Quality	Low Vol	Size
Current Z-Score Herding	-0.21	0.70	-0.59	-0.88
Current Z-Score Herding Percentiles	43%	72%	32%	26%
1-Month Fwd Return Beta to Z-Score Herding	0.10%	0.18%	-0.11%	0.08%
1-Month Fwd Return T-Stat to Z-Score Herding	0.81	2.89	-1.46	0.70
Annualised Average Return Herding Up	5.92%	8.43%***	1.88%	7.06%**
Annualised Average Return Normal	9.98%***	4.57%***	5.47%***	5.31%**
Annualised Average Return Herding Down	2.22%	0.51%	9.53%***	4.59%
Annualised Sharpe Ratio Herding Up	1.00	1.69	0.25	1.45
Annualised Sharpe Ratio Normal	1.48	1.14	1.18	0.73
Annualised Sharpe Ratio Herding Down	0.22	0.16	2.31	0.67
Hit Rate Herding Up	52%	65%	64%	67%
Hit Rate Normal	65%	65%	65%	56%
Hit Rate Herding Down	46%	58%	74%	60%
Count of Herding Up Periods	33	52	53	39
Count of Normal Periods	135	130	111	135
Count of Herding Down Periods	54	40	58	48

Hit Rate = % of Months with Positive Return in Sub-Period
Z-Score Herding = 36M Z-Score of Herding Indicator
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Z-Score versus whole history of Z-Scores
Regimes defined as periods with Z-Score greater than 1 or less than -1

Source:Deutsche Bank, Factset, Worldscope

Liquidity Intensity is measured by Turnover which is calculated as the ratio of trading volume to shares outstanding. From a stock-level characteristics perspective, liquidity is the ability to trade an asset quickly, at low cost, and with limited price impact. High turnover reflects an active market of both buyers and sellers for the stock which would facilitate trading. We find this to be a better measure than trading volume as it is more size-neutral given that small-cap and large-cap stocks can have both low and high turnover rates. Like Valuations, we look at the spread in median Turnover between the long and short legs for each factor. We find this indicator to be somewhat noisy from period to period.

Figure 12: Historical Liquidity- 36M Z-Score of Excess Momentum Portfolio Overlap



Source:Deutsche Bank, Factset, Worldscope

Other than Momentum, we see that all of these factors perform well in normal liquidity ranges. However, we do see that Size and Low Volatility tend to outperform when they are rather liquid. Quality on the other hand has outperformed in periods where it is more illiquid or within normal historical liquidity ranges. This seems to result from high Quality stocks being less actively traded in turbulent markets, e.g. early 2000s Recession and Global Financial Crisis. This also explains why it is not a linear relationship. Investors preferred to hold on to these names as they became more attractive uniformly across market participants, driving up prices with relatively limited liquidity compared to its history.

Figure 13: Factor Performance and Liquidity Intensity

	Value	Quality	Momentum	Low Vol	Size
Current Z-Score Liquidity	-0.47	0.34	0.58	1.23	-0.63
Current Z-Score Liquidity Percentiles	37%	61%	69%	85%	33%
1-Month Fwd Return Beta to Z-Score Liquidity	-0.03%	-0.11%	0.33%	0.06%	0.05%
1-Month Fwd Return T-Stat to Z-Score Liquidity	-0.24	-1.62	1.49	0.72	0.45
Annualised Average Return Liquid	6.86%	1.70%	5.85%	5.37%*	6.14%**
Annualised Average Return Normal	7.48%***	4.7%***	2.95%	7.48%***	5.8%***
Annualised Average Return Illiquid	7.92%	6.9%**	0.35%	2.36%	3.55%
Annualised Sharpe Ratio Liquid	0.76	0.38	0.94	1.20	0.91
Annualised Sharpe Ratio Normal	1.15	1.17	0.29	1.61	0.84
Annualised Sharpe Ratio Illiquid	0.87	1.68	0.02	0.35	0.51
Hit Rate Liquid	59%	68%	62%	69%	62%
Hit Rate Normal	60%	64%	60%	69%	59%
Hit Rate Illiquid	53%	61%	58%	63%	53%
Count of Liquid Periods	49	40	37	32	58
Count of Normal Periods	134	137	124	124	129
Count of Illiquid Periods	38	44	60	65	34

Hit Rate = % of Months with Positive Return in Sub-Period
Z-Score Liquidity = 36M Z-Score of Median Turnover Spread
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Z-Score versus whole history of Z-Scores
Regimes defined as periods with Z-Score greater than 1 or less than -1

Source:Deutsche Bank, Factset, Worldscope

Macro Environment and Market Risk Sentiment

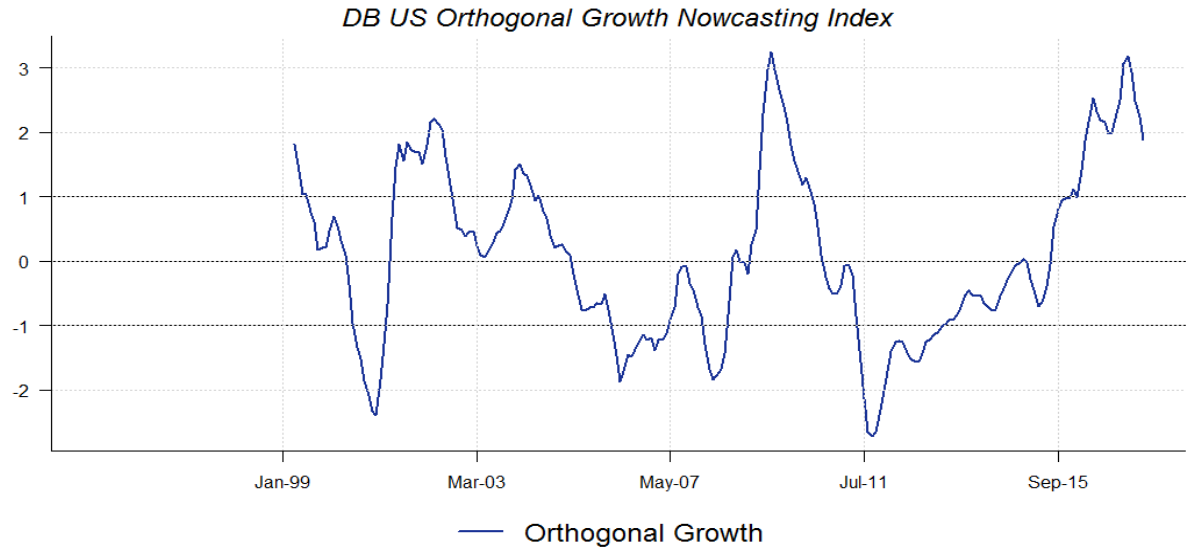
DB Quant Strategy: Delving Into New Territories (2015)

DB Quant Strategy: Quantcraft - Switching Styles (2012)

Macro Environment

We look at historical strategy performance in periods with similar macroeconomic growth and sentiment characteristics. We use our derived US Orthogonal Growth Nowcasting index. This indicator combines a number of representative series via Principle Component Analysis to extract the latent growth factor. We first generate two growth series that differentiate between hard data (e.g. GDP growth) and soft data (e.g. Surveys). We then regress the soft data on the hard data to extract the residual information contained in the soft data not already present in the hard data. This residual has been shown to be predictive of future changes in economic activity. More details can be found in our paper Natividade and Anand (2015) linked above. We choose to use the US nowcasting indices instead of other regional variants in line with the literature. Beber et al [2014] found that equity indices are more responsive to US growth indicators than they are to global data or even growth indicators from their own countries (specifically, Europe, Japan and the UK).

Figure 14: DB Nowcasting Macroeconomic Growth



Source: Deutsche Bank, Bloomberg Finance LP

We split our data into Growth and Contraction regimes based on whether the Orthogonal Growth Index is above or below 0 respectively. We saw a spike in the index following the US election reflecting expectations from the soft data that there would be an acceleration in economic growth. This indicator has "cooled" since peaking in March as global macroeconomic conditions have become less certain. However, we are still in a Growth regime where the forward looking indicators are bullish on continued economic growth, even if at a slower pace. These growth periods have historically provided a strong backdrop for more pro-cyclical factors like Value and Size. Low Volatility and Quality have both been less sensitive to the real macroeconomic environment, though they are influenced by macro sentiment as we will see below.

Figure 15: Factor Performance and Macroeconomic Growth

	Value	Quality	Momentum	Low Vol	Size
Annualised Average Return Growth	9.99%***	5.35%***	0.56%	6.19%***	8.31%***
Annualised Average Return Contraction	4.51%*	3.93%***	5.96%*	5.28%***	2.36%
Annualised Sharpe Ratio Growth	1.24	1.10	0.03	1.06	1.12
Annualised Sharpe Ratio Contraction	0.64	1.17	0.63	1.07	0.40
Hit Rate Growth	68%	64%	58%	70%	65%
Hit Rate Contraction	49%	64%	63%	65%	52%
Count of Growth Periods	106	106	106	106	106
Count of Contraction Periods	113	113	113	113	113

Hit Rate = % of Months with Positive Return in Sub-Period
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current Orthogonal Growth Score
Regimes defined as periods with Orthogonal Growth Score above/below 0

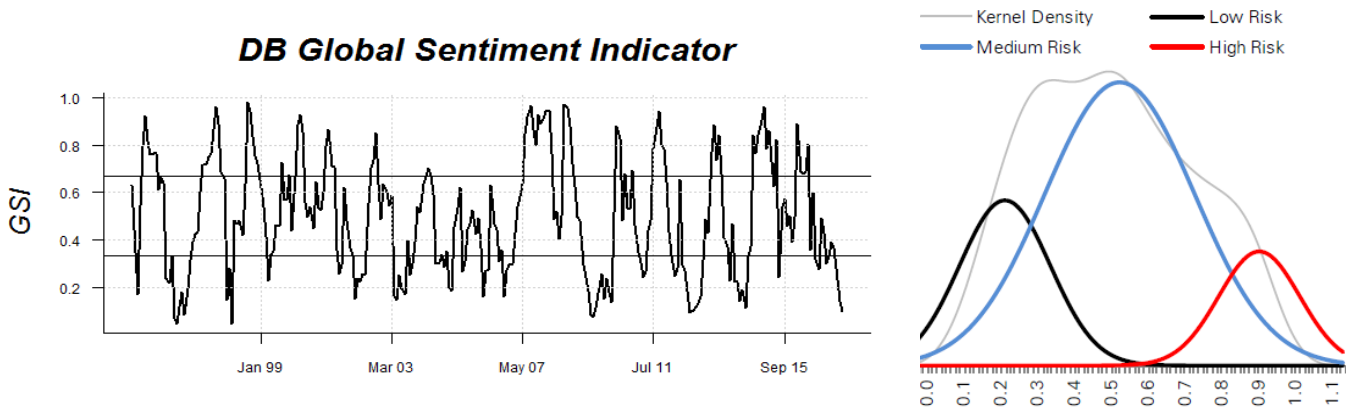
Source:Deutsche Bank, Factset, Worldscope, Bloomberg Finance LP

Risk Sentiment Environment

We also use our Global Sentiment Indicator to capture market risk appetite. As with the nowcasting index, this indicator combines a number of representative series via Principle Component Analysis to extract the latent factor, market

sentiment. A Gaussian mixture decomposition of the GSI's empirical distribution pointed to the existence of 3 distinct regimes of risk appetite – low, medium and high risk – as consistent with its tri-modal kernel density. Over the past 27 years the GSI has spent roughly 33% of the time in low risk, 40% in the intermediate regime, and the remaining in the high risk regime. Figure 52 plots this historical distribution. We define our regimes as High Risk as GSI > 2/3, Low Risk as GSI <=1/3, and Medium Risk as 1/3 <=GSI<= 2/3.

Figure 16: Market Risk Sentiment - DB Global Sentiment Indicator



Source: Deutsche Bank, Bloomberg Finance LP

We are currently in a Low Risk regime as indicated by the GSI which, like growth, has been supportive of factor based strategies in general. However, there are certain factors which appear more sensitive to market risk appetite. In particular, we see that risk regimes monotonically impact the performance of Value and Size, with the current regime having been the most supportive for both factors historically. Interestingly, Low Volatility has experienced its best performance in terms of risk adjusted returns and hit rate in Low Risk regimes. However, Quality seems to derive the majority of its outperformance in High Risk regimes reflecting flight to Quality episodes.

Figure 17: Risk Sentiment Regimes and Performance

	Value	Quality	Momentum	Low Vol	Size
Annualised Average Return High Risk	2.53%	7.00%***	8.82%	4.27%*	-0.67%
Annualised Average Return Medium Risk	8.09%**	4.19%***	0.51%	4.09%**	7.1%**
Annualised Average Return Low Risk	10.75%***	3.61%**	0.48%	8.9%***	8.32%***
Annualised Sharpe Ratio High Risk	0.32	1.75	0.67	0.77	-0.11
Annualised Sharpe Ratio Medium Risk	0.93	0.97	0.03	0.71	0.91
Annualised Sharpe Ratio Low Risk	2.06	0.88	0.06	1.98	1.52
Hit Rate High Risk	47%	71%	64%	60%	48%
Hit Rate Medium Risk	58%	60%	62%	63%	59%
Hit Rate Low Risk	69%	63%	52%	77%	66%
Count of High Risk Periods	58	58	58	58	58
Count of Medium Risk Periods	93	93	93	93	93
Count of Low Risk Periods	71	71	71	71	71

Hit Rate = % of Months with Positive Return in Sub-Period
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current GSI Score vs History
Regimes defined as periods with GSI High = >2/3,Low =<1/3,Medium Rest

Source:Deutsche Bank, Factset, Worldscope, Bloomberg Finance LP

Given the Risk On/Risk Off relationship between Value and Quality, we also look at the performance of double sorted tertile portfolios across risk regimes. In Low Risk Periods, we see some limited ability to refine our value strategy tertile (long leg) by conditioning on Quality. However, we see a much larger impact for Quality when conditioned on Value with Cheap & High Quality Names generating an Information Ratio of 1.54 compared to an Information Ratio of only 0.89 for Expensive & High Quality names in Low Risk environments .

Figure 18: Risk Sentiment and Value/Quality Conditional Performance

	Expensive & Low Quality	Cheap & Low Quality	Expensive & High Quality	Cheap & High Quality
Annualised Average Return High Risk	-3.02%	-0.80%	2.56%	4.96%
Annualised Average Return Medium Risk	6.74%	13.86%**	11.76%**	15.85%***
Annualised Average Return Low Risk	6.40%	16.13%***	10.56%**	18.58%***
Annualised Sharpe Ratio High Risk	-0.16	-0.04	0.15	0.29
Annualised Sharpe Ratio Medium Risk	0.42	0.75	0.81	1.05
Annualised Sharpe Ratio Low Risk	0.44	1.17	0.89	1.54
Hit Rate High Risk	52%	53%	55%	57%
Hit Rate Medium Risk	57%	65%	59%	67%
Hit Rate Low Risk	61%	75%	61%	77%
Count of High Risk Periods	58	58	58	58
Count of Medium Risk Periods	93	93	93	93
Count of Low Risk Periods	71	71	71	71

Hit Rate = % of Months with Positive Return in Sub-Period
***,**,* represent 1%, 5%, and 10% significance levels
Current Percentile = Percentile of current GSI Score vs History
Regimes defined as periods with GSI High = >2/3,Low =<1/3,Medium Rest

Source:Deutsche Bank, Factset, Worldscope, Bloomberg Finance LP

Conclusions

In this note, we walked through a number of metrics that represent relevant risks for factor investors. These relationships seem to be particularly impactful when they diverge significantly from historical norms. This was a consistent theme highlighted in our regime analysis of each indicator. Interestingly, we also found that not all indicators meant the same thing for all factors.

Pro-cyclical factors like Value and Size performing best when they are relatively expensive given that they may be "cheap for a reason" at extreme levels. This was in opposition to Low Volatility and Momentum which performed best with support from Valuations.

Measures of crowdedness and liquidity showed strong non-linear relationships with future performance. In the near to medium term, mild crowding may enhance the performance of some strategies. With a few exceptions, factors have performed best when they were within normal bands (within 1 standard deviation of their mean).

Our proprietary measures of Macroeconomic Growth and Market Risk Sentiment effectively differentiate periods of strong factor performance. We find that positive Growth Regimes are broadly supportive of factor investing. However, we see stark differences in factor performance with respect to Risk Sentiment. We find that pro-cyclical factors Value and Size perform best in Low Risk environments. However, Quality derives much of its value in High Risk regimes reflecting flights to Quality.

Appendix 1

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