Deutsche Bank
Markets Research

North America

Quantitative Strategy
The Quant View

Date
4 May 2018

Improving Beta Estimation for Betting-Against-Beta Strategies

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Beta Decomposition: Correlation and Volatility

A stock's sensitivity to the market, or beta, is one of the most widely used metrics for security analysis. Beta is typically measured using historical sensitivities to market returns over a trailing period. In this report, we providing insight on how to better estimate betas by first decomposing beta into its correlation and volatility components and examining different signal construction decisions for each component (look-back window, frequency of the data). We also provide some novel evidence regarding the historical performance of the Betting-Against-Beta (BAB) strategy and how levering betas is related to the low volatility anomaly.

Improving Betas for BAB

The BAB strategy involves taking long, levered positions in low beta stocks and short, less levered positions in high beta stocks. As we show, altering signal construction decisions lead to estimation of ex-ante betas that more closely match ex-post betas and subsequently improve risk-adjusted returns for a BAB strategy by approximately 15%.

Source: Getty Images

Deutsche Bank Securities Inc.
Distributed on: 04/05/2018 18:27:11 GMT

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The Low Beta Anomaly

The Low beta strategy is based on the premise that the portfolio of high beta stocks will have greater exposure to the market when compared to the portfolio of low beta stocks enabling an investor to lever the low beta portfolio (i.e. invest more than a $1) and/or de-lever the high beta portfolio (i.e. invest less than $1) to have the same market exposure.

For example, let's say we split stocks into two portfolios based on beta, and the low beta portfolio has an average weighted of beta is 0.5 and the high beta portfolio has a beta is 1.5. Then the "Betting-Against-Beta" (BAB) strategy popularized by Frazzini and Pedersen (2014) dictates that an investor invest 3x the capital in low beta stocks relative to high beta stocks. The resulting long/ short market exposure (assuming the ex-post realized betas match the ex-ante betas) is 0.5 x 3 – 1.5 = 0. The findings in their paper relative to standard asset pricing theory is disturbing – if beta is a priced risk factor, high beta stocks should have three times the return of low beta stocks and this non-linear strategy should produce zero expected returns.

There are two pre-conditions for the BAB strategy to generate higher risk-adjusted returns. First, ex-ante beta must be a good proxy for ex-post market exposure which insures that capital imbalance (more capital invested in low beta, less capital invested in high beta) does not lead to correlation with market returns. Second, the low beta portfolio returns must have an expected return that is greater than that of the high beta portfolio returns after accounting for leverage. In the above example, the low beta portfolio return must be greater than at least 1/3 times the return on the high beta portfolio.

In a seminal paper, Fama and French (1993) show that beta has very little ability to explain the cross-section of expected returns after controlling for size and book-to-market ratio providing some support for the profitability of the BAB strategy. Subsequent research has confirmed this fact, and more recent evidence (as we show over the last two decades post-2000) has actually pointed to a low beta return premium as low beta stocks have out-performed high beta stocks. These results are puzzling given the concept of the Capital Asset Pricing Model (CAPM) which postulates that a firm's systematic (market) risk that is measured by beta is positively related to expected returns. The inconsistency of the data fitting this hypothesis is further complicated as beta is still a reasonable proxy for systematic risk – stocks with high betas have higher volatility than stocks with low betas due to greater market exposure.

Breaking Down Beta

Beta is estimated as the coefficient of a simple ordinary least-squares regression of excess stock returns on excess market returns over a certain trailing period and can be traced back to the CAPM model, as outlined in equation (1). Beta represents the sensitivity of a stock's returns to market returns. For example, if the market rises 10% and the stock rises 5% during the same period, CAPM would suggest this stock has a beta of 0.5.

$$E(R_i) = R_f + B_i\big(E(R_m) - R_f\big) \qquad (1)$$

Where:

$E(R_i)$ = expected return of stock i

$E(R_m)$ = expected return of the market

R_f = risk free rate

B_i = beta of stock i

To better understand the economic drivers of beta, we decompose beta into volatility and correlations.

$$B_i = \rho_{i,m}\frac{\sigma_i}{\sigma_m} \qquad (2)$$

$\rho_{i,m}$ = correlation of stock i and market returns

σ_i = stock volatility for stock i

σ_{mi} = market volatility

We can think of beta as the stock's correlation with the market, with its realized volatility as an amplifier on correlation. Both components contribute to beta generally in a positive way. In unreported results, we find that on average, less than 2% of firms over our sample period have negative correlations and volatility is always positive by construction. The cross-sectional rank correlation between firm-level correlations and volatilities is also quite low, averaging -0.24 over the sample period. Since we are mostly interested in the cross-sectional ranking of stocks, we are less concerned with the denominator in equation (2), market volatility. Thus, when forming our betas, we multiply the correlation and stock volatility and normalize all values to have a mean of one.

We begin our analysis by sorting Russell 3000 stocks into five equal groups (quintiles) each month by beta estimated using one year of trailing daily returns. Our analysis begins on December 1987 and ends in December 2017 (with split samples of Dec 1987-Dec 2000, and Dec 2000- Dec 2017). The first six rows of the table below reports the equal-weighted portfolio returns for stocks sorted on beta, correlation, and volatility, respectively.

Figure 1: Descriptive statistics for top and bottom quintile portfolios formed on beta, correlation, and volatility from 1987-2017.

	1987 - 2017			1987 - 2000			2000 - 2017		
	Avg Returns	Avg Vol	Avg Beta	Avg Returns	Avg Vol	Avg Beta	Avg Returns	Avg Vol	Avg Beta
Low Beta	11.4%	11.5%	0.38	11.7%	10.9%	0.21	11.2%	12.0%	0.50
High Beta	11.5%	31.9%	1.80	14.0%	26.9%	2.03	9.6%	35.3%	1.63
Low Correlation	10.4%	18.1%	0.52	10.2%	13.9%	0.28	10.5%	20.8%	0.70
High Correlation	13.4%	20.7%	1.41	17.3%	17.6%	1.66	10.5%	22.8%	1.22
Low Vol	13.4%	10.8%	0.62	14.8%	10.3%	0.63	12.3%	11.2%	0.62
High Vol	7.4%	34.5%	1.40	6.6%	30.2%	1.37	8.0%	37.6%	1.42
Low Beta - High Beta	-0.1%	25.6%	-1.42	-2.3%	22.1%	-1.82	1.7%	28.0%	-1.12
Low Beta - 0.21 * High Beta	9.1%	8.6%	0.02	8.9%	8.8%	-0.19	9.3%	8.5%	0.18
Low Beta - Delevered High Beta	8.8%	8.4%	0.00	9.9%	9.4%	0.00	7.9%	7.6%	0.00

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

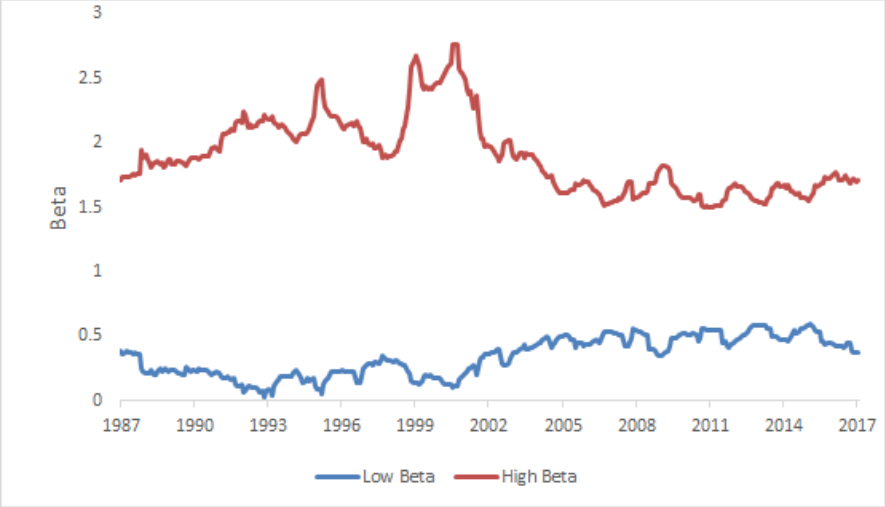
As we show in the first two rows of Figure 1, high beta has nearly the same return as low beta, but has 20.4% higher volatility over for the sample period 1987 to 2017. The higher volatility is a consequence of having a much higher beta (1.80 for high beta, 0.38 for low beta). The next six columns reflect split sample evidence. During the earlier period (1987-2000), high beta had higher returns (14.0%) when compared to low beta (11.7%); in the later period (2000-2017), high beta had lower returns (9.6%) when compared to low beta (11.2%). The differences in volatility are also much higher in the later part of the sample period. There is variation in the spread of beta across sample periods: in the earlier period the difference in average beta between high and low beta stocks is 1.82, while in the latter period that difference shrinks to 1.12.

Rows 3 and 4 of Figure 1 show that high correlation stocks out-perform low correlation stocks by 3% over the sample period. In the earlier period, this difference is 7.1%, while in the latter period there is almost no difference. The higher returns to high correlation stocks increase the returns of high beta relative to low beta stocks (holding volatility constant) in the earlier period. Rows 5-6 of Figure 1 show that low volatility has always had higher returns when compared to high volatility stocks regardless of the sample period (8.2% difference from 1987-2000, 4.3% difference from 2000-2017 and 6.0% difference from 1987-2017). Despite the large differences in average returns between low and high volatility stocks in the early sample period, high beta still out-performs low beta (by 2.3%) due to stocks with high market correlations out-performing stocks with low market correlations (by 7.1%). In the later period, average stock returns are similar for stocks with high and low firm-level market correlations which drive low beta to out-perform high beta (by 1.7%).

The last three rows of Figure 1 report long/short returns for portfolios formed on beta. Row 7 shows the results of a simple long short portfolio formed by investing $1 in the low beta portfolio and shorting $1 in the high beta portfolio. Row 8 illustrates a static BAB strategy formed by investing $1 in low beta portfolio and taking a negative $0.21 position in the high beta portfolio. The 0.21 ratio was calculated as the time series average ratio between the low and high beta portfolio betas (0.38/1.80). As we show, the average beta of this long/short strategy is very low (hence low market exposure) and the risk-adjusted return as measured by the Sharpe ratio exceeds one (8.8%/8.4%). The performance improves in the second half of the sample relative to the first due to low beta having higher average returns when compared to high beta during that period.

The last row matches the betas dynamically each month and then levers according to the ratio of low beta portfolio beta to high beta portfolio beta. For this strategy, there is very little difference between high and low beta returns pre- and post-2000.

Figure 2: Average beta for the lowest and highest quintile baskets



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 2 plots the average beta for the top and bottom quintile portfolio for stocks sorted on beta over time. As we show, the beta differences between the high and low beta portfolios are lower after 2000. This is important, as the decrease in leverage in the later period offsets the increase in the difference in average returns between high and low beta stocks which explains why the "betting-against-beta" strategy that dynamically adjusts leverage has similar expected returns in both the early and late time periods.

Improving Beta Estimation

In order to accurately estimate beta, we need to make choices on a number of parameters. How long of a look-back window is optimal? Do correlations change more or less slowly than volatilities? At what frequency should we sample returns for calculating beta (e.g. daily, weekly, monthly, etc)? Does exponentially weighting observations help? Ward et al (2016) explore various responsiveness (half-life) metrics and techniques for estimating volatility in the context of choosing the most appropriate horizon risk model for long and long/short portfolios. Frazzini and Pedersen (2014) constructed betas using one-year of daily returns to estimate volatility and five-years of three-day overlapping returns to estimate correlations.

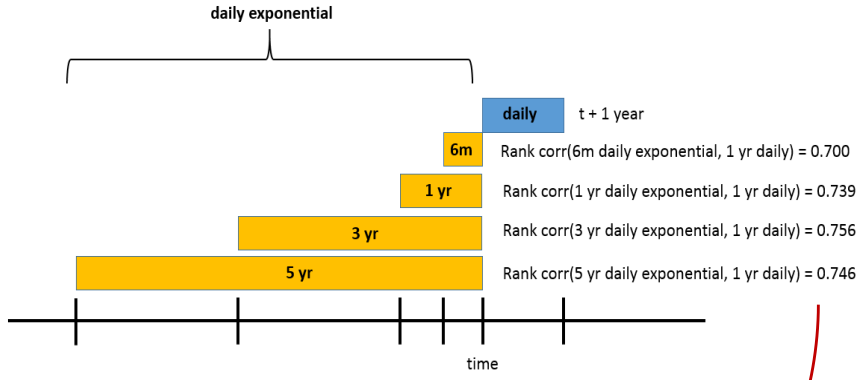
To evaluate different signal construction choices, we analyze the performance of various strategies using the following metrics:

1. Rank correlation with future one-year daily volatility or correlation
2. Sharpe ratio

We compute the average rank correlation between each measure of beta and future versions of these measures. To keep things consistent, for each metric, we use the one-year forward measure (calculated using daily returns over the next year) as the comparison metric.[1] For example, in the first row, first column, we calculate the average rank correlation between daily beta calculated with a six-month window and forward one year daily beta calculated with one year window. The following figure demonstrates our methodology. We repeat this analysis using both daily and weekly returns. All exponential windows have a half-life of half the look-back window (e.g. five-year window has a 2.5 year half-life, one-year window has a six-month half-life, etc). Our analysis starts in December 1991 and ends in December 2017.

1 For robustness, we also explore using a one-year measure estimated with weekly returns over the next year and find economically similar results.

Figure 3: Average rank correlation methodology and measures[2]



		Lookback Window				
		6m	1 yr	3 yr	5 yr	Mean
Correlation	Daily exponential	**0.700**	**0.739**	*0.756*	**0.746**	**0.735**
	Daily	0.696	0.729	*0.733*	0.711	0.717
	Daily 3 day overlap	0.633	0.682	*0.708*	0.696	0.680
	Daily 5 day overlap	0.569	0.628	*0.667*	0.656	0.630
	Weekly	0.512	0.591	0.655	*0.656*	0.604
	Monthly	0.228	0.317	0.424	*0.451*	0.355
	Mean	0.556	0.614	**0.657**	0.653	

		Lookback Window				
		6m	1 yr	3 yr	5 yr	Mean
Volatility	Daily exponential	0.876	***0.883***	**0.864**	**0.837**	**0.865**
	Daily	**0.877**	*0.878*	0.847	0.810	0.853
	Daily 3 day overlap	0.850	*0.858*	0.837	0.806	0.838
	Daily 5 day overlap	0.835	*0.848*	0.831	0.800	0.828
	Weekly	0.809	*0.832*	0.821	0.794	0.814
	Monthly	0.677	0.759	*0.788*	0.770	0.748
	Mean	0.821	**0.843**	0.831	0.803	

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

We find that correlations change more slowly than volatility. Consistent with Merton's (1980) findings, covariance estimation improves with higher frequency of data, we find daily measures of calculation are far superior to those using weekly or monthly data.

Does a measure of beta that matches ex-post betas translate into a "better" low beta strategy? Next, we analyze how variations in beta construction affect risk-adjusted performance as measured by the Sharpe ratio of the BAB strategy (methodology outlined in the previous section).

2 Best in row – Highlighted in blue. Best in column - Bolded

Figure 4: Betting-Against-Beta - Sharpe ratios (quintiles, equal-weighted)[3]

BAB Sharpe ratio using beta estimated from $\rho_{6m}^{daily\ exponential}, \sigma_{1\ yr}^{daily} = 1.045$

BAB Sharpe ratio using beta estimated from $\rho_{1\ yr}^{daily\ exponential}, \sigma_{1\ yr}^{daily} = 1.154$

BAB Sharpe ratio using beta estimated from $\rho_{3\ yr}^{daily\ exponential}, \sigma_{1\ yr}^{daily} = 1.163$

BAB Sharpe ratio using beta estimated from $\rho_{5\ yr}^{daily\ exponential}, \sigma_{1\ yr}^{daily} = 1.220$

		Lookback Window				
		6m	1 yr	3 yr	5 yr	Mean
Correlation	Daily exponential	**1.045**	1.154	1.163	1.220	1.146
	Daily	1.043	1.135	1.122	*1.168*	1.117
	Daily 3 day overlap	1.022	1.244	1.169	*1.204*	**1.160**
	Daily 5 day overlap	0.956	1.183	***1.175***	1.173	1.122
	Weekly	0.841	1.030	1.145	*1.158*	1.044
	Monthly	0.612	0.608	0.824	*1.002*	0.762
	Mean	0.920	1.059	1.100	1.154	

		Lookback Window				
		6m	1 yr	3 yr	5 yr	Mean
Volatility	Daily exponential	1.220	**1.165**	1.097	**1.119**	**1.150**
	Daily	1.207	1.135	**1.100**	1.086	1.132
	Daily 3 day overlap	1.212	1.139	1.086	1.100	1.134
	Daily 5 day overlap	**1.221**	1.123	1.079	1.074	1.125
	Weekly	1.201	1.086	1.070	1.074	1.108
	Monthly	1.198	1.164	1.086	1.083	1.133
	Mean	1.210	1.135	1.087	1.089	

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

When we run our BAB strategy reported in Figure 4, shorter (longer) look-back windows when estimating volatility (correlation) result in a higher Sharpe. We next consolidate our findings below. For each table, we calculate column and row averages and mark the following scores:

XX – Best

XX – Falls within 2.5% of the best

X – Falls within 10% of the best

For example, for the first table in Figure 4 (rank correlation between historical correlations and future correlations), using daily exponential window produced the best rank IC, so we mark it "XX". Next, the rank correlation using daily windows fell within 2.5% of the best score, so we mark this cell "XX". Lastly, using daily 3 day overlapping returns produced a rank correlation within 10% of

3 Best in row – Highlighted in blue. Best in column - Bolded

the best, so we mark this cell "X". We do this for each cell and fill out the total score card.

Figure 5: Scorecard

Correlations		
Frequency	Rank Corr	Sharpe
Daily exponential	**XX**	XX
Daily	XX	X
Daily 3 day overlap	X	**XX**
Daily 5 day overlap		X
Weekly		X
Monthly		

Volatility		
Frequency	Rank Corr	Sharpe
Daily exponential	**XX**	**XX**
Daily	XX	XX
Daily 3 day overlap	X	XX
Daily 5 day overlap	X	XX
Weekly	X	X
Monthly		XX

Correlations		
Window	Rank Corr	Sharpe
6m		
1 yr	X	
3 yr	**XX**	X
5 yr	XX	**XX**

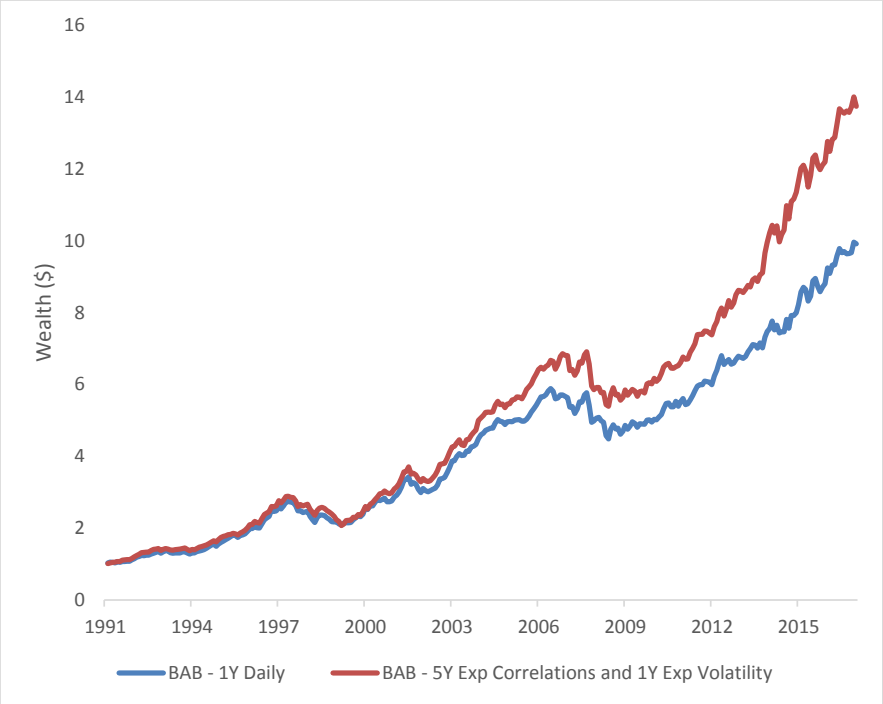
Volatility		
Window	Rank Corr	Sharpe
6m	X	**XX**
1 yr	**XX**	X
3 yr	XX	
5 yr	X	X

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

From these results, we suggest measuring historical beta by using a five-year exponentially weighted window (2.5 year half-life) to estimate correlations and a one-year exponentially weighted window (6 month half-life) to estimate volatilities. Our decisions are arbitrary, but as we show, small changes in these decisions have very small impact on the final results.

In Figure 6, we compare the improved BAB strategy (using signal construction decisions listed above) to a simpler version that uses daily returns over the past one year to estimate both volatility and correlation. As we show, the Sharpe ratio increases by approximately 15% (from 1.08 to 1.25) from 1991 through 2017.

Figure 6: Wealth curves for "Betting-Against-Beta" strategy (using one-year daily returns vs one-year (five-year) exponentially weighted returns to estimate volatility (correlation) to form beta.



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Conclusion

One major drawback of using historical measures to estimate beta is the lack of real-time, forward-looking information. A natural extension is to explore using forward-looking measures such as options-implied volatilities. In future work, we hope to explore how to best incorporate combining implied and realized volatilities and use realized correlation and option skew to improve beta estimations.

Macro update

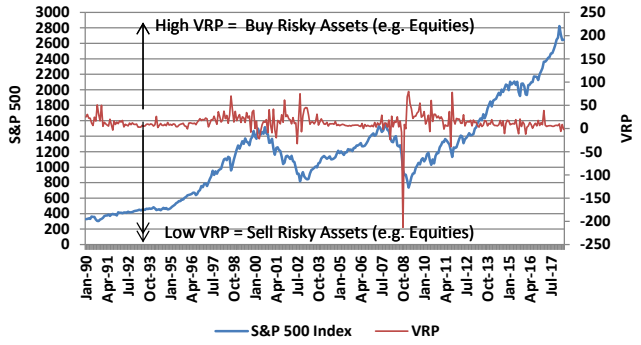
Turning our attention to the bigger picture, we also take the opportunity to update our favorite top-down market indicators.

Our favorite market timing indicator

Our Variance Risk Premium (VRP) indicator is a contrarian indicator that measures market overreaction and underreaction to realized risk. In simple terms, VRP is the difference between options-implied risk (i.e., the VIX index) and realized risk (i.e., the actual risk in the market, historically measured over the last month). If VRP is high, we see this as a buying opportunity for risky assets, like equities and high-yield bonds. Why? Our reasoning is as follows: when VRP is high, VIX has typically shot up dramatically (i.e., the market is in panic mode). At the same time, realized risk has probably also risen, but not to the same extent. In other words, the market has overreacted relative to what the actual realized data is telling us. Our research shows that such episodes are good buying opportunities for risky assets on about a three-month horizon. On the other hand, when VRP is low, it tends to be a complacency indicator – investors are failing to price rising realized risk into the market, and as a result, we favor selling risky assets like equities.

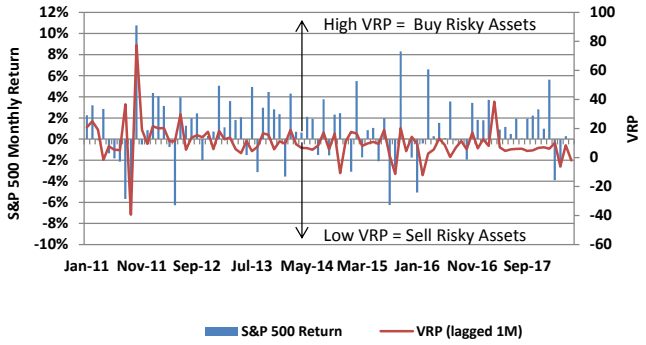
Our VRP indicator is at -2.0, less than the long-term average of 14. This reading signals slightly bearish sentiment. Generally, we pay attention to the VRP when it hits extreme levels (like +/- 2 standard deviations, or between -6 and 34).

Figure 7: Variance Risk Premium (VRP)



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 8: Recent VRP (lagged) and market returns

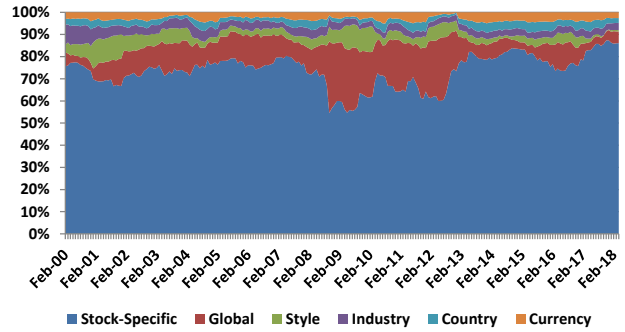


Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

The opportunity set for investors

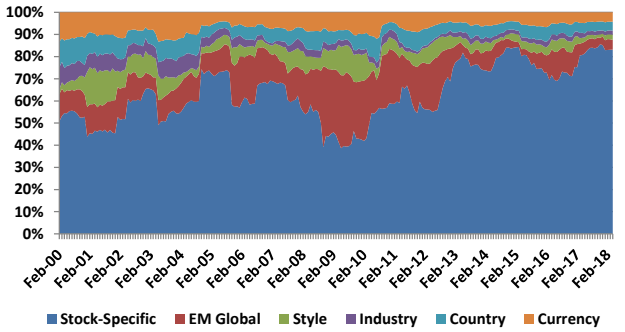
Another metric that we watch closely is the so-called "opportunity set" for investors. Think of this as the total alpha on the table. Our main interest is to understand what is driving that opportunity, because this can allow us to position our strategies to 'pick the juiciest fruit in the orchard.' In Figure 6, we show the opportunity set for global equity investors, and in Figure 7, we show the same for Emerging Market equity investors.

Figure 9: Global opportunity set



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 10: Emerging Markets opportunity set



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

The key result is the size of the blue portion relative to the other colors. The blue area represents the opportunity explained by stock selection, whereas we can think of the other colors as representing the opportunity from top-down calls, like picking the right countries, industries and styles. When the financial crisis occurred in 2008, we moved into a much more macro-dominated world. As a result, the portion of overall opportunity that could be explained by individual company characteristics (e.g. valuation, growth profile and earnings quality, etc.) shrunk sharply. For example, few investors cared if a stock looked good on fundamentals if it was exposed to Europe. Such an environment was challenging for quants and non-quants alike, since both camps tend to use stock-specific information to differentiate between stocks.

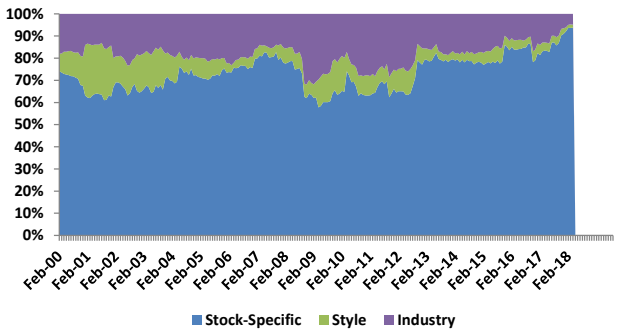
The small-cap opportunity set

In Figure 8, we show the opportunity set for the large-cap universe, and in Figure 9, we show the opportunity set for the small-cap universe.

Figure 11: Large-cap opportunity set

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 12: Small- cap opportunity set



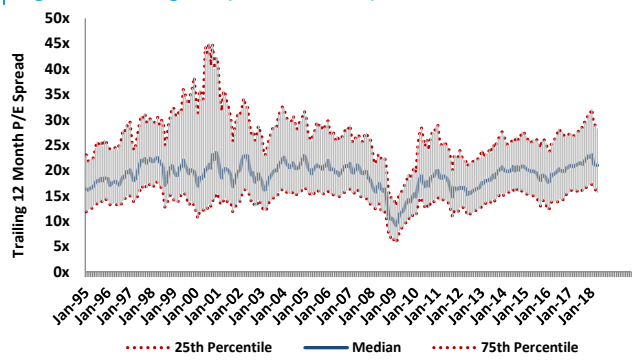
Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Both charts show that bottom-up stock picking is making a strong comeback. The blue area in both charts has reached levels last seen in 2007. The crucial observation is that the relative opportunity coming from stock selection is higher for small-cap stocks. In other words, this universe is particularly fruitful for managers with skill in picking individual stocks. We note that the relative opportunity set has remained fairly steady during the past month for small caps.

Valuation spreads

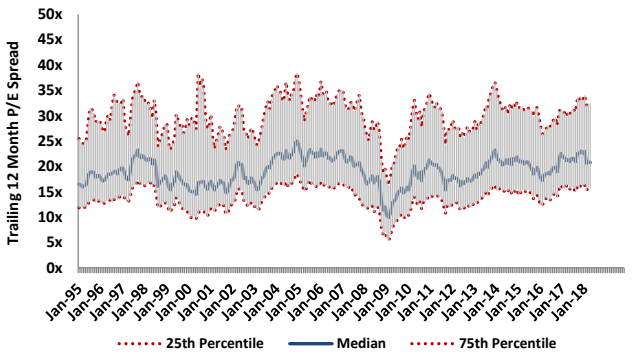
Similar to the opportunity set, valuation spreads allow investors to gauge the level of stock selection opportunity in the market. Widening valuation spreads typically indicate more stock-level differentiation, and consequently, a better environment for stock selection. On the other hand, narrowing valuation spreads are indicative of lower levels of stock differentiation. Figure 10 and Figure 11 show the median 25th percentile and 75th percentile of trailing price to earnings for the Russell 1000 and 2000 index constituents. Interestingly, we see that valuation spreads are wider on a more consistent basis for small-cap stocks. This reinforces the earlier evidence we saw in the opportunity set – the small-cap space is rich with opportunity for skilled stock pickers.

Figure 13: Large cap valuation spreads



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 14: Small cap valuation spreads

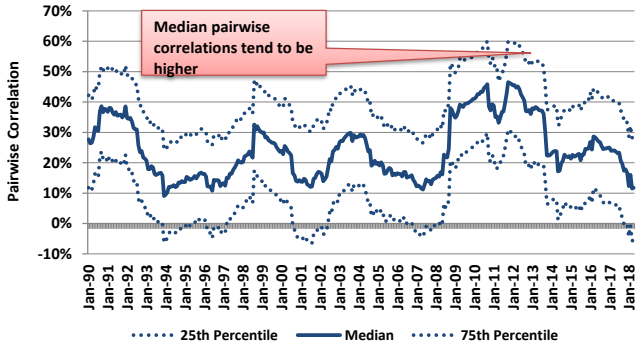


Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Keeping an eye on correlations

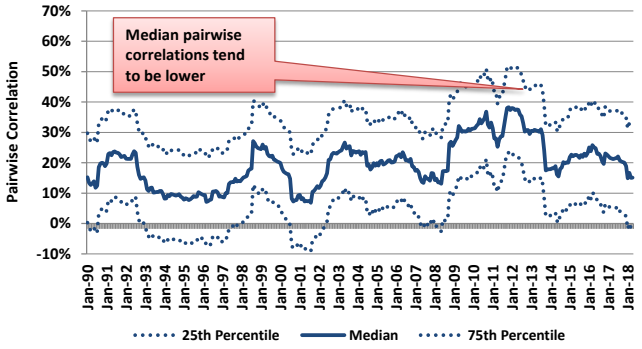
The median pairwise correlation among stocks in the market is closely related to the opportunity set and valuation spreads. This is calculated by taking every possible pair of stocks and computing the correlation of their monthly returns based on the past 24 months of data, and then taking the median across all the pairs. Figure 12 shows the median pairwise correlation for large caps. In general, median pairwise correlations for small-cap stocks (shown in Figure 13) tend to be lower when compared to large-cap stocks. This tells us that small-cap names tend to trade more on their own merits, rather than being driven by common factors.

Figure 15: Median pairwise correlation for large caps



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 16: Median pairwise correlation for small caps



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

The DB Quant Dashboard

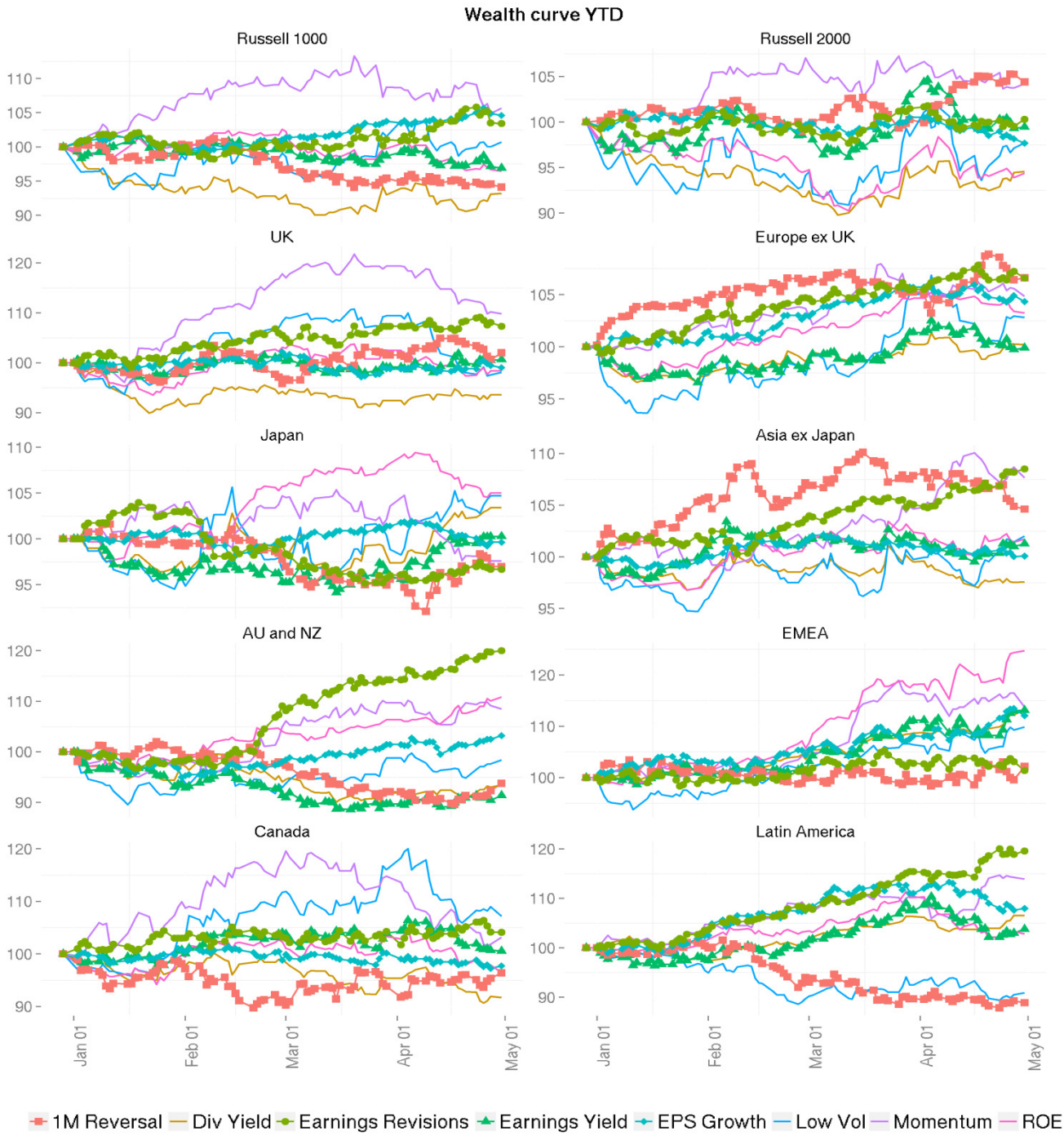
Which styles have been working around the world?

The DB Quant Dashboard is an easy-to-use 'cheat sheet' that shows which styles have been working in key markets around the world. We track cumulative factor performance year-to-date. For those who prefer the previous tabular format (which includes more factors), those results can be found in Appendix A.

For more details see our website

For the most recent weekly factor performance, as well as factor performance delineated by different universes (e.g., large cap, small cap) and regions, please contact us at DBEQS.Americas@db.com to be added to our Weekly Dashboard distribution list

Figure 17: Global YTD cumulative factor performance (Q10-Q1 return spread)



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Bottom-up stock selection

QCD US stock selection model

- The QCD model is our flagship stock selection model for US equities.
- The model incorporates a number of unique features, including dynamic factor selection, a non-linear TREE component, as well as active style and sector rotation.
- For complete details on the model, please see Luo et al, QCD Model: DB Quant Handbook, 22 July 2010.

Current stock recommendations

Figure below shows the best 20 Buy and Sell ideas from today's model. We note that a complete ranking for all Russell 300 stocks is available in a spreadsheet format. If you would like to get a copy of the spreadsheet, please contact us at DBEQS.Americas@db.com

Figure 18: Current QCD model stock recommendations

BEST BUY IDEAS (SECTOR NEUTRAL)

Ticker	Name	CUSIP	GICS Sector	QCD Score (higher is better long)
MCK	MCKESSON CORP	58155Q103	Health Care	18.1%
DXC	DXC TECHNOLOGY COMPANY	23355L106	Information Technology	16.8%
CAH	CARDINAL HEALTH INC	14149Y108	Health Care	16.7%
IT	GARTNER INC	366651107	Information Technology	16.3%
ESNT	ESSENT GROUP LTD	G3198U102	Financials	14.2%
CIVB	CIVISTA BANCSHARES INC	178867107	Financials	14.2%
DENN	DENNYS CORP	24869P104	Consumer Discretionary	12.7%
CCL	CARNIVAL CORP/PLC (USA)	143658300	Consumer Discretionary	11.8%
GBX	GREENBRIER COMPANIES INC	393657101	Industrials	10.8%
UFPI	UNIVERSAL FOREST PRODS INC	913543104	Industrials	10.4%
MMI	MARCUS & MILLICHAP INC	566324109	Real Estate	9.8%
SCHN	SCHNITZER STEEL INDS -CL A	806882106	Materials	9.1%
STLD	STEEL DYNAMICS INC	858119100	Materials	9.0%
CBRE	CBRE GROUP INC	12504L109	Real Estate	8.8%
PPC	PILGRIM'S PRIDE CORP	72147K108	Consumer Staples	8.1%
CVGW	CALAVO GROWERS INC	128246105	Consumer Staples	6.8%
DTE	DTE ENERGY CO	233331107	Utilities	6.3%
PEG	PUBLIC SERVICE ENTRP GRP INC	744573106	Utilities	5.8%
T	AT&T INC	00206R102	Telecommunication Services	4.3%
TMUS	T-MOBILE US INC	872590104	Telecommunication Services	3.4%
PSX	PHILLIPS 66	718546104	Energy	0.9%
PBF	PBF ENERGY INC	69318G106	Energy	0.6%

BEST SELL IDEAS (SECTOR NEUTRAL)

Ticker	Name	CUSIP	GICS Sector	QCD Score (lower is better short)
JONE	JONES ENERGY INC	48019R108	Energy	-27.5%
NAT	NORDIC AMERICAN TANKERS LTD	G65773106	Energy	-24.8%
DERM	DERMIRA INC	24983L104	Health Care	-21.9%
OTIC	OTONOMY INC	68906L105	Health Care	-18.9%
MBI	MBIA INC	55262C100	Financials	-18.8%
RAD	RITE AID CORP	767754104	Consumer Staples	-18.8%
ENT	GLOBAL EAGLE ENTERTAINMENT	37951D102	Consumer Discretionary	-18.7%
ICON	ICONIX BRAND GROUP INC	451055107	Consumer Discretionary	-18.6%
WIN	WINDSTREAM HOLDINGS INC	97382A200	Telecommunication Services	-15.7%
WATT	ENERGOUS CORP	29272C103	Industrials	-15.5%
RAS	RAIT FINANCIAL TRUST	749227609	Real Estate	-14.8%
FTR	FRONTIER COMMUNICATIONS CORP	35906A306	Telecommunication Services	-14.7%
TERP	TERRAFORM POWER INC	88104R209	Utilities	-13.6%
REV	REVLON INC -CL A	761525609	Consumer Staples	-13.5%
WMIH	WMIH CORP	92936P100	Financials	-12.5%
MTSI	M/ACOM TECHNOLOGY SOLUTIONS	55405Y100	Information Technology	-11.9%
NM	NAVIOS MARITIME HOLDINGS INC	Y62196103	Industrials	-11.3%
RSYS	RADISYS CORP	750459109	Information Technology	-11.1%
PCYO	PURE CYCLE CORP	746228303	Utilities	-10.7%
IPI	INTREPID POTASH INC	46121Y102	Materials	-9.5%
LXU	LSB INDUSTRIES INC	502160104	Materials	-9.4%
PEI	PENNSYLVANIA RE INVS TRUST	709102107	Real Estate	-9.2%

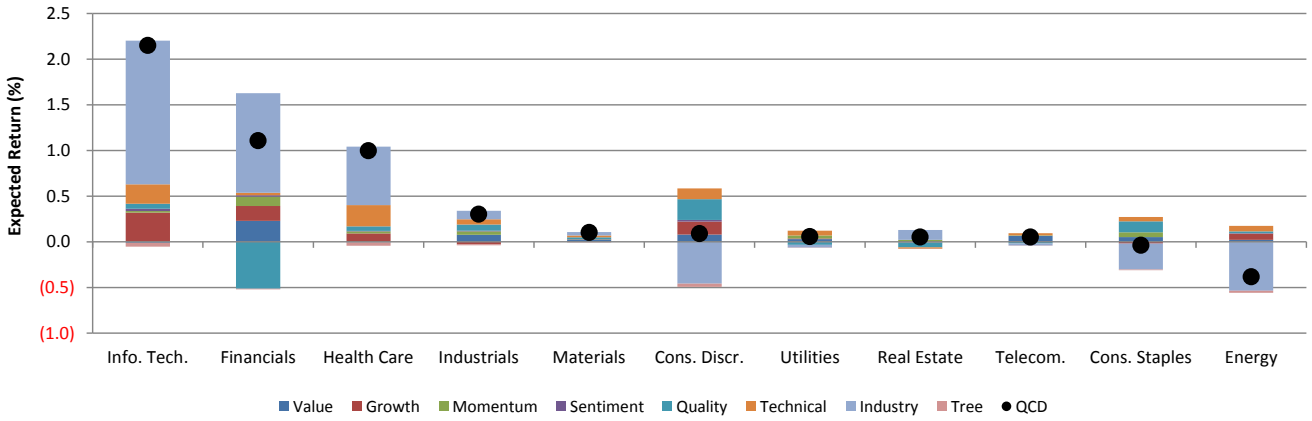
Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

The recommendations in the table above may or may not reflect those of Deutsche Bank's fundamental analysts, given the different criteria used in evaluating the stocks

Current sector recommendations

The QCD model also implicitly makes sector predictions. Figure below shows the current ranking of the 10 GICS Level 1 Sectors, ranked from best (most likely to outperform this month) to worst (least likely to outperform). The bars show the key drivers for each call.

Figure 19: Current QCD sector recommendations



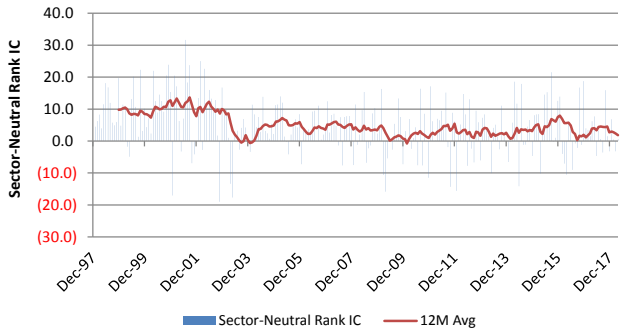
Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Model performance

Figures below show the pure signal performance, measured as a monthly sector-neutral rank information coefficient (IC), and the performance of a model portfolio, after costs, based on a realistically-optimized, market-neutral strategy.

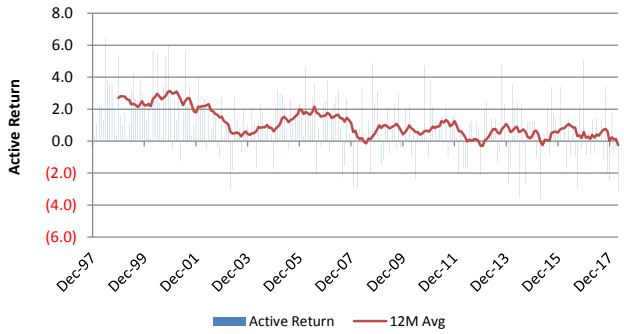
Past performance is no guarantee of future results. Transaction costs can vary. Additional information is available upon request.

Figure 20: Model performance, sector-neutral rank IC



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

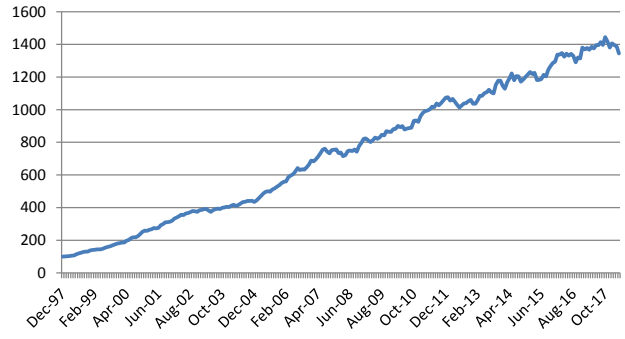
Figure 21: Model portfolio active return, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

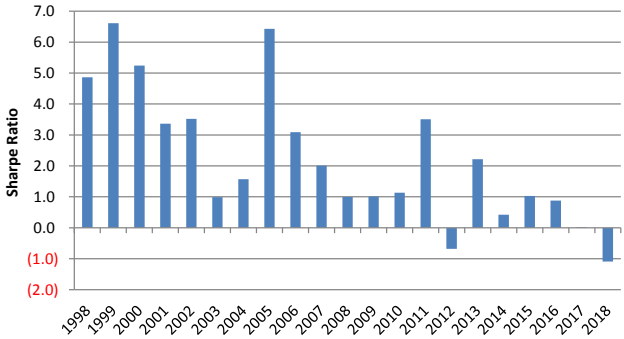
Figures below show the cumulative performance of the optimized strategy, and the annualized Sharpe Ratio (after costs) by calendar year.

Figure 22: Model portfolio cumulative, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 23: Annualized Sharpe Ratio, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

N-LASR global stock selection model

- The N-LASR model is our flagship stock selection model for global equities.
- The model is based on a machine learning algorithm called AdaBoost, and is designed to adaptively learn which factors to use, often in a non-linear way.
- For complete details on the model, please see Wang et al, Signal Processing: The Rise of the Machines, 5 June 2012.

Current stock recommendations

Figure below shows the best 20 Buy and sell ideas from today's model. We note that a complete ranking for all global stocks is available in a spreadsheet format. If you would like to get a copy of the spreadsheet, please contact us at DBEOS.Americas@db.com

Figure 24: Current N-LASR model stock recommendations

BEST BUY IDEAS

Ticker	Name	SEDOL	Country	N-LASR Score (higher is better long)
CRM	SALESFORCE.COM INC	2310525	USA	2.01
NICE IT	Nice Ltd	664713	Israel	1.92
RDSA LN	Royal Dutch Shell PLC	B03MLX	UK	1.86
TDG	TRANSDIGM GROUP INC	B11FJK3	USA	1.85
MTELEKOM HE	Magyar Telekom	457746	Hungary	1.85
UTG LN	Unite Group	69286	UK	1.80
001430 KS	Seah Besteel Corp	649450	Korea	1.79
386 HK	China Petroleum & Chemical Corp H Shares	629181	China	1.76
4543 JT	Terumo Corp	688507	Japan	1.76
1113 HK	CK Asset Holdings Ltd	BYZQ07	Hong Kong	1.73
IRPC TB	IRPC PCL	690529	Thailand	1.70
IHFL IB	Indiabulls Housing Finance Limited	B98CG5	India	1.69
1310 HK	HKBN Ltd	BW0DD8	Hong Kong	1.69
1308 HK	SITC International Holdings Co Ltd	B61X7R	China	1.69
VLW AU	Villa World Ltd	B4X8YY	Australia	1.69
RDSB LN	Royal Dutch Shell PLC B	B03MM4	UK	1.68
CP.	CANADIAN PACIFIC RAILWAY LTD	2793115	Canada	1.68
VLO	VALERO ENERGY CORP	2041364	USA	1.68
MA	MASTERCARD INC	B121557	USA	1.67
DAI GY	Daimler AG	552902	Germany	1.63

BEST SELL IDEAS

Ticker	Name	SEDOL	Country	N-LASR Score (lower is better short)
PTNR IT	Partner Communications Co Ltd	637442	Israel	-2.40
1522 HK	BII Railway Transportation Technology	BDZS7K	China	-2.31
5227 TT	Advanced Lithium Electrochemistry (Ca	BGH182	Taiwan	-2.17
7190 JT	Mercuria Investment Co Ltd.	BD5KZP	Japan	-2.16
2706 JT	Broccoli Co Ltd	638427	Japan	-2.13
1253 HK	China Greenland Broad Greenstate Grc	BZ125B	China	-2.13
3303 HK	Jutal Offshore Oil Services	B1F2XD	China	-2.08
8166 HK	China Eco-Farming Ltd	BFNVWK	Hong Kong	-2.08
BWPT IJ	Eagle High Plantations Tbk PT	B58PM8	Indonesia	-2.06
1431 HK	YuanShengTai Dairy Farm Ltd	BGLZXH	China	-2.05
CBOI IB	Central Bank of India	B236VP	India	-2.04
3519 TT	Green Energy Technology Inc	B1CDRR	Taiwan	-2.04
111820 KS	GY COMMERCE Co Ltd	B53YPT	Korea	-2.02
4426 TT	Li Cheng Enterprise Co. Ltd.	B0418Z	Taiwan	-2.01
6616 JP	Torex Semiconductor Ltd	BKHNK1	Japan	-1.99
2138 JT	Crooz Inc	B1MY86	Japan	-1.97
LNG AU	Liquefied Natural Gas Limited	B02L5H	Australia	-1.96
BOI IB	Bank of India	609978	India	-1.95
1185 HK	China Energine International (Holdings	603620	China	-1.94
PXM PW	Polimex Mostostal Siedlce SA	531929	Poland	-1.91

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

The recommendations in the table above may or may not reflect those of DB's fundamental analysts, given the different criteria used in evaluating the stocks.

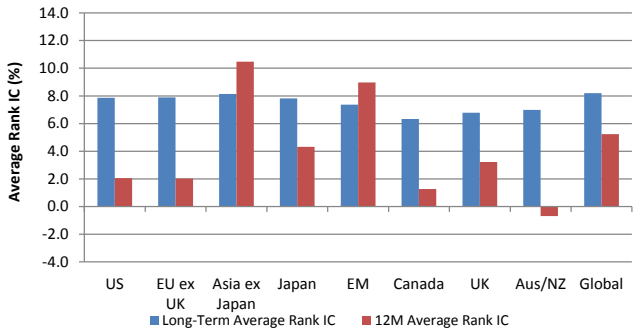
Model performance

Figures below show the average pure signal performance, measured as a monthly rank information coefficient (IC) in different regions and the performance of a

Past performance is no guarantee of future results. Transaction costs can vary. Additional information is available upon request.

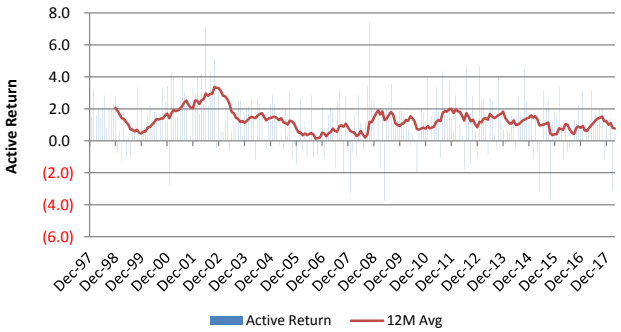
global model portfolio after costs, based on a realistically-optimized, market-neutral strategy.

Figure 25:Regional model performance, average rank IC



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

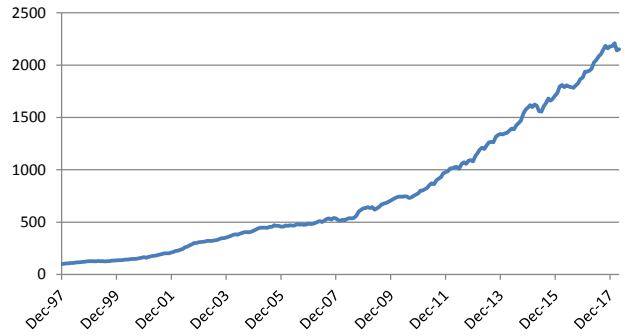
Figure 26: Global portfolio active return, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

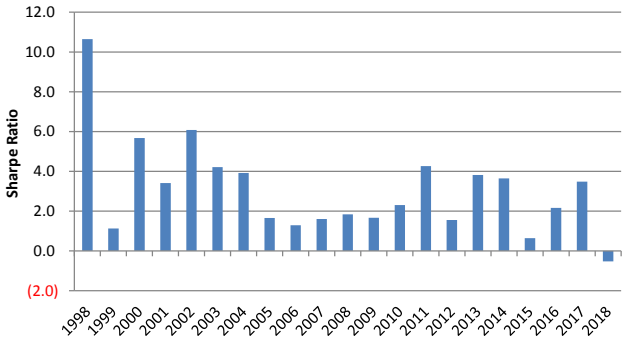
Figures below show the cumulative performance of the optimized strategy, and the annualized Sharpe Ratio (after costs) by calendar year.

Figure 27: Global portfolio cumulative, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 28: Annualized Sharpe Ratio, after costs



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Top-down country rotation

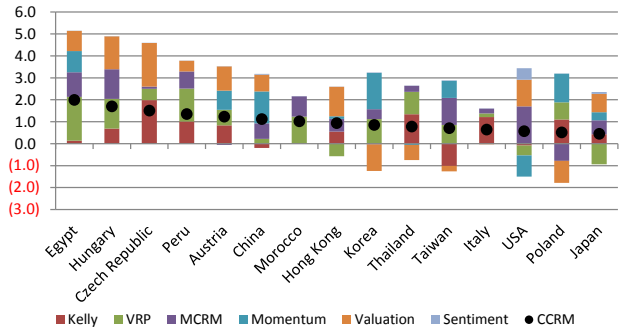
CCRM country rotation model

- Our Composite Country Rotation Model (CCRM) uses three sets of inputs to dynamically rotate between countries in the MSCI All Country World Index.
- The inputs include top-down macro signals (e.g. VRP, Kelly's Tail Risk), aggregate bottom-up fundamental signals (e.g. country-level valuation and momentum) and lead-lag signals, based on economic trade linkages.
- For complete details on the model, please see Luo et al, Signal Processing: New Insights in Country Rotation, 9 February 2012.

Current recommendations

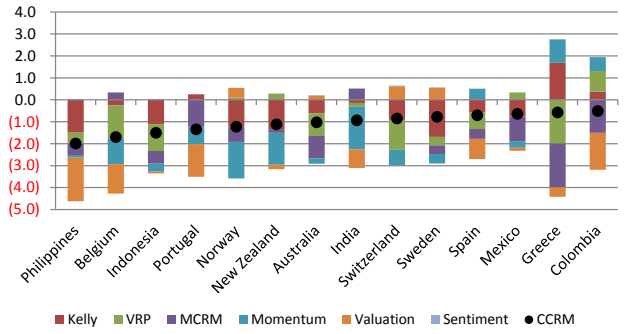
Figures below show the top and bottom third of countries, as ranked currently by our CCRM model. The bars show what is driving these calls.

Figure 29: Top tercile countries



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 30: Bottom tercile countries

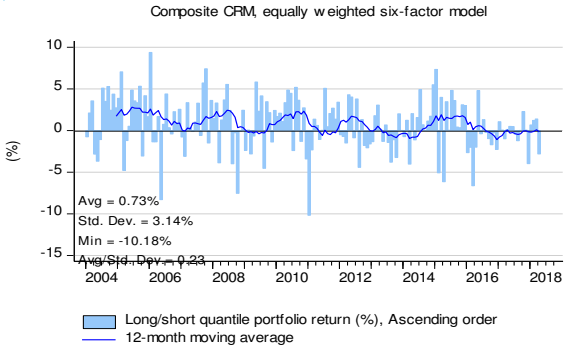


Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Model performance

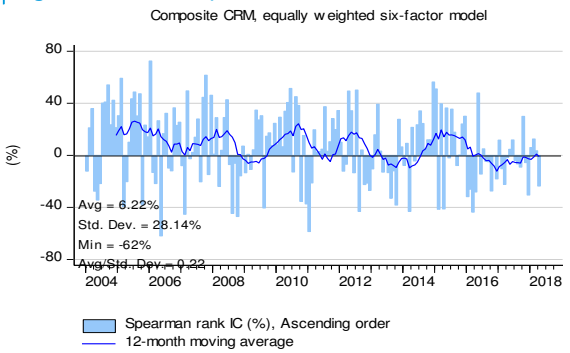
Figures below show the performance of the model over time.

Figure 31: Long/Short portfolio return (%)



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 32: Model performance with rank IC



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Top-down asset allocation

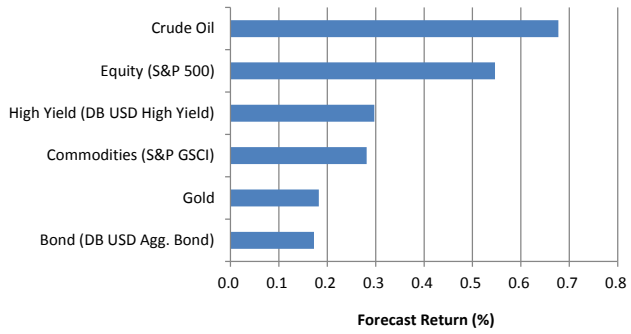
Quant Tactical Asset Allocation (QTAA) model

- Our Quantitative Tactical Asset Allocation (QTAA) model uses a model-of-models methodology to rotate between six asset classes.
- The model uses a wide range of fundamental and market-based factors as inputs, and dynamically selects a subset of those factors to use at each point in time.
- For complete details on the model, please see Luo et al, Signal Processing: Quant Tactical Asset Allocation, 19 September 2011.

Current recommendations and performance

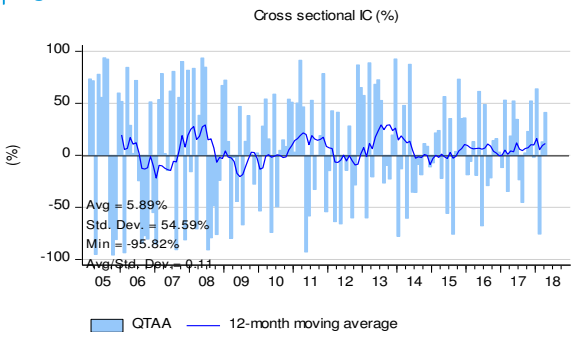
Figures below show the current ranking of our six asset classes, ranked from best to worst in terms of month-ahead forecast returns and the monthly performance of the QTAA model over time.

Figure 33:Current QTAA forecasts



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 34: Performance of QTAA model



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Top-down style rotation

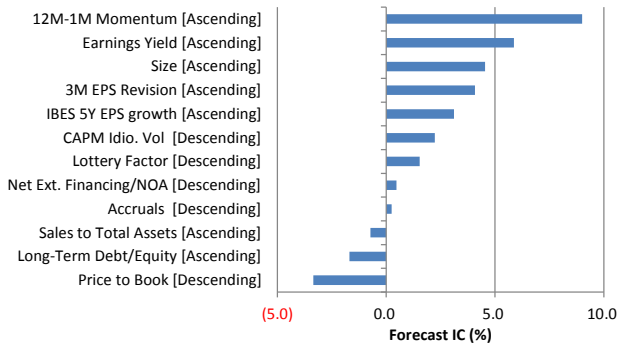
Style rotation model

- Our Style Rotation model dynamically rotates between 12 "typical" quant factors.
- The model uses market-based and macroeconomic inputs to predict month-ahead factor returns using a backward stepwise linear regression model.
- For complete details on the model, please see Luo et al, Signal Processing: Style Rotation, 7 September 2010.

Current recommendations and performance

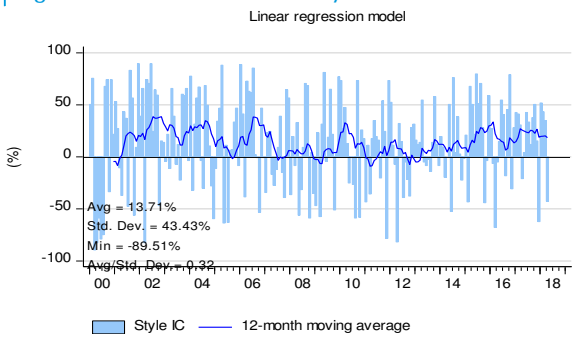
Figures below show the current ranking of our 12 factors, ranked from best to worst in terms of month-ahead forecast performance and the monthly performance of the Style Rotation model over time.

Figure 35: Current Style Rotation forecasts



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 36: Performance of style rotation model



Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Appendix A: Factor performance

Figure 37: US factor performance, measured as rank IC (Russell 3000 universe)

Factor Name	Direction[1]	Current # of Stocks	Average IC (%) Last M	12M Avg	3Y Avg	Since Inception Avg	Std Dev	Avg / Std Dev	Max	Min	p-value[2]	# of Months	Avg # of Stocks	Hit Rate (%)	Serial Corr (%)[3]
1. Value															
1 Dividend yield, trailing 12M	Ascending	2,935	3.52	(0.88)	2.31	2.79	13.93	0.20	42.59	(33.26)	0.00	364	2,889	54.67	98.24
2 Expected dividend yield	Ascending	2,935	2.38	(0.92)	2.54	3.02	14.43	0.21	44.46	(33.89)	0.00	364	2,889	54.12	98.88
3 Price-to-operating EPS, trailing 12M, Basic	Descending	2,102	(4.79)	(0.66)	0.31	2.45	10.37	0.24	30.82	(32.28)	0.00	288	2,329	56.94	93.76
4 Operating earnings yield, trailing 12M, Basic	Ascending	2,902	(8.95)	1.07	3.17	4.63	12.45	0.37	47.24	(33.30)	0.00	288	2,885	62.50	95.64
5 Earnings yield, forecast FY1 mean	Ascending	2,789	(9.42)	0.89	4.00	4.39	11.91	0.37	48.88	(34.61)	0.00	364	2,570	63.19	94.77
6 Earnings yield, forecast FY2 mean	Ascending	2,768	(8.06)	1.01	3.65	3.83	11.59	0.33	47.02	(34.31)	0.00	364	2,484	63.46	94.38
7 Earnings yield x IBES 5Y growth	Ascending	1,261	(7.96)	2.22	0.93	1.69	10.09	0.17	41.11	(26.63)	0.00	288	1,836	59.72	93.28
8 Sector-rel Operating earnings yield, trailing 12M, Basic	Ascending	2,831	(7.76)	1.40	2.70	4.19	8.13	0.52	28.96	(14.90)	0.00	288	2,882	68.75	95.28
9 Hist-rel Operating earnings yield, trailing 12M, Basic	Ascending	2,318	(3.99)	0.29	0.57	1.43	6.33	0.23	20.73	(18.74)	0.00	194	2,113	60.82	95.99
10 Operating cash flow yield (income stmt def)	Ascending	2,935	(2.79)	0.07	1.64	3.83	10.73	0.36	47.14	(32.67)	0.00	364	2,889	62.91	95.07
11 Cash flow yield, FY1 mean	Ascending	1,722	6.61	(2.10)	(1.60)	2.22	16.89	0.13	66.06	(54.29)	0.02	334	919	55.69	94.74
12 Free cash flow yield	Ascending	2,840	(7.48)	1.11	3.39	4.72	7.81	0.60	31.93	(22.64)	0.00	327	2,570	74.31	94.38
13 Price-to-sales, trailing 12M	Descending	2,846	(0.06)	(0.70)	(1.51)	1.44	10.91	0.13	30.02	(41.46)	0.01	364	2,812	55.49	98.73
14 Price-to-book	Descending	2,782	8.09	(2.61)	(0.35)	0.61	10.83	0.06	26.28	(35.75)	0.28	364	2,775	48.35	95.99
15 EBITDA/EV	Ascending	2,905	(4.33)	0.29	1.58	3.88	9.74	0.40	39.32	(27.15)	0.00	364	2,838	64.84	92.04
16 Price-to-book adj for ROE, sector adj	Descending	2,562	(2.61)	(3.33)	(1.17)	0.32	8.63	0.04	22.50	(33.21)	0.48	364	2,461	48.63	95.73
2. Growth															
17 Hist 5Y operating EPS growth	Descending	2,832	(10.84)	0.94	1.44	1.33	8.45	0.16	30.58	(22.70)	0.01	276	2,757	55.80	95.22
18 Hist 5Y operating EPS acceleration	Ascending	2,832	1.06	0.78	1.38	0.92	6.32	0.15	25.31	(16.13)	0.02	276	2,757	56.16	92.90
19 IBES 5Y EPS growth	Ascending	2,286	(11.15)	1.86	1.76	1.12	7.87	0.14	21.65	(27.86)	0.01	364	2,300	56.59	98.08
20 IBES 5Y EPS growth/stability	Ascending	2,286	(9.87)	2.97	2.73	1.60	7.65	0.21	20.64	(19.20)	0.00	364	2,300	58.52	98.38
21 IBES LTG EPS mean	Descending	1,539	0.41	(3.55)	(0.84)	1.39	14.92	0.09	37.64	(52.38)	0.08	364	2,092	48.90	97.12
22 IBES FY2 mean DPS growth	Ascending	2,150	(2.37)	0.84	2.76	1.39	8.33	0.17	24.12	(21.96)	0.02	191	1,687	53.40	84.26
23 IBES FY1 mean EPS growth	Ascending	2,770	4.26	3.55	2.54	1.21	7.22	0.17	20.76	(24.42)	0.00	364	2,543	61.81	88.72
24 Year-over-year quarterly EPS growth	Ascending	2,908	(2.96)	1.49	1.98	2.49	6.75	0.37	23.85	(21.12)	0.00	288	2,892	65.97	79.47
25 IBES FY1 mean CFPS growth	Descending	1,611	(5.42)	(1.82)	(2.02)	0.13	10.38	0.01	38.08	(42.07)	0.83	291	711	50.17	92.23
26 IBES SUE, amortized	Ascending	2,454	(7.90)	2.13	2.30	1.06	6.24	0.17	20.62	(16.30)	0.00	303	1,371	56.44	73.08
3. Price Momentum and Reversal															
27 Total return, 1D	Descending	2,935	3.92	0.23	2.86	4.72	7.13	0.66	16.33	(33.75)	0.00	364	2,889	76.92	1.94
28 Total return, 21D (1M)	Descending	2,935	(1.73)	1.47	0.44	1.78	10.62	0.17	29.03	(43.69)	0.00	364	2,889	56.59	1.08
29 Maximum daily return in last 1M (lottery factor)	Descending	2,929	(3.14)	2.93	4.60	5.07	14.60	0.35	39.13	(56.07)	0.00	364	2,780	64.01	50.95
30 21D volatility of volume/price	Descending	2,935	(1.68)	0.35	0.47	0.39	6.56	0.06	24.16	(21.49)	0.25	364	2,881	51.65	52.79
31 Total return, 252D (12M)	Ascending	2,845	(6.46)	2.68	1.96	2.96	14.00	0.21	39.62	(57.00)	0.00	364	2,801	62.64	89.67
32 12M-1M total return	Ascending	2,845	(7.15)	3.12	2.21	3.74	13.18	0.28	37.65	(49.06)	0.00	364	2,801	63.19	88.24
33 Price-to-52 week high	Ascending	2,843	(3.73)	2.81	4.02	3.18	17.44	0.18	49.63	(62.50)	0.00	364	2,089	61.26	84.39
34 Total return, 1260D (60M)	Ascending	2,279	(12.72)	2.70	2.73	1.38	10.94	0.13	25.63	(35.41)	0.02	352	2,253	57.10	97.28
4. Sentiment															
35 IBES LTG Mean EPS Revision, 3M	Ascending	1,508	1.11	(0.09)	0.21	0.78	3.79	0.21	11.16	(12.06)	0.00	364	2,065	60.99	58.92
36 IBES FY1 Mean EPS Revision, 3M	Ascending	2,746	(1.10)	1.29	1.37	2.74	8.25	0.33	29.96	(33.00)	0.00	364	2,512	65.93	72.22
37 IBES FY1 EPS up/down ratio, 3M	Ascending	2,714	(8.36)	1.82	1.45	2.88	7.69	0.37	27.54	(24.41)	0.00	364	2,389	67.31	78.98
38 Expectation gap, short-term - long-term	Descending	2,062	0.73	0.83	0.55	1.16	5.34	0.22	11.80	(19.91)	0.00	364	2,129	57.69	91.10
39 IBES FY1 Mean CFPS Revision, 3M	Ascending	1,635	0.65	2.12	2.00	2.01	14.79	0.14	69.38	(75.04)	0.01	333	852	63.36	61.61
40 IBES FY1 Mean SAL Revision, 3M	Ascending	2,723	(4.41)	3.07	2.65	1.39	7.83	0.18	27.43	(24.32)	0.00	263	2,279	61.98	68.54
41 IBES FY1 Mean FFO Revision, 3M	Ascending	170	6.20	2.66	2.77	2.52	19.61	0.13	71.43	(80.00)	0.02	336	97	56.85	68.17
42 IBES FY1 Mean DPS Revision, 3M	Ascending	1,340	(7.11)	0.53	1.08	0.79	5.03	0.16	14.91	(17.55)	0.03	188	1,097	59.57	63.50
43 IBES FY1 Mean ROE Revision, 3M	Ascending	2,125	3.73	2.44	1.88	1.03	6.30	0.16	23.70	(22.19)	0.03	188	1,853	59.57	61.12
44 Recommendation, mean	Descending	2,787	(3.30)	1.39	0.15	0.76	7.44	0.10	21.85	(19.41)	0.08	293	2,691	57.34	94.83
45 Mean recommendation revision, 3M	Descending	2,768	0.44	0.17	0.19	1.02	3.92	0.26	19.86	(11.55)	0.00	290	2,678	62.07	60.70
46 Target price implied return	Descending	2,764	0.59	1.18	2.26	0.25	16.09	0.02	60.74	(39.59)	0.81	229	2,525	48.03	81.03
47 Mean target price revision, 3M	Ascending	2,745	(4.72)	2.57	1.85	2.19	12.48	0.18	30.14	(41.94)	0.01	226	2,512	61.50	74.49
5. Quality															
48 ROE, trailing 12M	Ascending	2,763	(11.67)	2.11	2.95	3.80	10.09	0.38	33.42	(29.52)	0.00	288	2,854	65.28	94.33
49 Return on invested capital (ROIC)	Ascending	2,889	(10.31)	2.71	3.68	4.12	10.23	0.40	33.02	(31.24)	0.00	288	2,869	68.75	96.31
50 Sales to total assets (asset turnover)	Ascending	2,842	(5.94)	2.05	(0.26)	1.37	8.57	0.16	22.78	(22.02)	0.00	364	2,824	55.22	99.45
51 Operating profit margin	Ascending	2,838	4.75	2.53	3.28	1.35	5.62	0.24	16.98	(14.17)	0.00	364	2,743	60.44	97.99
52 Current ratio	Descending	2,204	9.15	(0.23)	0.08	1.67	10.09	0.17	31.95	(38.66)	0.00	364	2,244	54.12	97.58
53 Long-term debt/equity	Ascending	2,761	(1.08)	(1.80)	(1.18)	0.68	9.35	0.07	35.65	(28.14)	0.17	364	2,759	49.18	97.15
54 Altman's z-score	Ascending	2,094	(10.45)	3.20	3.34	0.63	9.19	0.07	31.74	(30.44)	0.19	364	2,161	51.10	97.85
55 Merton's distance to default	Ascending	2,330	(7.19)	3.87	4.97	3.50	12.14	0.29	35.09	(41.45)	0.00	364	2,347	65.66	94.51
56 Ohlson default model	Descending	2,174	(3.34)	2.14	2.81	2.34	6.55	0.36	16.95	(25.59)	0.00	327	2,140	67.58	98.14
57 Accruals (Sloan 1996 def)	Descending	2,126	10.05	(0.25)	(1.17)	0.29	4.22	0.07	12.07	(15.48)	0.20	364	2,142	53.57	88.05
58 Firm-specific discretionary accruals	Descending	1,077	10.39	(0.51)	(1.46)	0.20	3.67	0.06	10.45	(12.89)	0.34	304	1,957	53.62	66.95
59 Hist 5Y operating EPS stability, coef of determination	Ascending	2,832	(3.50)	1.85	1.09	0.93	4.90	0.19	20.01	(12.27)	0.00	276	2,757	52.90	97.07
60 IBES 5Y EPS stability	Descending	2,286	(5.83)	1.96	2.66	1.34	8.27	0.16	25.00	(34.33)	0.00	364	2,300	54.95	98.92
61 IBES FY1 EPS dispersion	Descending	2,789	(5.50)	2.35	4.31	1.86	9.44	0.20	31.67	(28.25)	0.00	364	2,570	60.16	83.14
62 Payout on trailing operating EPS	Ascending	2,102	7.65	(2.09)	0.35	0.66	12.99	0.05	38.55	(30.91)	0.33	364	2,206	48.90	97.36
63 YoY change in # of shares outstanding	Descending	2,893	(3.19)	0.99	1.64	2.54	8.81	0.29	19.53	(46.21)	0.00	364	2,786	59.89	92.48
64 YoY change in debt outstanding	Descending	2,351	0.21	(1.88)	(0.83)	0.08	4.08	0.02	13.07	(10.40)	0.72	364	2,226	53.85	89.52
65 Net external financing/net operating assets	Ascending	2,920	(3.46)	(0.03)	0.75	2.28	8.46	0.27	44.61	(21.76)	0.00	364	2,855	60.16	94.76
66 Piotroski's F-score	Ascending	2,935	(4.05)	1.30	2.21	2.87	8.06	0.36	29.20	(27.83)	0.00	364	2,891	67.58	88.67
67 Mohanram's G-score	Ascending	535	(3.06)	2.22	2.37	2.53	9.93	0.25	35.27	(32.14)	0.00	276	417	57.61	95.54
6. Technicals															
68 # of days to cover short	Descending	332	(4.07)	2.45	2.31	2.22	7.33	0.30	33.80	(25.16)	0.00	364	2,030	59.89	91.89
69 CAPM beta, 5Y monthly	Descending	4,052	4.34	0.41	1.43	0.99	12.76	0.08	40.19	(42.70)	0.18	305	3,039	50.82	96.47
70 CAPM idosyncratic vol, 1Y daily	Descending	2,989	(5.06)	2.14	5.67	5.21	17.63	0.30	42.60	(60.80)	0.00	352	2,907	61.93	98.83
71 Realized vol, 1Y daily	Descending	2,845	(3.14)	2.12	5.61	5.06	18.31	0.28	42.69	(59.63)	0.00	364	2,805	60.99	98.60
72 Skewness, 1Y daily	Descending	2,845	0.21	(0.99)	0.60	1.12	5.36	0.21	13.93	(22.86)	0.00	364	2,805	56.04	89.85
73 Kurtosis, 1Y daily	Descending	2,845	7.65	(0.69)	0.93	1.38	5.60	0.25	15.28	(15.82)	0.00	364	2,805	61.81	91.52
74 Idiosyncratic vol surprise	Descending	2,858	(2.18)	(1.19)	0.53	2.57	7.68	0.34	22.66	(33.71)	0.00	351	2,867	64.39	87.84
75 Normalized abnormal volume	Ascending	2,928	0.72	0.77	1.34	2.17	6.37	0.34	23.10	(16.38)	0.00	364	2,883	64.84	64.51
76 Float turnover, 12M	Descending	3,150	(3.69)	(0.29)	3.45	0.55	10.96	0.05	23.54	(31.61)	0.35	353	2,836	49.01	99.23
77 Moving average crossover, 15W-36W	Ascending	2,865	(1.78)	2.44	2.17	2.12	13.09	0.16	46.29	(55.07)	0.00	364	2,584	59.34	91.04
78 Log float-adj capitalization	Ascending	2,935	(1.83)	0.47	(0.06)	3.12	11.07	0.28	29.53	(40.68)	0.00	364	2,886	61.26	99.46
79 # of month in the database	Ascending	2,935	(4.47)	(0.58)	1.20	2.09	8.57	0.24	35.61	(23.86)	0.00	364	2,889	56.32	99.99
80 DB composite options factor	Ascending	1,789	(1.87)	1.97	0.27	1.09	3.69	0.30	13.99	(13.88)	0.00	201	1,936	63.68	26.18

Note:

1 Direction indicates how the factor scores are sorted. Ascending order means higher factors scores are likely to be associated with higher subsequent stock returns, and vice versa for descending order.

2 P-value indicates the statistical significance of the factor's performance. A smaller p-value suggests that is it more likely the factor's performance is different from zero.

3 This is the autocorrelation of the factor scores over time. Higher serial correlation indicates lower portfolio turnover based on the factor.

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

Figure 38: Global factor performance, measured as rank IC (S&P BMI World universe)

Factor Name	Direction[1]	Current # of Stocks	Average IC (%)			Since Inception									
			Last M	12M Avg	3Y Avg	Avg	Std Dev	Avg / Std Dev	Max	Min	p-value[2]	# of Months	Avg # of Stocks	Hit Rate (%)	Serial Corr (%)[3]
1. Value															
1 Dividend yield, trailing 12M	Ascending	10,957	0.83	2.69	3.98	4.14	9.99	0.41	36.88	(23.89)	0.00	340	8,475	64.71	97.87
2 Dividend yield, FY1	Ascending	8,360	(1.04)	0.96	2.25	3.86	10.24	0.38	32.17	(22.90)	0.00	283	5,840	62.90	98.24
3 Dividend yield, FY2	Ascending	8,267	(1.01)	1.05	2.18	3.71	10.32	0.36	33.19	(24.39)	0.00	273	5,818	62.64	98.24
4 Price/Earnings	Descending	9,083	(1.28)	0.74	0.94	3.51	12.36	0.28	39.66	(50.73)	0.00	333	6,732	59.46	96.36
5 Price-to-FY0 EPS	Descending	8,450	(2.41)	(1.33)	(0.30)	2.39	9.98	0.24	28.98	(37.08)	0.00	340	6,410	59.12	96.51
6 Earnings yield, FY0	Ascending	9,618	(2.84)	0.62	1.80	3.67	8.77	0.42	31.67	(18.68)	0.00	340	7,430	62.65	96.43
7 Earnings yield, forecast FY1 mean	Ascending	9,105	(3.40)	1.74	2.25	4.30	10.38	0.41	35.35	(22.20)	0.00	340	6,868	62.94	95.76
8 Earnings yield, forecast FY2 mean	Ascending	8,978	(2.88)	1.27	1.75	3.86	11.34	0.34	37.31	(31.50)	0.00	340	6,705	60.29	95.90
9 Cash flow yield, FY0	Ascending	6,497	3.94	(1.13)	0.27	3.16	6.60	0.48	26.42	(11.80)	0.00	216	5,507	68.98	97.36
10 Cash flow yield, FY1 mean	Ascending	6,400	5.50	(0.53)	(0.46)	1.52	9.48	0.16	31.42	(32.01)	0.01	272	4,884	54.41	95.99
11 Price/Sales	Descending	10,513	2.20	0.40	1.36	1.41	9.13	0.15	26.48	(31.59)	0.00	340	7,946	55.88	99.26
12 Price/Book	Descending	10,599	5.64	(0.97)	(0.12)	0.92	10.25	0.09	31.56	(37.54)	0.10	340	8,001	54.71	98.44
13 Est Book-to-price, median	Ascending	7,931	5.73	(1.30)	(0.74)	0.60	9.68	0.06	30.37	(26.29)	0.35	224	6,015	51.34	98.27
14 EBITDA to EV	Ascending	3,117	(2.29)	(0.01)	2.74	3.93	10.64	0.37	36.69	(26.20)	0.00	340	5,042	63.24	95.63
15 Sales/EV	Ascending	10,330	(2.49)	1.48	2.36	1.97	7.49	0.26	24.81	(20.06)	0.00	340	7,896	63.24	99.04
2. Growth															
16 IBES 5Y EPS growth	Ascending	8,933	(3.59)	2.44	1.89	1.24	5.88	0.21	19.09	(21.86)	0.00	340	6,619	60.59	98.03
17 EPS Growth	Ascending	9,785	(2.89)	1.57	1.50	2.02	6.42	0.31	29.72	(28.97)	0.00	324	7,357	65.12	88.01
18 IBES LTG EPS mean	Descending	4,438	3.49	(2.36)	(0.68)	1.07	11.29	0.09	28.22	(40.36)	0.08	340	4,281	51.18	96.51
19 IBES FY1 mean EPS growth	Ascending	8,496	0.14	2.15	0.54	0.38	5.81	0.07	14.44	(20.10)	0.23	340	6,710	54.41	88.62
20 IBES FY1 mean CFPS growth	Descending	4,529	2.91	(1.21)	0.19	1.46	4.00	0.37	7.47	(11.39)	0.00	216	4,282	62.04	91.65
21 IBES FY2 mean DPS growth	Ascending	8,252	(3.54)	1.26	1.27	2.14	10.16	0.21	38.85	(31.49)	0.00	282	5,699	58.87	88.32
22 Asset growth	Descending	10,488	5.07	(0.95)	0.52	0.59	7.95	0.07	21.57	(27.36)	0.17	340	7,760	52.06	93.71
3. Price Momentum and Reversal															
23 Total return, 1D	Descending	10,983	3.15	0.48	1.98	3.40	7.02	0.48	21.94	(41.58)	0.00	340	8,573	71.18	1.76
24 Weekly Total Return	Descending	10,982	0.22	1.23	2.28	2.71	8.38	0.32	30.60	(33.64)	0.00	340	8,572	63.82	1.32
25 Total return, 21D (1M)	Ascending	10,980	0.87	(1.04)	(0.24)	0.13	10.82	0.01	27.69	(44.07)	0.83	340	8,567	52.94	3.93
26 Total return, 252D (12M)	Ascending	10,701	(2.71)	5.00	3.11	4.17	13.87	0.30	41.64	(46.50)	0.00	340	8,354	66.76	90.63
27 12M-1M total return	Ascending	10,701	(3.22)	5.51	3.46	4.72	13.38	0.35	40.96	(42.52)	0.00	340	8,354	68.53	88.94
28 Total return, 1260D (60M)	Ascending	9,190	(5.66)	3.08	2.24	1.58	13.37	0.12	40.32	(44.84)	0.03	340	6,865	58.53	97.72
4. Sentiment															
29 IBES LTG Mean EPS Revision, 1M	Ascending	4,423	(2.10)	0.29	0.20	0.64	2.57	0.25	7.26	(8.59)	0.00	340	4,245	61.76	1.17
30 IBES LTG Mean EPS Revision, 3M	Ascending	4,384	(1.83)	0.41	0.46	0.80	3.35	0.24	11.05	(10.26)	0.00	340	4,192	61.18	60.61
31 IBES FY1 EPS up/down ratio, 1M	Ascending	6,224	(1.33)	2.91	1.68	3.48	5.32	0.65	17.76	(13.76)	0.00	340	4,589	75.29	34.22
32 IBES FY1 EPS up/down ratio, 3M	Ascending	8,089	(0.92)	3.13	2.22	3.51	5.66	0.62	17.92	(12.36)	0.00	340	6,191	74.41	78.24
33 IBES FY1 Mean EPS Revision, 1M	Ascending	8,973	(0.62)	2.38	1.37	2.71	4.97	0.54	16.50	(12.79)	0.00	340	6,716	71.47	23.31
34 IBES FY1 Mean EPS Revision, 3M	Ascending	8,869	1.48	3.10	2.08	3.26	6.45	0.50	19.37	(20.12)	0.00	340	6,620	72.94	73.82
35 IBES FY1 Mean CFPS Revision, 3M	Ascending	6,167	0.63	2.02	1.56	2.30	5.25	0.44	15.81	(23.83)	0.00	262	4,695	75.19	63.45
36 IBES FY1 Mean DPS Revision, 1M	Ascending	6,894	1.10	2.24	1.57	1.72	4.17	0.41	12.65	(16.63)	0.00	281	4,802	72.60	10.98
37 IBES FY1 Mean DPS Revision, 3M	Ascending	6,813	0.99	2.33	1.99	2.20	5.55	0.40	19.08	(24.51)	0.00	279	4,743	71.68	65.90
38 IBES FY1 Mean FFO Revision, 1M	Ascending	8,129	0.43	2.28	1.48	2.08	3.97	0.52	11.73	(8.89)	0.00	208	5,108	75.96	13.51
39 IBES FY1 Mean FFO Revision, 3M	Ascending	7,960	3.36	3.25	2.13	2.76	5.56	0.50	16.27	(14.53)	0.00	205	5,009	73.17	67.85
40 IBES FY1 Mean ROE Revision, 1M	Ascending	8,986	(0.19)	2.51	1.61	1.74	4.07	0.43	13.70	(10.51)	0.00	260	6,098	68.46	15.38
41 IBES FY1 Mean ROE Revision, 3M	Ascending	8,871	(1.42)	2.95	2.22	2.20	5.05	0.44	15.70	(13.58)	0.00	258	5,974	68.99	69.40
42 Target price implied return	Descending	8,960	(2.23)	0.25	1.08	1.04	13.31	0.08	55.58	(36.25)	0.24	224	6,932	54.02	82.89
43 Recommendation, mean	Descending	9,210	(0.36)	1.30	0.23	1.60	6.53	0.24	17.41	(16.84)	0.00	293	7,561	63.82	94.73
44 Mean recommendation revision, 3M	Descending	9,172	1.36	0.48	0.39	1.64	2.84	0.58	10.01	(10.13)	0.00	290	7,535	72.07	60.24
5. Quality															
45 Return on Equity	Ascending	10,383	(6.54)	3.18	3.42	4.07	9.49	0.43	30.68	(34.69)	0.00	292	8,105	68.84	97.18
46 return on capital	Ascending	10,469	(8.60)	2.75	3.25	4.24	11.52	0.37	49.47	(34.02)	0.00	340	7,486	66.47	98.00
47 Return on Assets	Ascending	10,585	(4.34)	1.82	3.43	4.60	12.62	0.36	44.20	(30.31)	0.00	340	7,606	64.71	98.07
48 Asset Turnover	Ascending	10,524	3.52	0.69	2.55	2.65	15.80	0.17	44.64	(51.55)	0.00	340	8,001	58.24	99.85
49 Gross margin	Ascending	10,016	1.28	1.49	1.20	1.71	5.56	0.31	16.60	(13.45)	0.00	340	7,339	62.94	98.95
50 EBITDA margin	Ascending	10,517	4.19	(0.11)	2.03	3.79	13.22	0.29	42.97	(41.30)	0.00	340	8,024	59.71	96.66
51 Berry Ratio	Ascending	8,674	1.14	0.54	0.74	2.51	8.92	0.28	29.57	(20.79)	0.00	340	5,802	59.12	97.90
52 IBES FY1 EPS dispersion	Descending	9,105	(5.45)	0.59	2.11	0.81	9.49	0.09	32.68	(25.37)	0.11	340	6,868	52.35	88.01
53 IBES 5Y EPS growth/stability	Ascending	8,931	(2.07)	2.96	2.15	1.57	5.78	0.27	18.66	(20.47)	0.00	340	6,619	60.88	98.29
54 YoY change in debt outstanding	Descending	8,870	0.66	(0.54)	0.22	0.22	3.69	0.06	11.51	(11.34)	0.26	340	6,651	53.82	91.50
55 Current ratio	Descending	8,796	8.14	(0.52)	0.06	0.55	8.41	0.07	27.86	(27.01)	0.23	340	6,557	49.41	98.54
56 Long-term debt/equity	Ascending	10,377	8.19	0.12	0.51	0.77	6.24	0.12	22.37	(18.17)	0.02	340	7,907	54.71	98.90
57 Merton's distance to default	Ascending	8,934	(3.87)	3.50	3.83	2.86	10.83	0.26	31.19	(31.18)	0.00	340	6,848	60.88	93.18
58 Capex to Dep	Descending	8,600	2.21	(0.10)	0.85	1.47	6.48	0.23	22.38	(19.93)	0.00	340	5,699	60.29	97.11
6. Technicals															
59 Realized vol, 1Y daily	Descending	10,696	5.84	4.19	6.07	5.23	14.45	0.36	29.45	(44.64)	0.00	340	8,359	62.94	98.96
60 Skewness, 1Y daily	Descending	10,696	3.35	1.64	2.96	1.74	5.19	0.34	15.03	(32.98)	0.00	340	8,359	65.29	90.09
61 Moving average crossover, 15W-36W	Ascending	10,687	0.02	4.13	2.97	2.96	13.87	0.21	37.15	(45.46)	0.00	340	7,488	63.53	91.35
62 Normalized abnormal volume	Ascending	10,945	10.93	3.63	3.53	2.50	6.28	0.40	20.47	(14.71)	0.00	340	8,366	63.53	66.87

Note:

1 Direction indicates how the factor scores are sorted. Ascending order means higher factors scores are likely to be associated with higher subsequent stock returns, and vice versa for descending order.

2 P-value indicates the statistical significance of the factor's performance. A smaller p-value suggests that is it more likely the factor's performance is different from zero.

3 This is the autocorrelation of the factor scores over time. Higher serial correlation indicates lower portfolio turnover based on the factor.

Source: Bloomberg Finance LP, Compustat, IBES, MSCI, Russell, S&P, Thomson Reuters, Worldscope, Deutsche Bank

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