GLOBAL VOLATILITY SUMMIT

JULY 2016 NEWSLETTER

Dear Investor,

The Global Volatility Summit ("GVS") brings together volatility and tail hedge managers, institutional investors, thought-provoking speakers, and other industry experts to discuss the volatility markets and the roles volatility strategies can play in institutional investment portfolios. The GVS aims to keep investors updated on the volatility markets throughout the year, and educated on innovations within the space.

Deutsche Bank has provided the latest piece in the GVS newsletter series on behalf of BlueMountain Capital. Part II of the newsletter is enclosed. Please refer to the GVS website for Part I.

Cheers,
Global Volatility Summit

EVENT

The 7th Annual GVS was held on March 16th in New York City. Joined by the other event sponsors, including banks and exchanges, ten volatility and tail hedge managers hosted a crowd of 350 attendees including senior investment representatives from the largest global pensions, sovereign wealth funds, endowments, foundations, and insurance companies.

2016 MANAGER PARTICIPANTS

Argentière Capital
BlueMountain Capital
Capstone Investment Advisors
Capula Investment Management
Ionic Capital Management
Man AHL
Parallax Volatility Advisors
PIMCO
Pine River Capital Management
True Partner Capital

2016 KEYNOTE AND GUEST SPEAKERS

The 2016 keynote speakers were Barney Frank and Marcus Luttrell. Barney Frank served as a US Congressman for over 30 years and most recently as the Chairman of the House Financial Services Committee from 2007 through 2011. He was a key author of the Dodd-Frank Wall Street Reform and Consumer Protection Act. Marcus Luttrell is a decorated Navy Seal and best-selling author of Lone Survivor. You can access their biographies and more information about the event on the website: www.globalvolatilitysummit.com.

Grassroots crowding measures

In this section, we examine more direct measures of crowding based on investor holding and interest (i.e., buying power). These are metrics that we would expect to be more reliable measures of crowding because they use information that is directly related to how investor share positions.

Holdings based measures

On face value, using the holdings data reported directly by money managers (via 13F and other regulatory filings) seems to be the most obvious way to measure crowdedness. If most managers hold deep value stocks then we might infer that value strategies are crowded. Unfortunately, the problem with ownership data is the lag between when a fund actually holds a position and when it has to report that position (roughly two months later).This means that any information gleaned from ownership data will be somewhat backwards looking. Nonetheless, it is worth investigating.

We use the Thomson Reuters ownership database as our source for fund holdings.[10] The Thomson Reuter's institutional dataset collects holding data from global institutions, mutual funds, and individual investors. Short and cash positions are not disclosed in the Thomson Reuters database. Data is available on a quarterly basis since 13F disclosures are typically filed quarterly by intuitions. Using this data, we compute the percentage of ownership for each stock on each quarter end, using the most recently reported regulatory filings. The percentage of ownership is essentially shares held by a class of institutions divided by total shares outstanding. We term this as ownership intensity factor.

We use the Thomson Reuters ownership database as our source for fund holdings. Note that 13F disclosures are typically filed quarterly by intuitions

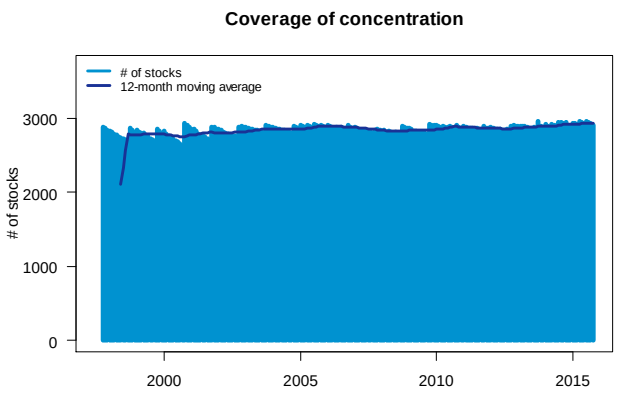
7. Ownership intensity

We test whether ownership intensity is indicative of crowding. Figure 72 shows the times series coverage of the ownership intensity factor within the Russell 3000 universe. The coverage is fairly strong. Undoubtedly, every stock should have an owner and our dataset has an expansive breadth of owners. We also analyze the distribution of the change in intensity (see Figure 73).

Interestingly, the figure shows that the average change in ownership for companies is approximately 0.5%. The mean and median are both positive which suggests that on average, owners increase their positions in companies. It may also reflect the onset of institutional money into equities and out of other asset classes.

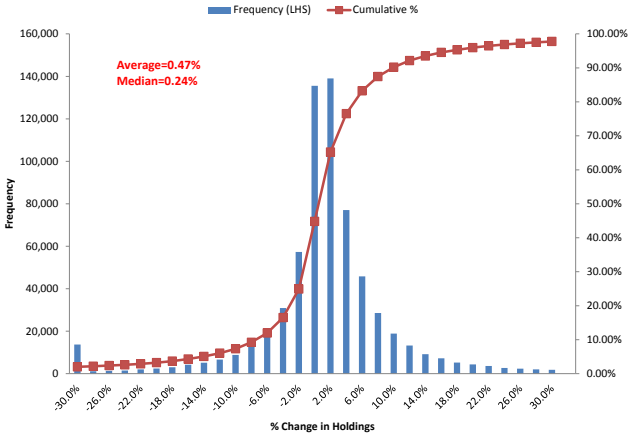
[10] We have published multiple research papers using this database, see Jussa et al [2014], Wang et al [2014], and Wang et al [2106].

Figure 72: Coverage of ownership intensity



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

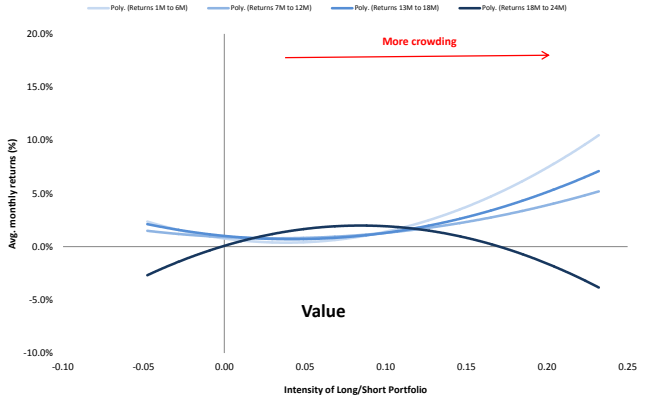
Figure 73: Time series percentiles of ownership intensity



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

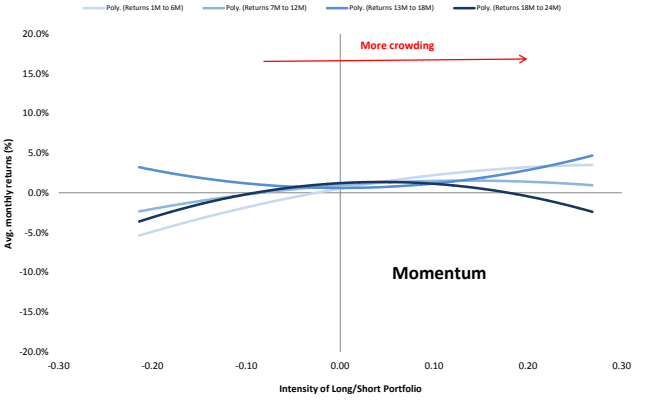
We compute the intensity of the factor portfolio by subtracting the short leg intensity from the long leg intensity. Ownership intensity provides a useful and intuitive measure of crowding (see Figure 74 to Figure 79). Essentially the correlation between factor intensity and future factor returns becomes consistently negative near the two year mark. This is especially the case for value, growth, momentum and low volatility. Ownership intensity could be a strong long-term predictor of crowding. Additionally, the results show a near-term outperformance when the strategies begin to become crowded.

Figure 74: Intensity and performance – value



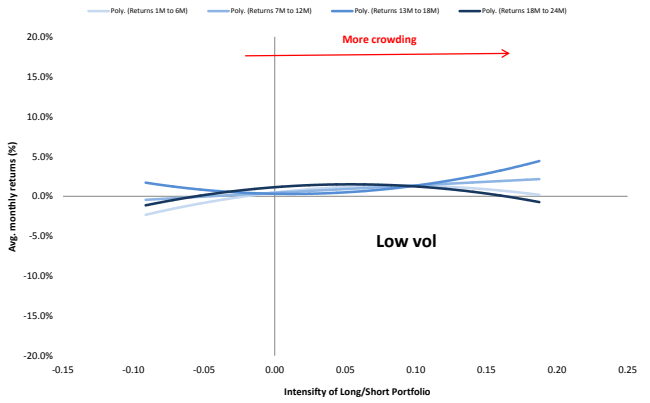
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 75: Intensity and performance – momentum



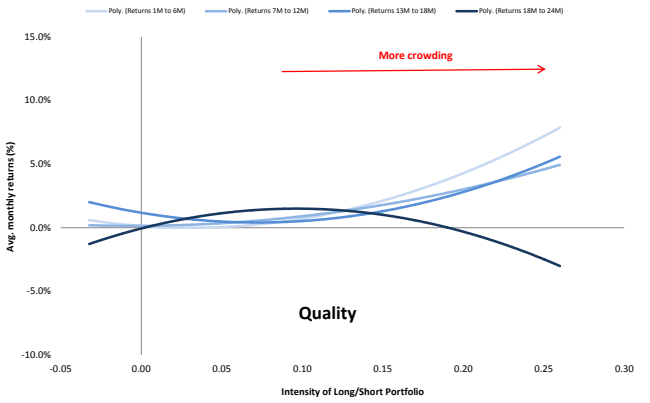
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 76: Intensity and performance – low volatility



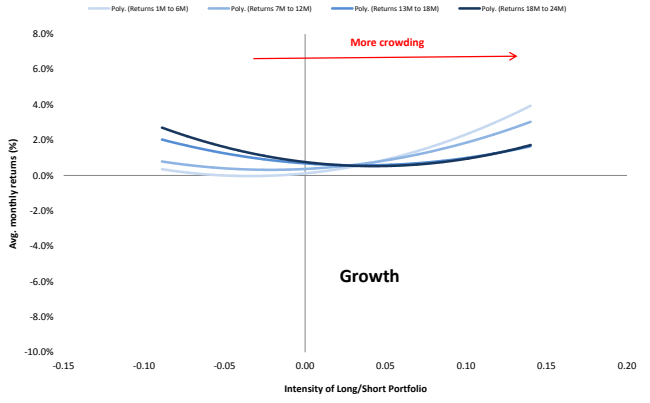
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 77: Intensity and performance – quality



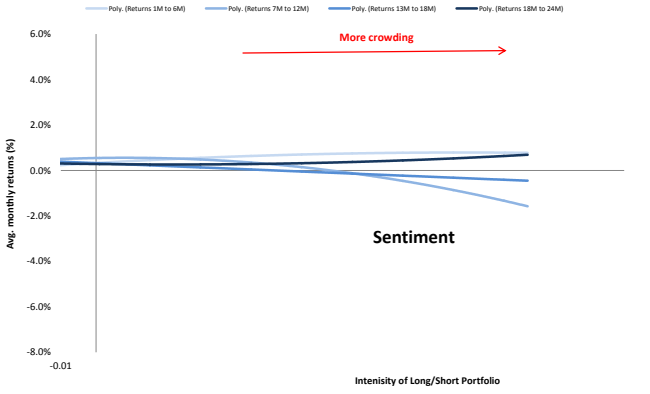
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 78: Intensity and performance – growth



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

Figure 79: Intensity and performance – sentiment



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

Next, we take this opportunity to revisit our short interest regression model and replace it with ownership intensity measure.

Owner intensity – regression model

Another means of integrating ownership intensity into our crowding analysis is to bridge in our short interest dataset. Recall that our crowding indicator based on utilization used the following regression:

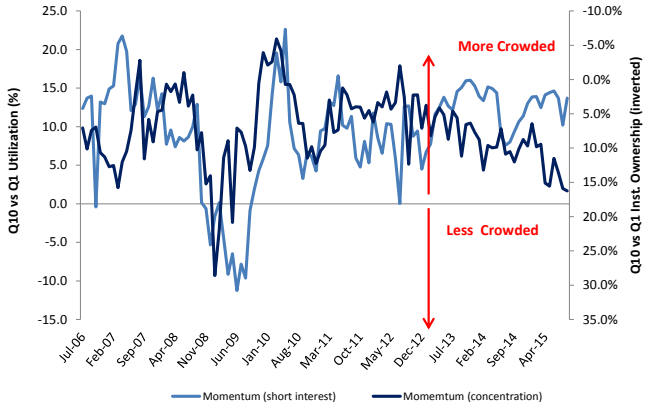
$$C_{i,t} = c + \sum_{j=1}^{J} \sum_{q=2}^{Q} \beta_{i,t,j,q} D_{i,t,j,q} + \sum_{q=2}^{Q} \beta_{i,t,size,q} D_{i,t,size,q} + \sum_{q=2}^{Q} \beta_{i,t,\sigma,q} D_{i,t,\sigma,q} + \varepsilon_{i,t}$$

We redefine our crowding measure by simply using the ownership intensity metric as our dependant variable, $C_{i,t}$ (instead of utilization). In Figure 80 and Figure 81, we compare the results for Value and Momentum to those obtained using Utilization. It turns out the charts match to a certain degree but also show significant difference at times. The results for Value using the Utilization-based metric show that crowdedness is rising, while the Institutional Ownership-based metric show it is declining.

We redefine our crowding measure by simply using the ownership intensity metric as our dependant variable

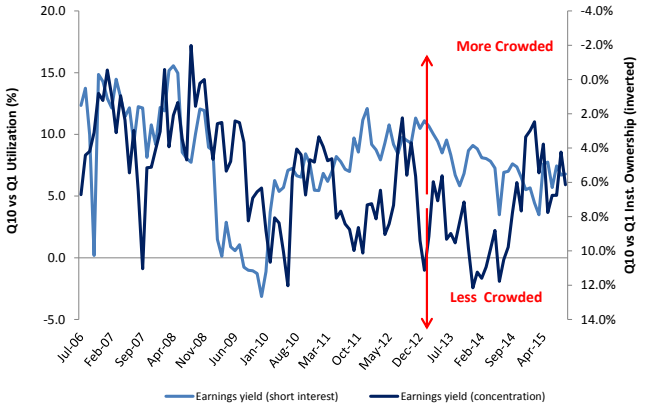
Given the lag in the institutional holdings data, would we prefer Utilization as our primary means of determining factor crowdedness? Not necessarily. The close match between the charts does give us some comfort that we are on the right track.

Figure 80: Incremental Utilization versus incremental Institutional Ownership for Q10 value stocks



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

Figure 81: Incremental Utilization versus incremental Institutional Ownership for Q10 Momentum stocks



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

Next, we analyze another potential crowding measure based on institutional ownership.

8. Buying power

In Sias [2002], herding is measured using the holdings dataset consisted of observing buying patterns of investors or owners. An owner is defined as a buyer if the ownership of the stock increases. More specifically, if the position held by the owner increases as a fraction of the shares outstanding, then the owner is a buyer. For example, if an owner held 0.01% shares of IBM and the following quarter it held 0.02% shares of IBM, then it would be classified as a buyer.[11] For each stock s at each quarter end q the herding or buying power measure is simply:

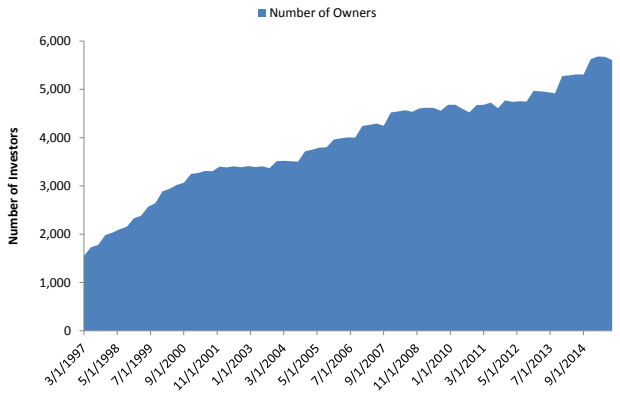
$$\text{buying\_power}_{s,q} = \frac{\#\text{ of Owners Buying}_{s,q}}{\#\text{ of Owners Buying}_{s,q} + \#\text{ of Owners Selling}_{s,q}}$$

Since the data is measured quarterly, owners that buy and sell the same number of shares within the same quarter will not be counted as a trade. By aggregating the buying power at a sector, market, and strategy level, we can test whether this measure is indicative of crowding. To get a better sense of the dataset, Figure 82 plots the number of owners over time. The current number of owners exceeds 5,000 investors. Figure 83 shows the average number of stocks held by owners. Investors on average hold approximately 75 stocks.

Sias' approach to measure herding using the holdings dataset was by observing buying patterns of investors

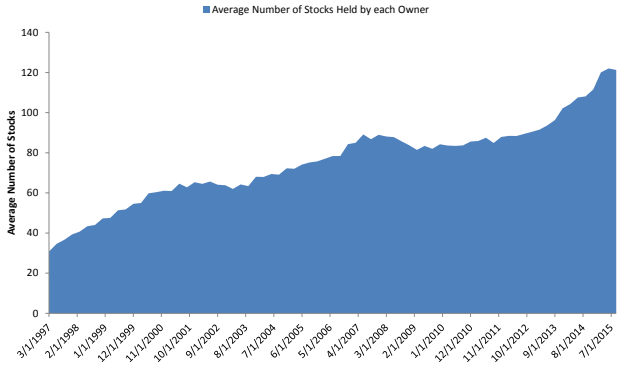
[11] Note that 0.01% and 0.02% represent shares held over shares outstanding for that particular institution at quarter end.

Figure 82: Time series of the number of owners



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

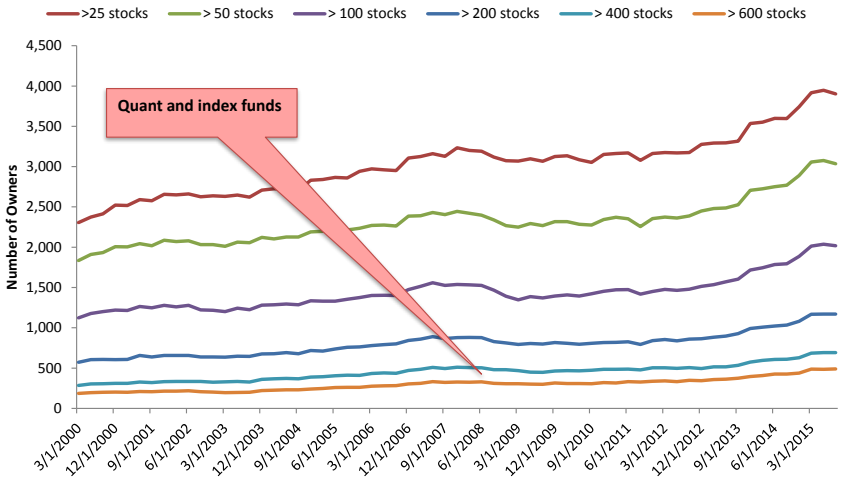
Figure 83: Average number of securities held by owners



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

Lastly, Figure 84 shows the number of owners alongside stocks held. The chart shows that there are fewer owners who own a large numbers stocks, as expected. Owners tending to hold a significantly large number of stocks tend to be quant and index funds.

Figure 84: Number of owners and stocks held



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

We compute the buying power of the portfolio by subtracting the buying power of the long leg minus the buying power of the short leg. We can then analyze the correlation between the buying power and future returns. If our indicator is negatively correlated to future performance, then this would suggest a mean-reversal behavior. On the other hand, if it is positively correlated to future performance, then this would suggest a potential trending indicator. The strength of the correlation is also important.

Buying power based crowding measures are strongly and consistently negatively correlated to future returns for all quantitative factors (see Figure 85).

Figure 85: Comparing buying power and intensity for quant factors

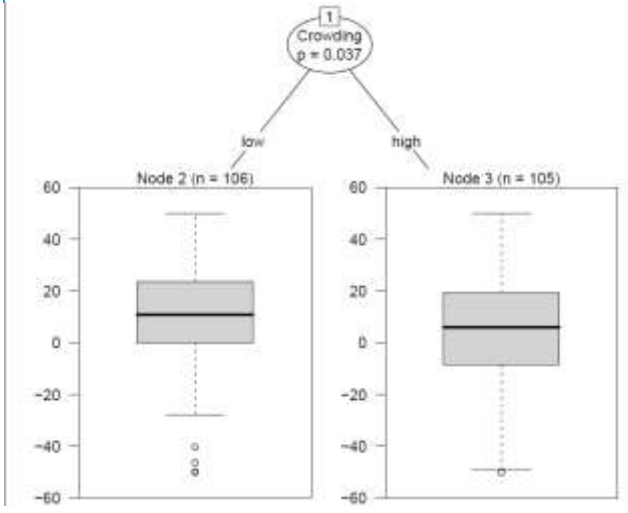
Factors	Intensity				Buying power			
Dividend yield	11%	20%	26%	18%	-5%	-14%	-2%	-21%
Earnings yield	26%	12%	16%	3%	-14%	-17%	-18%	-16%
Momentum	34%	13%	8%	3%	7%	7%	-4%	13%
1M Reversal	4%	-23%	-5%	6%	36%	0%	-20%	7%
EPS growth	33%	25%	1%	-3%	-8%	-16%	-17%	1%
ROE	34%	24%	15%	-4%	-20%	-21%	-12%	-5%
Low Vol	7%	11%	13%	0%	-11%	-20%	-11%	-12%
Earnings revisions	13%	-4%	-13%	-1%	-21%	1%	-13%	4%
Avg. Monthly Returns	1 to 6	7 to 12	13 to 18	19 to 24	1 to 6	7 to 12	13 to 18	19 to 24

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

The ownership intensity factor merely shows the level of institutional ownership for each sector or strategy. It is lagged by one quarter. On the other hand, the buying power factor shows the interest from buyers in a stock quarter over quarter

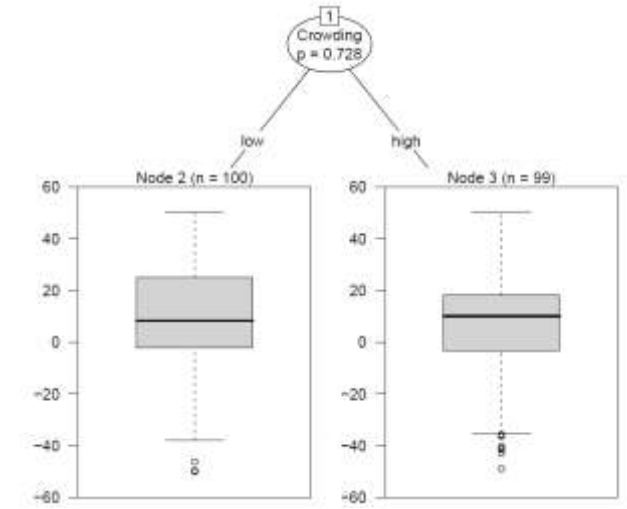
This can be seen more clearly when running the CART model on the quality portfolio using buying power as the crowding measure (see Figure 86 and Figure 87). At high levels of crowding, 12-month forward returns tend to be slightly lower and more negatively skewed than 13 to 24-month forward returns.

Figure 86: Buying power and 12-month forward returns for quality portfolio



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

Figure 87: Buying power and 13 to 24-month forward returns for quality portfolio



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

We also run a multivariate regression analysis on future 12- and 24 month returns using buying power (see Figure 88). The results show that the longer horizon of 24 month future returns does not improve the significance level. The results can potentially be explained by the fact that the ownership data is delayed and lagged. This may explain why the results show more severe impact on the near term rather than the long term returns.

Figure 88: Average coefficients for multivariate regression using buying power

	12-Month Forward Returns		24-Month Forward Returns	
	Average Beta	Average T-stat	Average Beta	Average T-stat
Crowding	(2.23)	(3.09)	(4.62)	(4.01)
Crowding squared	0.01	0.55	0.03	1.96
Crowding change	0.96	1.88	1.08	1.31
Crowding saturation	(0.54)	(1.20)	(2.18)	(2.90)

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

It is also important to highlight that the ownership intensity and buying power are similar yet different factors. The ownership intensity factor shows the level of institutional ownership for each sector or strategy. It is lagged by one quarter. On the other hand, the buying power factor shows the interest from buyers in a stock quarter over quarter. Its gives an indication of pure investor demand for a particular sector or strategy.

The ultimate crowding measures

In this section, we examine two portfolio level of crowding measures: the concentration and diversification ratios. We have studied them as crowding measures in Luo, et al [2014] and Wang, et al [2016].

9. Concentration ratio

In classic economics, the concentration ratio is a measure of the output produced by each firm in an industry. CR4 measure the market share of the four largest firms in an industry. Similarly, CR8 measures the market share of the eight largest firms in an industry. The concentration ratio is a measure of market control within an industry. It essentially measures the degree to which an industry is oligopolistic (i.e., dominated by a few companies).

The traditional measure of competitiveness and concentration is the Herfindahl index:

$$Herfindahl\_Index = \sum \text{market\_shares}_n{}^2$$

A similar measure of company domination can be calculated at the portfolio level. The measure is called the concentration ratio or CR[12].

$$CR = \frac{\sum_{i=1}^{N} w_i^2 \sigma_i^2}{\left(\sum_{i=1}^{N} w_i \sigma_i\right)^2}$$

It is a measure of portfolio concentration that takes the volatility of the stocks into account. A higher CR is indicative of more concentrated positioning. For example, take the hedge fund aggregate portfolio (HFA) based on institutional ownership data. This simply aggregates the positions of most hedge funds. It shows which companies most hedge funds are heavily invested in. If the HFA portfolio has significant positions in a few highly volatile companies, then the CR would show that this portfolio is fairly "concentrated".

In general, if a portfolio has heavy positioning in volatile names, the CR would reflect that this portfolio is concentrated

In general, if a portfolio has heavy positioning in volatile names, then the CR would reflect that this portfolio is concentrated. In effect, the CR measures not only the concentration of weights, but also the concentration of risks as assets are weighted proportionally by their volatilities. [13]

The concentration ratio and portfolio crowding

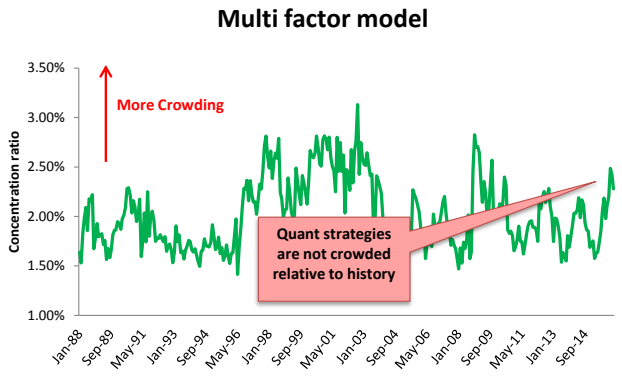
The CR ratio is typically used to measure crowdedness in aggregate portfolios. For example, the CR can be used to measure the crowdedness of the HFA portfolio described earlier. However, quants typically invest in a larger number of securities than typical hedge funds. To test whether quantitative strategies are crowded, we construct the quantitative representative portfolio or QRP.

[12] As shown in Choueifaty and Coignard [2008] and Luo, et al [2014]

[13] See Choueifaty and Coignard [2008] for more details.

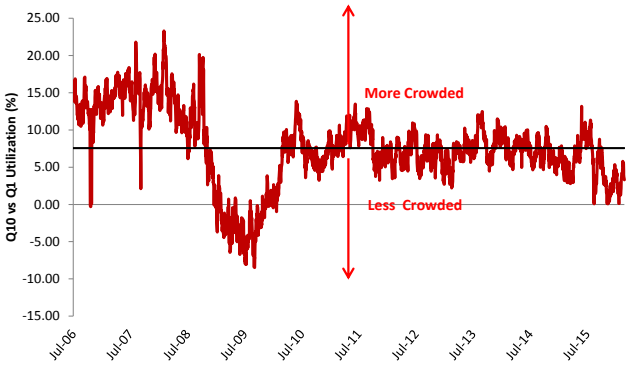
To do this we simply build a portfolio based on standard factors that quants typically use, such as value, growth, momentum, sentiment, low volatility, and quality. We sector neutralize each factor because quants typically avoid making sector calls. Combining all these factors together forms our multifactor, long only portfolio. We take the top 300 best stocks based on this multifactor model and market cap weight them within the portfolio. We select a fixed number of stocks (i.e., 300) because the CR ratio is fairly sensitive to the number of securities. All else being equal, a larger breadth of securities will decrease the CR ratio. Figure 89 shows the CR ratio for our QRP.

Figure 89: CR for QRP (all history)



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

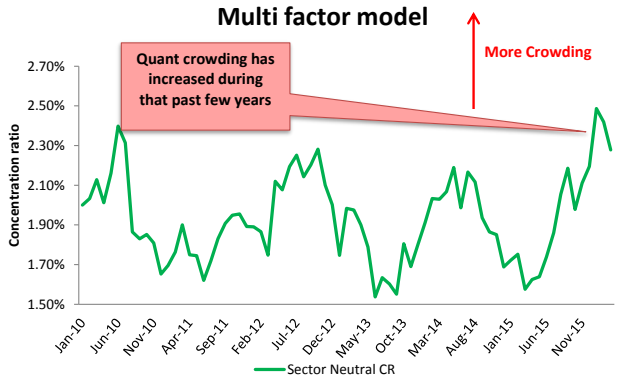
Figure 90: Incremental utilization for multifactor model



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

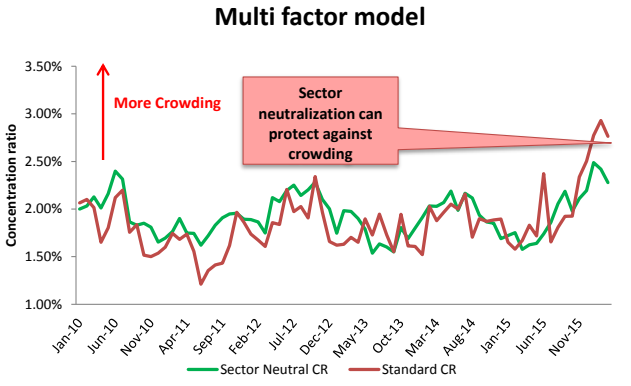
The results show that quant strategies are not overly crowded relative to history, but more so than using our incremental utilization measure, (see Figure 90). Figure 91 shows an uptick of crowding in recent years. Quant crowding is at a five-year high as measured by CR. We also find that quant strategies that are not currently sector neutralized show even stronger signs of crowding (see Figure 92). This would imply that currently, quant strategies are sensitive to sector effects. Sector neutralization tends to lower the volatility of a portfolio.

Figure 91: CR for QRP (recent history)



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

Figure 92: Non-sector neutral CR



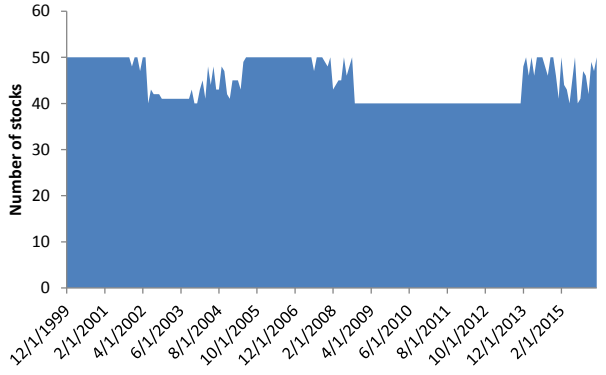
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

We also find that the correlation between CR and forward annual QRP excess returns is -20%. However, the overall crowdedness of QRP tells us little about the underlying factors behind the model.

One of the most widely discussed and employed underlying drivers of quant portfolios is low volatility. We can also use CR to measure the crowdedness of low volatility or minimum variance portfolio. We construct our minimum variance portfolio using stocks in the S&P 500 universe.[14] We assign a 5% maximum asset weight constraint and limit our portfolio with around 40 and 50 stocks.

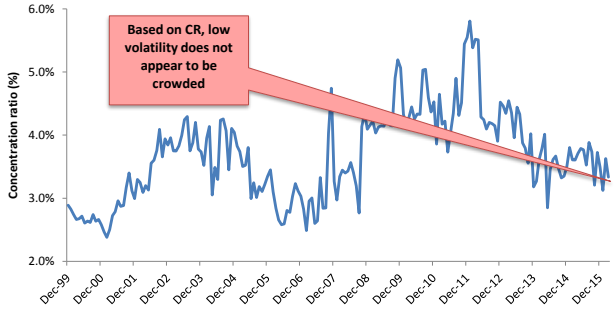
Figure 93 shows the number of stocks in the minimum variance portfolio. Figure 94 shows the time series CR for the minimum variance portfolio.[15] CR shows that low volatility strategies are currently not crowded. This seems to contradict with the other crowding measure we have analyzed thus far.

Figure 93: Coverage of minimum variance portfolio



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

Figure 94: CR for minimum variance portfolio



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

Real life portfolio simulations

As a robustness check, we create another multi-factor model using a blend of quant factors. We employ a mean variance optimization using the Axioma medium-term fundamental risk model to create a long-only active portfolio with the Russell 1000 as benchmark. We also set a 5% maximum asset weight constraint. Additionally, we ensure that the portfolio holds between 90 and 100 stocks. This portfolio serves as a proxy for a typical quantitative manager.

Next, we compute the CR of this portfolio. We compute the market relative CR by subtracting the Russell 1000 CR. [16] Figure 95 shows the relative CR from 1994 onwards. The results indicate no significant crowding relative to history. We also backtested a sector-neutral quant portfolio. This also showed no significant levels of quant crowding relative to history (see Figure 96).[17]

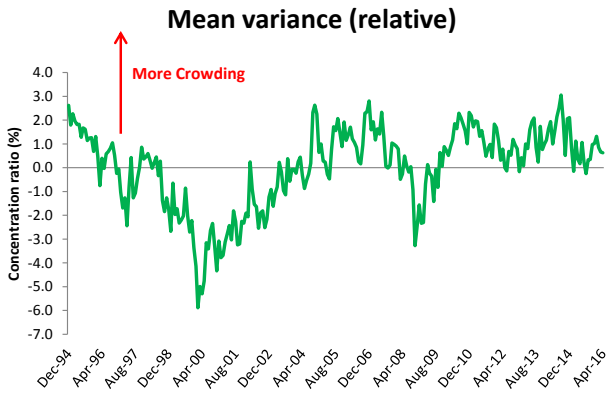
[14] We use the Axioma risk model to optimize the minimum variance portfolio.

[15] The volatility is calculated based on daily returns over the past three years.

[16] We use the Axioma risk model for the calculation of the concentration ratio. We also Z-score the CR prior to computing the relative CR.

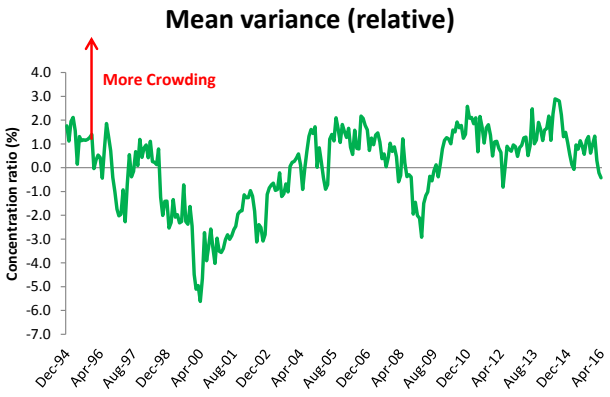
[17] We sector neutralized the alpha signal instead of using a constraint in the Axioma optimizer.

Figure 95: CR for optimized portfolio – Russell 1000



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

Figure 96: CR for optimized portfolio – sector neutral – Russell 1000



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

We also find that the correlation between relative CR (as well as sector-neutral relative CR) and forward annual excess returns is -40% and - 39% respectively. This would suggest that relative CR is a reasonable measure of crowding.

However, the CR does not consider the correlation among stocks in the portfolio. We address this next by introducing the diversification ratio.

10. Diversification ratio

The diversification ratio (DR) is similar to CR, but it takes into account the correlation among the stocks in the portfolio (see Luo, Wang, Cahan, et al [2013]). It is defined as the weighted average volatility divided by the total portfolio volatility (which accounts for correlation). [18]

$$DR = \frac{\sum_{i=1}^{N} w_i \sigma_i}{\sigma_p}$$

$$\sigma_p = \sqrt{\sum_{i=1}^{N} w_i^2 \sigma_i^2 + \sum_i \sum_{i \neq j}^{N} w_i w_j \sigma_i \sigma_j \rho_{ij}}$$

The diversification ratio (DR) is similar to CR, but it takes into account the correlation of the stocks in the portfolio

In general, if a portfolio has heavy positioning in volatile names that are highly correlated, the DR would reflect that this portfolio is concentrated. Reverting back to our HFA example, if the HFA portfolio has significant positions in a few highly volatile companies, then the DR would show that this portfolio is undiversified or concentrated. If those names are also highly correlated, then the DR would show significant concentration. The DR can also be written as a function of CR. Therefore, the higher the pairwise correlation, the lower the DR.

$$DR = \frac{1}{\sqrt{\rho_{average}\,(1 - CR) + CR}}$$

[18] See Choueifaty and Coignard [2008] for more details.

The diversification ratio and factor crowding

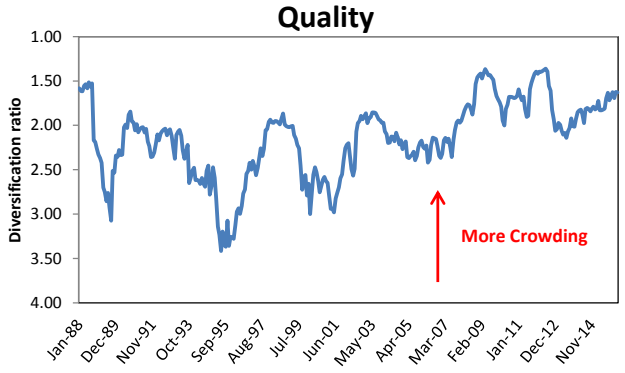
We test how well DR can measure factor crowdedness using a similar methodology outlined for CR.[19] We construct long only factor portfolio reflective of the strategies that quants and other investors typically invest in. These portfolios are: value, growth, momentum, sentiment, quality, reversal, and low volatility. To construct these portfolios, we take the top 50 names ranked by each factor. The universe is the Russell 3000. Note that the portfolios are not sector neutralized.

Furthermore, we market cap weight as well as conviction weight (i.e., factor-score weight). We also apply a 5% maximum weight constraint. Figure 97 and Figure 98 show the time series DR for the momentum and low volatility portfolio, respectively. We have inverted the y-axis, therefore a higher reading is indicative of less diversification, more concentration, and hence more crowding. We immediately notice that the DR has a trending component. On average, it has increased over time.

Based on DR, quality and low volatility are showing signs of crowdedness, relative to their own history

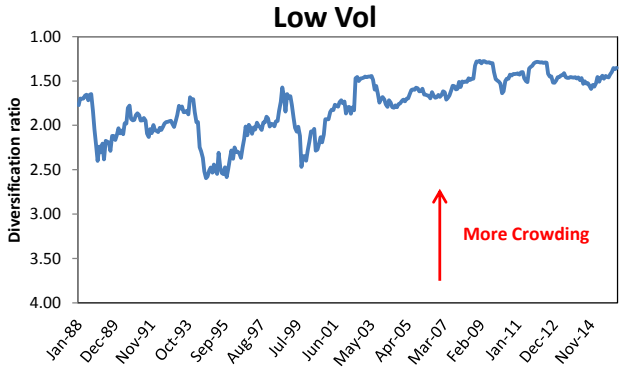
This likely reflects the fact that more systematic and passive strategies have entered the marketplace post the 1990s. And investors are chasing similar strategies causing an increase in correlation. Based on DR, quality and low volatility are showing signs of crowdedness, relative to their own history.

Figure 97: DR for quality cap-weighted portfolio



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

Figure 98: DR for low volatility cap-weighted portfolio

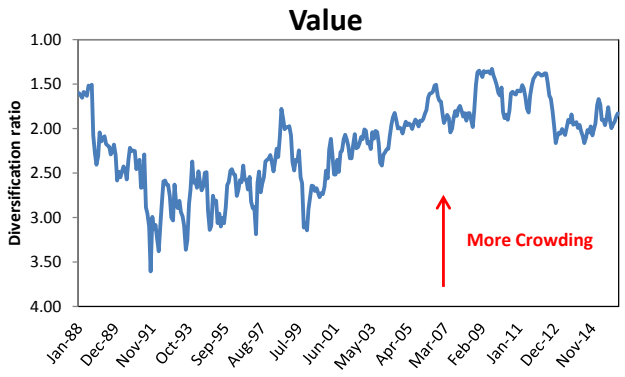


Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

We also analyze the time series DR for the other factor portfolios (see Figure 99 to Figure 102). Again the DR ratio is showing an increasing trend overtime.

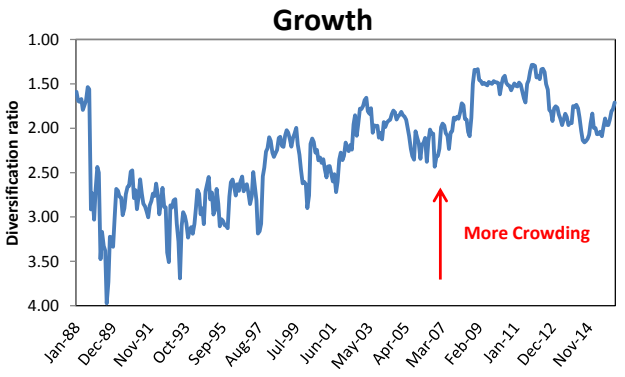
[19] The calculation of DR requires the covariance matrix. We compute the sample covariance matrix for the DR calculation using one year of daily returns.

Figure 99: DR for value cap-weighted portfolio



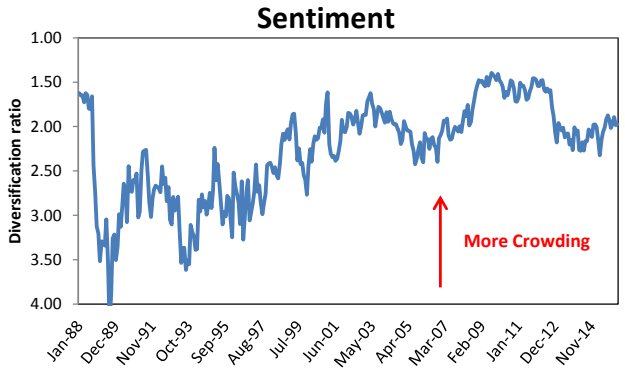
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 100: DR for growth cap-weighted portfolio



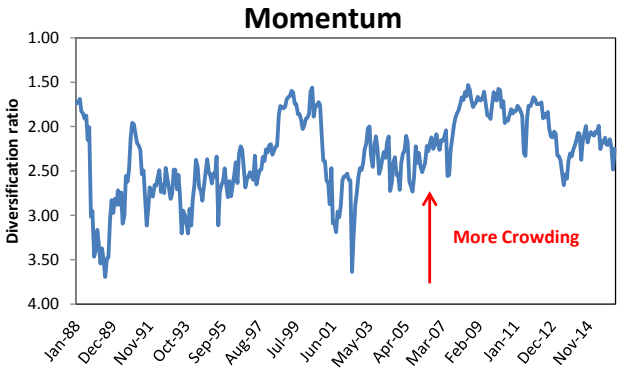
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 101: DR for sentiment cap-weighted portfolio



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

Figure 102: DR for momentum cap-weighted portfolio



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

Again, we need to test how the DR is related to future performance. We compute the correlation between DR and future 12-month cumulative returns (see Figure 103).

As shown in Figure 103, the correlation between DR, for the cap-weighted quality and low volatility portfolio and one-year future returns are sizeable – 49% and -64%, respectively. Overall, there is no significant difference between the cap-weighted and conviction-weighted portfolios.

Figure 103:DR and crowdedness

	Div yield	Value	Momentum	Reversal	Growth	Quality	Low Vol	Sentiment
DR Cap Weighted	-4%	-20%	-19%	35%	11%	-49%	-64%	35%
DR Conviction Weighted	8%	-10%	-30%	30%	-7%	-50%	-73%	30%

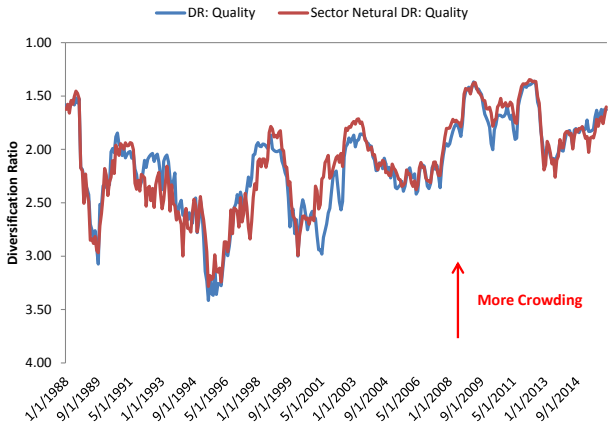
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Robustness checks for the diversification ratio

Sector effects

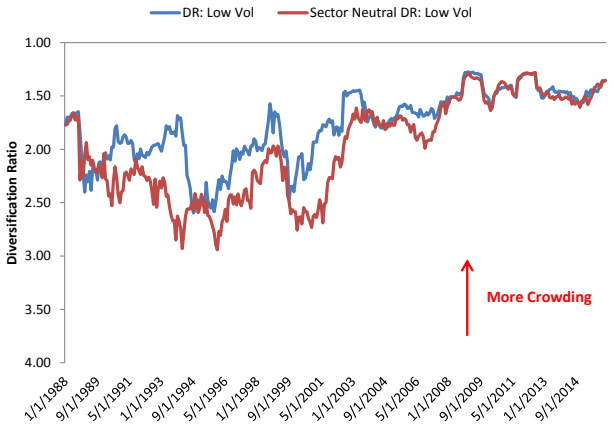
Factor portfolios can take on significant sector exposure. Therefore the strong results behind the DR crowding metric may be driven by sector effect. As such, we sector adjust our factor portfolio and repeat our analysis.[20] Figure 104 and Figure 105 compare the time series DR and sector adjusted DR for the quality and low volatility portfolios. We see no significant difference between the original DR and sector adjusted DR.

Figure 104: Sector adjusted DR for quality cap-weighted portfolio



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

Figure 105: Sector adjusted DR for low volatility cap-weighted portfolio



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

In terms of the influence of sectors, using adjusted DR as a crowding measure, we see no significant differences when compared to the original DR measure (see Figure 106).[21] This implies that the strong performance of DR as a crowding measure is not driven primarily by sectors.

Figure 106:DR sector adjusted and crowdedness

	Div yield	Value	Momentum	Reversal	Growth	Quality	Low Vol	Sentiment
DR Cap Weighted	-4%	-20%	-19%	35%	11%	-49%	-64%	35%
DR Cap Weighted (sector neutral)	-12%	1%	-14%	24%	5%	-39%	-66%	33%

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

Trend effects

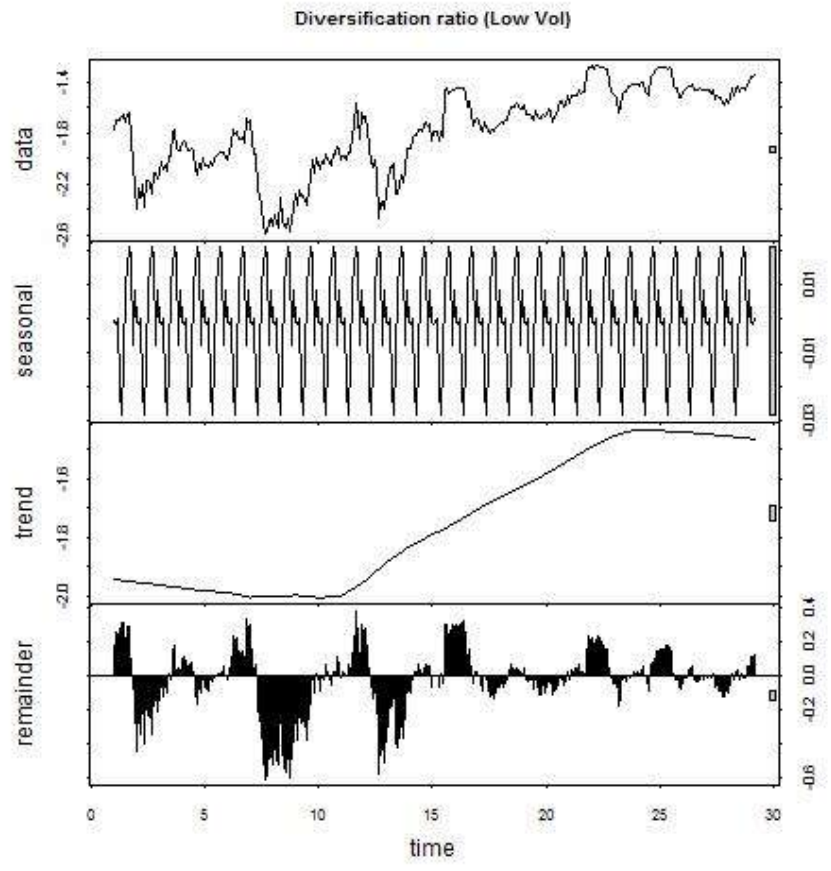
Next, we perform one more robustness check. We recall that the DR had a significant trend component while returns normally do not. In this last section, we de-trend our DR measure to test if it still holds up as an adequate crowding measure. Figure 107 shows the original DR ratio, the seasonal component, the trend component, and the residual DR (RDR).[22] The seasonal component is fairly small. However, the trend component is significant. The RDR is what really interests us.

[20] We sector adjust our factor portfolios by z-score the factors cross-sectionally across the GICS level 1 sectors rather than cross-sectionally across the entire Russell 3000 universe.

[21] The correlation is computed from the year 2000 onwards.

[22] We use the STL package in R to de-trend the DR ratio.

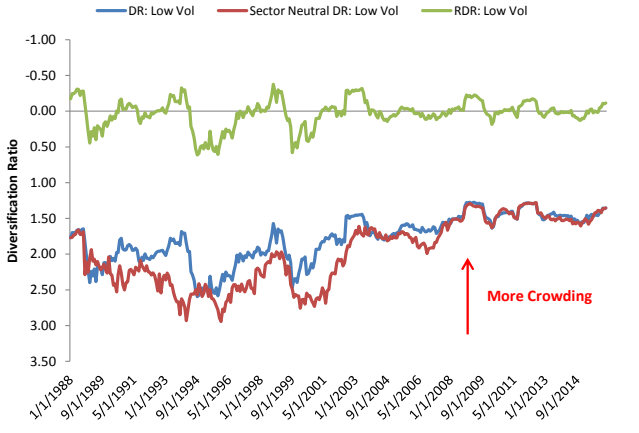
Figure 107:De-trending DR



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

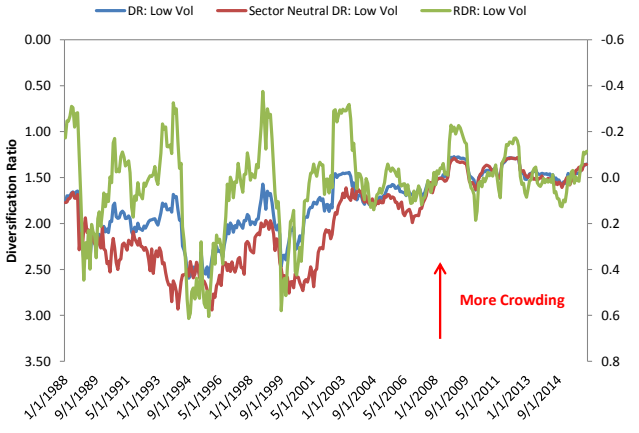
Figure 108 compares the original DR, sector DR, and the RDR. Note that the RDR does show mild signs of crowding (i.e., its currently above zero). This can be seen more easily by putting the RDR onto the secondary axis (see Figure 109).

Figure 108: Residual DR for low volatility cap-weighted portfolio



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

Figure 109: Residual DR for low volatility cap-weighted portfolio (secondary axis)



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

In terms of the strength of RDR as a crowding measure, we see no significant differences compared to the original and sector adjusted DR's (see Figure 110). Again, our results reiterate that DR is a robust and effective measure of investor crowding, especially for low volatility.

Figure 110: DR remainder and crowdedness

	Div yield	Value	Momentum	Reversal	Growth	Quality	Low Vol	Sentiment
DR Cap Weighted	-4%	-20%	-19%	35%	11%	-49%	-64%	35%
DR Cap Weighted (sector neutral)	-12%	1%	-14%	24%	5%	-39%	-66%	33%
DR Cap Weighted (residual)	11%	5%	-15%	33%	21%	-22%	-51%	34%

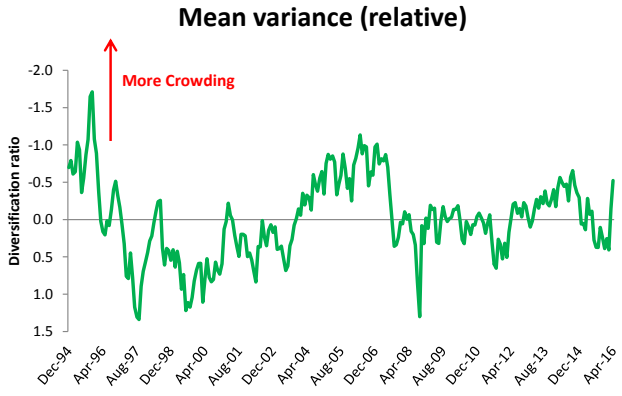
Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Real life portfolio simulations

Lastly, we use the same multi-factor model (a blend of quant factors) to create a long-only optimized portfolio. We employ a mean variance optimization using the Axioma medium-term fundamental risk model. We also set a 5% maximum asset weight constraint. Additionally, we ensure that the portfolio holds between 90-100 stocks.

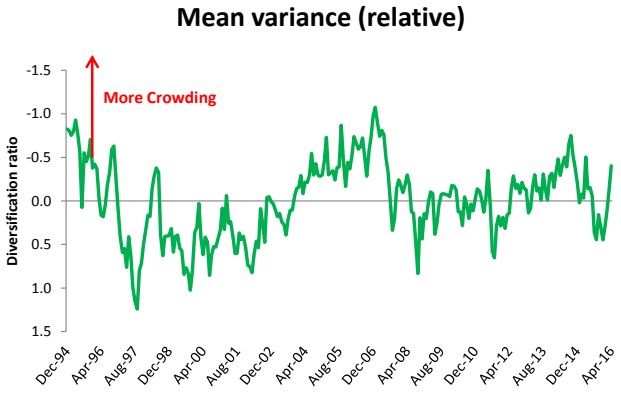
Next, we compute the DR of this portfolio and further subtract the market DR (based on the Russell 1000 index). To compute the market relative DR, we divide by the Russell 1000 DR. [23] Figure 95 shows the relative DR from 1994 onwards. The results indicate no significant quant crowding relative to history. We also backtested a sector-neutral quant portfolio. This also shows only modest levels of quant crowding relative to history (see Figure 96).[24]

Figure 111: DR for mean variance portfolio – Russell 1000



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

Figure 112: DR for mean variance portfolio – sector neutral – Russell 1000



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

We want to highlight that the correlation between relative DR (as well as sector neutral relative DR) and forward annual excess returns is -15% and -9%, respectively.

[23] We use the Axioma risk model for the calculation of the concentration ratio. We also Z-score the CR prior to computing the relative CR.

[24] We sector neutralized the alpha signal instead of using a constraint in the Axioma optimizer.

What about funds flow?

Lastly, we examine the practicality of using funds flow data as a measure of crowding. The results suggest that funds flow is an interesting dataset; but, it is more effective as a conditional variable to gauge the initial stages of crowding. Funds flow is useful at assessing inflection points in the market. Irrespective, we highlight the funds flow dataset in this research and welcome the opportunity to do further research on it.

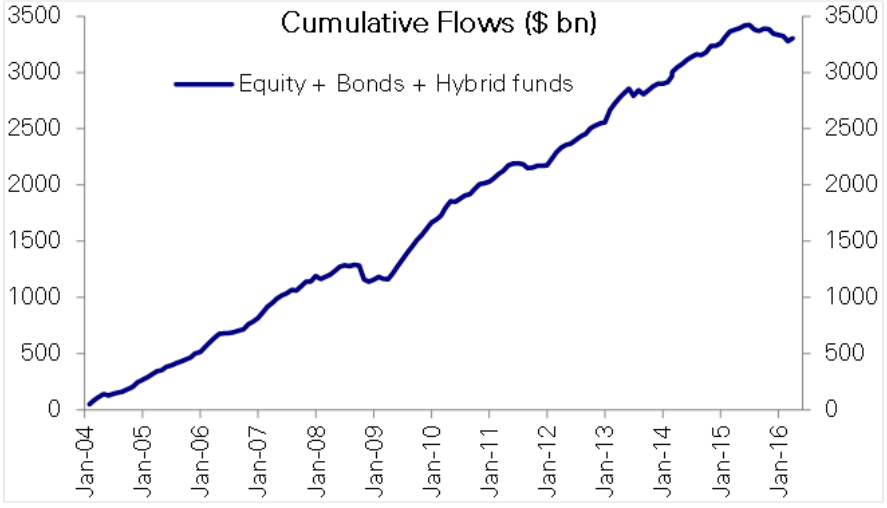
A brief introduction of funds flow

Fund flows track net new end-investor money flowing into or out of mutual funds and ETFs. Our data set (from data providers EPFR Global and ICI) tracks funds with total assets under management of almost $22 trillion globally covering products across a wide range of asset classes, regions, countries, sectors, styles and sizes. Fund flows provide an important measure of investor demand and when combined with supply indicators explain movements in prices well. For example, simple measures of US equity demand based on fund flows and supply (issuance and buybacks) when combined have a 75% correlation with quarterly S&P 500 price changes over the last 20 years. To get a better sense of the dataset, we briefly analyze some recent themes based on the funds flow dataset.

Key recent trends and rotations

The data shows a large remarkably steady pool of combined inflows into equity, bond and asset allocation (hybrid) funds running around $325bn a year for the last ten years (see Figure 113). What is the source of these steady flows? We view the steady flows as a normal allocation from new savings. If some proportion of income is saved, some proportion of this "new money" will be allocated to bonds and equities and the rest to cash. Savings and its allocation to bonds and equities explain why the norm in financial markets is of inflows. Their steadiness is an empirical regularity and likely reflects the steadiness of global savings.

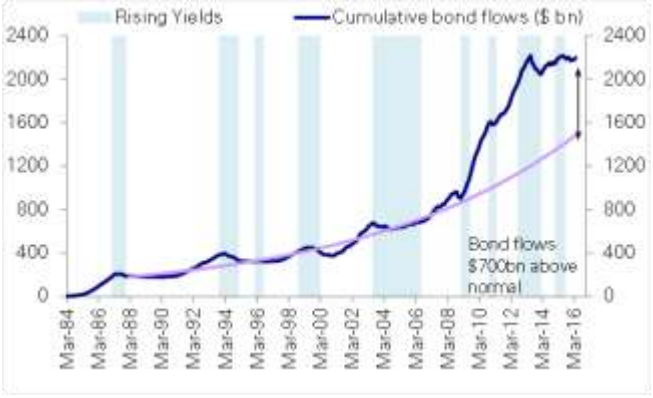
Figure 113: Pool of combined inflows into equity, bond, and hybrid funds



Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

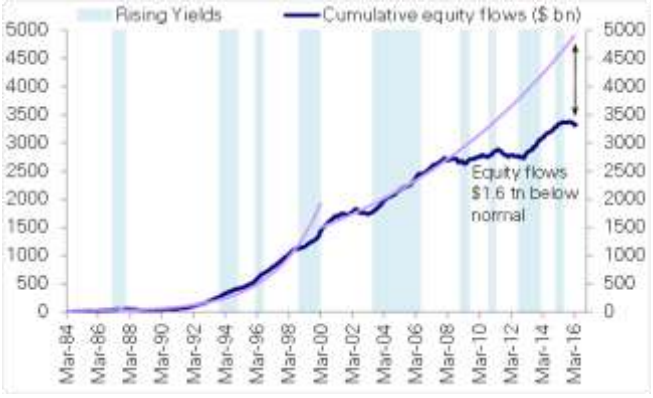
Breaking it down, the data shows a large over-allocation to fixed income above the normal trend whereas allocation to equities has been below the trend (see Figure 114 and Figure 115). Rotation from equities to bonds is common around recessions historically, but in the present cycle, it has continued well beyond the typical period. This has been driven by the absence so far of sustained rate normalization which is the normal cyclical asset reallocation mechanism between bonds and equities. An extended period of rate normalization may see a re-allocation back to equities. The potential scope is massive as cumulative flows to bonds relative to the historical trend are extremely high (+$770 billion above trend) while to equities are very low (-$1.4 trillions).

Figure 114: Allocation to bonds is above trend



Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

Figure 115: Allocations to equities is below trend

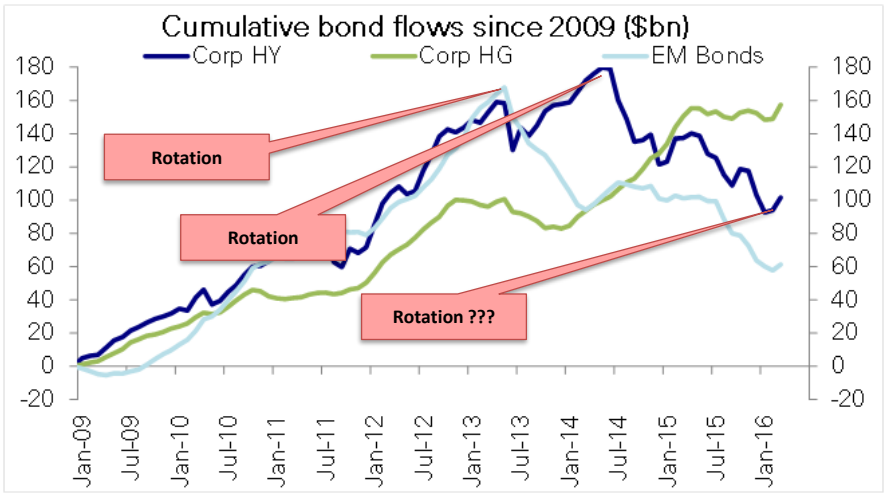


Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

Funds flow, crowding, and rotations

The funds flow dataset provides a rich source of investor insight. In particular, funds flow is useful at capturing persistent and consistent trends as well as rotations within asset classes. For example, in 2013 we saw a strong rotation out of emerging market bonds and into high-yield corporate bonds (see Figure 116). Thereafter high-yield bonds have seen a large outflow rotation since June 2014 of last year when oil prices began to fall. Currently it appears that high-yield and high-grade corporate bonds, as well as emerging market bonds, could be in a "rotationary" state. However, this difficult to accurately gauge or predict.

Figure 116: Bond rotation episodes

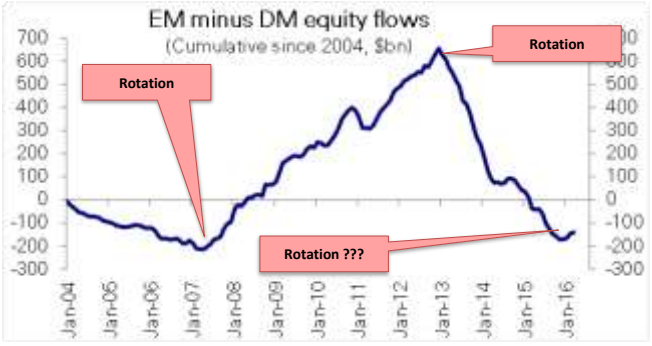


Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

When analyzing funds flow for equities, we observe more rotations. Emerging markets (EM) relative growth peaked in 2010, EM equities began to see outflows with a modest lag beginning in early 2011 (see Figure 117). After a brief respite in 2012, outflows resumed in early 2013 and initially benefited all of developed market (DM) equities, but went primarily to Europe and Japan since early 2015 (see Figure 118). Currently, we could be at another inflection point as relative outflows out of EM and into DM has turned. However, this is difficult to predict even at the country level.

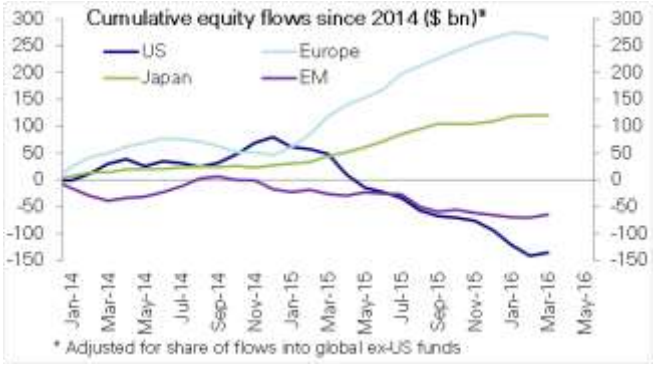
Whilst funds flow is an important and insightful metrics, incorporating the dataset into crowding may be challenging. Trending episodes are typically long, consistent and persistent. As such, rotations are difficult to gauge and predict

Figure 117: Emerging and developed market rotations



Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

Figure 118: Country rotations



Source: Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, EPFR Global, ICI, Deutsche Bank

Whilst funds flow is an important and insightful metric, incorporating the dataset into crowding may be challenging. Trending episodes are typically long, consistent, and persistent. As such, rotations are difficult to gauge and predict. Funds flow may be useful as a conditional variable to gauge the initial stages of crowding. Irrespective, we highlight the funds flow dataset in this research and welcome the opportunity to do further research on these useful and insightful measures. Please keep an eye out for further research in this space.

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Appendix 1

Important Disclosures

Additional information available upon request

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David Folkerts-Landau
Chief Economist and Global Head of Research

Raj Hindocha
Global Chief Operating Officer
Research

Marcel Cassard
Global Head
FICC Research & Global Macro Economics

Steve Pollard
Global Head
Equity Research

Michael Spencer
Regional Head
Asia Pacific Research

Ralf Hoffmann
Regional Head
Deutsche Bank Research, Germany

Andreas Neubauer
Regional Head
Equity Research, Germany

International Locations

Deutsche Bank AG
Deutsche Bank Place
Level 16
Corner of Hunter & Phillip Streets
Sydney, NSW 2000
Australia
Tel: (61) 2 8258 1234

Deutsche Bank AG
Große Gallusstraße 10-14
60272 Frankfurt am Main
Germany
Tel: (49) 69 910 00

Deutsche Bank AG
Filiale Hongkong
International Commerce Centre,
1 Austin Road West,Kowloon,
Hong Kong
Tel: (852) 2203 8888

Deutsche Securities Inc.
2-11-1 Nagatacho
Sanno Park Tower
Chiyoda-ku, Tokyo 100-6171
Japan
Tel: (81) 3 5156 6770

Deutsche Bank AG London
1 Great Winchester Street
London EC2N 2EQ
United Kingdom
Tel: (44) 20 7545 8000

Deutsche Bank Securities Inc.
60 Wall Street
New York, NY 10005
United States of America
Tel: (1) 212 250 2500