Quantitative Strategy
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Emerging Issues

QUANTitative Easing

Research Summary
Past episodes of Quantitative Easing have had far reaching consequences for quant factor portfolios. In this report we study the implications of the latest round of QE on quant factors, and suggest ways to mitigate its impact and even profit from it.

A quant perspective on investing in a post-QE3 world

Extraordinary intervention
The recently announced QE3 represented the next chapter in a rapidly growing book of Fed interventions. Needless to say, reams of paper have been expended in debating the merit or lack thereof of such policy. We don't seek to add to that pile. Instead, we focus on the implications of QE from a quant perspective. Specifically, we are interested in how quant factors and strategies perform around QE episodes. Can we learn something from the (admittedly short) history of such actions?

Quant factor implications: Beware the low volatility tilt
Our key finding is that – as one might expect – past QE events triggered a shift from risk-averse to risk-seeking behavior. While the factors that have done best after past QE events have been different each time, we do find a critical commonality: the factors that work post-QE have tended to be those tilted away from low risk in the lead-up to the event. In other words, in a post-QE3 world, watch out for a risk rally, and watch out for factors that are positively aligned with low volatility.

Tilt towards growth and sentiment; avoid value, momentum, and quality
We find that growth and sentiment factors had the lowest correlation with low volatility right before QE3, whereas value, momentum, and quality were all significantly exposed to lower volatility stocks. Given what happened after past QE events, this suggests a potential post-QE3 factor allocation.

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Stock screen

Buy ideas for a post QE3 world

Based on the analysis in this report, we screen for 30 stocks in the S&P 500 that have good exposure to growth and analyst sentiment. Our research suggests that these two factors have the potential to do well post-QE3. For the full details, see the rest of this report.

Figure 1: S&P 500 buy ideas for playing the post-QE3 world

Company Name	Ticker	Sector	Market Cap ($m)
Sunoco Inc	SUN	Energy	4,942
Lennar Corp	LEN	Consumer Discretionary	6,138
Regions Financial Corp	RF	Financials	9,837
Pultegroup Inc	PHM	Consumer Discretionary	5,250
D R Horton Inc	DHI	Consumer Discretionary	6,061
Crown Castle Intl Corp	CCI	Telecommunication	18,596
Nrg Energy Inc	NRG	Utilities	4,860
Equity Residential	EQR	Financials	18,178
First Solar Inc	FSLR	Information Technology	1,738
Tesoro Corp	TSO	Energy	5,555
Metropcs Communications Inc	PCS	Telecommunication	3,527
Assurant Inc	AIZ	Financials	2,904
Dean Foods Co	DF	Consumer Staples	3,035
Quanta Services Inc	PWR	Industrials	5,115
Frontier Communications Corp	FTR	Telecommunication	4,613
Yahoo Inc	YHOO	Information Technology	17,494
Textron Inc	TXT	Industrials	7,504
Cf Industries Holdings Inc	CF	Materials	12,968
Gap Inc	GPS	Consumer Discretionary	17,158
Alexion Pharmaceuticals Inc	ALXN	Health Care	20,667
Western Digital Corp	WDC	Information Technology	10,288
Suntrust Banks Inc	STI	Financials	13,551
Ameren Corp	AEE	Utilities	7,938
Boston Properties Inc	BXP	Financials	16,900
American International Group	AIG	Financials	59,338
Autonation Inc	AN	Consumer Discretionary	4,848
Bb&T Corp	BBT	Financials	22,040
Southwest Airlines	LUV	Industrials	6,643
Ensco Plc	ESV	Energy	13,318
Helmerich & Payne	HP	Energy	4,824

Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Extraordinary intervention

The lead up to QEs

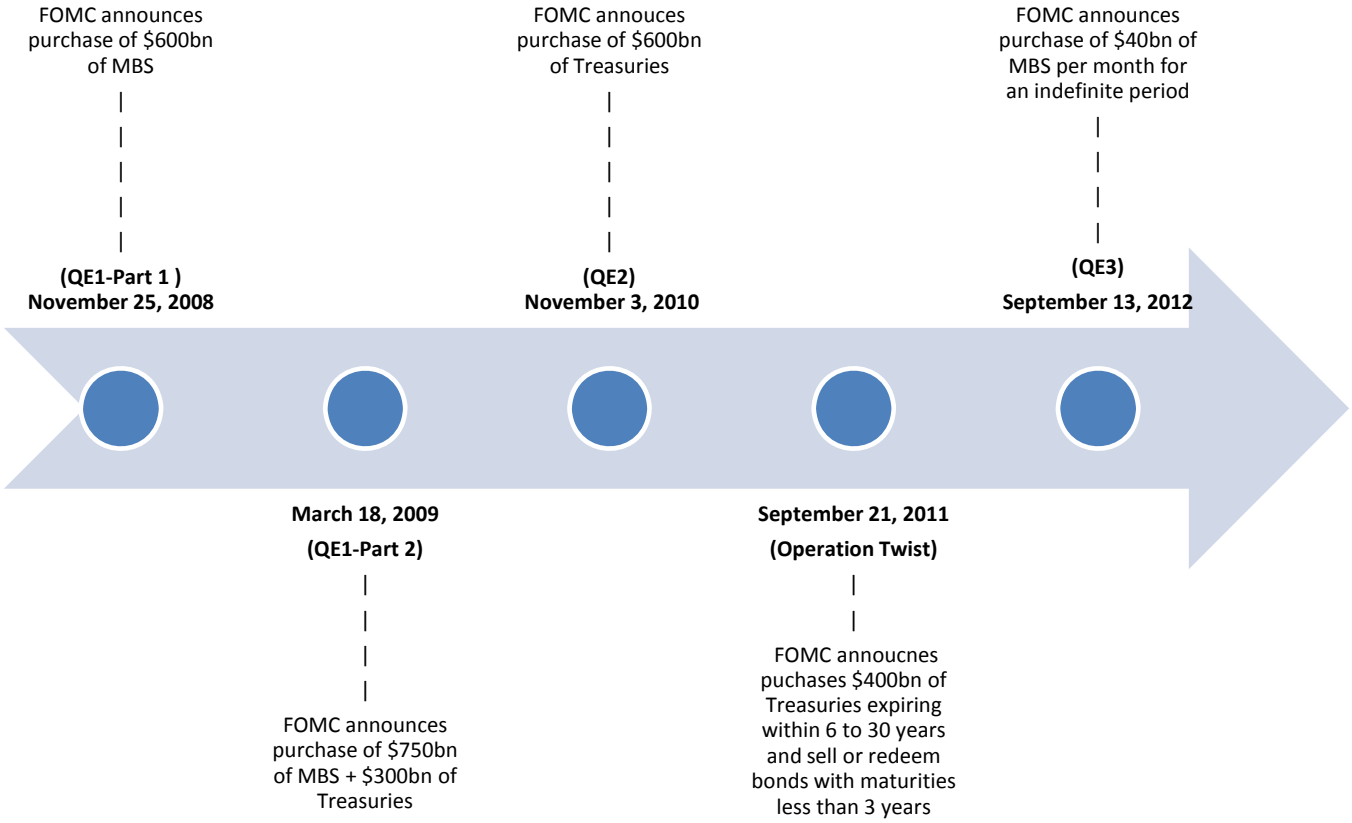
The dire ramifications of the global financial crisis (including the collapse of Lehman Brothers) forced worldwide governments to act quickly and swiftly to stabilize deteriorating market conditions. Most global economies were suffering from high unemployment, deteriorating housing prices, and stale economic growth. To combat these conditions, many worldwide governments employed traditional and non-traditional stimulative monetary policy to try to avoid crippling economic consequences. The Federal Reserve (Fed) responded by lowering the targeted Federal Funds rate and discount rate, and furthermore initiated a series of capital injections into the economy know as quantitative easing (QE).

One of the many theories underlying QE is to flood the overall market with liquid capital via asset purchases. This is achieved when the Fed purchases Treasuries or other instruments from institutions. The influx of excess capital is theoretically supposed to stimulate lending by the banks and thus lead to an increase in consumption by individuals, i.e. the multiplier effect. Furthermore, investors are indirectly encouraged to allocate their portfolios away from interest bearing instruments since interest rates are relatively low and towards equities which could potentially offer higher relative returns. As such, theoretically speaking, one would expect economic and market conditions to improve. Although the purported benefits of QE are being debated at length by economists, investors, and strategist alike, in this research we focus on the effects of QE on the quant investment community. Specifically, we are interested in the implications of QE on the performance of quantitative factors.

A timeline of events

During the past four years, the Fed has initiated a series of QE efforts in order to stabilize and stimulate the economy. Officially, the Fed has initiated three rounds of QE. These rounds are widely known as QE1, QE2, and QE3. Figure 2 below shows a timeline of the major events surrounding the QE efforts. Starting in November of 2008, the Federal Open Market Committee, or FOMC, announced the purchase of approximately $600 billion of mortgage backed securities and other instruments. This marked the start of QE1. We term this event as "QE1-Part 1".

Figure 2: Timeline of QE events



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

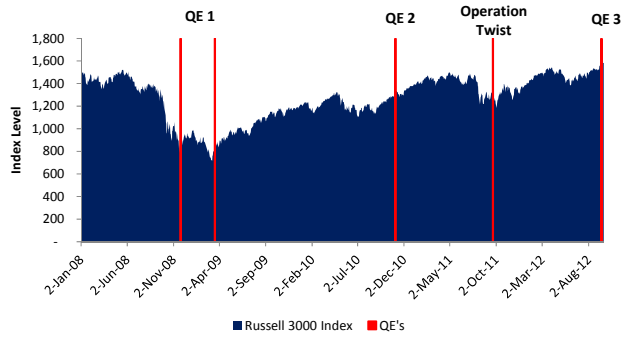
Soon after, in March of 2009, the FOMC announced a second round of QE to promote an economic recovery. This time they announced over one trillion dollars in purchases of mortgage backed securities and longer-term Treasuries. Without a doubt, this was a significant monetary event and as such we term this event "QE1-Part 2". More than a year later, in November of 2010, the FOMC announced further purchases of longer-term Treasuries amounting to approximately $600 billion (i.e. QE2).

Less than a year later, in September of 2011, the FOMC announced "Operation Twist", a plan where the committee set out to purchase $400 billion of Treasuries with remaining maturities of six to thirty years and to sell an equal amount of Treasuries with remaining maturities of less than three years. More recently, on September 13, 2012, the FOMC announced another round of QE (i.e. QE3). In this announcement, the FOMC agreed to purchase additional mortgage backed securities at a pace of $40 billion per month. The sheer amount of QE has had and will have penetrating effects throughout the economy and financial markets. Before exploring the impact of QE on quant investors, we briefly look at the market reaction surrounding QE rounds.

Overall market reaction surrounding QEs

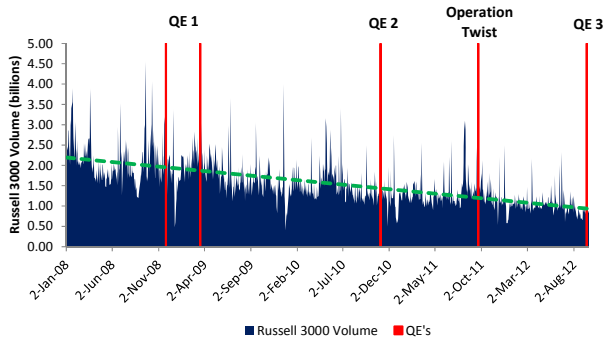
Firstly, we look at one of the most widely publicized and hotly contested charts pertaining to QE. Figure 3 shows the market index (as represented by the Russell 3000 index) overlaid with each QE event discussed previously. On the surface we discern that QE has typically had a positive impact on the overall stock market. The market appears to be trending upwards post a significant QE announcement albeit there are certain times where we notice a pull back in the market months after the QE announcement date.

Figure 3: Russell 3000 performance around QEs



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Figure 4: Russell 3000 volume around QEs

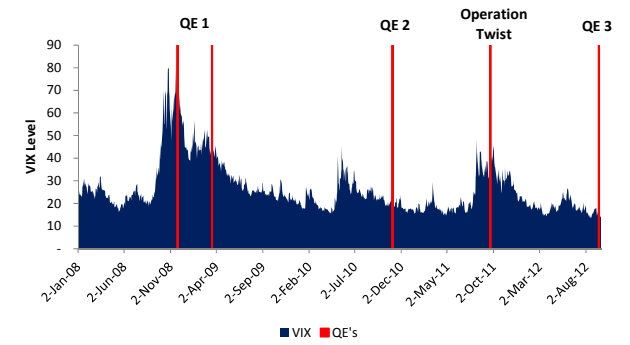


Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

However, the run up in the market is underpinned by steadily declining volumes. Figure 4 shows the volume of Russell 3000 overlaid with each QE event. Although there are some noticeable spikes in equity volumes post a QE event, the overall trend is downward sloping. One of the "theoretical" goals of QE is to increase market participation within equities; but here we notice that overall equity volumes have been consistently in decline.

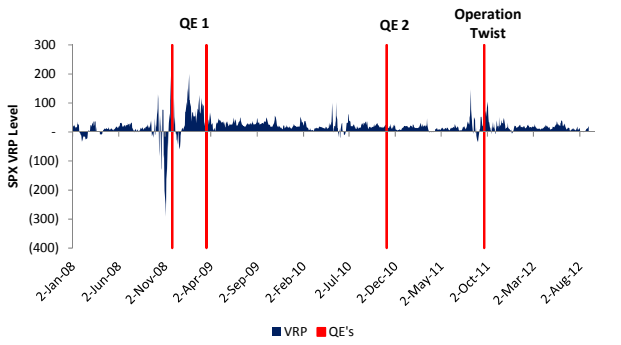
However, we do notice a significant reduction in market implied volatility post QE events. Figure 5 shows the VIX time-series overlaid with QE events. The VIX is sometimes referred to as the fear index or fear gauge. Figure 5 shows that QE rounds appear to have somewhat temporarily tamed the fear within the market as measured by the VIX.

Figure 5: VIX around QEs



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Figure 6: VRP around QEs



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Lastly we look at the relationship between QE rounds and the Variance Risk Premium (VRP), one of our favorite market timing tools.[1] Regular readers of our research may recall that VRP is a useful market timing factor. VRP is simply the difference between the options implied variance and the realized variance of the market index. The indicator is something of an overreaction measure; when VRP is high it suggests the market is in panic mode, and is pricing in much higher risk than what can be justified by the actual data. This represents a buying opportunity.

[1] For more details on VRP and its applications in market timing, see: Luo et al., 2012, "Signal Processing: From macro to micro", *Deutsche Bank Quantitative Strategy*, 2 May 2012

Figure 6 shows the time-series of our VRP indicator with each QE event. Here we look to see if VRP is potentially a leading indicator of QEs. There appears to be no discernible relationship between the direction of VRP and a QE event, however, we do note that the volatility of VRP tends to increase pre and post a QE event.

A quant perspective

Setting up the analysis

To better grasp the impact of QE from a quant's perspective, we perform a detailed event study analysis on a number of different quant factors pre and post each QE event. Essentially we track the performance of various different factor style portfolios in the days leading up to and after a QE event. We select a diverse blend of individual factors that include value, growth, momentum, sentiment, and volatility styles. We track the performance of these individual style portfolios 60 business days prior to and post a QE announcement.

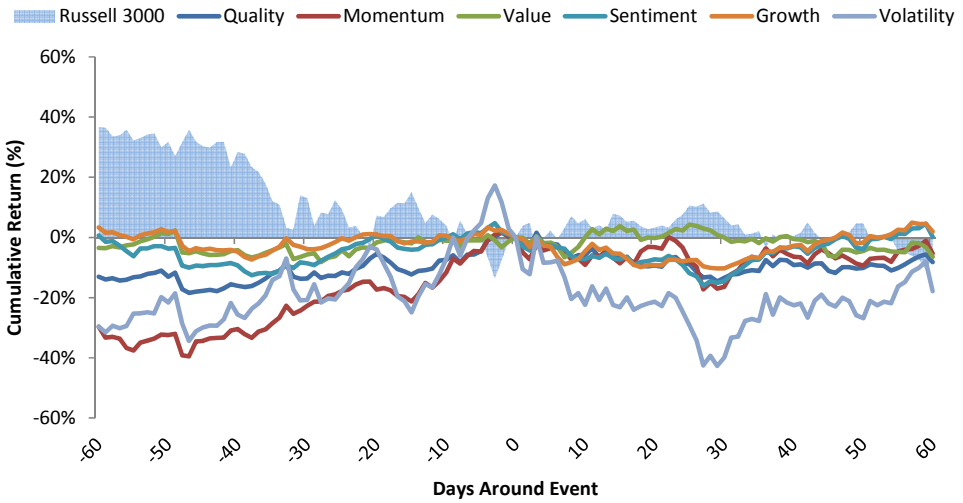
Our factor style portfolios are long/short portfolios. These are formed by taking a long position in the top decile and a short position in the bottom decile of stocks based on the individual style factors (e.g. momentum, value, etc.).[2] Our universe of study is the Russell 3000. In the charts that follow, we analyze all three QE events discussed thus far. While we have a limited number of events to work with, we are particularly interested in indentifying any post-QE trends in factor performance that might help us positions ourselves in the aftermath of QE3.

QE1 Part 1 – A mixed bag

To get things started, we first look at factor and market performance around QE1-Part 1. Note that all of our portfolios are calibrated such that they take a long position in stocks with a higher factor value (i.e. we take a long position in stocks exhibiting high values of momentum or earning yield) and a short position in stocks with lower factor values on a relative basis. The only exception is our volatility portfolio which is calibrated so that it takes a long position in low volatility stocks and short position in high volatility stocks. Figure 7 shows the results of the event study analysis. First, we point out the sharp selloff in the market prior to the announcement which of course was a catalyst for QE1-Part 1.

[2] We used the following factors to define our style portfolios: ROE (quality portfolio), 12 month trailing earnings yield (value portfolio), FY1 EPS Revisions (sentiment portfolio), year-over-year EPS growth (growth portfolio), and realized 1 year daily volatility (volatility portfolio).

Figure 7: Factor performance around QE1-Part 1



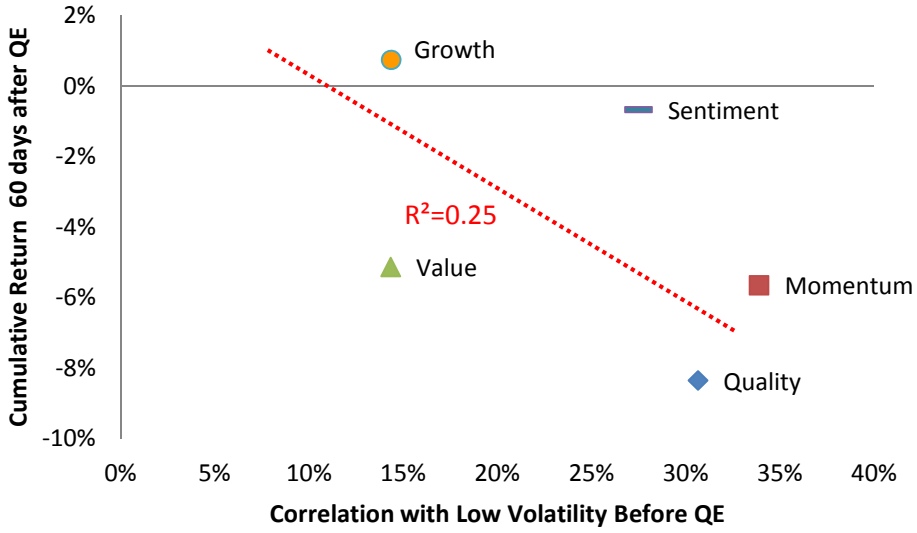
Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

In terms of factor performance, the pre- and post-QE performance lines up somewhat with intuition. Recall that the 60 days prior to QE1-Part 1 we saw some of the most tumultuous events that the financial markets had ever experienced, with the bankruptcy of Lehman Brothers and the rescues of AIG and Fannie Mae/Freddie Mac. So unsurprisingly, buying quality stocks and buying low volatility stocks were two strategies that were paying off very well in the pre-QE period. Momentum was also working well, which might seem counterintuitive at first but remember that at that point in time the stocks that had been outperforming in the past were in fact more defensive names – so momentum was also a more defensive strategy in that period.

Aside from volatility, most factors showed relatively stable performance subsequent to the announcement. What is most noteworthy about this chart is the volatility portfolio (which buys low volatility names and sells high volatility names). We see a sharp performance drop for this portfolio in the 30 days after the announcement. This indicates that low volatility stocks temporarily underperformed on a relative basis. This is the classic sign of the onset of a risk rally episode instigated when investors become more confident about macroeconomic conditions and thus seek relatively riskier investments.

We can dig deeper into this point by looking at the relationship between volatility and post-QE returns (Figure 8). On the x-axis is the cross-sectional correlation between each of the scores of the stocks on a particular factor in the days before QE and the inverse of volatility for each stock. A positive correlation indicates that stocks that rank well on a particular factor tended to be *lower* volatility. So in this example, we can see quite clearly that buying momentum and quality in particular was akin to buying low volatility at the time of QE. The y-axis shows the cumulative returns for each factor in the 60 days *after* QE.

Figure 8: Post QE1-Part1 returns based on portfolio correlation to low volatility



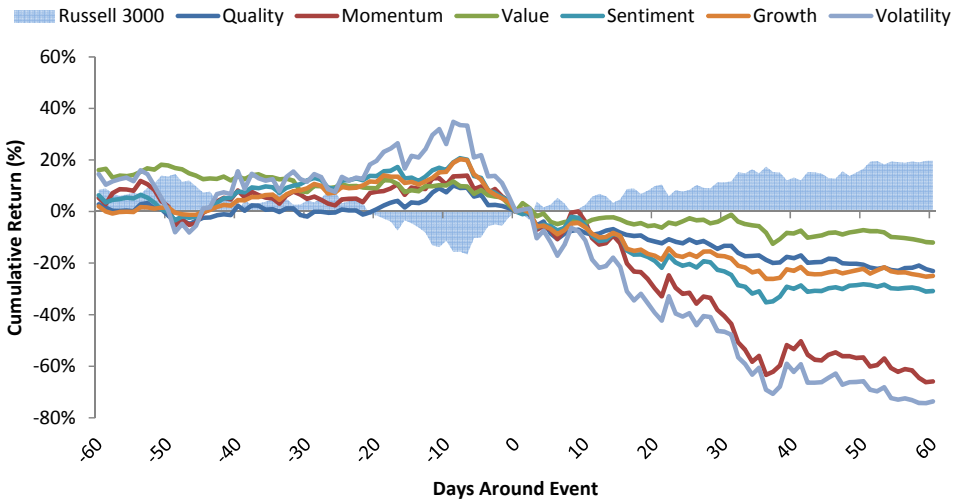
Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

The chart shows a clear negative relationship. This indicates that factors that were tilted towards low volatility stocks pre-QE actually did very badly in the post-QE environment. This is no surprise; QE gave investors the confidence to move towards a more risk-seeking stance, and as a result any factor that tilted towards lower risk names was punished. Of course, one event is hardly the evidence to hang an investment strategy on. Below we consider a similar analysis for the rest of the QEs to date.

QE1 Part 2 – A risk rally reaction

Figure 9 shows the results of the event study analysis for QE1-Part 2. Here we see a completely different picture. All factors portfolios underperformed post the QE announcement. Momentum and volatility were especially hit hard. These are in fact the tell tale signs of a risk rally.

Figure 9: Factor performance around QE1-Part 2



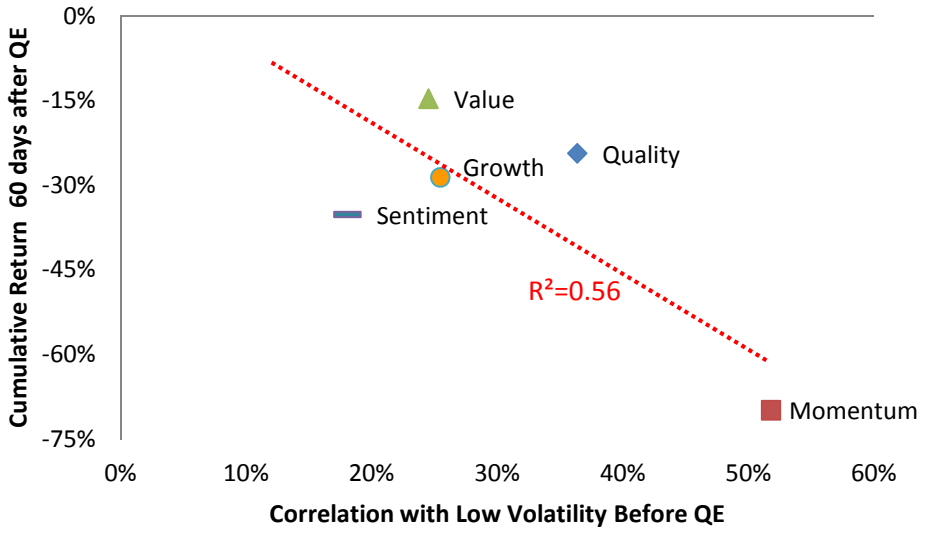
Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

During risk on (i.e. risk rally) and risk off episodes, factor performance can rapidly change and even invert, especially when measuring performance on a daily basis.[3] For example, during cautionary times, investors may be seeking safer stocks (i.e. lower beta stocks). As such, lower beta stocks may be exhibiting momentum. However, during an unexpected risk rally, investors' risk appetite suddenly shifts. Investors are now seeking relatively riskier stocks (i.e. higher beta stocks). However since momentum portfolio currently hold long positions in lower beta stocks, its performance deteriorates sharply as lower beta stocks underperform and higher beta stock outperform during a risk rally.

The same example can be made for other factors such as volatility, growth, etc. In fact, our past research showed that a factor's exposure or sensitivity to beta can significantly explain overall factor performance during sudden risk on and off episodes. The factor performance depicted in Figure 9 shows what a massive impact QE1-Part 2 had on risk perception in the market.

As before, we also examine the relationship between pre-QE correlations with low risk, and post-QE performance (Figure 10).

Figure 10: Post QE1-Part2 returns based on portfolio correlation to low volatility



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Again there is a clear negative relationship (Figure 10). Interestingly, the actual factors that did badly post-QE1-Part 2 are not exactly the same as what we saw before. But the key point is that once again it was the factors that were aligned with low risk that got punished the most post-QE.

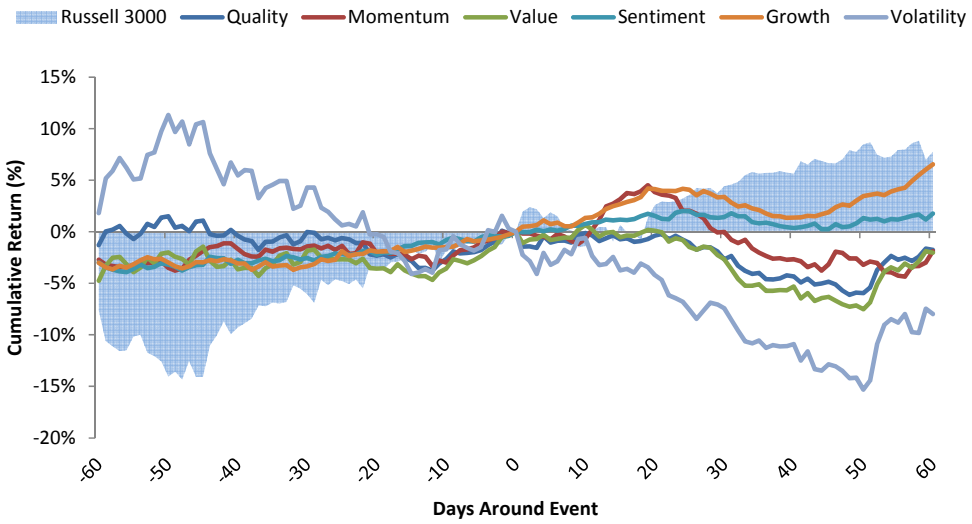
QE2 – Another risk rally reaction

Figure 11 shows the results of the event study analysis for QE2. Does the figure look somewhat familiar? Here we see that most factors portfolios underperformed post the QE announcement. Again, as in the other QE episodes, the volatility portfolio was hit the hardest. We also notice a slight reversion in factor performance almost 3 months after the QE2 announcement. These results are particularly interesting since factor performance behaved similar to QE1-Part 2. Note though that this time around, growth actually performed best in

[3] See for example our more detailed analysis of these dynamics in: Alvarez et al., 2012, "Portfolios Under Construction: Uncertainty and style dynamics", *Deutsche Bank Quantitative Strategy*, 18 April 2012

the 60 days after the event – perhaps a hint that the second round of easing gave investors the confidence that growth stocks would do better as the economy recovered.

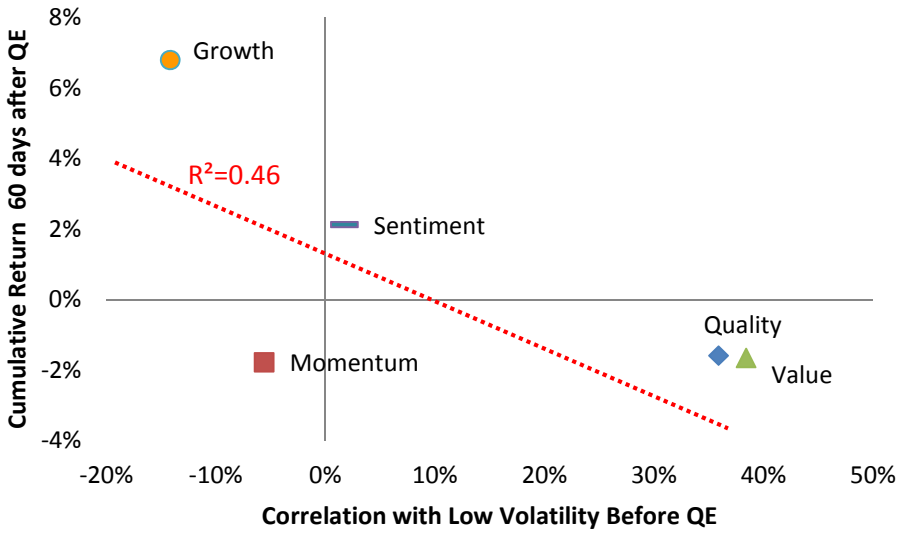
Figure 11: Factor performance around QE2



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Without sounding like a broken record, what we do notice again is a trend in which the factors that are more correlated to low volatility right before the QE announcement underperformed subsequently (Figure 12).

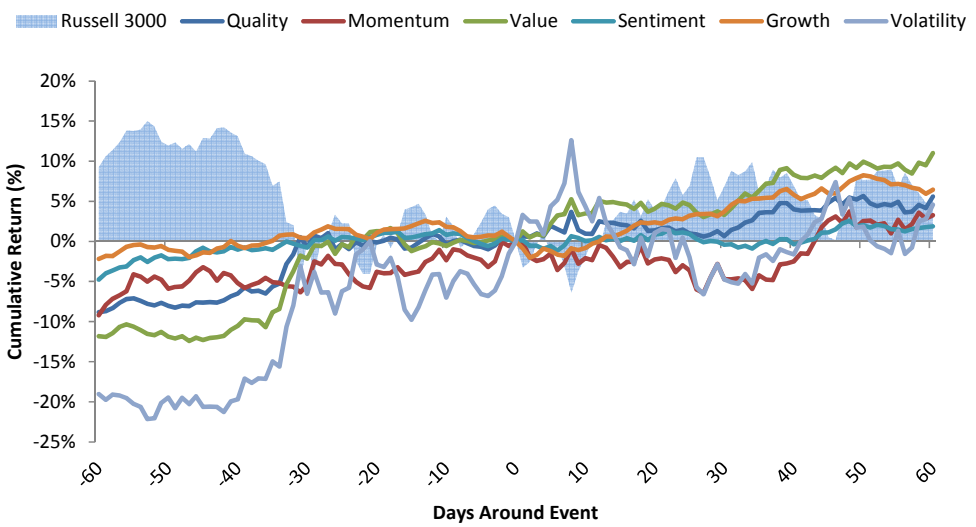
Figure 12: QE2 returns based on portfolio correlation to low volatility



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Does this same pattern exist for Operation Twist? Although Operation Twist is not officially a part of QE2, we present the results here nevertheless to hopefully uncover any potential commonalities. Figure 13 shows the results of the event study analysis for Operation Twist. We do notice a run up in factor performance prior to the announcement, however, the results after the announcement date are somewhat mixed. Having said that, we do notice again a mild and temporarily selloff in volatility and momentum post the announcement date.

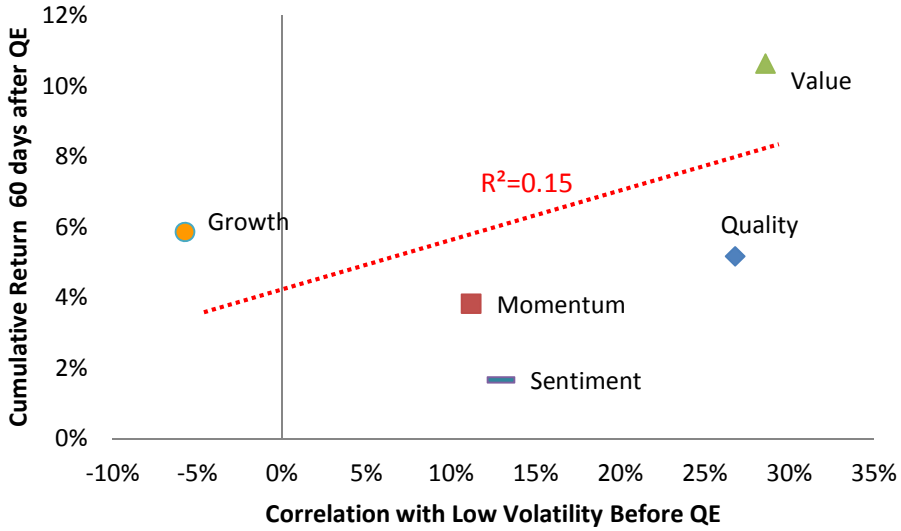
Figure 13: Factor performance around Operation Twist



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Operationally speaking, Operation Twist is different from the other QE measures. The Fed bought long-term Treasuries and simultaneously sold the same amount of short-term Treasuries. As such, the Fed did not inject any new net capital into the market and hence we expected factor performance results to be different than QE1 and QE2. The policy difference with Operation Twist is also apparent when looking at factor performance against volatility subsequent to Operation Twist (Figure 14). Here we see a different picture and more importantly a different trend from previous QE rounds. After this particular episode, we actually find that those factors that were aligned with low volatility pre-QE actually did better, not worse, in the post-QE period. However, it's worth pointing out again that Operation Twist was not a liquidity injection in the same vein as the other QEs, so it certainly seems plausible that it did not trigger a risk rally to the same extent as we saw in the previous charts. Growth again stands out as the best performing factor, as Operation Twist was more designed to stimulate economic growth.

Figure 14: Operation Twist returns based on portfolio correlation to low volatility



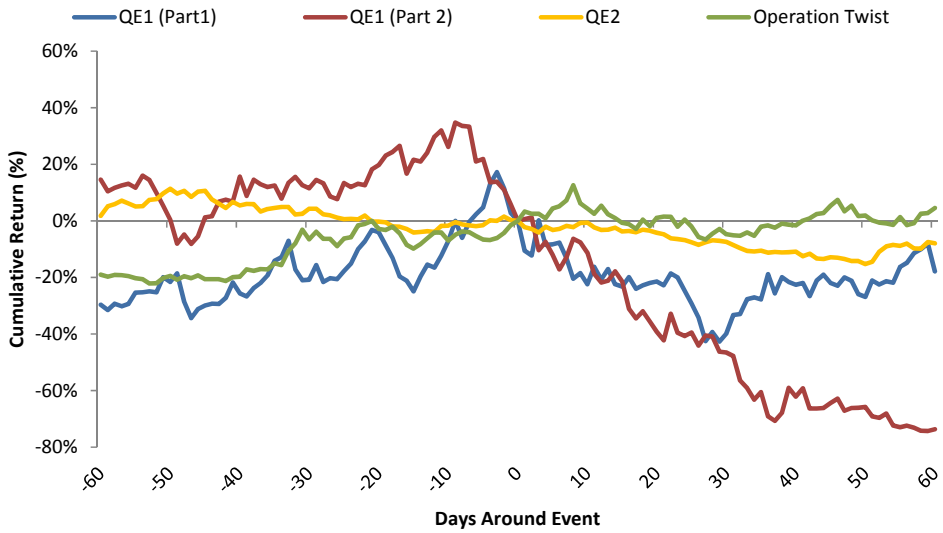
Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

QE3 and beyond

Be wary of volatility

A recurring observation in QE episodes we have looked at thus far is the selloff in low volatility stocks. This can be especially problematic for quant investors. Figure 15 shows the results of the event study analysis for our volatility portfolios surrounding the QE events. Although we only have four events to guide us, quant investors should nevertheless be aware of the potential sell off in low volatility stocks subsequent to a QE episode. This seems to be the one common themes across the four previous iterations of QE.

Figure 15: Volatility portfolio performance around all QE events



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Dealing with this sudden surge in performance of high volatility stocks can be challenging for quant investors. Of course, a well diversified factor portfolio would help dampen the drawdown in low volatility stocks. However, in our recent research we have gone beyond this to show how quant investors can actively manage their volatility exposure using top-down indicators.[4]

In summary, quants should be particularly careful about evaluating their volatility exposure in the aftermath of QE3. In the long-run, it generally pays to be short volatility (i.e. hold low volatility stocks) but post-QE events, this can be a risky strategy.

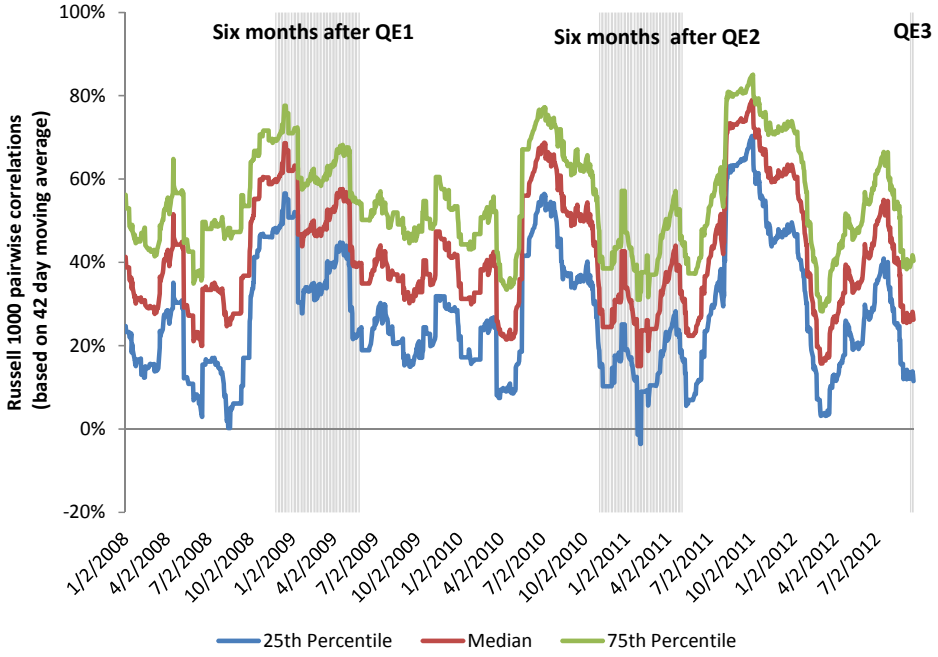
Don't forget about correlation

We also looked at how stock pairwise correlations evolved subsequent to announcement of QE1 and QE2. We tracked stock pairwise correlations from the QE announcement date to six months after the announcement. Our universe of stocks is derived from the Russell 1000 index. To better gauge the short-term reaction on stocks, we computed our pairwise correlations daily on all stock combinations based on a 42 day moving window. We then

[4] Cahan et al., 2012, "Signal Processing: Disentangling the downside", *Deutsche Bank Quantitative Strategy*, 20 September 2012.

computed the median, 75th percentile, and 25th percentile of the pairwise correlation distribution. Figure 16 shows the results of our analysis.

Figure 16: Russell 1000 pairwise correlations around QEs



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

The results are actually quite interesting. We see a temporary drop in pairwise stock correlation subsequent to QE announcements. However, this is followed by an upward trend in correlations several months after the QE announcements. What does this mean for quant investors? One possibility is that this effect is driven by a shift to more stock-specific investing. Before each QE, macro events tend to be the dominant driver of stock returns, and indeed instead of trading stocks on their own merits (e.g. fundamentals) investors tend to treat all equities as one risky asset class. But after a QE, sentiment potentially improves and investors become more confident in differentiating between stocks.

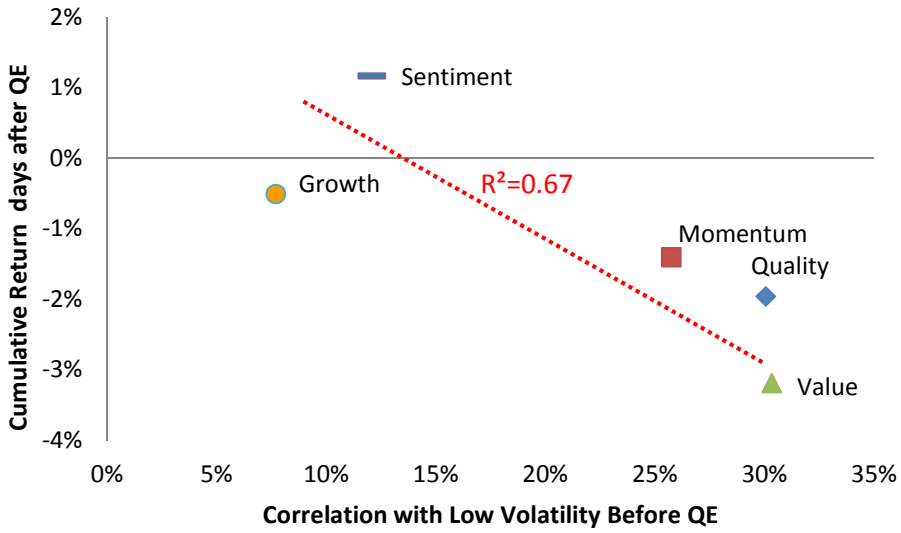
Positioning post QE3

Investment ideas for the post-QE3 world

What can we learn from past QEs that can help us today, in the post-QE3 world? We think the key message is to be very careful about one's volatility exposure. In particular, it is – somewhat ironically – risky to have a low volatility exposure in the aftermath of QE episodes. In the past, such episodes have led to a sharp shift from risk-averse to risk-seeking behavior, which has punished lower risk strategies.

Even if one doesn't explicitly take a position on volatility, an unwanted exposure can easily creep into a portfolio via one's factor exposures. So what did those exposures look like pre-QE3? Figure 17 shows that value, momentum, and quality had a low volatility bias before QE3, and indeed like in past QE episodes, these are the factors that have performed the worse in the weeks since QE3 was announced.

Figure 17: QE3 returns based on portfolio correlation to low volatility



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Therefore, we recommend that value, momentum, and quality exposures in particular be evaluated carefully. If history is any guide, these factors are at a higher risk of underperforming in the next 60 days, given the likely softening in the negative attitude towards risk that QE3 could precipitate.

On the other side of the coin, one could potentially shift more focus towards growth and sentiment factors. These have been doing well since QE3, and more importantly, did not have the strong low risk bias of the other factors leading into QE3. Again, if history is any guide, these factors should do well if QE3 does lead to a more risk-seeking environment. The screen at the front of this report suggests S&P 500 names that rate favorably on these two factors currently. For those looking for stock ideas that capture the themes discussed in this paper, those are a good starting point.

Concluding remarks

Stepping back and looking at the big picture, the QE events illustrates a number of the points we have been trying to make in our research over the past few years. To our mind, the key message from this, and our past research, is the importance of actively managing and understanding the volatility and beta exposure of one's portfolio. This is important all the time of course, but is crucially so when the market is rapidly switching from risk averse to risk seeking and then back again, i.e. precisely the type of rapid regime switches that are triggered by QE-type events. In our research, we have written extensively on this topic, and based on our findings we would refer readers to a few ideas that we think would be fruitful in times like these:

- Neutralize the unwanted beta/volatility exposure out of quant factors. Quant factors can take on significant exposures to beta and volatility at various points in the economic cycle. For example, we saw that momentum underperformed severely after QE1-Part 2. This is because momentum actually carried a hidden negative beta exposure at that time, which meant that as investors re-risked this style was hit hard. In our past research, we suggested a simple algorithm for removing such unwanted exposures.[5] As an illustration of how this works, consider the short case study below.
- Use macroeconomic variables to choose style weights. Instead of defensively removing beta exposure from factors, another alternative is to proactively manage factor exposures by conditioning them on the macroeconomic environment. Since QE is itself a response to the macro world, such a strategy can help one better adjust to a changing world. In our past research we suggested a model for doing this.[6]
- Use advanced portfolio construction to manage the higher moments. Most investors tend to focus on the first two moments of the return distribution, i.e. mean and variance. However, tail events –like those forced on volatility after QE1-Part 2 for example – can destroy years of outperformance in a single blow. In our research we have suggested portfolio construction techniques that better manage the downside risk of quantitative strategies, and hopefully help cushion the blow of one-time (or three times and counting!) events like QE.[7]
- Actively manage volatility exposure through top-down signals. As we already mentioned, another effective way to cushion the blow from turning points like those precipitated by QE is to use top-down indicators to turn on or off one's volatility exposure. In one of our most recent papers, we suggested a methodology for doing so that uses the Variance Risk Premium as a timing tool[8]

Case study: Neutralization in action

As we've seen, QE1-Part 2 was followed by a very significant risk rally that was devastating for factor performance largely across the board. But suppose instead of holding the raw factors, we had been holding beta-neutralized factors instead (again for the exact methodology, see Alvarez et al. [2010]). Figure 18 shows the result we've seen before, i.e. the raw factor performance around QE1-Part 2, while Figure 19 is new and shows how neutralized versions of the factors would have performed. The result is markedly different – most the neutralized factors actually outperform in the 60 days after the QE event, whereas the un-neutralized factors significantly underperform. The only exception is volatility, which is

[5] Alvarez et al., 2010, "Portfolios Under Construction: Volatility = 1/N", *Deutsche Bank Quantitative Strategy*, 16 June 2010

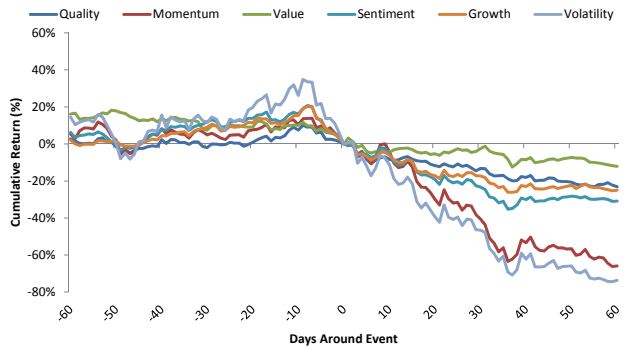
[6] Luo et al., 2010, "Signal Processing: Style rotation", *Deutsche Bank Quantitative Strategy*, 7 September 2010

[7] Luo et al., 2011, "Portfolios Under Construction: Robust factor models", *Deutsche Bank Quantitative Strategy*, 24 January 2011

[8] Cahan et al., 2012, "Signal Processing: Disentangling the downside", *Deutsche Bank Quantitative Strategy*, 20 September 2012

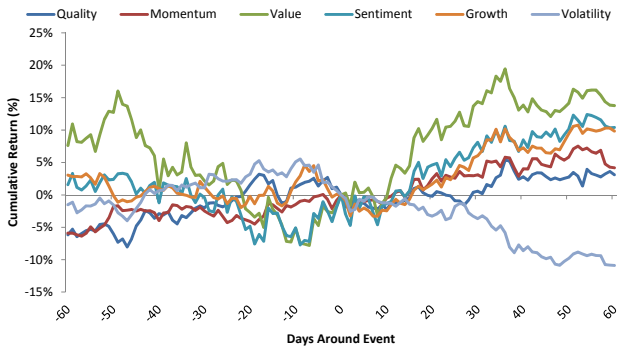
largely in-line with what we would expect: even after neutralization, volatility is still tilted towards low volatility names (recall we trade it in the direction where we are buying lower volatility names), and hence struggles in the re-risking. But for all the other factors, stripping out the hidden volatility exposure would have been very effective at mitigating the impact of the QE event.

Figure 18: Performance around QE1-Part 2



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

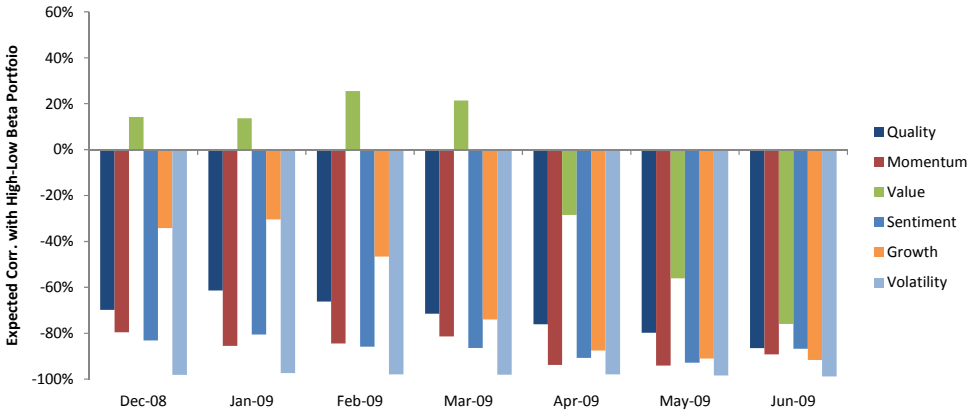
Figure 19: Neutralized performance around QE1-Part2



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

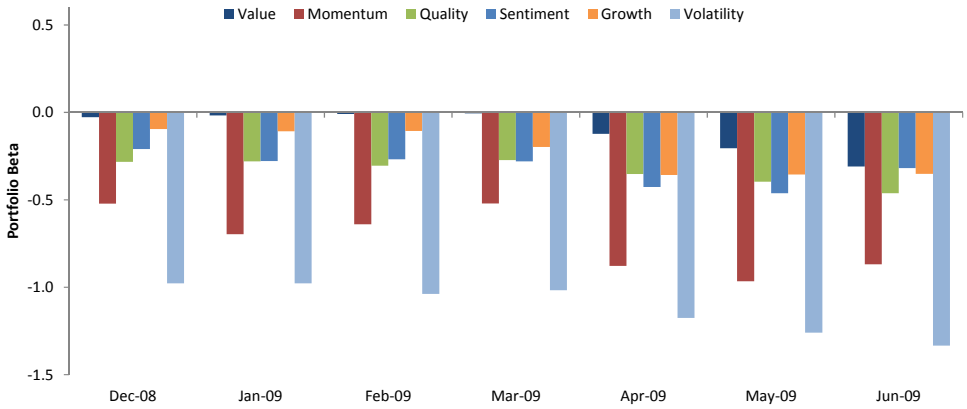
To see why neutralization is so effective, consider Figure 20 and Figure 21. The former shows the expected correlation between each factor and beta, around the dates of QE1-Part 2; the latter shows the beta for the long-short factor portfolios. In both cases, the reason neutralization works is clear: most the factors have a very strong negative alignment with beta in the months before and after the QE event. Therefore it is no surprise that performance suffers significantly as the market shift back into risk-seeking mode. By stripping out these exposures through the neutralization process, we cushion the blow of the sharp risk rally that followed QE1-Part 2.

Figure 20: Expected correlation with beta around QE1-Part 2



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

Figure 21: Beta of factor portfolios around QE1-Part 2



Source: Bloomberg Finance, LLP, Compustat, IBES, Russell, Thomson Reuters, Worldscope, Deutsche Bank

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Appendix 1

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