Anatomy of a Crisis

Kent Daniel
Co-CIO of Equity, Quantitative Investment Strategies
Goldman Sachs Asset Management
New York City

The global economic crisis in September 2008 was preceded by the crises of 2007: the subprime mortgage crisis, the corporate credit crunch, and the "quant liquidity crunch." The evolution of these crises appears to have resulted from a set of "deleveragings" that started in the subprime mortgage market but then spilled over into a number of other asset markets and resulted in large premiums in multiple markets. To respond to these events, new proprietary factors have been deployed that are not vulnerable to the actions of others. These factors have performed, and continue to perform, well during the financial crisis.

In the past few years, the world has witnessed high levels of market volatility. The turmoil that initially appeared to be isolated to the mortgage market spread into credit markets and then into the global equity markets. I would like to describe my view of the evolution of the economic crisis of the last several years. I will do so from the point of view of a quantitative investor (a "quant").

I would like to begin with an explanation of quantitative investing. Next, I will highlight the chronology of market events over the last several years. The events in the chronology include the subprime crisis, the corporate credit crisis, and an event particular to quantitative equity investors that is called the "quant liquidity crunch." The quant liquidity crunch occurred in the first week of August 2007 and was a prelude to a number of events that followed. Finally, I will analyze the impact of the events from the point of view of a quantitative investor and describe how the Quantitative Investment Strategies (QIS) group in Goldman Sachs has adjusted its approach in response to this new environment.

What Is Quantitative Investing?

Some have characterized quant investing as trying to drive down a twisty road by looking only in the rearview mirror. This joke, of course, is based on the perception that quants rely too heavily on historical data and historical relationships in formulating their investment strategies. Although some quants may base their strategies exclusively on statistical analysis of historical data, our view is that doing so is not what good quantitative investors do. Rather, we believe a good quant blends good use of data with sound economic and behavioral analysis.

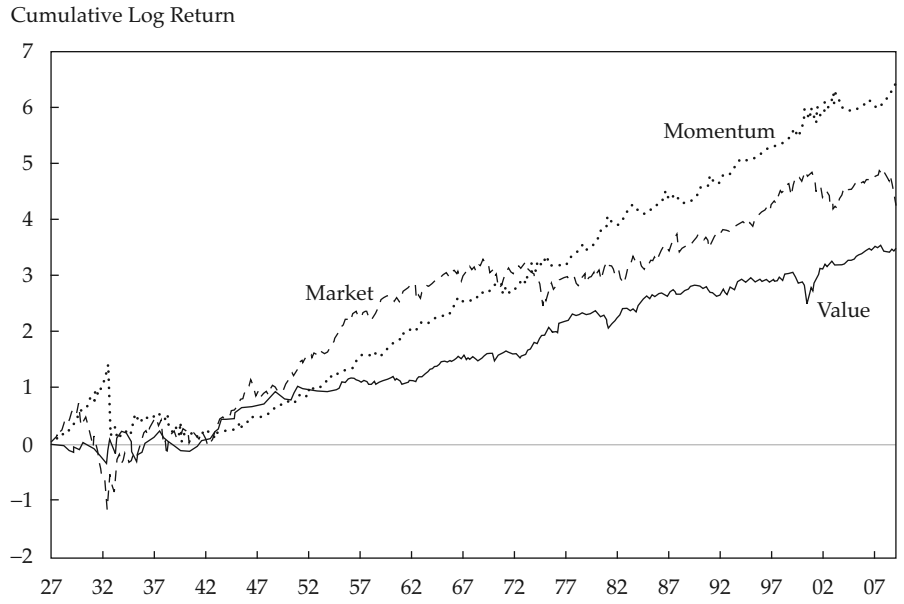
Like traditional managers, we do fundamental analysis aimed at identifying superior indicators of company value and company mispricings. Where we differ from traditional managers is that we then populate our databases with the data and develop mathematical models that tell us the relationship between these indicators and future company returns. We also test the resulting strategies using these databases. In some cases, we use data from as far back as the 1920s to guide our economic intuition; we want to make sure that we are uncovering true economic relationships and not just spurious patterns.

How well have standard quant strategies worked historically? The cumulative returns of two basic long–short strategies—momentum and value—are shown in **Figure 1** for the 81-year period from 1927 through 2008.[1] In addition, Figure 1 plots the returns to a market strategy that

This presentation comes from the Equity Research and Valuation Techniques conference held in Toronto on 2–3 December 2008.

[1]The precise definitions of these three factors and their return histories are available on Kenneth French's website, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Figure 1. Cumulative Returns of Value, Momentum, and Market: January 1927–December 2008



Source: Based on data from Kenneth French data library.

takes a long position in a diversified portfolio of stocks and shorts T-bills to capture the equity premium. In the value strategy, the investor buys a portfolio of stocks with a low price relative to book value and shorts a portfolio of stocks with a high price relative to book value. In essence, the strategy buys cheap stocks (i.e., value stocks), sells expensive stocks, and is market neutral—that is, it has no net market exposure. For the momentum strategy, the investor buys past winners and sells past losers. In this case, the time frame for determining whether a stock is a winner or a loser is its performance in the preceding year, excluding the last month. As can be seen in Figure 1, although there have been periods of severe underperformance for each of these strategies, each has been broadly effective over this period.

Now to put some numbers on this analysis (we are quants after all!). The Sharpe ratio of the market strategy is slightly above 0.35: The market premium over T-bills has averaged about 7 percent per year, and market volatility has been about 20 percent per year. The Sharpe ratios of the value and momentum strategies are slightly higher, about 0.40 and 0.57, respectively. Also, because the strategies have been relatively uncorrelated over time, had an investor combined these three strategies with equal weights, the investor's Sharpe ratio over this period would have been 0.94. This dramatic improvement in the Sharpe ratio is strong motivation for incorporating fundamental factors (e.g., value) and also some technical factors (e.g., momentum) into a quant strategy. The success of quant strategies that combine a range of value, momentum, and other measures has helped to popularize quant investing.

We have more than a dozen strategies, or "factors," in the models we use. Conceptually, we group these factors into six themes: valuation, profitability, quality, management, momentum, and sentiment. I have already discussed very basic value and momentum strategies. Under the profitability theme, we use factors that identify whether a company is profitable, such as its profit margins and the efficiency of its operations. Factors in the quality theme focus on, for example, the sustainability of earnings and the sources of these earnings. Management factors indicate whether a company's management is taking actions to enhance shareholder value. The factors in our sentiment theme use the information we extract from the statements and actions of other market participants, such as those of security analysts. We view each of the factors as taking advantage of some uncorrelated source of inefficiency in the market. We combine all six of these measures to generate a stock's alpha, or expected return.

Our approach to portfolio construction uses these individual company alphas in combination with other optimization criteria with the goal of maximizing each portfolio's risk-adjusted expected return net of transaction costs. The inputs to our

optimization process are return forecasts, transaction cost estimates, risk estimates, and of course, client objectives. Our risk model and risk forecasts are central to the optimization process. We measure the various risks associated with each company and assess whether the return gain associated with over- or underweighting a specific stock or combination of stocks can offset the extra risk incurred. The trading costs associated with a particular security are also an important consideration in whether a stock will be added to the portfolio and if so, what amount will be purchased. We constantly examine trade-offs—for example, if a security is expensive to trade, we will not take as large a position in it. All of these factors are part of our optimization procedure, and the outcome is the client portfolio.

Over the last 20 years, the dollar value of assets managed by quantitative investors has exploded. This growth is likely based on the growing academic evidence on the efficacy of quant strategies and on the success of actual quant managers. But as the quant space has became more crowded, the performance of the most popular quant strategies has declined—and dramatically so in late July 2007. I will present some evidence on the effects of this crowding—including the quant equity "crunch" of August 2007—in a moment. But first, I will review the development of the crisis prior to August 2007.

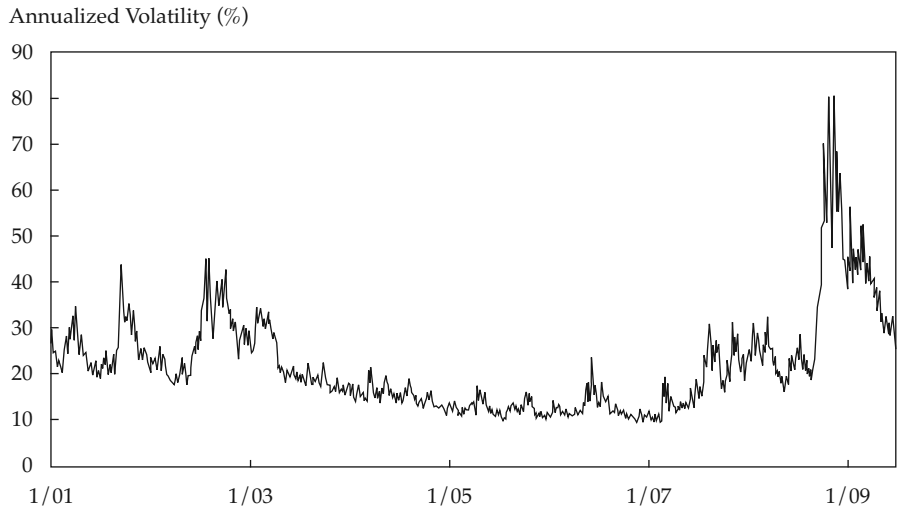
Implied Volatility Changes in the Market

The Chicago Board Options Exchange Volatility Index, or VIX, is a measure of the forward-looking, or implied, volatility of the S&P 500 Index. **Figure 2** plots the daily VIX close from 2 January 2001 to 30 June 2009. In 2002, following the collapse of the tech bubble, implied volatility was roughly 45 percent. Over the subsequent five years, the VIX trended down, reaching a level below 10 percent in January 2007. But as Figure 2 dramatically illustrates, with the onset of the recent crises, the VIX soared to unprecedented levels, jumping above 80 percent in October 2008.[2]

The decline in volatility over the period from the third quarter of 2002 through early 2007 is an interesting story, as is the fact that in January 2007, the VIX actually fell below 10 percent—a remarkably low level given that the average long-term market volatility is about 20 percent. What was responsible for the drop in volatility over this period? Partly it was a perception that macroeconomic risk had declined, that there had been a "great moderation." However, another contributing factor was that, especially after 2002, substantial quantities of investment capital entered the markets in a way that, at least initially, had the effect of reducing volatility. Moreover, because some investors equated volatility with risk, as volatility declined, they may have been encouraged to put even more capital on the line. For example, hedge funds may have increased leverage, which again provided a short-term stabilizing influence and pushed volatility down to even lower levels. This feedback mechanism resulted in low volatilities and low perceived risk in the economy,

[2]The VIX closed at 45.08 percent on 5 August 2002, 9.89 percent on 24 January 2007, and 80.06 percent on 27 October 2008.

Figure 2. Implied Volatility, VIX: 2 January 2001 to 30 June 2009



Sources: Based on data from Datastream and GSAM.

which led investors to believe that they could safely employ higher levels of leverage. Thus, the low volatility in the short run may have resulted in longer-term instabilities.

This feedback mechanism appears to have started to reverse in early 2007 when, because of the losses resulting from the subprime mortgage disruption, money managers and proprietary trading desks were forced to sell assets to decrease leverage. The price pressure effects resulting from this "deleveraging," in turn, led to further losses and to still more instability and higher volatility.

Chronology of Events

The crisis period begins with the subprime mortgage market disruption toward the end of 2006 and ends with the confluence of events that heralded the global economic crisis, which peaked in late 2008. Following is a recap of these events.

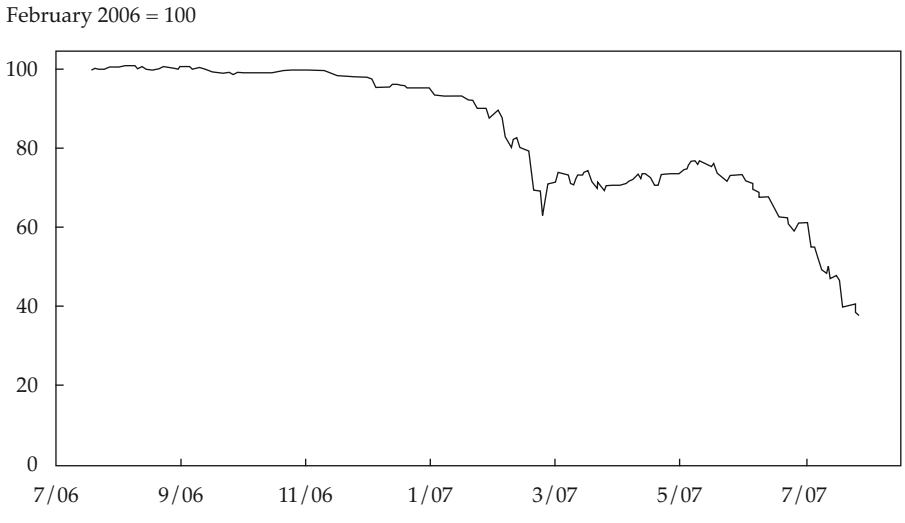
Subprime Mortgage Market Disruption. **Figure 3** is a plot of subprime mortgage prices, specifically the ABX BBB– Index, from July 2006 to August 2007. The ABX BBB– Index is the most subordinated tranche of a basket of residential mortgages. In fact, it is so junior that all of an investor's capital is lost if just 15 percent of the underlying mortgages' values are lost. Up until mid-2006, the subprime market appeared healthy, but by the last few months of 2006, rumblings could be heard in the press about the overvalued housing market, the prevalence of adjustable-rate mortgages, and lax mortgage-lending standards.

Early in 2006, the spread over LIBOR for these subprime mortgage-backed securities (MBS) was about 2 percent, even though investors would have lost their entire investment if the underlying mortgages had lost just 15 percent. By the beginning of January 2007 through the end of February 2007, the spread widened to about 20 percent because of concerns about residential housing prices and the associated mortgages. Consequently, the value of these securities fell from just over par, about 101, to 63 (a fall of approximately 38 percent). A slight recovery materialized in March, April, and May 2007 before prices fell again as foreclosure rates started to rise and housing prices began to fall more dramatically.

Corporate Credit Crunch: 16–30 July 2007. Before July 2007, the market appeared to believe that the dramatic fall in the value of subprime mortgages was an isolated event that would have little effect on the broader economy. In mid-July 2007, however, investment-grade credit spreads spiked dramatically, as illustrated in **Figure 4**. The figure graphs the spreads of three baskets of securities—the CMBX-AAA, the CDX-IG, and the super-senior tranche of the CDX-IG (CDX-SS)—for the March 2006 to September 2008 period.

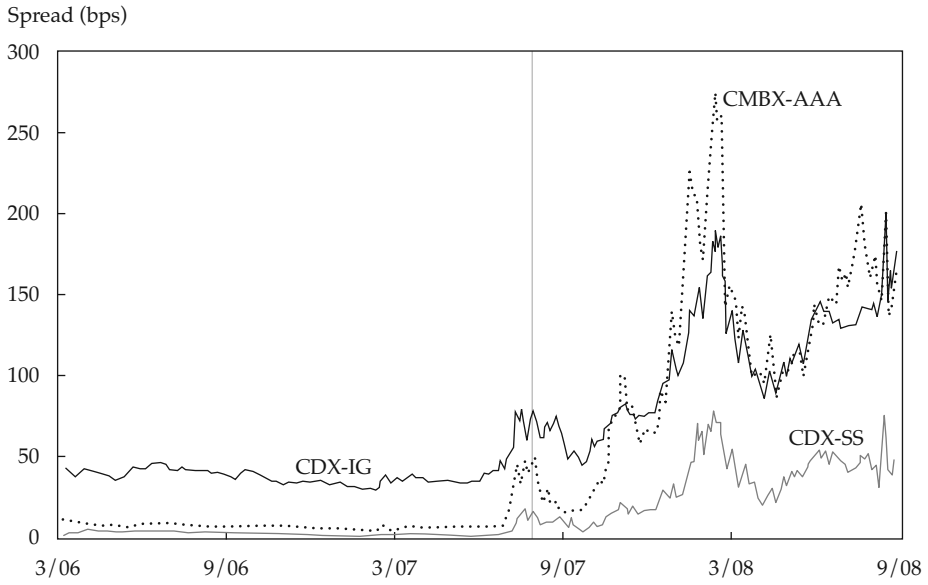
Underlying the CMBX is a basket of 25 commercial mortgage-backed securities; the CMBX-AAA is the most senior of all the CMBX tranches. The tranche is rated AAA because for investors to lose any of their investment (i.e., not to be fully repaid), losses on the underlying mortgages have to be greater than 30 percent. The spread was correspondingly low, dipping to a very narrow 0.038 percent per year, in early 2007.

Figure 3. ABX BBB– Price, 19 July 2006 to 3 August 2007



Source: Based on data from MorganMarkets, JPMorgan Chase.

Figure 4. Credit Derivative Spreads, 6 March 2006 to 29 September 2008



Source: Based on data from MorganMarkets, JPMorgan Chase.

Underlying the CDX is a portfolio of 125 investment-grade (IG) credit derivative swaps (CDS), for which the spread was about 40 bps (or 0.40 percent) per year (bps/year) over the March 2006 to August 2007 period. The spread means that the credit protection buyer (i.e., the buyer of the CDX-IG) effectively paid 40 bps/year in exchange for payments from the protection seller (i.e., seller of the CDX-IG) sufficient to recover all losses should any of the bonds in the underlying CDS portfolio default in the subsequent five years. Thus, the CDX-IG represents the cost of insuring a portfolio of bonds against losses due to default.

In 2004, the CDX-IG spread was at a level of 80 bps/year. Over the following three years leading up to 2007, the spread halved, consistent with the contemporaneous decline in the VIX discussed earlier. Interestingly, the lowest spreads ever seen on the CDX-IG and CMBX-AAA occurred right in the middle of the subprime mortgage meltdown—on 22 February 2007 and 16 February 2007, respectively. In hindsight, it seems clear that the subprime meltdown should have had some impact on the commercial real estate and corporate debt sectors, but in early 2007, investors did not appreciate the full implications of the subprime sector meltdown: Even though confidence in subprime MBS was falling dramatically, CDX-IG and CMBX-AAA spreads continued to trend down in January 2007 exactly as they had over the past three or four years. Only in March 2007 did these spreads begin to widen. A more dramatic widening would take place four months later when IKB Deutsche Industriebank AG announced major losses resulting from an overabundance of subprime mortgages on its balance sheet. IKB Deutsche was later bailed out by a consortium of German banks. Likely in response to IKB Deutsche's announcement, the CDX-IG spread moved from 40 bps/year to about 80 bps/year.

It is useful to compare this 80 bps/year spread—the cost of insuring against default risk—with actual default rates. The worst period on record for a comparable basket of U.S. investment-grade corporate bonds was from 1931 to 1935. Over that five-year period, about 14 percent of investment-grade bonds defaulted. Assuming a loss-given-default of about 70 percent, the loss rate for this five-year period was about 9.8 percent, or 190 bps/year. So, although investment-grade spreads were fairly high in July 2007, they were nowhere near Great Depression levels. However, as I will show in a moment, by 2008, the spreads were to reach levels far higher than 190 bps/year.

The Quant Liquidity Crunch: 3–10 August 2007. The stage is now set for the first week of August 2007—the most dramatic week, by far, that quantitative equity investors had ever experienced.[3] During this week, moves in the standard quant factors—such as valuation, momentum, and quality—were an order of magnitude larger than previously observed.

[3]See "The Quant Liquidity Crunch," GSAM, August 2007.

One thing that was remarkable to those of us involved in managing quantitative portfolios at the time was that markets appeared calm to non-quantitative investors. Indeed, for the week of 3–10 August 2007, when the quant liquidity crisis occurred, the spreads on corporate bonds, measured by the CDX-IG and CDX-SS, actually narrowed. Volatility in the broader market (e.g., the DJIA, the S&P 500, and non-U.S. indices) was not extraordinary in any way. In fact, one colleague at Goldman Sachs remarked that you could not tell that anything was happening without quant goggles. That was very much the way it felt to us.

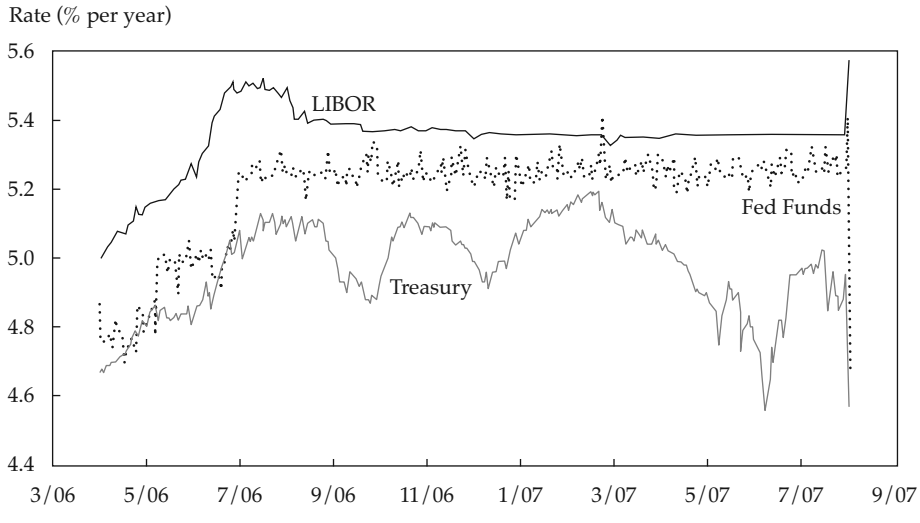
Similar to equity markets, money markets also showed no distress leading up to the first week of August 2007. **Figure 5** plots the yields on three-month T-bills, annualized three-month LIBOR, and the federal funds rate from 4 April 2006 to 10 August 2007. During the last three days of the quant crisis, 8–10 August, both LIBOR and the federal funds rate initially jumped, perhaps in response to a large demand for liquidity related to moves in quant portfolio values. The European Central Bank and the U.S. Federal Reserve responded with large liquidity injections on 9 and 10 August. The cumulative effect of these events was a decrease in the T-bill and the federal funds rates. LIBOR, however, remained high, reflecting an increase in perceived risk and greater liquidity premiums.

Figure 6 plots the five-day standardized returns for a representative quant portfolio in the United States—from December 1990 through December 2008. This portfolio is formed as a combination of common factors coming from each of the six themes. The portfolio performs strikingly well leading up to August 2007. Note, however, that toward the right-hand end of the graph is a large downward move, followed by a slightly smaller upward spike. The downward spike is the return to the portfolio in the week of 3–10 August, and the upward spike is the second week of August (10–17 August).

What one can see in the graph is that there was a downward move in the portfolio during the first week of August that was far larger than anything historically observed. In the United States, the downward move was about 35 standard deviations; it was slightly smaller than this in other regions. To put this move in perspective, historical data generally show that the distribution of market returns is fat tailed—that is, it is not normally distributed. However, the moves in August 2007 were far more severely outsized than any of the previous events we had observed historically, even in periods of severe market stress. Moreover, over this week, we saw similar dramatic moves in quant factors in Japan, Europe, and the United Kingdom. The reason for the dramatic moves was not only extreme moves in each of the six themes comprising the portfolio but also the fact that these moves occurred at the same time and in the same direction.

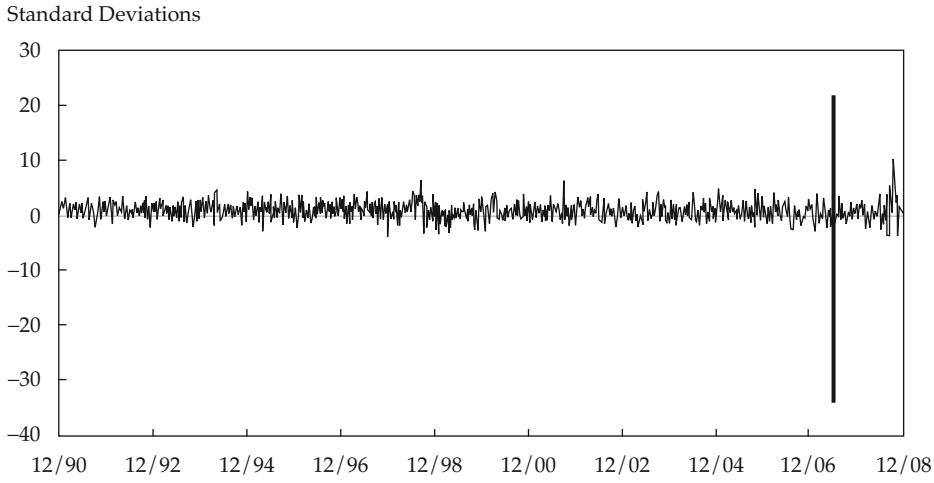
The returns of the individual themes—momentum, valuation, profitability, quality, sentiment, and management—used to construct the regional portfolios are shown in **Figure 7**. The figure plots the daily normalized returns to each of

Figure 5. Three-Month Treasury, Three-Month LIBOR, and Fed Fund Rates: 4 April 2006 to 10 August 2007



Source: Based on data from Bloomberg.

Figure 6. Five-Day Standardized Returns of Quant Equity Portfolio Returns in the United States, December 1990–December 2008

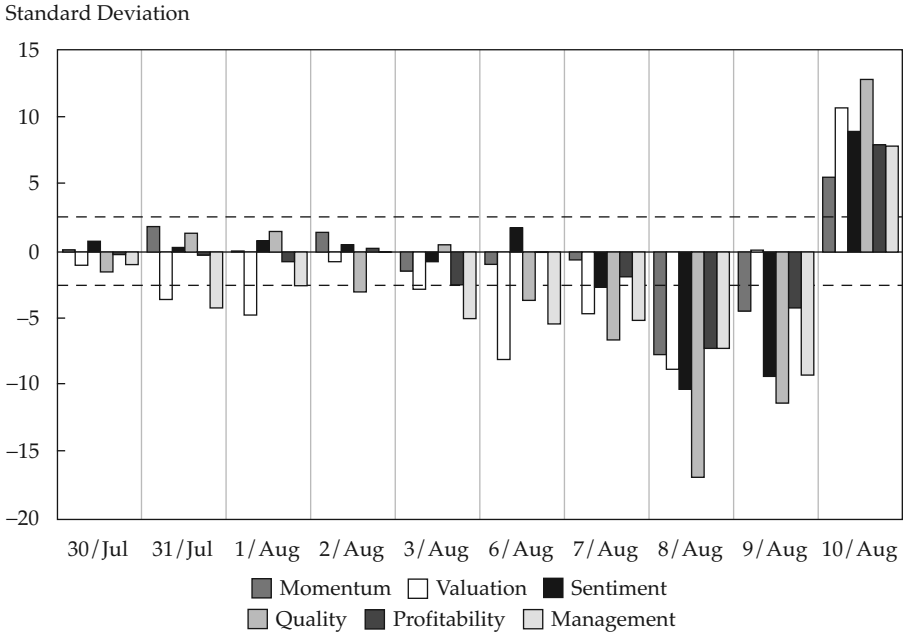


Source: Based on data from the Quantitative Investment Strategies team, GSAM.

the themes in the United States on a daily basis. The first day of the quant crisis, 3 August, was the worst day of performance we had ever seen, with much worse to come (although on 3 August we were unaware of that fact). Five of six U.S. themes were negative that day, and three were down by more than two standard deviations. Although we are certainly aware that factor returns are not normally or independently distributed, both the magnitude of the theme moves and the correlations between themes were unusually high.

The next trading day was Monday, 6 August, and the situation worsened considerably. That day, five of the six themes were negative and one was down by more than four standard deviations. All six themes were negative the next day, with three

Figure 7. U.S. Normalized Theme Returns, 30 July 2007 to 10 August 2007



Source: Based on data from the Quantitative Investment Strategies team, GSAM.

down by more than four standard deviations. On Wednesday, 8 August, all six themes were down by more than six standard deviations. Thursday was the same story. Finally, on Friday, 10 August, we saw a dramatic rebound in quant factors, something that continued into the next week.

On Friday, Monday, and Tuesday (3, 6, and 7 August), when the quant crisis was in full swing in the United States, one thing that was striking to us was that non-U.S. quant factors seemed unaffected: The factor movements in Japan, Europe, and the United Kingdom were unremarkable. But on Wednesday morning, 8 August, Japanese quant portfolios fell in value in the same way that U.S. portfolios had done over the preceding three days, and when the European and U.K. markets opened later that day, quant portfolios in those three regions also fell dramatically.

We have not identified the precise cause of the move of the crisis into these other regions. It felt like a virus had made a jump into the other regions. In fact, I remember early the morning of the 8th walking down the dark hall toward my office. One of our senior researchers walked out of his office. He was as white as a sheet, and he said simply, "It's in Japan." I knew exactly what he meant.

I would like to emphasize that during this period of extreme performance of quant factors, such regional stock markets as the Nikkei in Japan, the FTSE in the United Kingdom, and Eurostoxx in Europe were essentially flat. However, there was large cross-sectional volatility: Value stocks declined. Growth stocks rose. High "quality" stocks fell, and low-quality rose.

Our interpretation of the crisis that roiled quant strategies in early August 2007 is that it resulted from spillover from the turmoil in the mortgage and credit markets. A number of multistrategy hedge funds participating in the credit markets were using quantitative equity strategies correlated with ours. These funds had experienced large losses on their positions in illiquid mortgage and credit markets, losses that were probably magnified by the leverage used in these funds. At the end of July, these funds needed to raise capital. To make matters worse, the hedge funds did not want to sell their mortgage and credit positions, which had fallen in value so dramatically and which they perceived as "too cheap," so the funds instead chose to sell their more liquid equities. Quant equity strategies had not performed particularly well in 2007 up to that point, and large margin balances are needed to trade them, so the decision to sell equities in lieu of debt was an easy decision to make.

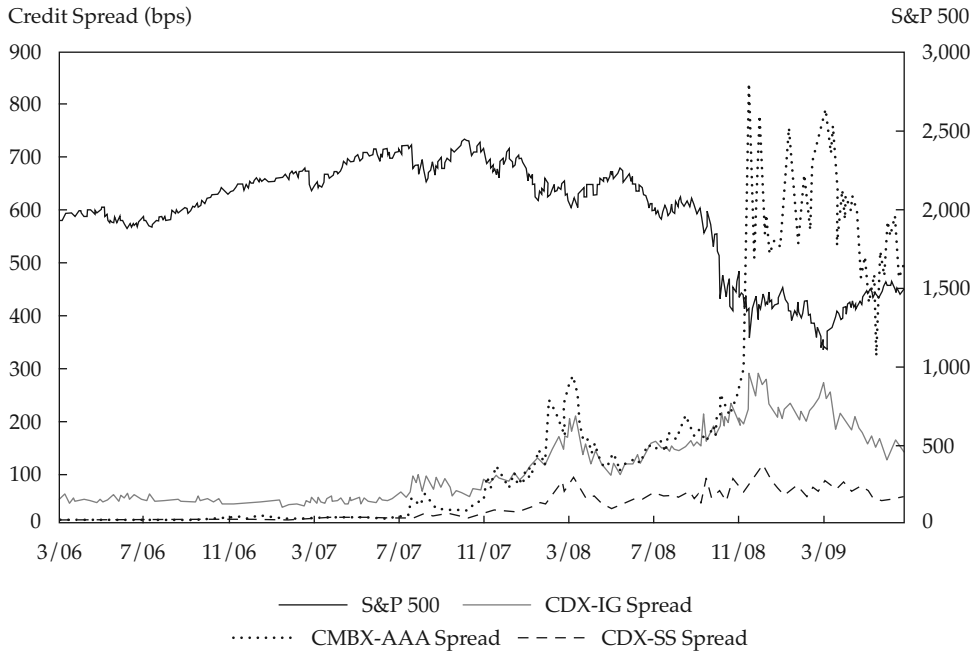
A "prisoner's dilemma" developed. Even though patience and slow trading would have reduced the cost of unwinding positions and would have been in everyone's best interests, many market participants made a judgment that others might decide to liquidate, so selling first was the only way to go. The result was panic unwinding. Essentially, everyone saw the sell-off coming, even though equities were not incredibly misvalued. Thus, in anticipation of massive selling, everyone tried to get in front of everyone else; in particular, smaller players tried to sell what they could as fast as they could. For the bigger players, like Goldman Sachs, selling was not really an option. Spreads kept widening, and liquidity dried up. Very few people were willing to trade. Trading volume was low, and price impact, when trading was possible, was very, very high.

We believe a margin cycle—mark-to-market losses that led to increased risk and leverage, which led, in turn, to selling pressure to raise cash—caused the quant liquidity crisis. This scenario was particularly relevant for levered hedge funds. First, loss of capital increased their leverage. Then, to reduce risk and leverage, they had only two choices: raise more capital or sell down positions. Most funds chose to sell down positions, which resulted in greater losses, which increased risk and leverage further, and, in turn, led to more selling. Buying in a large way in August 2007 finally stopped the freefall, and those who invested at the bottom, even given the poor environment subsequent to that time, actually did quite well.

The Crisis Spreads: August 2007–June 2009. The crisis in subprime mortgages continued to worsen through the second half of 2007 and into 2008, as shown in **Figure 8**. Subprime mortgages, as measured by the ABX BBB– Index, fell in value by 96–97 percent by September 2008. The CDX-IG spread had risen to 280 bps/year by late November 2007—higher than the loss rate in the Great Depression. The CMBX-AAA spread, which was 4 bps/year in February 2007, reached a level of 800 bps/year in December 2008. The TED spread (i.e., the spread between LIBOR and U.S. Treasury bills) also jumped to previously unseen levels of more than 4 percent.

If these numbers were indicative of the way the economy was heading, they foreshadowed that the situation would be more than twice as bad as the experience of the Great Depression. But most economists did not anticipate that economic activity and unemployment would collapse as catastrophically as they had during the Great Depression.

Figure 8. Credit Derivative Spreads and S&P 500 Levels, 6 March 2006 to 30 June 2009



Sources: Based on data from Datastream and GSAM.

We believe that the continued widening of credit spreads was, instead, a result of continuing deleveraging. As assets continued to decline in value and more investors were forced to sell to bring down leverage, it ultimately became a test of who could hold on for the long term. Equity and credit investments were very cheap. The risk for investors, however, was that even though these investments clearly appeared cheap, they could always get cheaper.

One of the very striking features of this period was the slow movement of the crisis from one market to another. Rumblings of unease could be heard as early as November 2006 in the subprime mortgage market, as indicated by movements in the ABX BBB– Index. But this turmoil cascaded into the broader credit markets only in March 2007. The crisis spread to the quant universe in August 2007 before transpiring as a global market crisis that would befall nearly all equity markets in 2008.

Although the falls in markets appeared as a slow procession of events, the recent pickup in market sentiment has occurred more simultaneously. Figure 8 shows that following the equity market "bottom" of 9 March 2009, equity markets rose and credit spreads narrowed simultaneously. Since March, with only a few hiccups, this reversal behavior has continued across credit and equity markets.

Implications for Quant Asset Management

One key lesson has emerged from the quant crisis and the ensuing broader economic crisis: Standard quant factors do not work well when markets are disrupted. In other words, when things are really bad, when investment firms are forced to reduce risk, companies do not move toward their fundamental valuations because of investors' selling out of positions based on these standard quant factors. This reaction could result either from investors being forced to delever or from their fear that by remaining in the market, they would eventually be forced to delever.

Our response to these recent events has been to do two things: (1) build a barometer of the risk in the market and (2) continue our research and concentrate our efforts on building new proprietary factors.

Financial Disruption Indicator. The risk index that the QIS group created is the QIS Financial Disruption Indicator (FDI), which comprises a number of indicators to gauge turbulence in the markets. An increase in the FDI triggers us to lower the risk we are targeting in our portfolios. The FDI quantifies disruption levels in terms of standard deviations away from the norm. By October 2008, the indicator had reached a new high—more than five—a level

never before seen in recent history. The next highest level, in excess of four, occurred in 1998 when Long-Term Capital Management collapsed and during the Russian debt default. We have observed that when the measured level of disruption is very high—for example, at three or higher—standard quant strategies perform poorly. Evidence points, however, to quant strategies (even the standard strategies) performing well when risk falls.

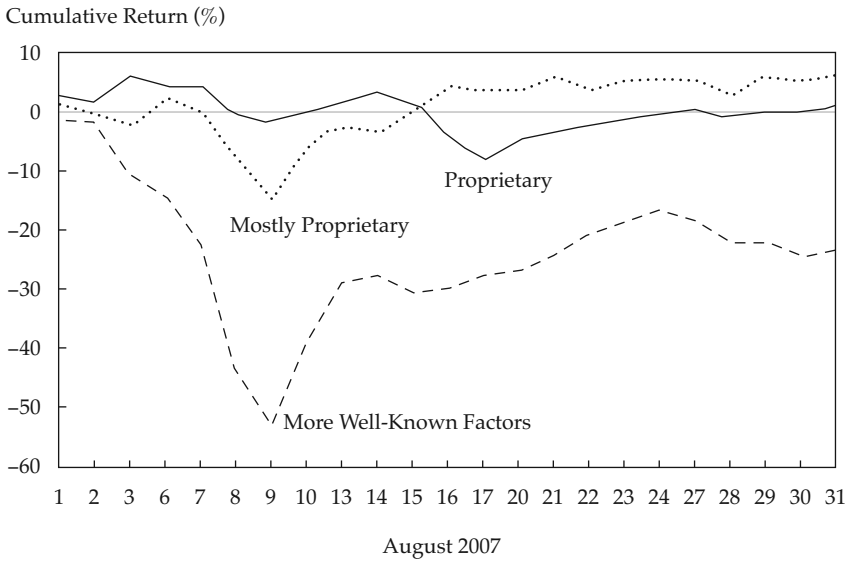
Proprietary Factors. In addition to creating the FDI, QIS has also built a number of proprietary factors appropriate to the new market environment. So, if quant investors can no longer rely on well-known factors like 12-month price momentum and BP (book-to-price ratio) to generate alpha, where will they find alpha in the future? Alpha opportunities can exist only when prices do not fully reflect public information, which can occur only when investors over- or underreact to information. In essence, we believe that the value effect is actually an overreaction effect but that the market no longer systemically overreacts to the information in BP. Similarly, the momentum effect is a result of investor underreaction, but the market no longer systemically underreacts (as much) to the information in 12-month returns.

Quants have made the market more efficient with respect to the information in these simple factors, but they have definitely not eliminated the tendency for people to over- or underreact more generally. For example, we believe that investors overreact to information that confirms their prior beliefs and underreact to information that contradicts those beliefs. Thus, the underlying behavioral bias is overconfidence in prior beliefs. It is, therefore, unlikely to disappear anytime soon.

In searching for new alpha sources, the goal is to find relevant information for which there is systematic over- or underreaction from investors generally. Some areas where we have looked are less widely used data sources, textual analysis (systematically interpreting text-based sources of information), industry-specific data and signals, and information from related companies (competitors, clients, suppliers, etc.). In the past few years, we have developed a number of new factors in each region based on these new sources.

Figure 9 compares performance of our new factors with that of popular factors in August 2007 in the United States. The new factors have been divided into those that we consider to be mostly proprietary (i.e., in the public domain but not yet widely known) versus those that are completely proprietary (not yet in the public domain). In all cases, the new factors held up much better than the widely known factors during the quant liquidity

Figure 9. Performance of Signals during the Liquidity Crisis in August 2007 in the United States



Notes: Signal returns are scaled to target 1 percent daily volatility, which is equivalent to 16 percent annualized volatility. The data are scaled to normalize different return series.

Source: Based on data from the QIS group, GSAM.

crunch of August 2007, indicating that crowding in these factors is not yet a problem (or at least it was not in August 2007). This pattern of performance is observed across all four major regions (the United States, the United Kingdom, Japan, and the European Union).

Conclusion

The quant liquidity crunch that occurred during the first week of August 2007 exposed a weakness in quant strategies. As more and more quant managers piled into the market, we all began to share the same factors for selecting stocks and constructing portfolios. The result was not only significant concentration in the stocks held in quant strategies but also substantial underperformance of the factors—particularly as highly levered hedge funds dumped stocks in lieu of debt in an effort to reduce rising risk levels in the early days of August 2007.

In the QIS group, we continue to focus our research efforts on adding more proprietary factors to our investment themes, looking for unique data sources, and building new databases that are completely proprietary. We believe one path to success lies in finding even cheaper ways to trade while continuing to focus on transaction cost models and best execution. Because challenging times lie ahead, teamwork, resources, experience, and expertise will be necessary for successful quantitative investing.

Author's Note: This article draws heavily from several GSAM working papers, "The Quant Liquidity Crunch," "Quantcentration: Implications for Quantitative Equity Investing," and "The Anatomy of a Crisis."

Editor's Note: This presentation was updated by the author in August 2009.

This article qualifies for 0.5 CE credits.