Volatility Clustering, How to avoid the Tails?

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A large part of risk management is measuring the potential future loses of a portfolio of assets.

The volatility clustering feature indicates that asset returns are not independent across time.

Many empirical studies point out that “it is difficult to justify the observed level of volatility by variations in ‘fundamental’ economic variables alone. The occurrence of large (positive or negative) returns is not always explainable by the arrival of new information on the market”.

Long-range of volatility is dependent on ‘fundamental’ mechanism of economic variables.

**Volatility Clustering** captures the idea that some markets represent periods of notably high or low volatility. Large positive and negative changes in prices tend to be followed by large changes, and small changes tend to be followed by small changes. The persuasive evidence of volatility clustering is analyzed in this paper with the daily returns of S&P 500 Index since 1950. Volatility clustering is also related to the so-called ‘leverage effect’ that refers to the inverse relationship between an asset class return and its changes of volatility.

Convex Capital’s research indicates a prudent investment approach is to earn higher-risk adjusted return by avoiding higher volatility clusters and fatter tails.
Time-varying nature of volatility presents both opportunities and threats.

Volatility is time-varying. Time series of financial asset returns however, often exhibit volatility clustering property; large (small) changes in prices tend to cluster together. Returns themselves can be uncorrelated but absolute returns (squared values) display a positive, significant autocorrelation (correlation of the same time series with its own past and future) with a rate of decay. This is recognized as a stylized property inherent in most financial time series in a number of different markets, including equity, currency and futures markets. The evidence of volatility clustering supports the case for estimating a near-term volatility using various statistical approaches.

We analyzed the daily price returns of the S&P 500 Index from Jan 1950 to Oct 2013¹ (16057 trading days) to observe the trend of volatility (moving averages of standard deviation) under different windows (10-day, 20-day, 50-day and 250-day). The chart shows the daily returns in left axis (gray lines in the upper section) and moving windows of volatility in right axis (colored lines in the lower section). U.S. equity markets sustained periods of high volatility during the late 70s and early 1980s, October 1987 crash, 9/11 and 2008 recession, and also experienced periods of low volatility during the late 1990s and early 2000s. However, it is rather difficult to clearly identify the volatility clusters in this chart except for eyeballing the range of returns. The squared daily returns (absolute returns) however, show the empirical behavior of positive autocorrelation (i.e. positive correlation of one period to the next, which

Decays to zero over time) with the presence of sustained periods of high or low volatility. This is the typical manifestation of volatility clustering, which is very stable across asset classes and time periods, which forms the basic premise behind volatility estimation using GARCH\(^1\) and other stochastic models. In the chart above, the blue bars are squared (absolute) daily returns in left axis whereas the gray/black lines depict 50-day and 250-day moving window of standard deviation in right axis. Volatility clustering can be observed in the symmetrical pattern of absolute returns (blue bars) and volatility (gray/black lines) (sample periods are highlighted with red-squared blocks). This is also called co-movement of volatilities.

Black (1976) observed that: "there is a lot of commonality in volatility changes across stocks…In general it seems fair to say that when stock volatilities change, they all tend to change in the same direction." This commonality of volatility changes holds not only across assets within a market, but also across different markets.

Convex Capital estimates volatility on a daily basis across asset classes in various markets. On the other hand, we believe that macroeconomic variables and volatilities have positive strong relationships as there is a natural tendency of volatility to rise during recessions and financial crisis, and drops during market expansions. Convex Capital’s proprietary Economic Risk Rating measures the impact of macroeconomic variables on market volatility.

There is a tendency for changes in asset prices to be negatively correlated with changes in volatility. In other words, the volatility of any asset class tends to reduce as it appreciates, and increases as the asset depreciates. Fundamentally, this can be linked to so-called ‘leverage-effect’, first noted by Black (1976). As asset prices decline, companies become more leveraged since the relative value of their debt rises relative to that of their equity. This suggests that a negative return should make the firm more levered, hence riskier and therefore lead to higher volatility; the causality effect eventually reverses with the consistent volatility feedback effect, which means increase in volatility leads to future negative returns.

\(^1\) Generalized AutoRegressive Conditional Heteroskedascity
It is often a wishful thinking to be invested in the 10-best days of the S&P 500 Index and avoid the 10-worst days! A prudent investment approach however, should be driven by ‘skill’ and not ‘luck’. The analysis of 10 best and worst days of the S&P 500 Index indicates one common element - extreme volatility through a roller-coaster ride and higher trading volume! Although the cumulative return of 10-best days outperformed that of 10-worst days an investor would have ended up having a -20.35% return (table and chart below) over a 20-day period with 144% annualized standard deviation!

Another interesting stylized fact is that trading volume is positively correlated with market volatility, and often times excess volatility is induced in the market by excessive trading in erratic patterns. In the absence of perfect market-timing, which is often successful with ‘luck’ than ‘skill’, the ride is often smoother when the tails are avoided.....

Mebane Faber in his article "Where the Black Swans Hide & 10 Best Days Myth" argues that "returns improve and volatility is reduced when an investor is invested in uptrending markets thus avoiding the volatility and clustering of best and worst days inherent in declining markets.....in declining markets returns are much lower and volatility is much higher."
The real benefit of effective risk management comes from setting the risk posture of the portfolio in low and high volatility clustered regimes, and re-adjusting as the time decays and cluster changes. Taking inordinate amount of risks in a high volatility cluster makes a portfolio vulnerable to ‘tail risk’. A ‘safer’ risk-managed investment strategy tends to outperform in the long run by eliminating the “tails”.

S&P 500 Index posted a ‘buy-hold’ annualized return of 11.2% from Jan 1950 to Oct 2013 (16057 trading days) with 15.4% standard deviation. The histogram of weekly volatility (chart below) indicates a distribution skewed to its “right” (higher volatility).

We analyzed a number of strategies that invested in the S&P 500 Index based on different volatility clusters, measured in terms of Mean + σ (standard deviation). The analysis shows three investment strategies that had the highest risk-adjusted returns were the ones invested when the volatility was within Mean - 1σ and Mean + 1σ. The annualized return of the S&P 500 Index was 17.5% during 2392 days when the 20-day volatility was less than Mean vol - 1σ compared to 10.2% when it was greater (table below). This supports the stylized facts that asset class return and changes of volatility are negatively correlated. All three strategies that invested when the volatility was below Mean vol - 1σ, Mean vol and Mean vol + 1σ outperformed not only the three opponent strategies that invested when the volatility was above the same thresholds, but the ‘buy-hold’ return of 11.2%, with lower standard deviation and higher Sharpe Ratio.

Convex follows an investment model that changes the weight of an asset class within a portfolio on a daily basis based on changes in its volatility. The Daily Volatility Adjustment decreases (increases) asset class weights based on increase (decrease) in volatility (volatility clustering) with linear and non-linear adjustment under different economic regimes.

<table>
<thead>
<tr>
<th>20d Vol less than</th>
<th>Mean Vol. - 1σ</th>
<th>Mean Vol.</th>
<th>Mean Vol. + 1σ</th>
<th>20d Vol greater than</th>
<th>Mean Vol. - 1σ</th>
<th>Mean Vol.</th>
<th>Mean Vol. + 1σ</th>
</tr>
</thead>
<tbody>
<tr>
<td># of days</td>
<td>2392</td>
<td>11848</td>
<td>14727</td>
<td># of days</td>
<td>13522</td>
<td>4066</td>
<td>1187</td>
</tr>
<tr>
<td>Annualized Return</td>
<td>17.5%</td>
<td>11.5%</td>
<td>12.0%</td>
<td>Annualized Return</td>
<td>10.2%</td>
<td>10.5%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.5%</td>
<td>9.1%</td>
<td>12.0%</td>
<td>Standard Deviation</td>
<td>15.2%</td>
<td>12.4%</td>
<td>9.6%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>7.02</td>
<td>1.24</td>
<td>0.98</td>
<td>Sharpe Ratio</td>
<td>0.65</td>
<td>0.83</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Source : Convex analysis
References and Related Papers:

3. The Leverage Effect Puzzle: Disentangling Sources of Bias at High Frequency : Yacine A¨ıt-Sahalia, Jianqing Fan, Yingying Li (2013)
9. The Volatility of Volatility : Andrew Lo, CFA Institute Magazine (Sep/Oct 2013)
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