Risk: Toxic Gamma Radiation

Market volatility tends to fade and spike over time. Sharp corrections in financial markets occur more frequently than predicted by statistical theory. How do we explain these phenomena?

It seems to me that as a broad rule, and in particular where risk management is based on Value at Risk, that leverage is a function of underlying realized or historical volatility. In order for a portfolio to maintain a roughly constant level of risk, as represented by second moments, that is correlation and volatility, the level of leverage varies inversely with volatility. Intuitively this is prudent. Solvency requires that leverage is applied only to assets exhibiting low variability and that highly variable assets should not be highly levered.

Leverage is a function of the expected net excess returns and the volatility of the investment strategy pre leverage. As more arbitrageurs enter the market they reduce the level of mispricing between securities so that the return on capital employed in the trade is diminished and more leverage is required to produce the same return on equity. As arbitrageurs also enforce market efficiency they reduce price variation. Reduced volatility and reduced arbitrage encourage increased leverage. Increased leverage increases the probability that an unexpected data point violates the volatility assumptions leading to the need to reduce leverage.

Gross leverage is an important measure of systemic risk, both for individual participants as well as for regulators seeking to better understand system wide risk. However, delta adjusted notional exposure does not provide insight into second derivative effects which might accelerate or dampen any increase or decrease in leverage. To understand second order effects, it is useful to quantify the gamma. In a zero sum

market, market net gamma is also zero. Gross gamma is the more interesting and useful quantity. Gamma concentrations at different market levels should be of interest to investors and regulators alike. These are analogous to the rapids, twists and turns along a river. Classifying gamma exposure according to the hedging activity of trader with the exposure is also important. Active delta hedgers are the target of scrutiny in the quantification of gamma since this is the source of feedback when markets begin to spiral out of control.

Realized volatility outside the expectations of historical volatility can trigger an increase or decrease in leverage. As volatility exhibits negative correlation with returns the likelihood is that a volatility breach is associated with fall in market levels. This is likely to trigger deleveraging. As markets trade to lower levels, negative gamma is likely to trigger further selling resulting in sharp corrections. At the same time, volatility rises further due to the market selling off implying a lower level of target leverage, the consequence of which is the need to deleverage. This negative feedback is likely responsible for most catastrophic market corrections.

Regulators should be mapping out gamma concentrations in addition to leverage to understand areas of unstable equilibria in markets. One would expect intelligent traders to seek and monitor the same information in their effort to avoid the landmines on the trading field, or to capitalize on them.

Unfortunately, mapping out gamma concentrations only identifies areas of unstable equilibria. What should regulators and traders do with this information? The answer to this is far away. A sharper definition of the general problem of managing systemic risk is also far away. The above is merely one facet of a vastly richer problem.

A corollary to the above characterization of gamma as a trigger for price movements is technical analysis. Often, technical analysis seems like the reading of tea leaves and

other superstitions, but it is possible that investors’ desire to insure profits leads them to buy options at psychological strikes thus creating concentrations of gamma at key levels. This manifests as areas on a chart where prices cannot linger and must either retreat from (a resistance level), or bounce off (a support). A resistance once breached becomes a support, since the price cannot settle there. Maybe, there is a logic to chart reading after all, although one remains sceptical.