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# Using Volatility Regimes: The FQ MRI (Market Risk Index)

**FQ Perspective**

by Ed Peters

The great bear market that began in August 2007 and the subsequent failure of risk controls put in place after the tech bubble collapse have created a good deal of soul searching in the investment community. This has generated simplistic explanations that either quantitative methods do not work, or conversely that they were applied incorrectly due to the ineptitude and greed of money managers, fund sponsors and regulators. In reality, there has been significant evidence for many years that the prevailing view of market risk was seriously flawed and so risk control methods would have limited success in times of extreme stress. However, the impact of flaws in the standard market risk model goes far beyond the debate that has occurred so far. There are also implications for investment processes and portfolio construction. In this article we will examine an alternative view of market risk and present a new Market Risk Index developed at First Quadrant.

## The Failure of the Standard Risk Model

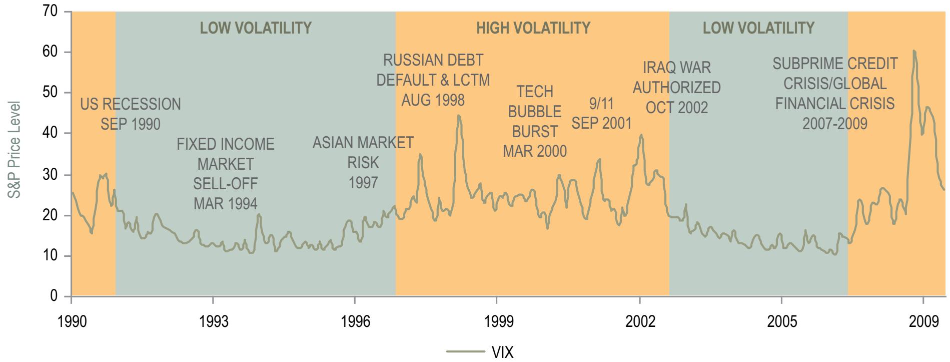
Despite the segregation of quantitative methods into a separate investment style, all investment managers these days use quantitative techniques. Likewise, institutional investors and consultants use quantitative analysis in order to structure funds for long-term investment and examine the trade-offs in risk and return. Any type of optimization or asset/liability study relies upon techniques descended from Harry Markowitz and Bill Sharpe, the original quants. So if basic quant methods are flawed, then everyone has problems.

For instance, most investors use the standard deviation of returns as a basic risk measure. We have given this statistic the generic name "volatility" and most use "volatility" to assess the risk of an investment whether they are quants or not. Likewise, the VIX or volatility index of S&P 500 options traded on the CBOE is now typically used as a fear index. The VIX is the "implied volatility" of the S&P 500 based upon current option prices. That is, it indicates that option writers think that the risk of a significant stock market decline is increasing so the cost of hedging is rising. Correlations are also used to measure the level of diversification in portfolios.

The standard deviation of returns (the standard measure of risk) has a significant number of assumptions built in regarding the nature of market returns. Among the more famous is the assumption that market returns are a random walk and are described by the normal distribution (or "bell-shaped curve"). It has been well known at least since Mandelbrot (1963) that market returns are not normally distributed. The distribution of market returns has fatter tails than the normal distribution and a higher peak at the mean. These larger than expected events are often called "anomalies." Removing them from the distribution by rationalizing that they are "hundred year floods" makes the resulting series more bell-shaped. This head-in-the-sand approach merely understates the risks since they occur far too frequently to be rare. Taleb (2007) has described these fat-tailed events as "black swans." While the black swan phrase is catchy, it misses most of the implications of large events. The fat-tails in the distribution indicate that the entire market *process* is different than the standard view of markets as a random or near-random walk.

So, the investment implications of fat-tails are vast and touch on everything from risk control, forecasting, trading, and portfolio construction. They indicate that the market is a dynamic, evolving complex system where volatility and correlations change over the business cycle not because of the specific characteristics of a security but because of the business cycle itself. That is, volatility goes through cycles of high and low levels which correspond to high levels of optimism or uncertainty. Correlations also change over the business cycle. In "Diversification and Risk Management: What Volatility

**CBOE MARKET VOLATILITY INDEX (VIX)**
*(January 1990 – July 2009)*

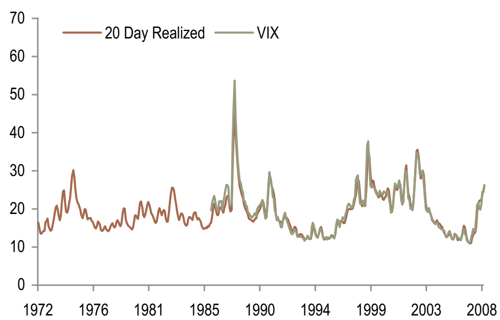



*Source: Chicago Board of Operations Exchange, First Quadrant L.P.*

Tells Us" (FQ Perspectives, Oct 2008) we discussed stock market volatility cycles and used the above chart of the VIX since 1990 to illustrate this.

The VIX is important because it provides a forward looking view of risk but has only been in existence since 1986. However, it can also be proxied by the 20 day annualized volatility of the stock market. Using this we have examined levels of volatility back to 1920 and have found the same cyclical pattern. The following chart shows this from 1972 to 2008:

**REALIZED AND IMPLIED VOLATILITY**
*(1972 – 2008)*




*Source: Datastream and First Quadrant L.P.*

Finally, the realized return to risk ratio of the market is not the theoretical relationship taught using traditional capital market theory. During periods of high volatility the stock market on average has a negative Sharpe Ratio (excess return over cash divided by standard deviation), but a strongly positive value during low volatility periods. In traditional capital market theory there should be no cyclical element to the relationship between risk and return and higher risk should be compensated for by higher return. The following table shows that has not been true for the last 258 months:

**ANNUALIZED S&P 500 EXCESS RETURN**
*(January 1988 – June 2009)*

| | Overall | High Vol | Low Vol |
|---|---|---|---|
| Return | 4.94 | -0.42 | 10.92 |
| Risk | 14.67 | 18.10 | 9.61 |
| Sharpe Ratio | 0.34 | -0.02 | 1.14 |
| Skewness | -0.64 | -0.54 | 0.43 |
| Kurtosis | 4.29 | 3.05 | 4.17 |
| Observations: | 258 | 133 | 125 |

High Vol = (VIX>20) Low Vol = (VIX<20)

*Source: Global Financial Data and First Quadrant L.P.*

So we can see that cyclical volatility is a part of market dynamics, not merely a special, recent event. In addition, the negative skewness that has long been observed in stock market returns is a function of the high volatility periods. The data highlight that capturing these volatility shifts presents opportunities for investors to increase returns, reduce risk, or both. The question is why do volatility cycles exist?

## Causes of Volatility Cycles

Peters (1994) postulated a cause for volatility regimes tied to the relationship between investment horizon and how investors interpret information based upon the length of their horizon. This hypothesis does not predict the direction of the stock market. Instead it explains why we have extended periods of high and low volatility and offers a direct connection with the business cycle and market liquidity.

Traditional capital market theory assumes that all investors have the same investment horizon. This simplifying assumption makes the math easier. Unfortunately it is far from reality and significantly understates risk. In truth, the market is made up of many investors, all with different investment horizons. They range from day traders with their tick-to-tick trading activity to sovereign funds investors who look out for decades. As you would expect, the information that motivates a day trader is far different than a sovereign fund. The short investment horizons tend to be more technical in nature. Long term investors are more fundamentally based and buy based upon long term valuation measures, estimates of growth and macro economic data. But we should not think that there are two classes of investors, long and short term. Instead there are an infinite number of investment horizons and as we pass from very short to very long term there is a combination of technical and fundamental data that investors use. Investors with different investment horizons can also use the same information, but they would likely interpret it differently. For instance, late in an economic expansion a drop in unemployment is likely to be considered a good sign to the day trader while a long term investor might consider that sign of building inflationary pressures. Likewise, a sudden drop in a stock on an intra-day basis is likely to be considered a buying opportunity by a long term investor. As long as investors diversify one another through their investment horizons there will be stability and low volatility in the market because the buyers and sellers are balanced. There is ample liquidity on both sides of the market. Typically this is a time of long term market optimism.

However, every few years something happens to cause long-term investors to question the validity of their long-term assumptions. The cause varies from cycle to cycle. For instance in 1974 it was the OPEC oil embargo. In 2007 it was the credit crisis. The common element is an event or series of events that causes the long-term to become highly uncertain. At these turning points in the business cycle long term investors either leave the market or shorten their investment horizon as they lose faith in the accuracy of their long-term information. The overall market investment horizon becomes shorter and more uniform. Investors begin interpreting information in a similar fashion. As a result, when there is bad news, there are more sellers than buyers and the market plummets. When there is good news, the reverse happens and the market soars. Liquidity becomes unbalanced as investors interpret information the same way and take the same side of the market. This causes market volatility to increase and stay high until the long-term becomes clearer. That process generally takes 18 months to two years though it has taken significantly longer and shorter than that in history. Each cycle is different in causality and length.

Because these levels of high volatility are due to fundamental, economic uncertainty, there is no reason to believe that they will ever go away. They are endogenous to the system. As long as we are capitalists, there will be business cycles. While we can hope that they will be less severe at certain times, there is no hope that the business cycle will be "tamed."

Changes in market risk also coincide with changes in the business cycle. We can relate a "typical" cycle according to the following table:

**MARKET RISK AND THE "IDEALIZED" MARKET CYCLE**

| Market | Macro Uncertainty | | | Market Uncertainty | |
|---|---|---|---|---|---|
| Risk | Economy | Inflation | Monetary | VIX | Credit Spread |
| **Low** | Growing | Low | Neutral | Low | Narrow |
| **Rising** | Slowing | Rising | Tightening | Rising | Widening |
| **High** | Contracting | Falling | Easing | High | Wide |
| **Falling** | Recovering | Falling | Easing | Falling | Narrowing |

Since the market goes through volatility cycles, or "regimes," using volatility estimates based upon long term averages will produce a distorted view of our near term (2-3 year) risks. As you can see from the long term history of the VIX, we are only at the average when we are passing from low to high volatility regimes and back again. George Carlin used to say, "There is no present, just the near past and the immediate future." So it is with the "average" level of volatility.

Because of the changing nature of market risk, asset allocation based upon a static covariance matrix will give misleading results. In "Does Your Portfolio Have Bad Breadth" (FQ Perspectives, Jan 09) we discussed how diversification fails during high volatility regimes. Though 2008 was an exceptionally bad year for diversification, this has been the case in less violent contractions. The presence of volatility regimes also has implications for forecasting models and asset-liability studies as described in "Best of Both Worlds" (FQ Perspectives, July 09). So what should we do about this?

## The FQ Market Risk Index

To measure the current state of the volatility cycle, FQ has created a Market Risk Index (MRI). While the composition of the index is mostly proprietary, the following description should give a good understanding of the principals underlying the construction of the index and how it can be applied.

The MRI itself is constructed using a somewhat obscure area of mathematics called fuzzy sets. While the name sounds humorous, fuzzy sets (sometimes called "fuzzy logic") are a serious branch of mathematics that has achieved widespread use in engineering, particularly in consumer electronics and control systems, and are part of everyday life. Most Japanese engineering firms use fuzzy sets in some way. You may have read about (or even own) a particular brand of car that can parallel park itself. It does so using a fuzzy logic controller. A certain electric razor that adapts its speed to the shape of your face uses a fuzzy logic controller. In Japan there is an entire subway system which is run by a fuzzy logic controller. The ride is so smooth (especially in the starting and stopping), that a TV commercial in Japan shows one rider drinking a bowl of soup without trouble throughout the ride. All of these electronic devices adapt themselves to current conditions using a fuzzy logic controller. It is this adaptability that makes fuzzy sets particularly useful in measuring a changing risk environment.

A brief description of fuzzy set theory is necessary to introduce the risk index. Fuzzy sets are very intuitive and easy to understand because we actually use them all the time without thinking about it. Whenever we make a decision based upon *similarity* to another situation we are using fuzzy logic. Behavioral Finance calls this similarity function a "heuristic" rather than a fuzzy set, but it is the same thing. So bear with us and we promise the effort will be worth it.

### *Fuzzy sets*

Fuzzy sets convert traditional set theory (which fuzzy set mathematicians refer to as "crisp sets") from a discrete function into a continuous one. In crisp sets you are either in the set or in its complement. An axiom in crisp set theory is that the intersection of the set and its complement is zero, or the null set. So you need a cut-off in order to use crisp sets to perform classifications. While that works fine for many things, like the set of dogs and the set of not-dogs, many everyday concepts are too complex for crisp sets. Suppose we want to create the set of "Tall Men." We need a cut-off, which to most people is 6' tall. So if you are a male who is 6' tall or taller you are definitely in the set of Tall Men. However, if you are 5'11.5" you are in the Not-Tall set with men who are 5'2" for instance. We can see from this example that the concept "tall men" is too complex for crisp set theory. In security analysis we see this shortcoming in a more multi-dimensional context. Security analysts have a set of criteria to classify stocks as "buys" or "sells." But few stocks actually meet all the criteria for a buy or sell. So we hear about "weak buys" or "strong sells" depending upon how *similar* a security is to the criteria the analyst uses to measure a definite buy or sell.

Fuzzy sets quantify this similarity function to get around the limitations of crisp sets. To create a fuzzy set of Tall Men, we need both an upper and lower cut-off. We have already set 6' as the upper cut-off. So if a man is 6' or taller he is definitely "tall," and we assign him a *membership* of 1.0 in the set of Tall Men. For a lower cut-off we can use 5' so if a man is 5' or shorter he is definitely "not tall" and we assign him a membership of 0.0 in the set of Tall Men. In between we can assign a linear function based upon a man's height when he is between 5' and 6.' So if a man is 5'6" tall he is halfway between "not tall" and "tall" and has a membership of 0.5 in the set of Tall Men while man who is 5'11.5" tall would have a membership of 0.985=(11.5"/12").

That is how fuzzy set theory turns traditional crisp set theory from a discrete function (where you either belong 1.0 or 0.0 to the set of tall men) to a continuous one where you can have fractional membership. Note that "membership" is a measure of similarity or "state" not of probability even though it ranges from 0 to 1. Another way to look at it is that two men who are 5'6" or 5'11.5" tall are 50% or 98.5% *similar* to a "tall man" respectively. A fuzzy membership value *describes*, it does not predict.

### *Fuzzy sets and Risk*

The fuzzy set concept lends itself well to classifying the current volatility state of the market. As we can see from the above graphs, the market actually transfers from "low risk" to "high risk" in a fairly orderly fashion. Typically market stresses build up in the market, and as they do the cost of hedging rises accordingly which is measure through the VIX. Examining the charts above, we can see that while volatility spikes, it typically does so when it is already in a high volatility regime. The market is especially susceptible to shocks when it is already in a state of high uncertainty. While there are cases, which we will describe below, where we could spike between low and high, those cases are rare.

So in using fuzzy sets to create a market risk index, we have to set criteria for the different membership functions. In the case of the FQ Market Risk Index we used four indicators:

1) The three month moving average of the VIX (VIX_MA3),
2) Long term credit spreads,
3) Global monetary policy, and
4) Global economic activity.

For the upper and lower cut-offs we used the VIX alone. After all it is market uncertainty we are trying to measure and when the VIX hits very high or low levels there can be no question which regime we are in much like the 5' and 6' cut-offs we used in the fuzzy set of tall men. We measured the quartiles of VIX_MA3 to determine the cut-offs since quartiles and medians are not affected much by extreme levels like averages are. We found that the top quartile had a value of greater than 23 and the lower quartile a value of less than 14. So we used those as our cut-offs. If VIX_MA3 is 23 or higher, then we are definitely in the very high risk environment no matter what the other criteria are. That is, if VIX_MA3 is 23 or higher, then the current environment is 100% similar to a high risk environment. Likewise, if VIX_MA3 is 14 or lower we are definitely in the very low risk regime. So:

1) VIX_MA3>=23 equals a membership of 1.0 in the set of the "Very High Risk" regime, and

2) VIX_MA3<=14 equals a membership of 0.0 in "Very High Risk"

When the VIX is between 14 and 23 we use a combination of all four criteria and created four index levels in 0.25 increments. This combination looks at how *similar* the current state of the economy and markets are to past states of high uncertainty:

1) Very High Risk = 1.00

2) High Risk = 0.75

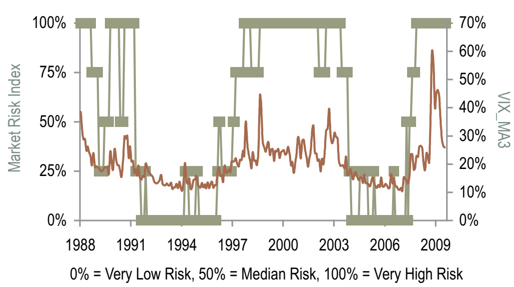
3) Median Risk = 0.50

4) Low Risk = 0.25

5) Very Low Risk = 0.00

The following shows how the Market Risk Index changes over time and how it compares to VIX_MA3:

**FQ MARKET RISK INDEX**
*(January 1988 – July 2009)*




*Source: Datastream and First Quadrant, L.P.*

As of this writing, the VIX has moved down dramatically from its highs of Q4 2008. However, the quartile measurements have not changed and VIX_MA3 is still well above the 23 threshold. So we are still in the "Very High Risk" environment.

### *Why Multiple Factors?*

So why not use the VIX alone since what we wish to measure is the volatility regime? There are multiple reasons. First, the VIX itself is volatile. While it does not typically spike when it's in the low volatility regime, it gives a good number of false positives and negatives when used on its own. Smoothing helps a little, but does not eliminate the problem.

Second, risk may be building while the stock market itself is in denial. Usually that is not the case but it can be. So we believed that it would be better to have multiple dimensions to measure risk that included both market sentiment indicators and macro economic measures. The VIX and credit spreads measure two separate but related areas of market uncertainty. The VIX measures the cost of hedging a portfolio of equities. Credit spreads measure the default risk premium on corporate bonds. Corporate bond analysts tend to be more cautious than the equity market when it comes to risk perceptions. So while credit spreads and the VIX have a fairly high correlation there are times they differ and that can be significant. Monetary policy and economic activity policy measures the current stage of the business cycle and as we saw above, volatility regimes and the business cycle tend to coincide.

Finally, we should return to our basic premise. That is, volatility regimes are caused by changes in the investment horizon of the total market. The VIX only measures one aspect of market uncertainty though it is a decisive measure at its upper and lower extremes. In between the sentiment of long term investors also depends upon fixed income markets and the macro economy. So it is important to use those measures as well.

### *Potential Problems*

Since the MRI is designed to measure changes in the risk environment, we can ask whether there are circumstances where the market would suddenly leap from a low risk to a high risk environment. While possible, such events would have to be truly exogenous to the market/economic environment. We can think of two possible categories.

The first would be a *political event*. This would include war or terrorist attacks. Even war usually has a warning period as tensions mount, but a sudden crisis would certainly cause a shift in the uncertainty environment. The Cuban Missile Crisis of 1962 is one example of a political event shifting the market from a median risk to high risk regime. But such events do not have to be on US soil. The 2007 riots in France raised volatility in French stock markets without affecting the rest of the developed markets.

The second would be a large *ecological event* such as a major earthquake or tsunami. The Panic of 1908 was largely caused by the San Francisco earthquake of that year and the uncertainty it created around major financial institutions ability to cope with their liabilities. We can imagine that the "big one" hitting California would have a significant impact on the volatility regime.

However, most changes in volatility regime are endogenous in nature. That is, they are internally generated in the market and economy and so the corresponding rise in market volatility as the danger increases is measurable. While massive political and ecological risks are possible, most risks are created within the markets and economies rather than coming from without.

Finally, we should state that it is not critical that the regime shift be timed precisely. The benefits in measuring the uncertainty environment in lowering risk or increasing returns can be gained without waiting for an "inflection point." Except for political and ecological events sudden jumps in regime are not likely.

## Using Volatility Regimes and the MRI

Accepting that the market has periods of high and low volatility for extended periods has some profound implications.

### *Forecasting*

Since market characteristics are different in periods of high and low volatility the factors that would predict market returns would also be different. That is, if the way investors are interpreting information varies according to the volatility regimes, then the information we use for forecasting should vary as well. FQ has already implemented this in the Asset Class model used in Global Tactical Asset Allocation (GTAA) and Global Macro. During the low volatility regime the AC model uses long term indicators and allocations change slowly over time. During the high volatility regime the model utilizes new factors that measure changes in sentiment and changes in short-term economic activity which will result in more active asset class shifts during this phase. We are also testing this volatility regime modeling technique in other sleeves in our GTAA, macro, and equity product sets. The results of this research will be communicated in the future.

### *Portfolio Construction*

Changes in the covariance matrix have significant effects on asset allocation. Using higher or lower volatility assumptions and changes in correlation can result in very different positions. In Essential Beta, our risk balanced long-only multi-asset portfolio, we use the MRI to determine the current risk environment. In order to keep risk constant, the discipline shifts away from equities in periods of high volatility and increases equities in periods of low volatility. The result is a higher Sharpe ratio over time as documented in previous FQ Perspective pieces.

### *Market Outlook*

Both traditional and quantitative investment management depend upon the smooth functioning of the market mechanism. Knowing that there is an approaching storm would allow investors to "go on alert" and make sure all of our risk controls are functioning properly and how an investment process would behave during the potential liquidity crunch that follows. Even if the storm blows over, it is always good to be prepared.

## A Final Word

While tools like the FQ Market Risk Index will help us going forward, it is important to point out that the FQ MRI is not return predictor, but a *market environment descriptor*. While empirically the high volatility environment has on average experienced negative excess returns, it also incorporates the largest positive and negative returns. The tails are fat on both the left and right sides of the distribution. Instead, using the MRI and volatility regimes recognizes a dynamic, not static, market environment that allows us to create better risk controls and forecasting models. Free markets are dynamic, evolving processes which is why they offer both risk and opportunity. Tools such as the Market Risk Index and volatility regimes allow us to better integrate this fact into our investment process.

## *References*

Darnell M., Peters E., Ye J. *Rethinking Beta*, FQ Perspectives (December 2008)

Goldwhite, P. *Diversification and Risk Management: What Volatility Tells Us,* FQ Perspectives (October 2008)

Mandelbrot, B. *The Variation of Certain Speculative Prices*, Journal of Business (1963), pp 384 - 419

Peters, E. *Fractal Structure in the Capital Markets,* Financial Analysts Journal (July/August 1988)

Peters, E. Chaos and Order in the Capital Markets, New York, Wiley (1991, 1996)

Peters, E. Fractal Market Analysis, New York, Wiley (1994)

Peters, E. *Balancing Betas: Essential Risk Diversification*, FQ Perspectives (February 2009)

Taleb, N. The Black Swan: The Impact of the Highly Improbable, New York, Random House (2007)

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