

*Testing Monte Carlo Risk Projections
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Introduction

Monte Carlo tools for financial planning have been around for some time now. The big question for most investors and their advisors seems to be determining how these tools add value. In a nutshell, Monte Carlo analysis allows investors and advisors to account for the impact of investment risk on a portfolio. We know that it is important to account for risk, so this makes sense, right? The problem of course is determining whether the projections about portfolio volatility (i.e. risk) into the future actually make sense. Where do these numbers come from? Is Monte Carlo any better than just using historical track record for portfolio volatility? The answers to the questions can only be addressed by benchmarking the volatility in performance of various assets and asset classes that come out of these models. How do you test such results?

Defining Mark-to-Market (this section partly excerpted from an earlier article)

The best way to test a portfolio model to determine whether its volatility projections make sense is to use the model to value options and compare the value of the options to where options are trading in the market. This is a standard technique for testing risk projections in professional circles, but is essentially unheard of among investors and the vast majority of advisors.

Options are financial instruments that give you the right to purchase or sell stock at a specific price (called the strike price). A *call option* gives you the right to purchase a share of a stock at a specified price (the strike price) until some future date. If you choose not to exercise the option, it expires worthless. For a more detailed explanation, see Investopedia:

<http://www.investopedia.com/university/options/option.asp>

The value of an option on a stock or fund with a specific strike price is determined by the assumed future volatility on the stock or fund and on the time until expiration. ***The same factors that drive a Monte Carlo portfolio model also provide the key inputs for valuing***

options. If the inputs to a Monte Carlo portfolio simulation model yield option values that are consistent with the values at which the options are trading in the market, you can have confidence that the projected future portfolio risk in the Monte Carlo model is consistent with the level of volatility implied by the prices of options.

Comparing options values driven by a Monte Carlo model to the level at which options are trading in the market is a standard tool in corporate portfolio risk management applications. This process is called *Marking to Market* or MTM. If you have options that are trading with expirations going out three years, these options values tell you what the market thinks future volatility will be. Many companies require that their portfolio simulation tools are consistent with current option quotes and the process of ensuring this is MTM. MTM testing is a standard practice in risk management. If your Monte Carlo model is projecting future market volatility that is dramatically out-of-line with the implied volatility in the options market, you may have a problem.

The idea of benchmarking a Monte Carlo model's projections by pricing options is predicated on the idea that the current price of options reflects the market's consensus view of future volatility—just as the current price of an equity represents the market's consensus estimate of the value of that stock. The only unknown in determining the price of options is volatility. The price of options represents the market's "consensus view" of future volatility in the underlying of a stock or fund.

Comparisons between options values in a Monte Carlo model (such as Quantext Portfolio Planner) and options values trading in the market can be performed for individual stocks, but for the vast majority of investors and advisors it will be sufficient to look at options on Exchange Traded Funds (or ETF's). In my testing, I focus on ETF's for broad market sectors to determine whether the Monte Carlo model's assessment of risk associated with the market as a whole and for individual sectors is close to the future volatility implied by the prices of options.

This paper examines the market projections for volatility (risk) generated using the Quantext Portfolio Planner (QPP). QPP is a Monte Carlo portfolio management tool. More information is available at <http://www.quantext.com>. We periodically perform MTM testing of QPP as a way to validate its results. Past articles are available on our website.

Analysis in August of 2006

Quantext Portfolio Planner (and its slightly more complex cousin QRP) has a set of standard inputs. The user specifies the amount of historical data that the program uses to calculate all of its parameters to run the Monte Carlo. I typically use the trailing three years of complete calendar months. For this analysis, I use the three years through the end of July 2006. The user can change the assumption for the long-term average and standard deviation of returns for the S&P500, but I have used all default values here. With these standard assumptions, QPP will generate Monte Carlo parameters and price options on portfolio components. The QPP results have been compared to market quotes on where options are currently trading—see, for example Yahoo! Finance options for SPY:

<http://finance.yahoo.com/q/op?s=SPY>

All options have expiration dates—the date by which you must decide to exercise or not. Options with long time periods until expiration reflect the market's view of longer-term market volatility and vice versa. For portfolio planning purposes, we are most interested in long-dated options—options that expires years into the future.

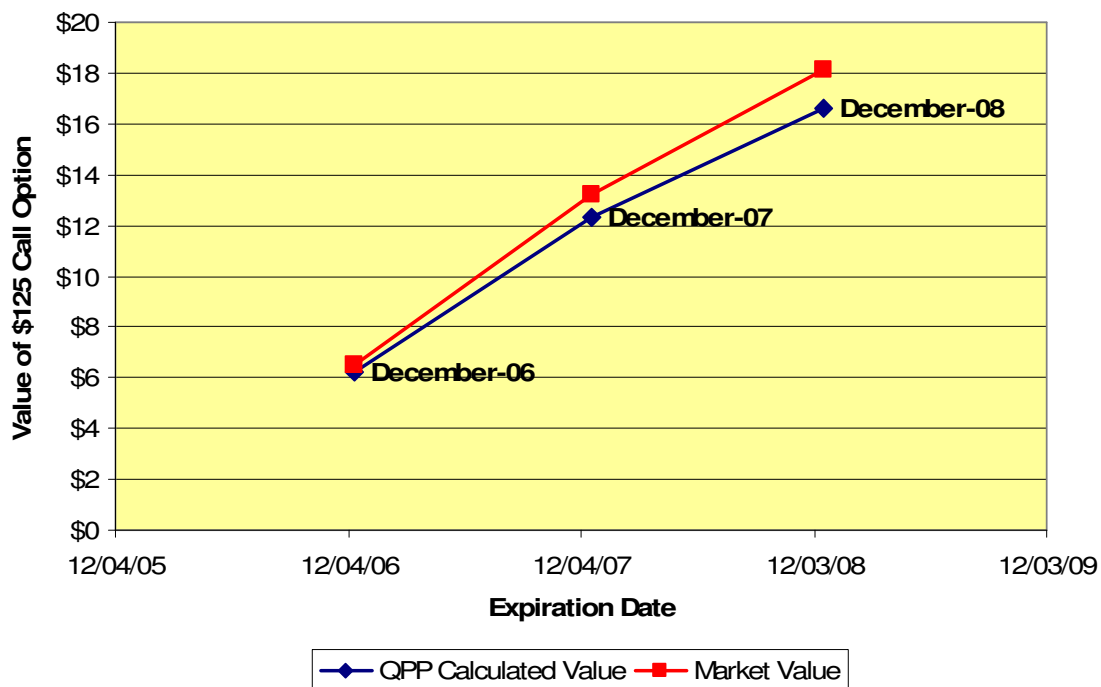
The starting point in benchmarking is always to look at options on the S&P500 using SPY. Using all default parameters in QPP, we simply run the model with the trailing three years of data and then look at the options with a strike price close to where the underlying is trading. I also use a value of 4.5% for the risk-free rate. As of this morning, SPY was trading at \$126.97 and so we looked at options trading with a strike

price of \$125. There are options trading on SPY out through 2008, so I chose to look at options with three expiration dates: December 06, December 07, and December 08. Options for a given month expire on a specific day of the month and these are listed on the exchange. Dec 06 options on SPY will expire on December 15, for example. The pricing of options is a standard tool in QPP and it is easy to enter the expirations and strike prices, etc:

Options for: SPY			Recent Share Price: \$126.96
Strike Price	Shares	Expiration	Current Expected Value Per Share
\$125.00	1	12/15/06	\$6.24
\$125.00	1	12/21/07	\$12.33
\$125.00	1	12/19/08	\$16.59

QPP output for call options

Call options give you the right to purchase the underlying (a share of SPY) for the strike price. If you want to buy the Dec 06 call option with a strike price of \$125, QPP estimates that the fair value of that option is \$6.24. The longer the time until expiration, the higher the odds that SPY will go well above (or below) its current level, so the prices of options increase with longer expiration dates. When we compare these options values to the values at which these options are trading, we obtain the following:



QPP calculated call option values vs. market quotes for SPY

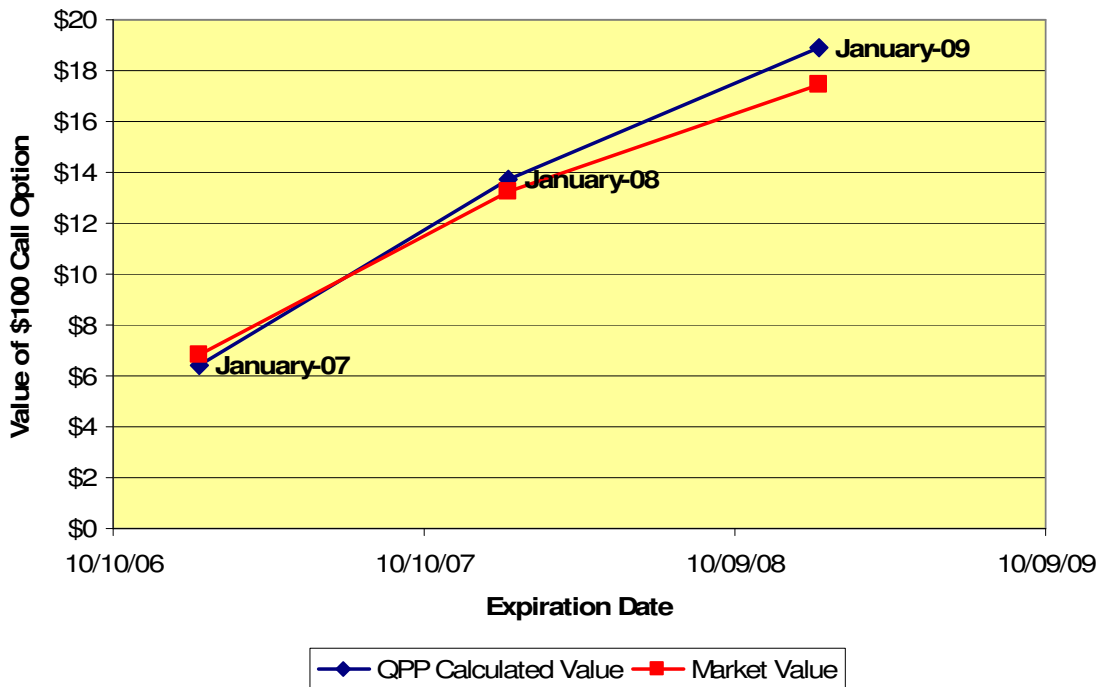
There is a high degree of agreement between the prices of call options in the market and priced in QPP. Even the options that expire out in December of 2008 differ in price by only 9% between QPP and the market. What these results show is that the volatility for SPY that QPP uses in running its Monte Carlo analysis is consistent with the option market’s “consensus opinion” on volatility out to the end of 2008.

In truth, the very close agreement seen here is not necessary. What is important is that the options values between the Monte Carlo tool and the market are generally consistent. We do not believe that the options market is necessarily a great forecast of future market volatility—just that it is a reasonable baseline around which to plan. What is especially important to note here is that the volatility assumed for the future of the S&P500 in QPP and mirrored in the options prices is about twice the level that we have seen over the past three years. The level implied by the options market and reflected in QPP is for annual standard deviation in returns of 15.07% per year—very close to the long-term average of the S&P500, but far above the 7-8% range of the past several years. See, for example:

<http://finance.yahoo.com/q/rk?s=VFINX>

Having benchmarked the value for SPY, I decided to look at the projected future volatility of emerging markets as reflected in EEM. EEM has a high Beta relative to the S&P500 and is also roughly twice as volatile as the S&P500. There are options on EEM that expire in January 2007, January 2008, and January 2009. EEM was trading at \$95.79 at the time of this writing. I chose the call options with a \$100 strike price for this analysis. The prices of the \$100 call options on EEM in the market match the prices generated by QPP quite closely (below).

As with SPY, it is notable that the volatility generated by QPP (and implied in the options markets) for EEM is far above what we have seen over the past several years—about 1.5 time as high.



QPP calculated call option values vs. market quotes for EEM

Discussion

If investors and their advisors are going to have confidence in Monte Carlo portfolio models, some standard testing is required. The value proposition of Monte Carlo simulation is to provide investors with an understanding the potential impacts of volatility on their portfolios. In the cases that we have shown here, there is good agreement between the prices at which options are trading in the market and QPP-generated options values, using default inputs. The agreement in option valuation means that QPP is generating volatility in SPY and EEM (i.e. for domestic and emerging markets) that is consistent with the volatility in these markets that is reflected in the options market. These results are an important benchmark test to demonstrate that QPP is generating reasonable volatility outlooks. I have looked for any form of Mark-to-Market validations to support other commercially available Monte Carlo portfolio planning tools, but I have not found any such validations, or even discussion of the issue of validating the volatility levels generated by a Monte Carlo model. My impression is that many of these models simply use some ad hoc historical data rather than actually generating an outlook for future volatility. The future does not, however, repeat the recent past and investors who are planning using data over recent years have good potential for nasty surprises.

The volatilities generated by QPP for SPY and EEM are considerably higher than we have seen in these markets over the last several years. If investors are under-estimating their potential losses in emerging markets because they are looking at recent years (which I believe many are), portfolios with substantial emerging markets positions will probably end up being a great deal more volatile than their holders expect. This situation is not new—we wrote about this issue back in early May, before the correction in emerging markets. The same issue holds—but to a lesser extent—for the S&P500. We have been experiencing a very low volatility market over recent years. All signs point towards a higher volatility environment in the future—if only due to reversion to the long term mean.

For a free extended trial of Quantext Portfolio Planner and a range of articles on portfolio planning, please visit <http://www.quantext.com/gpage3.html>