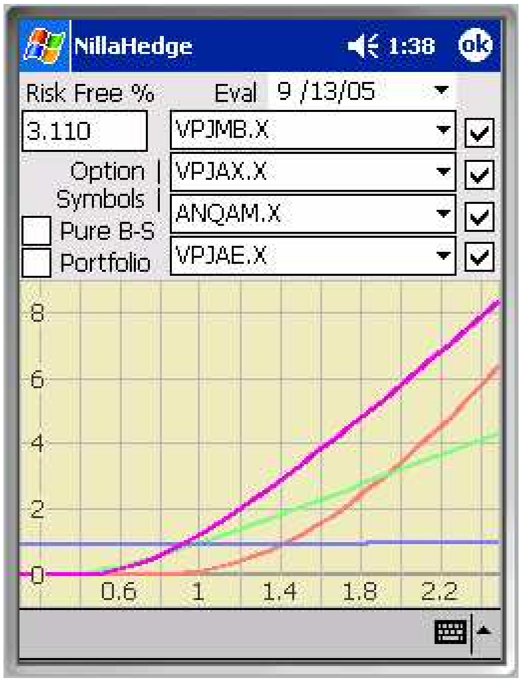
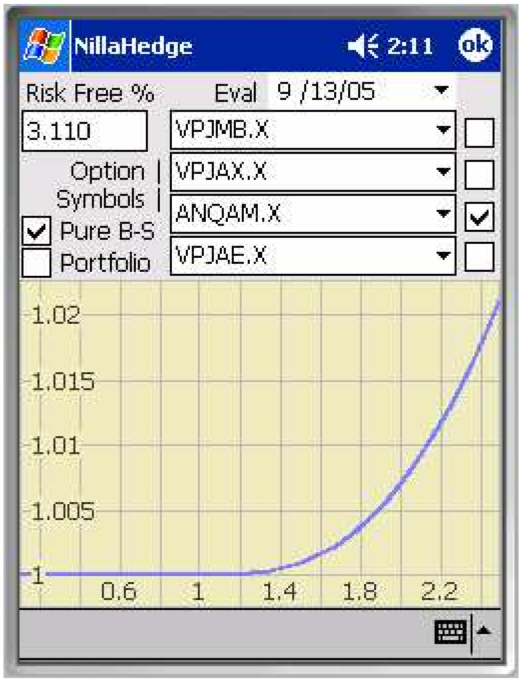
Volatility-Value Explorer



The Volatility-Value Explorer provides a graphical view of the relative sensitivity of options to their underlying stock's volatility. Up to four options can be compared simultaneously. The Volatility-Value Explorer has two modes of operation (really just ways to scale the Y-values), pure Black-Scholes and market price relative. In Pure Black-Scholes mode, the option's current market price is ignored - only the risk free rate and the underlying stock's price and volatility influence the plots. When the Pure B-S check box is unchecked, the option's last known market price becomes the reference against which imputed option prices are scaled.

The Plot

The first thing to remember about volatility-value plots is that both axes depict *ratios*, not volatilities, option value, or percentages thereof. The horizontal axis depicts the ratio of experimental volatility to the current volatility for the option's underlying stock, so $x = 1$ represents the currently stored volatility for the underlying stock. The vertical axis similarly depicts the ratio of the imputed Black-Scholes value to the option's last known market price or its Black-Scholes value (depending on the state of the Pure B-S checkbox), so $y = 1$ represents the option's relative value at a given relative volatility.

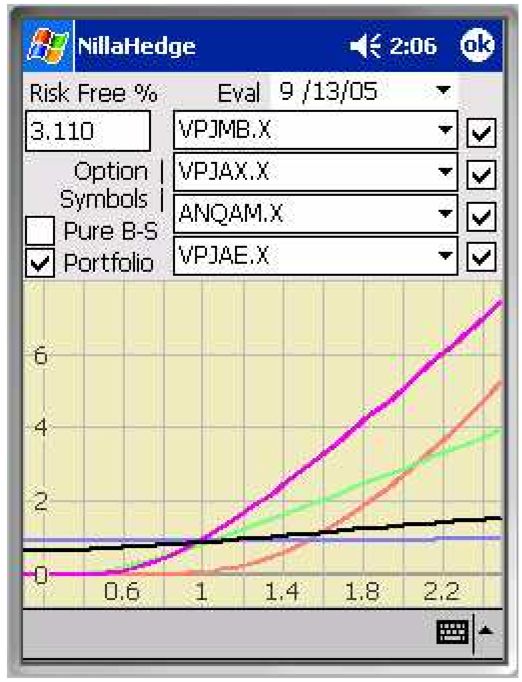


The colors assigned to option symbols are red, green, blue, and purple ordered from topmost symbol to bottom (e.g. VPJMB.X – red, VPJAX.X – green, etc.). When option positions exist in the database, the Portfolio checkbox will be enabled. When checked, a black line depicts the volatility-value curve for the current option portfolio with each option's contribution weighted by the cost of the associated positions (refer to the screenshot below).

Plot Enabling Checkboxes

The checkboxes on the right side of the dialog enable/disable plotting the volatility-value for the option symbol immediately to its left. When options produce very high value-volatility ratios while others are less responsive, it can be difficult to assess the behavior of the low ratio options. In that case, you can disable (uncheck) the high ratio options, triggering the plot to re-scale to accommodate the remaining curves, thus providing more insight into the low ratio options' behavior. Compare the first Volatility-Value Explorer plot with the one at right.

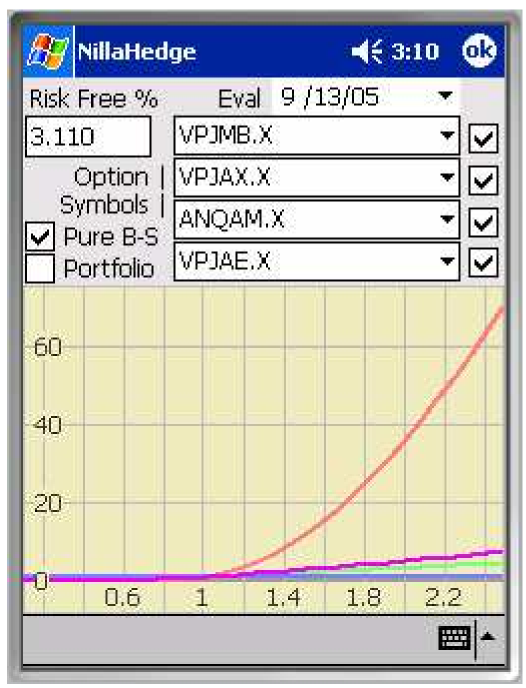
Pure Black-Scholes mode



When Pure B-S is checked, the plot represents the imputed option value divided by the Black-Scholes value at the reference (underlying stock's stored) volatility, consequently the volatility-value curves all pass through $(x, y) = (1,1)$. In market price mode (Pure B-S is unchecked), the Y-values in the plot represent the imputed option values divided by the option's stored market price, so the volatility-value curve can pass above or below $(1,1)$.

All things being equal, a premium option, whose currently stored market price exceeds its Black-Scholes value at the currently stored volatility, will pass below $(1,1)$ as VPJMB.X (red) does in the screenshot at right. Conversely, a bargain option, whose Black-Scholes value at the currently stored volatility is greater than the option's currently stored market price will pass above $(1,1)$ as VPJAE.X (purple) does.

Portfolio



The Portfolio check box enables you to see how your entire option portfolio is positioned with respect to volatility risk relative to the currently stored volatility for the underlying stock. The Volatility-Value Explorer plots a curve which sums all option positions in your portfolio, each option's contribution to the volatility-value curve being weighted by the cost of the position relative to the total cost of the option positions in the portfolio. It's unchecked at right to better show the volatility-value curves for ANQAM.X and VPJAX.X.

Evaluation Date

The Evaluation Date picker defaults to the current date, but can be set earlier or later to review how current parameters would affect volatility-value in the past or future.

Risk Free Rate

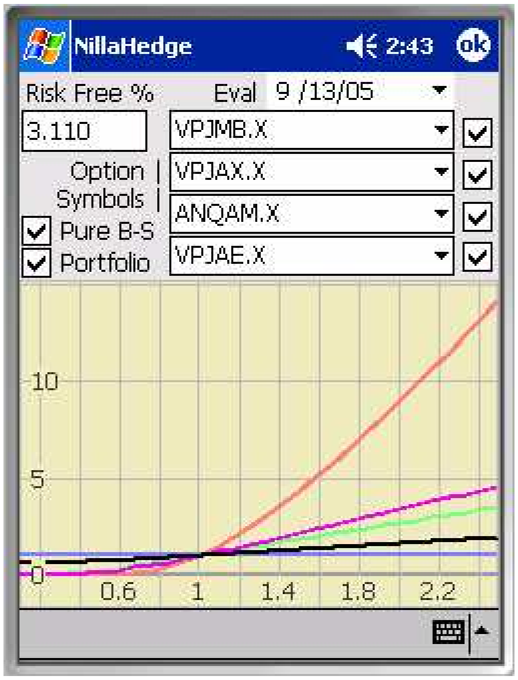
The Risk Free Rate edit box displays the currently stored value for the risk free rate. It's expressed as a percentage with a default value of 3%.

Volatility Risk

Volatility risk has been a key factor in the financial difficulties at Barings Bank and at Long Term Capital Management, so it's an issue of very real concern to professional portfolio managers. Accurately hedging against volatility risk is a complex topic beyond the scope of NillaHedge and this documentation, but the Volatility-Value Explorer does help you to quantify relative volatility risk, enabling you to make more informed choices.

The thing to remember about using the Volatility-Value Explorer is that is depicts what happens to option prices as a function of relatively heavy-handed modifications to the underlying stock's volatility. An assumption in analyses of this sort is that the reference volatility is 'reasonable,' but it becomes a critical assumption when attempting to assess relative volatility risk between options not drawn on the same underlying stock.

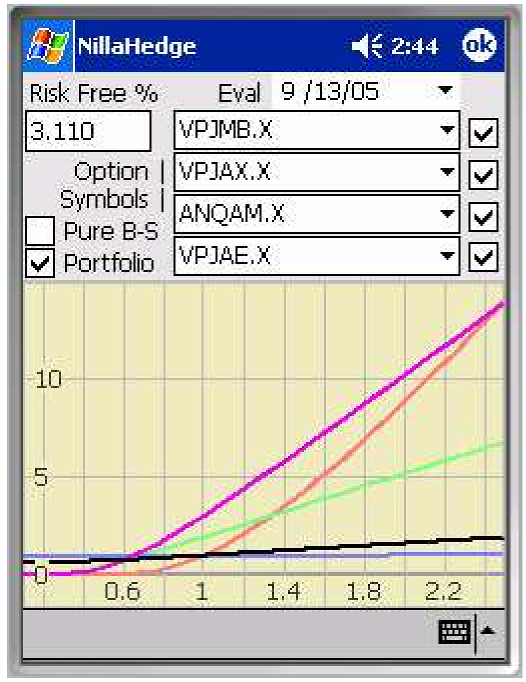
The Volatility Smile



If you are not already familiar with the volatility smile, it is a curve that results from plotting implied volatilities against strike price, with implied volatility increasing as the strike distances itself from the underlying stock price. In fact, the smile is really a surface. If you examine implied volatility versus time to maturity, you will note a similar effect. Part of the reason for non-constant implied volatility is that Black-Scholes theory assumes that stock returns are lognormally distributed, which means that the natural logarithm of stock returns is normally distributed. The lognormal assumption is attractive because it's close to reality and analytically tractable, but historical returns show that the actual distribution has somewhat fatter tails and a higher peak at the mean.

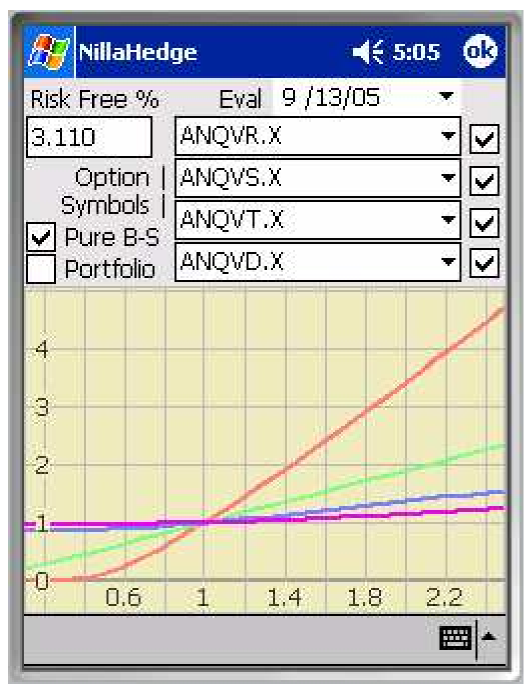
So, volatility risk intuition is potentially clouded by the volatility smile and our imperfect understanding of how to compare apples and oranges, e.g. AMAT to INTC, etc. Both potential problems are ameliorated by scoping your comparisons to options in the same neighborhood with respect to expiration and moneyness (degree to which the underlying stock's price is into the option's profitable zone).

After using the Volatility-Value Explorer for a few minutes, you'll surely notice that low value, high implied volatility options are much more likely to produce high option price ratios for a given multiple of volatility than those with higher intrinsic value, as illustrated by VPJMB.X in the previous four screenshots. VPJMB.X is a Jan-07 Put with a $10 strike selling for $0.15 while its underlying stock (AMAT) has a market value of $17.97.



It's wise to review the volatilities assigned to stocks underlying any options of interest before comparing the volatility-value ratios of the associated options. Without venturing outside of the family of options on Applied Materials (AMAT), note that the second pair of plots in the Volatility-Value Explorer section used a reference volatility of 0.231 (nearly VPJAE.X's implied volatility), causing VPJMB.X (red) to appear to be selling at a high premium and producing vastly different volatility-value ratios in Pure B-S and market price modes. In the next pair of plots in this section, the reference volatility is the implied volatility for VPJMB.X ($\sigma = 0.3553$), so VPJMB.X now passes through $(1,1)$ in market price mode and behaves identically in both modes. Unfortunately, VPJAE.X (purple) now appears to be a bargain option, demonstrating a similar Jekyl-Hyde schizophrenia when switching between Pure B-S and market price modes because it feels mispriced. You may also note that VPJAX.X (implied $\sigma = 0.2479$), which previously passed near $(1,1)$ now appears to be a bargain option because the reference volatility is so much higher than its implied volatility.

Alternatively, in the plot below right, we have four puts all expiring in Oct05 with ANQVR.X (implied $\sigma = 0.236$) struck out-of-the-money at $17, ANQVS.X (implied $\sigma = 0.2572$) struck slightly in-the-money at $18, ANQVT (implied $\sigma = 0.275$) struck at $19, and ANQVD.X (implied $\sigma = 0.088$) struck at $20, while AMAT has a market value of $17.83. Certainly, we've come to expect that out-of-the-money options exhibit higher volatility sensitivity, but since I mentioned them, the question you might really want to ask is "What's up with ANQVD.X's implied volatility?" The first thing of note is its extremely low *vega* = 0.0011, while its temporal brethren have *vega*s on the interval [1.78 .. 2.29), but perhaps more to the point, its *delta* = -1.0 and consequently its probability of closing in-the-money is 100%, meaning that other factor sensitivities,



including volatility, are not particularly influential at the current stock price.

One conclusion you might draw from the foregoing discussion is that you should always have a good understanding of what you're looking at in the Volatility-Value Explorer, but I hope the walk away benefit will be your recognition of the degree to which volatility can drive option value, so you won't enter positions without assessing the risks and grappling with the model parameters beforehand.

Compensating Volatilities

One technique that partially compensates for inaccuracies introduced by the lognormal assumption is to use an Exponentially Weighted Moving Average (EWMA) to compute the underlying stock trend and volatility. J.P. Morgan's RiskMetrics group produces well regarded Value-at-Risk assessments using lognormal models in conjunction with EWMA volatilities. In Risk Management, A Practical Guide,[1] Alan Laubsch recommends using decay factor $\lambda = 0.94$. Using that decay factor, 75 trading days (105 calendar days) capture 99% of an exponentially weighted average, so the usual recommendation is to collect 80 trading days (112 calendar days) of stock returns. On-line sources leave something to be desired in this realm, but Carol Alexander's (2001) Market Models provides very accessible coverage of volatility, exponentially weighted moving averages, and other models used in portfolio management, without sacrificing any details. Given a set of daily returns, the volatility at time *t* (σ_t) is given by: $\sigma_t = \sqrt{(1-\lambda)\sum_{j=1}^{\infty}\lambda^{j-1}r_{t-j}^2}$, where r_{t-j} are the daily returns. Nobody has an infinite supply of daily returns, but with $\lambda = 0.94$, the influence of four month and older stock returns have negligible influence on the value of the sum anyway. After establishing a starting point EWMA estimate of the historical volatility, you can adopt a recursive model, e.g. $\hat{\sigma}_t = \sqrt{(1-\lambda)r_{t-1}^2 + \lambda\hat{\sigma}_{t-1}^2}$. Such EWMA volatilities partially compensate for the mismatch between actual stock returns and lognormal models, and the testimonial is how extensively RiskMetrics' approach is used by banks to model their portfolio risk and compute reserve requirements. If you plan to use a volatility that differs markedly from the RiskMetrics' model discussed here, you should know why.

[1] http://www.wu-wien.ac.at/banking/sbwl/lvs_ss/vk4/rmguide.pdf