The Greeks — Vega

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Outline:

- Explanation of the greeks.
- Using greeks for short term prediction.
- How to find vega.
- Factors influencing vega.

Outline continued:

- Using greeks to shield your portfolio
- Vega neutral
- Making both delta and vega neutral
- Volatility over time.

What are the Greeks

What are the greeks and why be concerned with them?

Two reasons:

- the direction in which an option trade is about to head is predicted by the greeks (given a change in the market);
- greeks show how to protect your position against adverse movements in critical market variables.

Black–Scholes Price Factors

The price C of an option (or combination of options) depends on:

BS Factor	Corresponding Greek	Mathematically
share price, S	delta Δ	$\Delta C/\Delta S$
time to expiry, T	theta Θ	$\Delta C/\Delta T$
volatility, σ	vega ν	$\Delta C/\Delta \sigma$
risk-free rate, r	rho ρ	$\Delta C/\Delta r$
strike price, X	no greek, fixed	

This table pairs up each primary greek with the factor it controls. As you can see, delta relates to the price of the

underlying, vega relates to the volatility of the underlying and so on. But what is the relationship?

In fact, delta is a number that tells in what direction and to what extent the option price will move if there is a positive unit change in the stock price, in the stock price *only*.

Similarly, vega is a number that tells in what direction and to what extent the option price will move if there is a positive 1% change in the volatility, and only in the volatility.

Vega Example

For example, consider a 3-month call option with strike price \$50 on a stock currently at \$50. Assume the current volatility is 40%. The option costs \$4.21 and its vega is 0.10.

Since vega is positive, the option price will go up if the volatility goes up; and it will go up by 10 cents for every one percent gain in volatility. (At least for awhile.)

Conversely, the option price will retreat by 10 cents for every one percent loss in volatility.

In fact in this example, with the volatility at 41%, the option price is indeed \$4.31.

In this same example, if volatility goes up to 50%, the option price goes to \$5.19 (not quite \$1, vega is now at 0.098).

Miscellaneous Facts about Vega

Vega is always positive, and, moreover, is the same value for puts as for calls; thus option prices always increase as the volatility does.

Of course, the vega of a short position is negative.

Vega for a portfolio is the sum of the vegas of its constituents.

Vega is important to consider for straddles and calendar spreads.

Black-Scholes Formula for Vega

$$\nu = S\sqrt{\frac{T}{2\pi}}e^{-\left(\log(S/X)+(r+\sigma^2/2)T\right)^2/(2\sigma^2 T)}$$

or, in the Black-Scholes d_1 notation,

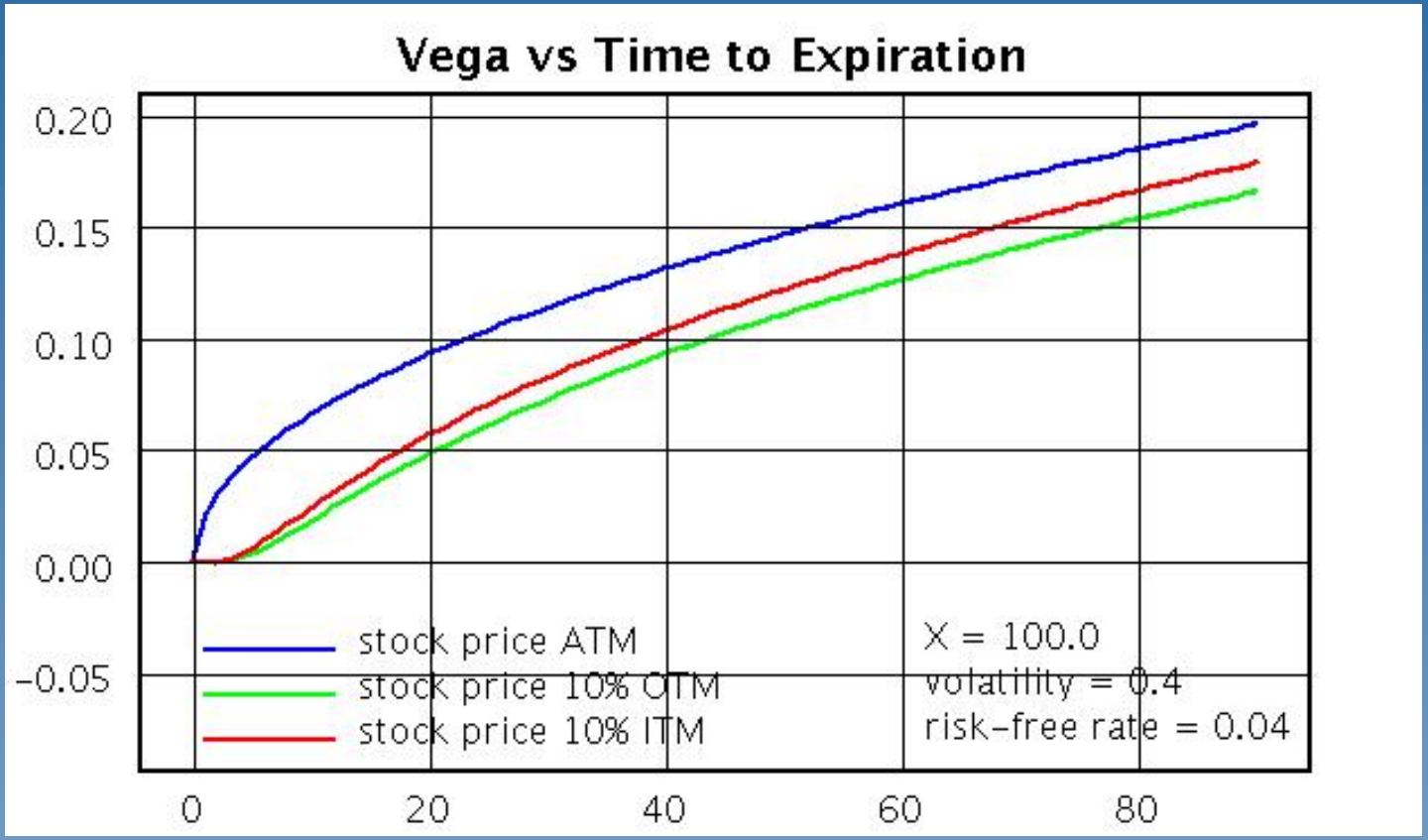
$$\nu = S\sqrt{T}\phi(d_1), \quad \phi() \text{ is the normal density}$$

Factors Influencing Vega

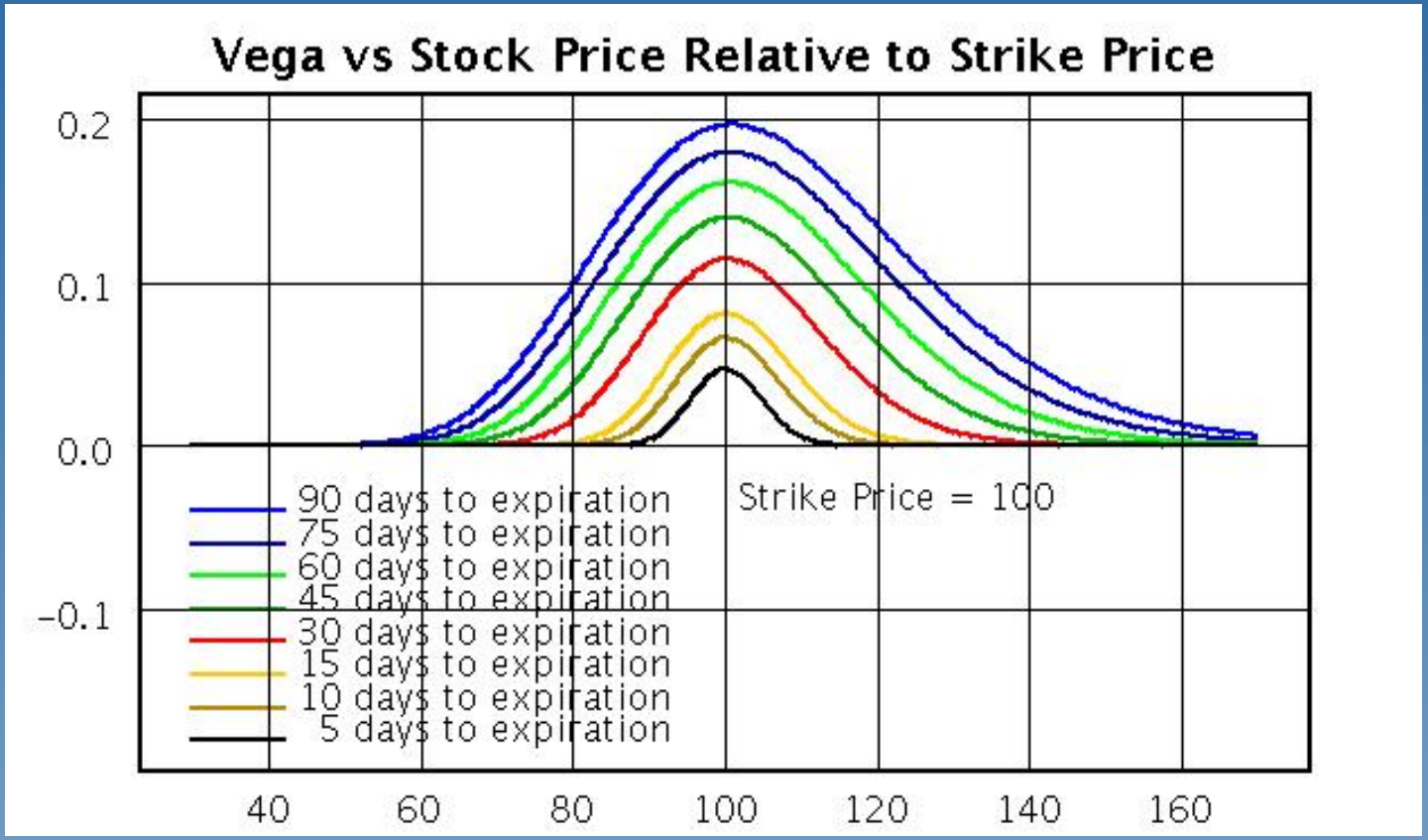
As vega becomes smaller, volatility has less effect on the option price. In the example, if vega were 0.05 instead of 0.10, then the option price will increase only half as much.

The size of vega itself mainly depends on the relative value between the stock price and the strike price and on the time to expiry of the option. In the following figure we show the dependence of vega on time to expiry.

Vega changes with Time to Expiry



Vega changes with Stock Price

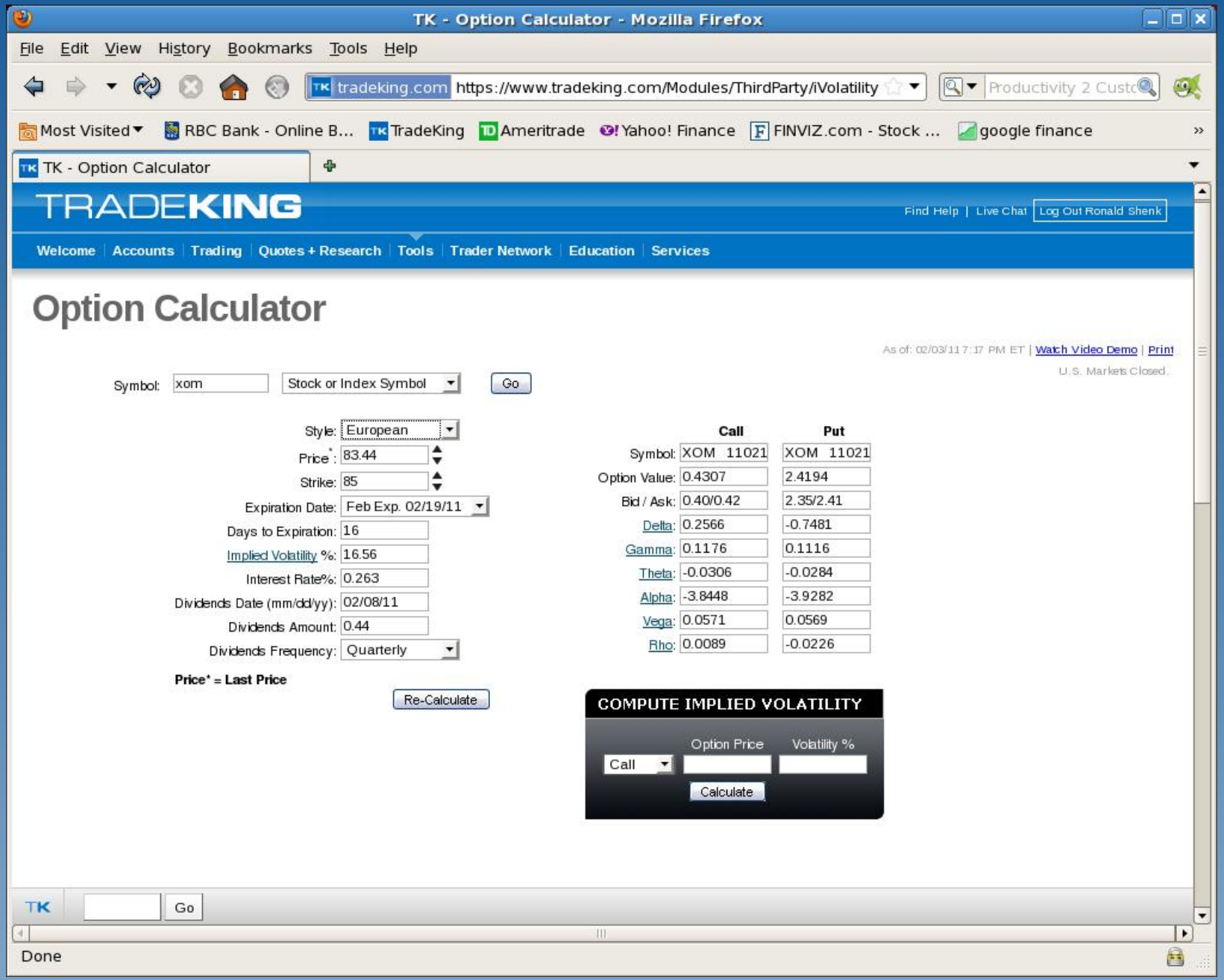


How to find Vega

To figure vega for your portfolio, find vega for all the components and add them up for your long positions and subtract for your short ones, Weight each according to its number of contracts.

To find vega for each component, consult your broker's web page. On the next slide I show TradeKing's.

I could find no non-login web site calculating vega given an option contract, but there are several that calculate the greeks provided you enter all the relevant information. E.g. http://www.option-price.com.


TK - Option Calculator - Mozilla Firefox
File Edit View History Bookmarks Tools Help
tradeking.com https://www.tradeking.com/Modules/ThirdParty/iVolatility
Most Visited RBC Bank - Online B... TradeKing Ameritrade Yahoo! Finance FINVIZ.com - Stock ... google finance
TK - Option Calculator
TRADEKING
Find Help | Live Chat | Log Out Ronald Shenk
Welcome | Accounts | Trading | Quotes + Research | Tools | Trader Network | Education | Services
Option Calculator
As of: 02/03/11 7:17 PM ET | Watch Video Demo | Print
U.S. Markets Closed.
Symbol: xom Stock or Index Symbol Go
Style: European
Price*: 83.44
Strike: 85
Expiration Date: Feb Exp. 02/19/11
Days to Expiration: 16
Implied Volatility %: 16.56
Interest Rate%: 0.263
Dividends Date (mm/dd/yy): 02/08/11
Dividends Amount: 0.44
Dividends Frequency: Quarterly
Price* = Last Price
Re-Calculate
Call Put
Symbol: XOM 11021 XOM 11021
Option Value: 0.4307 2.4194
Bid / Ask: 0.40/0.42 2.35/2.41
Delta: 0.2566 -0.7481
Gamma: 0.1176 0.1116
Theta: -0.0306 -0.0284
Alpha: -3.8448 -3.9282
Vega: 0.0571 0.0569
Rho: 0.0089 -0.0226
COMPUTE IMPLIED VOLATILITY
Option Price
Volatility %
Call
Calculate
TK Go
Done

The Greeks as a Shield

The most famous use of a greek to protect your position from market movements is *delta hedging*. By making your portfolio delta neutral you are protected to a degree from modest price movements.

Similarly if you want to protect yourself from modest volatility movements you make your position vega neutral.

But the vega of a stock is 0 so one cannot achieve vega neutrality by shorting stock. It is necessary to short some

other option to achieve it.

Suppose your current portfolio has a vega of ν_0 and you are willing to take a negative position in another derivative whose per unit vega ν_A. Shorting w units of the addition makes the combined portfolio vega neutral if

$$w = \frac{\nu_0}{\nu_A}.$$

Delta and Vega Neutral

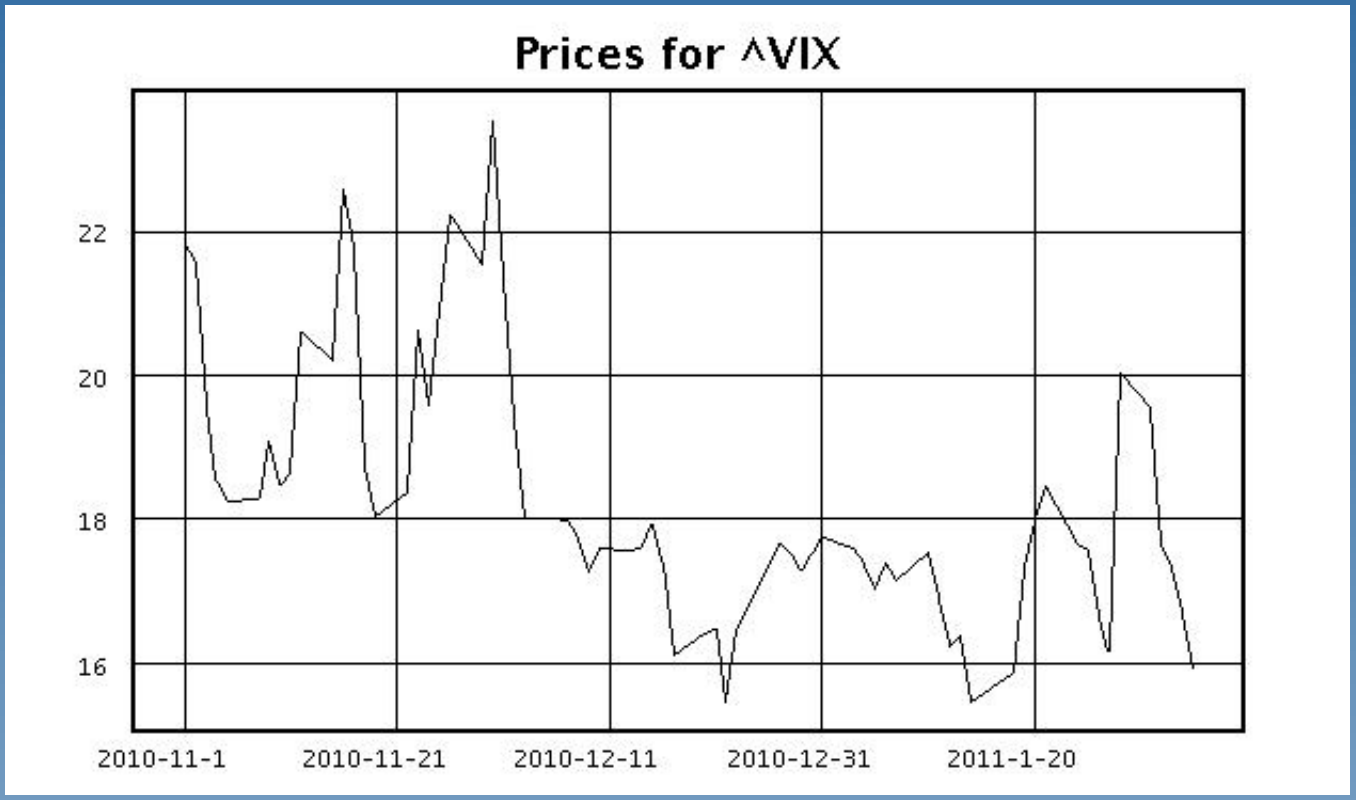
Suppose our original portfolio has a delta of 0 and a vega of $\nu_0 \neq 0$. We add to the portfolio by shorting w units an option with vega equal to ν_A. But now our new portfolio is no longer delta neutral, instead it has a delta of

$$-w\Delta_A$$

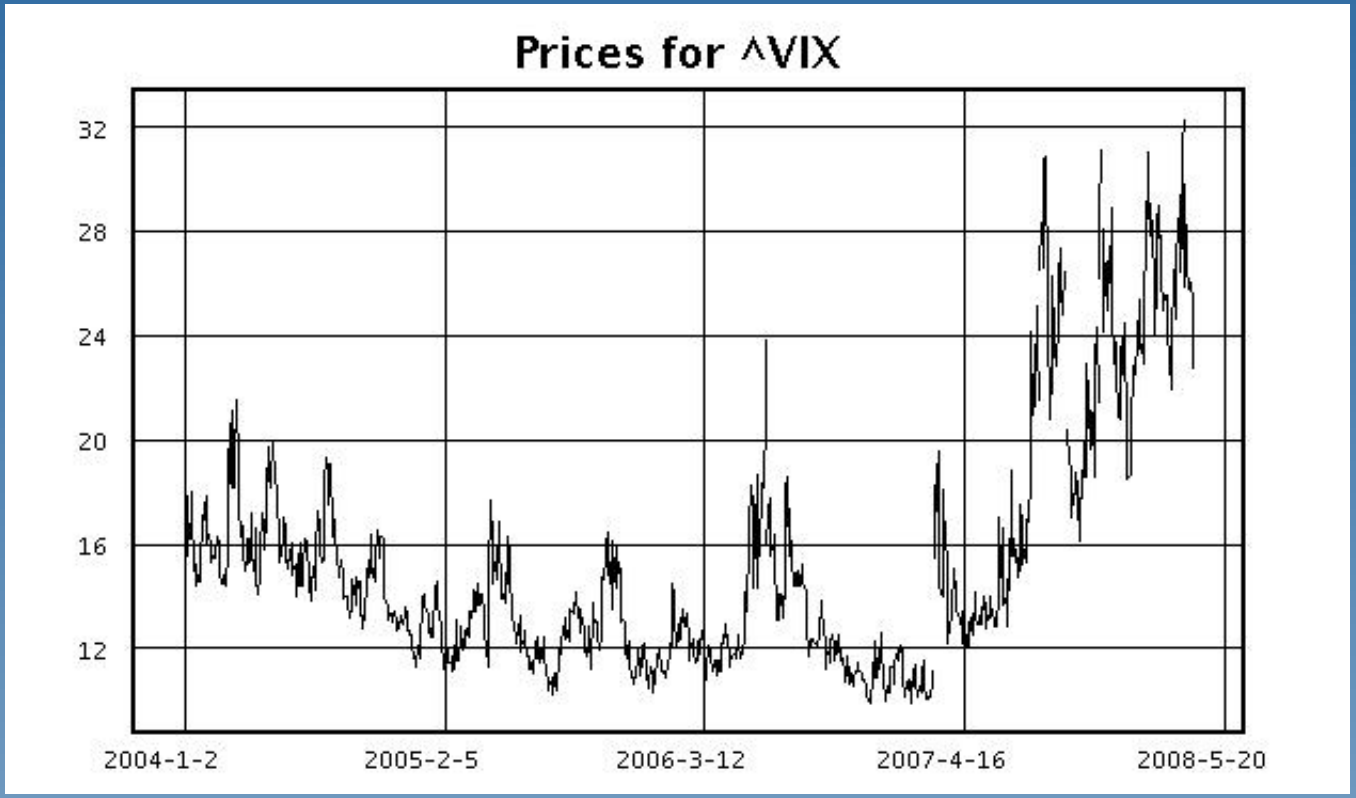
where Δ_A is the delta of added option (could be negative). We must therefore buy $w\Delta_A$ shares of A (sell if Δ_A is negative) to make the new portfolio both delta and vega neutral.

Volatility Over Time

Does volatility really change much from day to day?



From year to year?



Can VIX (volatility trends) foretell of pending trouble?