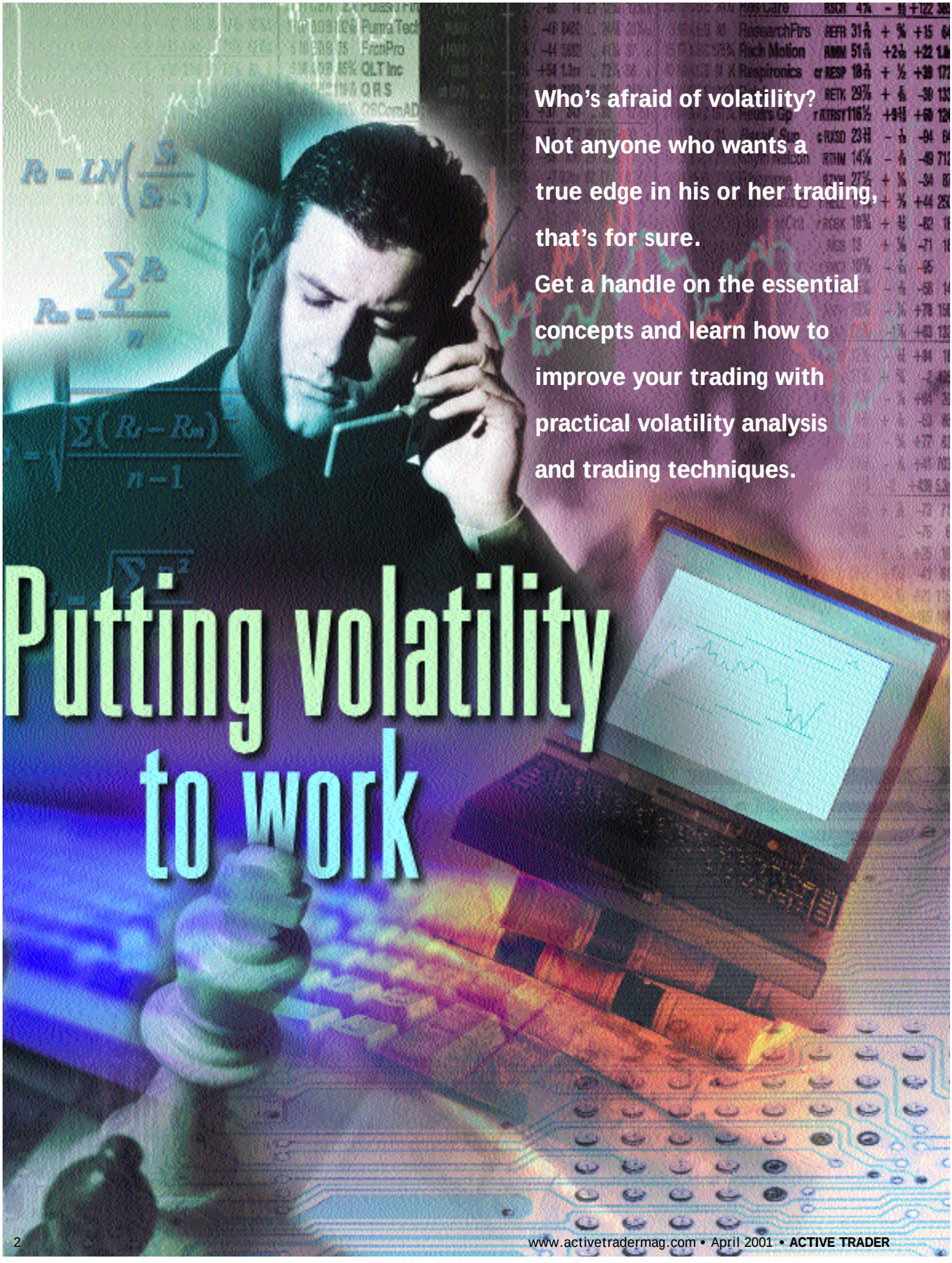

Putting volatility to work

Who's afraid of volatility? Not anyone who wants a true edge in his or her trading, that's for sure. Get a handle on the essential concepts and learn how to improve your trading with practical volatility analysis and trading techniques.

BY RAVI KANT JAIN

Volatility is both the boon and bane of all traders — you can't live with it and you can't really trade without it.

Most of us have an idea of what volatility is. We usually think of "choppy" markets and wide price swings when the topic of volatility arises. These basic concepts are accurate, but they also lack nuance.

Volatility is simply a measure of the degree of price movement in a stock, futures contract or any other market. What's necessary for traders is to be able to bridge the gap between the simple concepts mentioned above and the sometimes confusing mathematics often used to define and describe volatility.

But by understanding certain volatility measures, any trader — options or otherwise — can learn to make practical use of volatility analysis and volatility-based strategies. We'll explore these volatility calculations and discuss how to use them.

Volatility defined

There are two main measures of volatility: *historical volatility* and *implied volatility*.

Historical volatility is the measure of a stock's price movement based on historical prices. It measures how active a stock price typically is over a certain period of time. Usually, historical volatility is measured by taking the daily (close-to-close) percentage price changes in a stock and calculating the average over a given time period. This average is then expressed as an annualized percentage. Historical volatility is often referred to as *actual volatility* or *realized volatility*.

Short-term or more active traders tend to use shorter time periods for measuring historical volatility, the most common being five-day, 10-day, 20-day and 30-day. Intermediate-term and long-term investors tend to use longer time periods, most commonly 60-day, 180-day and 360-day.

Historical volatility

There's some unavoidable math involved here, but understanding the concepts is the important thing, since you'll never have to calculate historical volatility by hand — any piece of analytical software will do it for you.

To calculate historical volatility:

1. *Measure the day-to-day price changes in a market.* Calculate the natural log of the ratio (R_t) of a stock's price (S) from the current day (t) to the previous day (t-1):

$$R_t = LN\left(\frac{S_t}{S_{t-1}}\right)$$

The result corresponds closely to the percentage price change of the stock.

2. *Calculate the average day-to-day changes over a certain period.* Add together all the changes for a given period (n) and calculate an average for them (R_m):

$$R_m = \frac{\sum R_t}{n}$$

3. *Find out how far prices vary from the average calculated in Step 2.* The historical volatility (HV) is the "average variance" from the mean (the "standard deviation"), and is estimated as:

$$HV = \sqrt{\frac{\sum (R_t - R_m)^2}{n-1}}$$

4. *Express volatility as an annual percentage.* To annualize the historical volatility, the above result is multiplied by the square root of 252 (the average number of trading days in a year). For example, if you calculated the 10-day historical volatility using Steps 1-4 and the result was 20 percent, this would mean that if the volatility present in the market over that 10-day period holds constant for the next year, the market could be expected to vary 20 percent from it current price.

Sometimes historical volatility is estimated by "ditching the mean" and using the following formula:

$$HV = \sqrt{\frac{\sum R_t^2}{n}}$$

The latter formula for historical volatility is statistically called a *non-centered* approach. Traders commonly use it because it is closer to what would actually affect their profits and losses. It also performs better when n is small or when there is a strong trend in the stock in question.

In other words, historical volatility measures how far price swings over a given period tend to stray from a mean or average value. Table 1 (p. xx) illustrates how the 10-day historical volatility is calculated (using both methods above) for America Online (AOL) prices from Dec. 9 to Dec. 23, 1999. The resulting historical volatilities of approximately 52 and 54 percent sug-

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gest the stock will likely fluctuate this far from its current price if this level of volatility remains constant.

TABLE 1: HISTORICAL VOLATILITY

Date	Price	$R_t = L_n(S_t / S_{t-1})$	$(R_t)2$	$(R_t - R_m)2$
12/9/99	86.25			
12/10/99	91.5	.059088916	.0034915	.004193031
12/13/99	94	.02695581	.00072662	.001064098
12/14/99	88.8125	-.056767376	.00322254	.002611483
12/15/99	89.625	.009106893	.000082936	.0002182
12/16/99	86.125	-.03983457	.00158679	.00116758
12/17/99	85	-.013148473	.00017288	.0000560068
12/20/99	86.25	.014598799	.00021312	.00041061
12/21/99	85	-.014598799	.00021312	.0000798181
12/22/99	82.75	-.026827242	.0007197	.000447853
12/23/99	81.5	-.015220994	.00023168	.0000913227
	R_m=	-.005664704		
		Sum =	.01066089	.010340002
		10-day HV =	51.83%	53.81%

Implied volatility

Implied volatility is the current volatility of a stock, as estimated by its option price. An option's value consists of several components — the strike price, expiration date, the current stock price, dividends paid by the stock (if any), the implied volatility of the stock and interest rates. If you know the price of an option and all the above inputs, except volatility, then you can modify the option-pricing model to calculate the implied volatility. (For more basic information on options, see "Getting started in options," p. xx.)

Because there are many options on a stock, with different strike prices and expiration dates, each option can, and typically will, have a different implied volatility. Even within the same expiration, options with different strike prices will have different implied volatilities.

Generally, the implied volatilities of calls and puts show a distinct pattern, called the *skew of implied volatility*. Implied volatility tends to be higher for out-of-the-money (OTM) options compared to at-the-money (ATM) options. This is because OTM options present more risk on very large moves; to compensate for this risk, they tend to be priced higher. But equally OTM calls and puts do not necessarily have the same implied volatility, and this difference represents the bias or skew of the market. The skew can be caused by a strong directional bias in the stock or the market, or by very large demand for either calls or puts, which pushes implied volatility higher.

To use implied volatility in volatility analysis, it is necessary to calculate a representative implied volatility for a stock. This is merely an average of the implied volatilities of the different options on that stock. However, there is no accepted standard for which representative implied volatility to use. Many people simply use the average implied volatility of the at-the-money options for the next few expirations, while some take a more sophisticated approach by factoring in several at-the-money and out-of-the-money options. Figure 1 (opposite page) shows the relationship between 30-day historical volatility and implied volatility in IBM.

Implied volatility acts as a proxy for option value. It is the only parameter in option pricing that is not directly observable from the market, and cannot be "hedged" or offset with some other trading instrument. Because all other factors can be "locked in," the price of the option becomes entirely dependent on the implied volatility. This is an important fact to consider when looking for relative value in options; to compare the relative value of two options you need only look at their implied volatilities.

What implied volatility tells you

Implied volatility represents the market's expectation of a stock's future price moves. High implied volatility means the market expects the stock to continue to be volatile — i.e., make large moves, either in the same direction or up and down. Conversely, low implied volatility means the market believes the stock's price moves will be rather conservative. However, studying implied volatility reveals much more information.

Because implied volatility is a surrogate for option value, a change in implied volatility means there is a change in the option value. Many times, there will be significant changes in the implied volatility of the calls vs. the puts in a stock. This signals there may be a shift in the bias of the market, or that "something's going on."

For example, in late 1999, when Republic National Bank of New York (RNB) was acquired by HSBC USA, the implied volatility of RNB collapsed, pending closing of the deal. This was natural, as the price of the acquisition was fixed, so RNB's stock price was expected to be very stable.

However, one day after the deal was announced, implied volatility on out-of-the-money RNB puts jumped up significantly, accompanied by a rise in put volume. This suggested the market, or some large player, was getting nervous about something, or that there was a large rumor afloat. Two days later, news about a possible scandal that could have put the acquisition in jeopardy emerged and the stock dropped nearly 20 percent.

Besides the skew phenomenon, implied volatility provides

The best candidates for covered call writing are stocks with the biggest difference in implied vs. historical volatility.

significant insight on the market's current thinking. In early 2000, the implied volatility of the financial sector dropped quite rapidly — and in some cases significantly below historical volatility, even though stock prices for the sector had dropped quite a bit. This suggested the market was not worried and expected the sector to be stable in the future.

Usually, however, when a stock's price is dropping, it is typical to see implied volatility rise rapidly — signaling nervousness about the stock. Many times, breakouts from technical levels, accompanied by large implied volatility moves, signal the market thinks the breakout is significant and will lead to large moves in the stock. A breakout with little to no change in implied volatility may not be a convincing development. Thus, studying implied volatility patterns on a stock reveals much information regarding how the market views the stock.

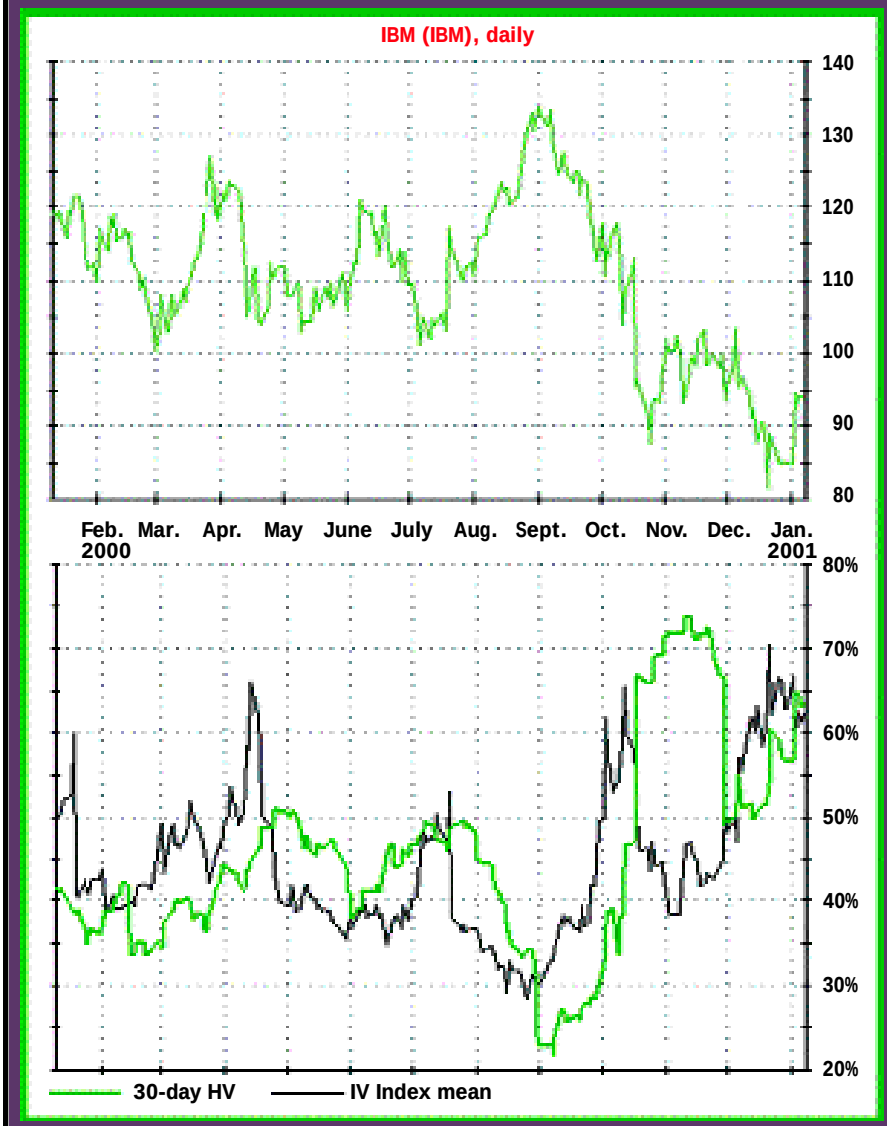
Historical vs. implied: The predictive ability of volatility

Because the implied volatility is the market's guess of future price volatility, it is interesting to see how accurate the market's predictive capabilities are.

We studied several stocks and ran regression analysis between their 30-day implied volatility and their historical volatility 30 days later. In other words, the implied volatility from Dec. 1 was compared with the actual historical volatility on Jan. 1, and so on. We also tested 30-day historical volatility against historical volatility 30 days later. The results are presented in Table 2.

FIGURE 1 IMPLIED VOLATILITY VS. HISTORICAL VOLATILITY

The 30-day historical volatility and implied volatility are juxtaposed on this daily chart of IBM



Source: iVolatility.com

TABLE 2: **PREDICTIVE ABILITY OF VOLATILITY**

The correlation between historical volatility (HV) and implied volatility (IV) in select stocks over roughly a 10-year period. The higher the number, the greater the correlation.

Stock symbol	HV vs. lagged IV	HV vs. lagged HV	Stock symbol	HV vs. lagged IV	HV vs. lagged HV
AMGN	0.31	0.14	JNPR	0.33	0.20
AOL	0.19	0.23	LU	0.11	0.16
C	0.06	-0.03	MSFT	0.38	0.12
CSCO	0.45	0.36	NDX	0.46	0.41
ERICY	0.15	-0.10	ORCL	0.27	0.24
GE	0.27	0.21	SPX	0.08	0.20
IBM	-0.15	-0.01	SUNW	0.45	0.28
INTC	0.33	0.08	WMT	0.22	0.29
JDSU	0.17	0.11			

The above values are based on data from May 1999 to December 2000

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FIGURE 2 **VOLATILITY SPREAD**

During this period, historical volatility remained (for the most part) higher than implied volatility, suggesting relatively low option volatility and proportionally lower option premiums

Source: iVolatility.com

The higher the correlation (with 1.00 being an exact correlation), the closer the prediction. As you can see, in most cases the implied volatility did not provide a very accurate prediction of the actual future historical volatility. The historical volatility itself also proved to be an unreliable predictor, suggesting that in the stock volatility business, history does not necessarily repeat itself.

Does this mean that the market is always wrong? No. It simply means it is very difficult to predict the future price volatility of a stock. However, it also means this difficulty leads to more trading opportunities and more market inefficiencies to trade against.

Volatility-based option strategies

Trading the difference in historical and implied volatility. Professional option traders, market makers and institutions trade volatility by running "delta-hedged" positions.

This means they buy or sell options and maintain a hedge against the option position in the underlying stock. This removes any net exposure to a small move in the stock. They continuously adjust this hedge as the market moves. Because the hedge is in the underlying stock, these traders effectively capture historical volatility on the hedges while capturing implied volatility on the option price. That is, if they sell options at a higher implied volatility than the historical volatility of their hedges, they make money. Similarly, if they buy options at a lower implied volatility than the historical volatility of the hedges, they make money.

Figure 2 (above) shows that delta-hedged volatility traders would have benefited from being long Coke (KO) in most of 2000 because the historical volatility stayed consistently higher than the implied volatility.

This strategy has a relatively low risk profile, but it involves a significant number of transactions. It also requires proper portfolio risk management systems. While this type of delta-hedging volatility trading is difficult to implement and not very appropriate for the individual investor or non-institutional trader, it illustrates how volatility analysis can be translated into a practical trading strategy.

This is not to say that volatility analysis is not an important part of the individual trader's arsenal. There are several strategies that can be greatly fine-tuned with proper volatility analysis.

Covered call writing. Covered call writing (i.e., taking a long stock position with a short out-of-the-money call) is a popular strategy. There are several services that provide covered call analysis, but none use any kind of volatility analysis. Covered call selection can be greatly improved with proper volatility analysis.

Covered calls give the best return if the stock ends up just higher than the strike price of the call. The first criteria for covered call selection should be choosing a stock you are mildly bullish on. If you are *very* bullish on a stock, and your view is correct, you will kick yourself for writing covered calls.

Next, you should look at the implied and historical volatility of the stock. It might seem that the higher the implied volatility, the better candidate the stock is for writing calls, but this is not always the case. If the historical volatility is very high, it implies the stock moves around a lot, and thus has a high probability of moving below the strike price. The best candidates for covered call writing are stocks with the biggest difference between implied and historical volatility.

Another thing to look at is the current implied volatility compared to the historical *range* of implied volatility. When implied volatilities are close to their historical highs, it may be a better time for writing covered calls.

If you are planning to exit such trades before expiration, you may want to look for stocks whose implied volatility tends to fall as the stock appreciates. In other words, as the call option you wrote becomes closer to being at-the-money, the volatility drops, giving you the chance to reverse the entire trade at a better profit. On the other hand, if you were long a stock whose implied volatility has risen, your profits will be negated by the higher premium you will have to pay for the option because of the volatility increase.

Referring again to Figure 1, notice that whenever IBM's stock price dropped, there was a spike in implied volatility. If, after a move down, you believed IBM would recover or stabilize, it would have been an ideal time to write covered calls.

Writing puts. Writing puts ("naked" puts) is another common strategy for those who are willing to be long the stock if it ends up below the put strike price. Many traders will sell puts

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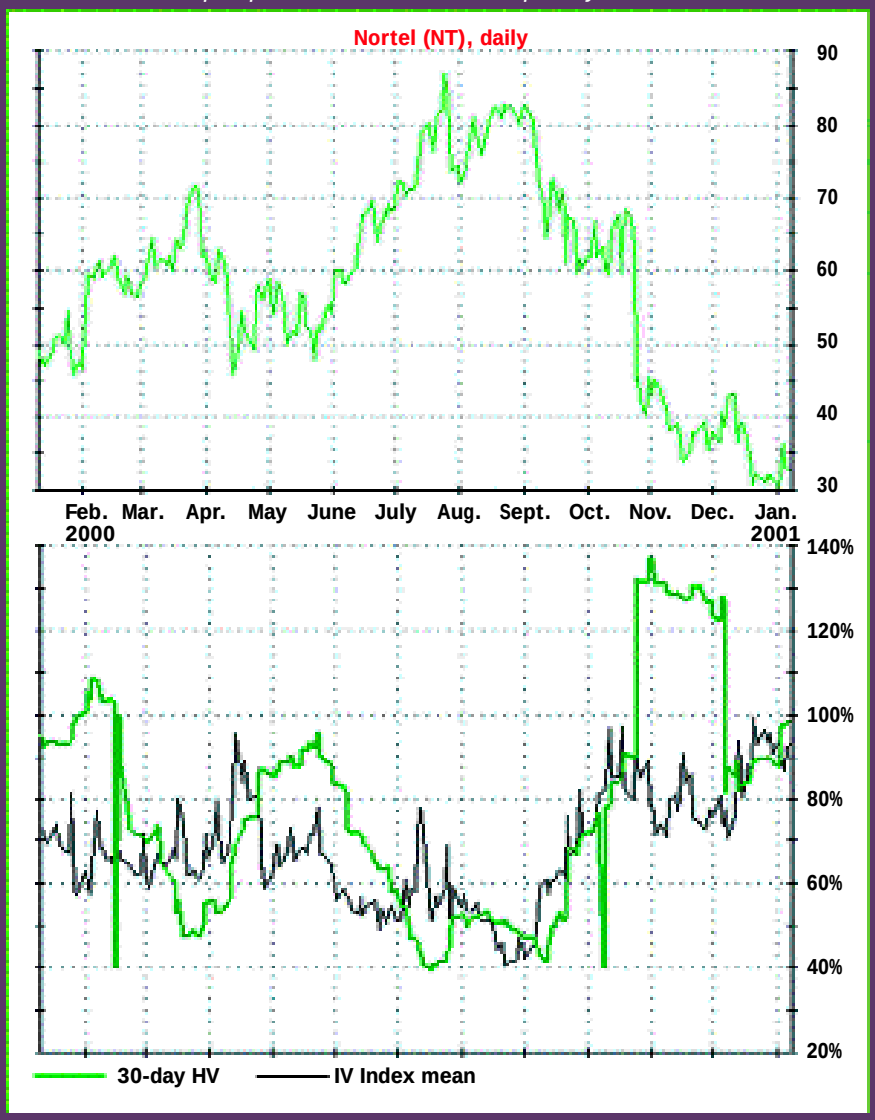
FIGURE 3 **COMBINING TECHNICAL SIGNALS AND VOLATILITY**

Although the market consolidated in October 2000 after falling from its highs, implied volatility made new highs that month, suggesting nervousness about the stock's prospects. The market subsequently tumbled to new lows.



Source: iVolatility.com

in lieu of buying the stock at a certain level.

Volatility analysis can help the decision-making process for this strategy. Stocks whose implied volatility tends to spike when the stock falls may not be good candidates for writing puts, because if you change your mind and want to exit the position, it could be very expensive. On the other hand, if a stock is dropping but implied volatility is not changing much, it may be a good candidate to write puts on, as the market is not suggesting nervousness about the stock.

Choosing call and put spreads. Call spreads (bull spreads) and put spreads (bear spreads) — simultaneously going long and short a put or call — are popular options strategies, as they offer a cheap way to take advantage of an anticipated price move in the stock. The problem many traders have found is that the returns are sometimes not so attractive when exiting the spread. This is typically because of the volatility effect.

For example, say you bought a 100/110 call spread (long the 100 call, short the 110) on a stock trading at 100. If the stock rises to 110 or above, you may wish to take profits on the spread. But at 110, your short option with the 110 strike price is at the money and, thus, has the maximum exposure to change in volatility. If the implied volatility for this stock has risen with the market move, then you will be buying back the 110 call at a higher volatility than when you put the spread on. This will eat into your profits on the spread. However, if the implied volatility has fallen, it will be in your favor.

When executing a call or put spread, you want to look for stocks whose implied volatility tends to fall as the stock moves up (for a call spread) or down (for a put spread). Looking again at Figure 1, it is clear that buying put spreads would not have been advisable, but buying call spreads would have been, as the implied volatility always seems to come off a bit when the stock rises.

Using volatility for non-options trading (straight stock positions)

One trap traders using volatility analysis tend to fall into is interpreting volatility itself as a directional indicator. High or low volatility by itself does not imply a certain direction or expected direction of the stock.

However, careful analysis of volatility patterns, combined with other indicators and stock movements, can lead to some interesting direction-based trading strategies. Different stocks behave differently, but in many cases, implied volatility tends to be a leading indicator of stock direction.

When a stock is falling, every trader is looking for an indication of whether the stock will continue in that direction or whether it will stabilize and present a possible buying opportunity. When a stock is declining and the implied volatility does not change (or falls), it suggests the market is not too nervous about the stock. On the other hand, if the implied volatility rises, it means the market continues to be nervous about the stock's downside potential.

This is shown in Figure 3 (above). In July 2000, although Nortel (NT) shot to new highs and broke technical levels, the implied volatility did not jump much, signaling lukewarm confidence in the move. But when the stock dropped off sharply in September, implied volatility made new highs, showing nervousness by the market. In October, even though the stock seemed to be trying to consolidate, the implied

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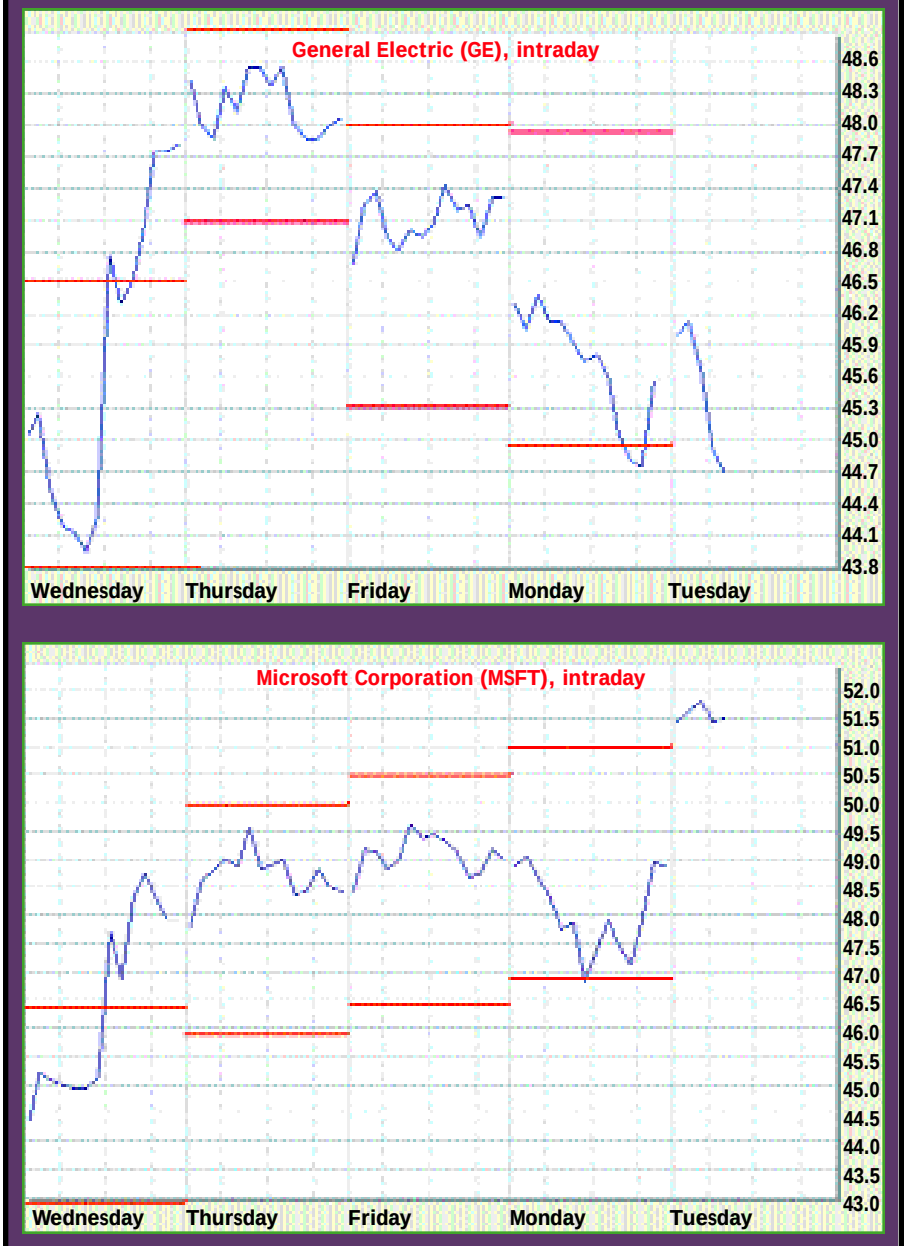
Option volume and volatility changes also can be important indicators. Sudden jumps in call or put volume, combined with jumps in implied volatility, signal extreme market activity and possible market bias.

FIGURE 4 **INTRADAY CONFIDENCE LEVELS**

Because volatility is a measure of how much price is likely to vary from an average value (its standard deviation), it can be used to determine likely trading ranges, or "confidence levels," such as the intraday levels shown here.



Source: PCQuote.com

volatility made new highs, suggesting a nervous market. Sure enough, the stock tanked in late October.

Option volume and volatility changes also can be important indicators. Sudden jumps in call or put volume, combined with jumps in implied volatility, signal extreme market activity and possible market bias — and possibly a directional indicator.

Combining implied volatility changes with technical analysis can be a powerful tool as well. It is not uncommon to see a rise in put volume and implied volatility as a stock is hitting technical levels on a rally. This can signal the market is worried about a downside correction and traders are buying puts as protection.

Using volatility for day-trading ranges

Volatility is an important tool for traders trying to calculate the expected daily trading range of a stock. Because the volatility of a stock is its standard deviation, a trader can statistically establish "confidence intervals" of the price moves. In statistics, a one standard deviation range means that there is a 67-percent likelihood the stock price will stay within the range (a 67-percent confidence interval). Similarly a 1.65 standard deviation range represents a 90-percent confidence interval.

The formula is:

$$S * M * V * \sqrt{(n/252)}$$

where

S = stock price
M = number of standard deviations
V = volatility
N= number of days

For example, if a stock is trading at $75 with a volatility of 50 percent, then for one day and one standard deviation, the expected range of the stock will be:

$$75*50 \text{ percent}*\sqrt{(1/252)} = 2.40$$

Accordingly, it's possible to build the following ranges:

Days	67-percent confidence	90-percent confidence
One	$72.60-$77.40	$71.04- $78.96
Two	$71.60-$78.40	$69.40- $80.60

Once the range is established, day traders can use them to pick daily entry and exit points, as well as stop-loss levels.

The volatility to use is an individual's choice. Some prefer to use short-term historical volatility while some use implied volatility. The stock price is usually the previous close, but it is not

uncommon to use the open price to calculate the daily range, especially when, as has been the case lately, many stocks open at a gap from the previous close.

The actual trading strategy is entirely up to the trader. But an example of one could be to enter a trade when the stock has moved beyond the 67-percent confidence range and take profit when it comes back in the range. Use the 90-percent range as stop-loss levels.

Figure 4 are intraday charts of General Electric (GE) and Microsoft (MSFT) showing the one-day expected trading band for the 67-percent confidence interval (the red lines are the upper and lower levels of the band). The charts are from Jan. 3 - Jan. 8, and were established using implied volatility and the open price.

Volatility plays a crucial role in every option, stock, futures and currency trader's life, whether they are aware of it or not. Understanding how volatility behaves and its relation to the market will give you an advantage you cannot get from simply analyzing price.

For additional volatility research, see www.ivolatility.com.