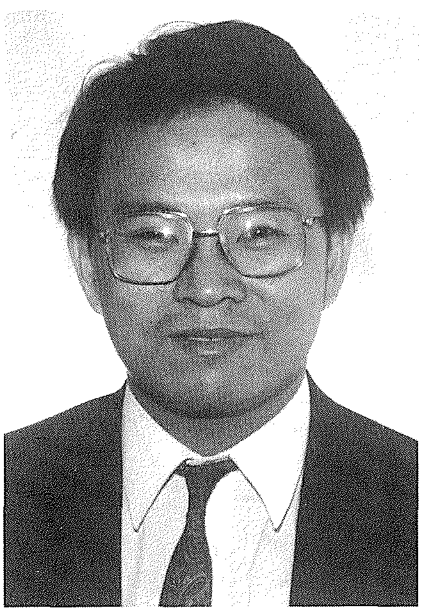
TRAPS IN READING VOLATILITY CHARTS

PRICE OR YIELD? THE SIGNALS MAY DECEIVE



BY JEREMY LIN

Volatility may not always be what it seems. In the interest-rate options market, the differences between price volatility and yield volatility can be challenging.

YIELD volatility in the Australian interest-rate options market is strictly defined as the standard deviation of a sample over time of yields of an instrument; price volatility is the standard deviation of a sample over time of prices for an instrument.

Yield volatility is widely used because the market quotes underlying security prices in interest-rate terms. Most models used in the market are variants of Black and Scholes model for call options. This model uses price volatility or price standard deviation as one of its input factors.

Confusion arises when one quotes yield volatility and then has to convert this to its equivalent in price volatility. This translation is a relatively simple procedure. However, questions arise when one analyses historical movements of these two seemingly interchangeable measurements. Here, a comparison is made of these two volatility figures with respect to the level of the price of the underlying security.

Conversion Formula

There is a quick and easy conversion formula between the two volatility measurements for interest rate options:

$$Vp = - Vy \, . \, Y/P \, . \, dP/dY \qquad (1)$$

where Vp is the price volatility,
Vy is the yield volatility,
Y is the yield of the underlying security,
P is the price of the underlying security, and
dP/dY is the first derivative of price P with respect to yield Y of the underlying security.

After simple manipulation the formula becomes:

$$Vp/Vy = - Y/P \, . \, dP/dY \qquad (2)$$

This expression tells us the ratio of price volatility against yield volatility at different yield levels and corresponding prices for an interest-rate security. One can therefore investigate the relationship between Vp and Vy for different levels of prices or yields. Mathematically, a simple first derivative with respect to P (price) of this expression will show this relationship.

Relationship between the two volatility measurements

Mathematically, the first derivative with respect to interest- rate security price of Expression (2) is the following:

$$Y/P^2 \, . \, dP/dY \qquad (3)$$

which happens to be always negative. This means that as the price of security goes up, the ratio of

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price volatility to yield volatility decreases. That is, a higher security price is translated into a higher yield volatility for a given level of price volatility. Or, for a given yield volatility level, the corresponding price volatility decreases as security price increases.

Graphs 1 and 2 show the price/yield volatility ratio for the XYB and CGS 7/2000 stock.

Other characteristics of Vp/Vy

(a) This ratio is constant at a given yield for the underlying security.

(b) At a constant price, the shorter the term to maturity of an instrument, the lower the ratio, or the discrepancy between yield volatility and price volatility is larger. dP/dY in Expression (2) can be used as a proxy for duration.

As the maturity draws close, the duration is shortened, therefore - Vp/Vy is smaller.

For example, bill options have a price volatility of about 0.25 per cent with a corresponding yield volatility of 10 to 12 per cent; this compares with 7.5 per cent price volatility and 12 per cent yield volatility for the 10-year bond futures contract.

(c) This differential between the two volatility measurements for securities of different maturities is more pronounced in a higher interest-rate environment.

Practical implication of the ratio Vp/Vy

Some practitioners in Australia use yield volatility for option trading to reflect their familiarity with the yield-pricing convention for interest-rate instruments.

Naturally, records for implied volatility and historical volatility are generally in terms of yield volatility. Any statistical analyses are therefore in the yield volatility concept. This leads to some interesting observations.

One simplistic method to determine the relative level of implied volatility is the use of the average and standard deviation for a historical sample of volatility. Roughly, 68 per cent of all observations fall within one standard deviation from the average of the sample population.

For example, if the average is 10 per cent and the standard deviation is 2.5 per cent for a sample of implied volatility, 68 per cent of the observations will fall between 7.5 per cent and 12.5 per cent. Therefore, if history repeats itself, future observations should more than likely fall within this band. This can be used as a simple guide for trading volatility.

However, this trading guide alone is not accurate because a substantial change in one direction of the price of the underlying interest-rate security over a short period would distort this analysis.

Take the 10-year bond contract traded on the SFE as an example. The nominal dollar price for this contract rose from a low of $90,000 to about $109,000 per contract over a six-month period from November 1990 to May 1991. Graph 3 shows the steep increase in the contract price for this period, and tends to be along one direction. On the other hand, the price change for 16 months before this period had been over a steady band.

Graphs 4 and 5 show historical implied price and yield volatilities from the beginning of July 1989 to end of May 1991. The central straight line is the average for the period, the upper straight line is the sum of the average plus one standard deviation, and the lower straight line is the average less one standard deviation. Graphs 6 to 9 are for the three-year and bank-bill contracts. The implied price volatility figures for the futures contracts are from ICCH.

Graph 4 shows the price volatility has fluctuated significantly over this period but tended to be within the historical upper and lower bounds as set by the standard deviation rule-of-thumb.

Over the same period, the movement in yield volatility (graph 5) was more pronounced and tended to be on the higher side of the historical measurement.

That is, from a historical point of view, on occasions when price volatility was high but not overwhelmingly so, the corresponding yield volatility would register figures that were significantly above average. This would have indicated a strategy to short volatility.

And indeed, the market was anticipating an imminent drop in yield volatility on some of these occasions, and options were sold. Although the volatility did come back the question remains whether one ought to have sold volatility when price volatility had not registered a convincing "sell volatility" signal.

When one looks back at the implied volatility data, there were occasions, when security prices were low, that a convincing "short volatility strategy" signal was not registered on the yield volatility chart but was clearly evident on the price volatility chart. If one followed yield volatility movement, one would have missed some of these trading opportunities—for example, around late October 1989.

A more startling comparison can be made from the graphs for the three-year and bank-bill contracts.

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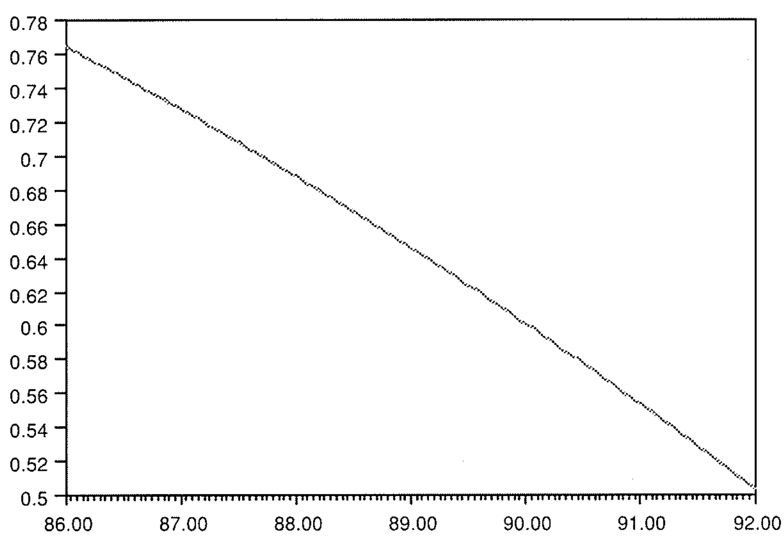
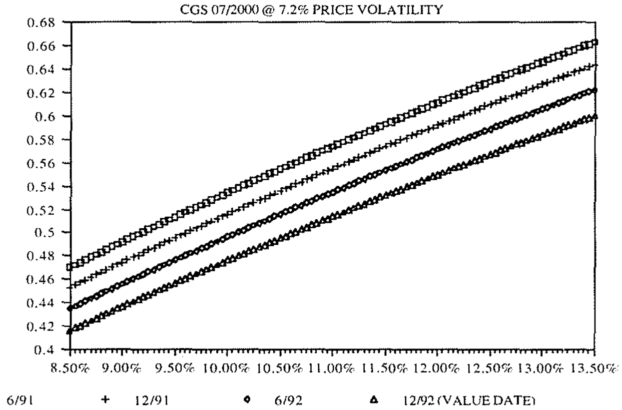
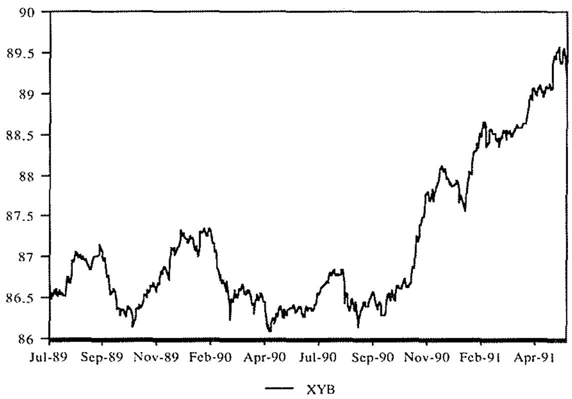
GRAPH 1: PRICE VOLATILITY/YIELD VOLATILITY



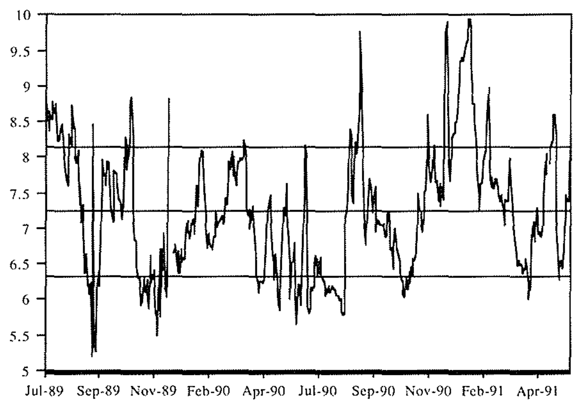
GRAPH 2: PRICE VOLATILITY/YIELD VOLATILITY



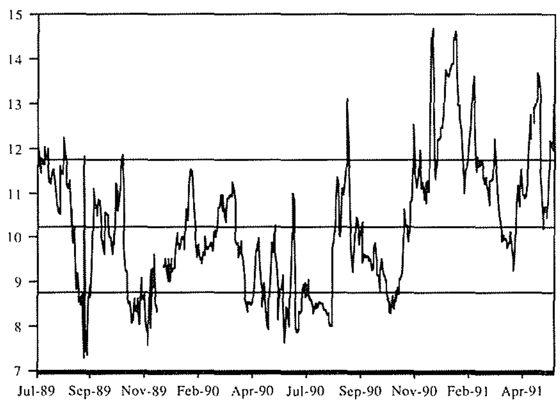
GRAPH 3: TEN-YEAR BOND FUTURES PRICE



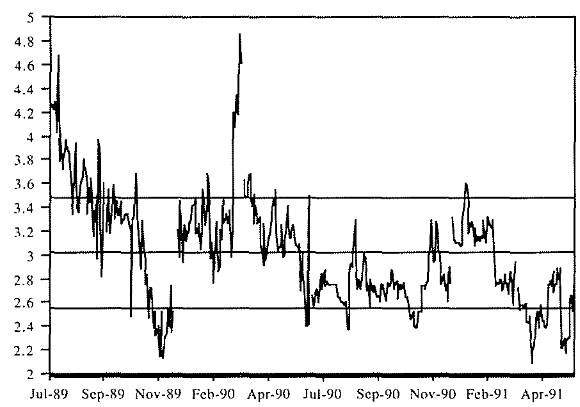
GRAPH 4: TEN-YEAR FUTURES PRICE VOLATILITY



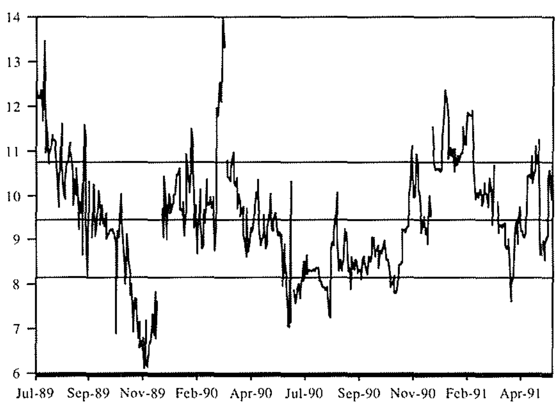
GRAPH 5: TEN-YEAR FUTURES YIELD VOLATILITY



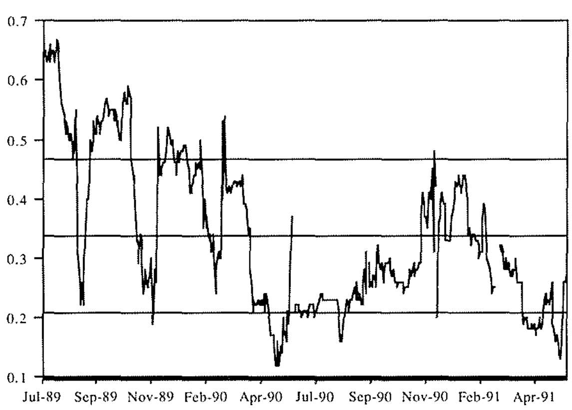
GRAPH 6: THREE-YEAR FUTURES PRICE VOLATILITY



GRAPH 7: THREE-YEAR FUTURES YIELD VOLATILITY



GRAPH 8: BANK BILL FUTURES PRICE VOLATILITY



GRAPH 9: BANK BILL FUTURES YIELD VOLATILITY