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Volatility Contracts™ — A New Alternative

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Risk enters into every business and financial decision. The Bank of International Settlements (BIS) estimates that $13 trillion of notional OTC option contracts were outstanding as of June 1999, a twenty-times increase from six and one-half years ago. In addition, BIS estimates exchange-traded options at $6 trillion. While investment banks and market-makers delta-hedge this exposure, neutralizing the directional risk exposure still leaves significant volatility exposure. Multinational corporations, looking closely, may find that in addition to directional risk they really have large amounts of volatility risk. Hedge fund managers and commodity trading advisers could easily use a new asset class to base new, uncorrelated trading programs.

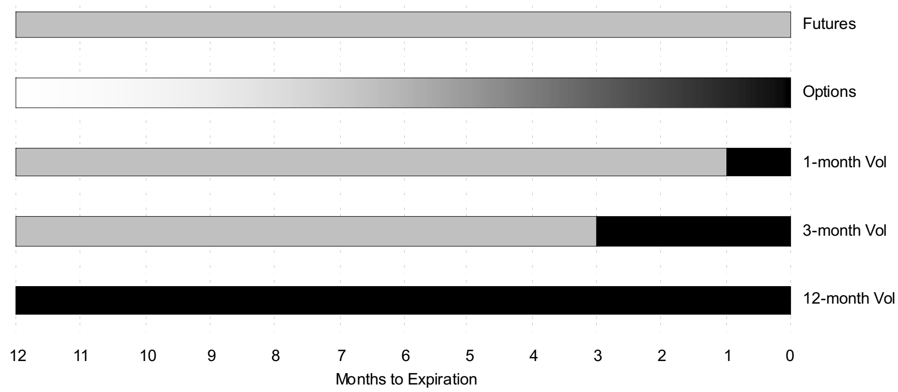
The relationship between volatility and asset valuation lies at the heart of financial theory (Markowitz [1952]). Moreover, while market participants have been able to reduce or increase their direct exposure to unexpected price movements through existing futures and options markets, there are limited means to trade volatility directly. The ability to directly trade or hedge pure index volatility not affected by exposure to the underlying index itself has been of interest to both the practitioners (Derman et al. [1996]) and the academics (Whaley [1993]). In fact, both U.S. and European exchanges have attempted to trade various forms of implied volatility based equity index contracts.[1] In this article, an alternative Volatility Contract[2] (Vol) is presented which has been designed to be an exchange-tradable instrument similar in many ways to a futures contract. However, instead of a contract based on the direction of prices, it is based on the fluctuations of prices over a certain time period. In other words, it is based on the realized or actual volatility that the underlying instrument goes on to display. This instrument goes a long way toward reducing this risk.

While futures trade based only on direction of the underlying, options trade based on both direction and volatility of the underlying. Vol would trade based purely on volatility. This contract should give rise to a number of hedging methods, speculative strategies, and arbitrage opportunities. The failure of previous exchange-traded volatility products has been primarily in the construction and method proposed, not in the viability of the concept or need for such a vehicle. In this article it is suggested that previous volatility contracts failed in trying to make the underlying itself predictive, instead of making it the item to be predicted.

CONTRACT DESCRIPTION

A Volatility Contract is an exchange-tradable financial instrument. It could be based on any underlying.[3] Essentially, if a futures or an option could be traded on an asset or instrument, then a Vol could as well. Volatility Contracts would settle to a calculated value

E X H I B I T 1
Period Anticipated



Futures: the period being anticipated is the final settlement at expiration.
Options: the period being anticipated is from the current date to expiration (which naturally grows shorter as time passes).
Vol: the period being anticipated is fixed.

■ Period Being Anticipated □ Anticipatory Period

of market return fluctuations over some designated time frame. To quantify these price fluctuations, one can calculate a term known as realized volatility. There is no perfect way of measuring realized volatility, but a standard method in finance is based on the annualized standard deviation of continuously compounded daily price returns. This standard method could be used, but that is not a necessity. A Vol, therefore, is an exchange-tradable instrument that would settle to the realized volatility of a specific underlying, over a specified period, regardless of the exact formula used to measure the volatility or the sampling period employed.[4]

As was mentioned, in a way, Vol is similar to a futures contract — where market participants try to determine the final expiration value during much of its life. During the realized volatility period, the contract's value would become more and more certain as final settlement approaches. One can think of trading a Vol while in the realized volatility period, similar to the way agricultural futures now trade in the delivery month. In other words, the Vol Contract would cease to be a pure anticipatory vehicle during its realized volatility period.

Example

Suppose that a certain exchange has a cash-settled futures contract on an index that begins trading on January 1. It has a December futures, options, and a three-month Vol that expire on December 31. Futures would settle to the index price on the final day of trading. Options would settle to the differential between the strike price and the final settlement price of the underlying futures, or zero if that result is negative. The three-month Vol would settle to the daily volatility of the underlying futures for the period from the close on September 30 through the final settlement of the futures on December 31. (As was stated before, the exact formula for calculating volatility needs to be defined in advance.)

Throughout the life of the futures contract, the market will be forecasting where the index price will end on December 31. For options, the goal is twofold: options traders are anticipating the final settlement price (as futures traders are so doing); but also, they are making a forecast on the volatility that the underlying will go on to display from the current moment until expiration. The Vol_3 traders will be forecasting the expected volatility of the December futures for the entire fourth quarter. Similar to options, the market will be trying to forecast the exhibited volatility of the underlying in the future. But, unlike options, the time frame being anticipated is fixed. In this case, for the first nine months, Vol will be a pure anticipatory vehicle. During the last three months of its life, information needed to settle the contract will become more and more known (see Exhibit 1).

Potential Uses

Investment banks and options market makers take on large amounts of volatility risk as a by-product of their dynamic process of delta hedging. As was stated, the options market is estimated at $19 trillion. Neuberger [1994] stated that "… over 80% of the hedging error that remains after delta-hedging is due to an incorrect forecast of the volatility over the life of the option. Delta-hedging reduces hedge errors by a factor of five; volatility hedging could potentially reduce hedge errors by a further factor of five." If so, then Volatility Contracts are clearly needed and should be quite liquid.

In addition to these potential hedgers with *direct* volatility risk, there is a class of hedgers that may find that their business could have problems when volatility changes. The most obvious example would be multi-national corporations. In this case, an exchange rate change may help one part of the company while hurting another. If this is the case, then the real risk is in exchange rates changing, not in the direction of those changes.

Speculators would make up another group of potential users. Hedge fund managers and commodity trading advisers would have a whole new asset class on which to base trading programs. Individual speculators that now presumably use straddles and strangles to "buy volatility" or "sell volatility" would be able to gain direct volatility exposure.

COMPARISON TO FUTURES AND OPTIONS

Similarity to Futures

Vol is similar to a futures contract in many ways.

- Its profit/loss profile is linear (unlike an option).
- It should be cash settled, the same as cash-settled futures.
- The value of the contract would change based on supply and demand.
- A performance bond should be required from both longs and shorts.
- The realized volatility period for Vol and the delivery month for commodities are periods that Vol and futures, respectively, cease to function as true anticipatory vehicles.
- Potentially, options could be traded on it.

Similarity to Options

- It has an underlying.
- Exchange-traded Vol should probably expire at the same time as the options — not necessarily when the underlying futures contract expires (spot, equities, indices, etc. do not expire) — to allow option market makers the closest possible hedging vehicle.

Dissimilarity to Futures

- It does not settle to spot or some index.
- The contract value is based on a calculation of the underlying's daily price returns over a specific time frame, not just on one final price at expiration.
- The performance bond might be different for long and short positions.

Dissimilarity to Options

- While a standard option's terminal value is based on the underlying's price on the day of expiration, Vol is based on the returns of the underlying over many days. In a way, Vol's expiration value is similar to that of an exotic option known as an Asian option (or average rate option), traded in over-the-counter markets, where the final settlement price is determined by averaging several intermediate settlement prices.
- It has no sensitivities — delta, gamma, theta, kappa (vega), rho.

DEFINITIONS

Realized, historical, actual, and future volatilities all refer to the same concept: the fluctuations in price level of the underlying over a period. The only difference would be whether the period occurs in the past (historical volatility), the future (future volatility), or non-specified (realized or actual volatility).

Realized volatility period. A predefined series of trading periods over which the settlement volatility is calculated. The last trading period would correspond to the expiration of the Volatility Contract in question. For example: if a trading period were one day and the realized volatility period were one month (twenty-one trading days), then it would take twenty-one daily returns to determine the settlement volatility. Regardless of the realized volatility period chosen or the number of trading periods within, the value is annualized (multiplying by the approximate number of trading periods within the year). Doing so would aid comparison with other time frames and conform to industry standards.

Trading period. A unit of time between observations. For example, if semidaily observations are deemed appropriate, then a trading period is approximately one-half day.

Settlement volatility. The final settlement price that determines the value at which the Volatility Contract expires.

REALIZED VOLATILITY MEASUREMENT

There are a number of formulas that could measure the realized volatility associated with a particular underlying. There are many reasons for both using, and not using, any particular calculation. However, the most

EXHIBIT 2
The Annualized Standard Deviation Formula of Returns

$$\sqrt{\frac{P}{n-1}\sum_{t=1}^{n}\left(R_t - \overline{R}\right)^2}$$

Where:

$$R_t = \mathrm{Ln}\left(\frac{M_t}{M_{t-1}}\right)$$

(each R_t is the continuously compounded return for one time period)

ln = natural logarithm
M_t = mark-to-market price at trading period t
M_{t-1} = mark-to-market price one period prior to M_t
$\overline{R}$ = mean of all R_ts
n = total number of trading periods within the realized volatility period
t = a particular observation (one for each trading period) within the realized volatility period
P = approximate number of trading periods in a year

EXHIBIT 3
Zero-Mean Formula

$$\sqrt{\left(\frac{P}{n}\sum_{t=1}^{n}R_t\right)^2}$$

widely accepted formula is the one that quantifies the annualized standard deviation of continuously compounded returns (see Exhibit 2).

If the trading period is daily, then there are about 252 trading periods in the U.S. within the calendar year. However, the exact number of trading periods depends on the calendar year in question and the country housing the contract — because each country can have a different holiday schedule. It is suggested that a constant of 250 be used regardless of local conditions. Such a constant would aid in market acceptance by reducing confusion. Also, it is a relatively trivial calculation to adjust the result to reflect for local market conditions. Suppose the Nikkei index trades in Singapore, Chicago, and Japan, and, accounting for the time difference, the three should have the same volatility because they are based on the same index. However, just because of local holiday schedules, the index trades a different number of days in each location. Unless a standard period is selected, the same contract would settle to different values. Why choose 250 specifically? It is approximately the average number of trading days in world markets, and it is a nice round number. For contract acceptance, it is immensely more important to have *one* standard than to have *many* exact values.

An alternative formula could be used. For instance, a zero mean could be employed. In Demeterfi [1999], the authors state, "The zero mean is theoretically preferable, because it corresponds most closely to the contract that can be replicated by options portfolios." If the zero mean is chosen, then the n - 1 term becomes just n — because a degree of freedom has been removed. It does not make logical or intuitive sense to force the statistical measure of standard deviation to conform to the markets. Doing so would imply that the trend exhibited is the "certainty" and that it should be removed, so that the *real* risk could be measured. For example, if a market rises every day by exactly 1% for one month, formula (2) would remove this trend and evaluate the one-month volatility as 0%. If the next month the same market fell by 1% each day, its one-month volatility would also be 0%. But, the two-month volatility for this market would be almost 16%! Clearly, zero plus zero should not equal sixteen. Also, this would imply that volatility has a directional bias. For if this market rose 1% in the second month instead, then the two-month volatility would be back to zero. The zero-mean formula suggested alleviates this problem. Not only that, it is simpler, and simplification may help in increasing its use (see Exhibit 3).

Note that an M-Vol (Monthly Volatility) would have only approximately twenty-one observations, which could be less during February/March, or during months with a high concentration of holidays. In order to alleviate the possibility of falling under twenty observations, which is needed for statistical validity, it is suggested that semidaily observations be used for all Vol Contracts. This has the added feature of being harder to manipulate, as will be mentioned in the next section. For markets with two sessions, the close of each session could be the two observation points. For markets that trade around the clock, the standard "close," along with a mark twelve hours apart, would work just fine. For markets that trade for a limited number of hours in one session each day, perhaps an open and a close price could be used. In short, one obser-

EXHIBIT 4
Suggested Formula

$$\sqrt{\frac{500}{n}\sum_{t=1}^{n} R_t^2}$$

vation should be at the close, and the second should be determined by each exchange. Finally, the period P should then be an agreed-upon constant, say, 500.

If semidaily observations are used, and the zero-mean formula is accepted, and the constant period P of 500 is adopted, then the following is the suggested standard formula for settlement of all Vol Contracts (Exhibit 4).[5]

Other formulas, such as one based on the high and low, or the high, low, and close, have market specific problems. It is easy to see that a market that is open for five minutes once per week, such as butter, which trades at the Chicago Mercantile Exchange, would have a much narrower high/low spread than the OTC currency market that is open twenty-four hours per day. Without an adjustment for the length of time that a market is open, then these formulas may not be a good measure of volatility. And the problem with incorporating a time adjustment is the added complexity and additional information required. Also, there is another potential problem with two separate sessions, when trading is not continuous. Continuously traded markets, or not, have no effect on the suggested formula in Exhibit 4.

HISTORICAL REVIEW

- Gastineau [1977] and Galai [1979] proposed a volatility index created from the implied volatility of option premiums.
- Brenner [1989] proposed the "Sigma Index," without stating how to construct such an index other than "It could be based on the standard deviation obtained by historical observations (with more weight given to recent observations). It could be based on implied volatilities of options that have just traded. Or we could use a combination of historical and implied volatilities to provide some balance between long and short-run trends." While Brenner and Galai alluded to a contract on historical volatility, they did not propose contract specifications or any standards for the design of such an instrument. Also, it is clear by the quote "with more weight given to recent observations," that they felt the underlying needed to itself "forecast" instead of the underlying being the item forecasted.
- Fleming [1993] proposed the volatility index (VIX). It is an index of a constant rolling thirty-day implied volatility. Since 1993 it has been continuously calculated and quoted.
- Whaley [1993] proposed that the CBOE trade options on the VIX and laid out the proposed contract specifications, assumptions, calculations, and methods. But no contracts were ever traded on the index.
- Neuberger [1994] touched on a Vol-type contract but dismissed it as "inflexible" and "easily manipulated." He proposed trading the log contract, a futures contract on the log of the futures price. The log contract is an interesting idea but fails to address what use it would be outside of market-maker hedging. For a contract to be successful, it needs to appeal to a broad array of market participants. It is hard to imagine one having an opinion on the log of a futures price.
- Over-the-counter volatility swaps began trading in late 1995.

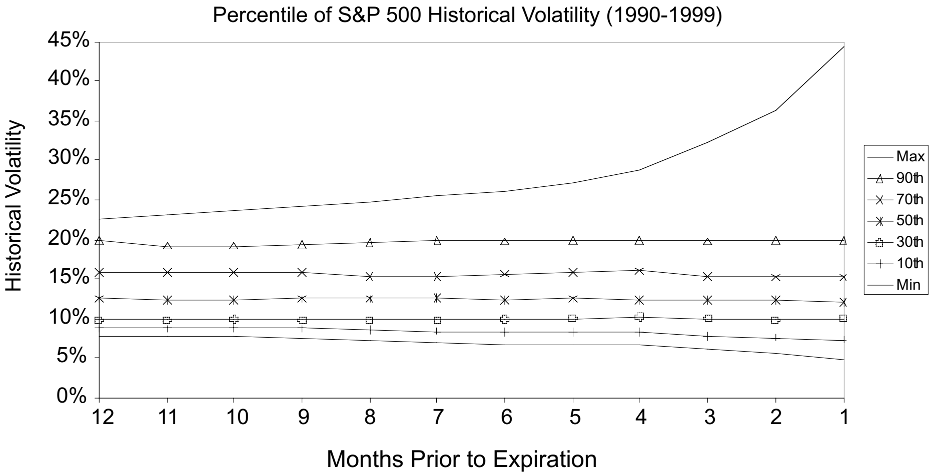
EXCHANGE-TRADED IMPLIED VOLATILITY

Several attempts have been made at trading volatility based on implied volatility contracts (VIX/CBOE, VOLAX/DAX). None of these attempts have been successful. The concepts and theories for derivatives on implied volatility all have a great pedigree and sound basis in mathematics and options theory. However, these indices appear useless as a trading vehicle. According to Brenner [1997], "While the concept of interpolating a standardized thirty-day, at-the-money option from traded options is simple, the implementation can be quite complicated." Just because one *could* trade volatility on implied volatility doesn't mean anyone would *want* to. No analysis has been done to see what truly appeals to market participants or what they would find useful. For a contract to be successful, it has to be understandable by more than just a few of the most sophisticated players. The following summarizes several potential problems.

Problem 1: Settling to Implied Volatility

Suppose an exchange begins trading a futures contract on an index that settles to implied volatility.

EXHIBIT 5
Term Structure of Volatility



What would participants be trying to determine? Of course, they would try to forecast the final settlement price. But what is the final settlement price? The implied volatility index. But, implied volatility is the market's estimation of future volatility. So if final settlement is to an estimate of the future, then what would they be forecasting *before* the final settlement? They would be forecasting an estimation. In other words, market participants would be trying to guess where the future guess of volatility would be. The problem in implied-volatility-based-past designs has been trying to make the index a good forecast of future volatility instead of letting the market place make the forecast and let the underlying be the item forecasted.

Problem 2: Liquidity

One of the reasons for choosing one of the most liquid markets was specifically the high liquidity. Such liquidity is required to get a "good" implied volatility value. Even in a highly liquid environment, should one use the last trade, the bid, the ask, the midpoint, or some combination? What if liquidity dries up? What if the bid (or ask) goes away? What if trades get executed first at the bid, then at the ask, without the market really moving? It is not acceptable to base the settlement of a contract on the liquidity of the underlying market. One problem is that it limits the potential markets. Another problem is that no one can guarantee that liquidity will be sufficient at expiration to get a "good enough" value.

Problem 3: Manipulation

Neuberger [1994] dismisses the idea of a contract settling to actual volatility because of market manipulation. While market manipulation may be of concern, it would be immensely easier to manipulate the implied volatility calculation at one specific moment (expiration) than it would be to manipulate the closing futures price every day for three months.

Problem 4: Settling to a Continuous X-Day Implied Volatility

Supposedly, one of the main reasons for a volatility contract was to provide option market makers with a viable hedging vehicle. In this respect, the volatility index methodology fails. The contract's design would effectively hedge this exposure for only one specific day — in the VIX case, thirty days from expiration. The problem here is that the market maker, when delta-hedging, has bought or sold implied and will receive or pay actual, as before. Supposedly, the market maker has traded implied and now wants to hedge. His or her needs would now center on hedging actual volatility. Vol is based on actual volatility, so it would be a much better match for this risk.

Problem 5: Attempting to Trade Options on a Contract that has no Underlying market

An option without a tradable underlying would severely limit market makers' abilities to hedge (as has been contemplated by the CBOE for the VIX). The result would be wider spreads and lower volume, which would yield even wider spreads and lower volume, etc. until the market dies. One could argue that a similar situation exists in the S&P 100 options pit right now (one of the most liquid markets in the world). But this is not entirely correct. There are many other very highly correlated vehicles from which to hedge. Before contemplating options, exchanges must list an underlying (that is to say, a Vol Contract should be listed before, or simultaneously with, options on Vol).

Proposed Contract Specifications

Contract Size	Volatility is normally quoted in annual percentage terms — Vol should be also. In addition, the contract multiplier should be multiplied by the number of months of the realized volatility period. If, for instance, Japanese yen Q-Vol were last traded at 11.22% (0.1122) and the contract multiplier were $100,000, then this Volatility Contract would be valued at $33,660 ($100,000 × 0.1122 × 3 months). If a Japanese yen M-Vol were traded at the same price of 11.22%, then its value would be $11,220 ($100,000 × 0.1122 × 1 month). Multiplying by the number of months might aid spreads and arbitrage between the different Volatility Contracts. The contract size would also correspond more closely to the smaller options premiums as expiration approaches. The month multiplier would add little confusion among participants. Such a design would lead to more potential use by option traders. Also, the variability of volatility is greatest with shorter times. Therefore longer-term contract can have larger notional values without the threat of tremendous volatility changes. Because financial products are usually higher in notional amount and lower in average volatility than commodity futures, it is expected that Vol multipliers ought to be higher for the financials than for commodities. The contract multiplier should be standardized as much as possible to avoid confusion and aid in market acceptance. For instance, all financials might have a contract multiplier of $100,000, all agricultural products $25,000 for U.S. dollar-based products.[6]
Tick Size	The minimum price fluctuation for financials could be 0.01% (0.0001). If the contract multiplier were $100,000, then the minimum tick size would be $10 for an M-Vol and $30 for a Q-Vol. For agricultural markets, the minimum may be 0.02% (0.0002) for M-Vol and Q-Vol. If the contract multiplier were $25,000, then the minimum tick size would be $5 for an M-Vol and $15 for a Q-Vol. An A-Vol could have the same 0.01% minimum as the financial markets, giving it a $30 tick size.
Expiration Date	Same date on which the options on the underlying expire.
Expiration Months	One-month and three-month Vol would appear to be most useful (also a twelve-month Vol for agriculturals). For example, similar to the way serial options trade, a three-month Vol and three one-month Vols could be available for each quarterly financial futures options expiration and each monthly serial options expiration respectively. Others would probably not be needed and could actually be detrimental. Sufficient study should be conducted and market demand should be assessed before adding additional time frames.
Settlement	Settlement should be to cash on the calculated value of realized volatility. The suggested realized volatility formula should be used. The specific items within the formula are: use the zero-mean standard deviation formula; continuously compounded returns; semidaily observations (with the daily close and another observation point determined by each exchange; this would be the easiest to understand and would also minimize manipulation and ensure statistical validity); and a constant for the number of periods within a year (500).
Performance Bond	Because of the potential for extreme moves in volatility, the performance bond should be higher in percentage terms than for futures contracts in general. Also, it may be prudent to charge different performance bond levels, depending on whether the market participant is long or short (options have such a long/short differential).
Initial Listing	The Vol contract should be listed when the underlying futures or corresponding options are listed.

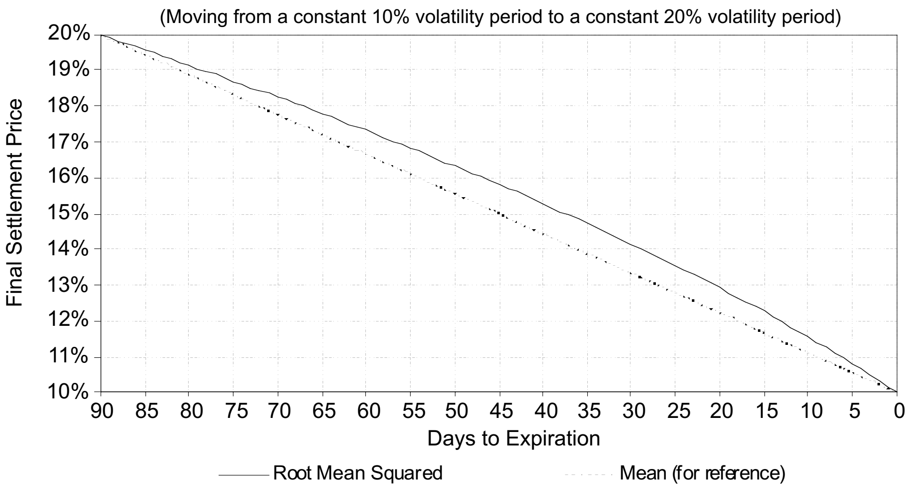
Design Considerations

Every aspect of Vol's design is toward simplicity. A successful market needs speculators, hedgers, *and* market makers. A contract designed only for hedgers probably will not work. Market makers will not make a "reasonable" market if there is no tradable underlying. A successful Vol contract would make option market spreads tighter, bringing more liquidity to the option market, which would bring more volume to the underlying and then back to the Volatility Contract, etc. Even though Vol cannot hedge every definition of volatility, no single contract could.

Number of Vols Needed

It is anticipated that only three Vols need to be listed for each underlying in agriculturals, and two Vols for financials: Vol_1, Vol_3, and Vol_{12} for agriculturals; Vol_1 and

EXHIBIT 6
Final Settlement Price of a Vol_3



Vol_3 for financials. Longer-term Vols, such as life of contract, would be of diminishing use to hedgers and speculators as time to expiration lengthens. Long-run volatility varies little from its long-run average. Hedgers would not be interested in protecting from such minimal risk; speculators would find little opportunity (see Exhibit 5).

If the variability in volatility is greater the shorter the time to expiration, why not have a two-week Vol, one-week Vol, three-day Vol, two-day Vol, etc., etc.? Because such additional contracts would not be needed and could actually be detrimental to the health of the market. The reasons are twofold. First, additional contracts could disperse the potential volume, increasing market spreads. Second, shorter-term hedges could be created from longer-term contracts. Take, for instance, a trader wanting to hedge an option sold with forty-five calendar days left to expiration. Neither a one-month Vol (with fifteen days to go before the start of the realized volatility period) nor three-month Vol (being forty-five days into the realized volatility period) appear to be a match. But Vol_3 would actually be a good match. For example, if the first forty-five days yielded a realized volatility of 10% and the next forty-five days turn out to be 20%, then the average is 15%. One can easily see that trading two contracts would give one the same dollar exposure to an expected increase in volatility. In reality, one would not just simply average the values but use a root-mean-squared formula. The formula is different, but the concept is the same (see Exhibit 6).

Volatility Swaps

Volatility swaps are gaining momentum in the OTC world because contracts based on volatility are in demand also because of their simplicity. In Demeterfi [1999], the formula is just the realized volatility less the price agreed upon today times a contract multiplier. Vol is nearly as simple. The main difference is the fixed time period. Exchanges have always standardized their products; the OTC world has always customized them. By standardizing, exchanges can concentrate volume into the "best" (most representative) example of the underlying. Offering two or three Vols would help concentrate volume into the most representative examples. This concentration argument is the reason not to offer an Annual Vol on financials.

CONCLUSIONS

Currently, investment banks and market makers have significant volatility exposure with no acceptable method of hedging. In this article, a Volatility Contract has been proposed that is designed to be an exchange-tradable instrument based on volatility that would be traded in a manner similar to a futures contract in that market participants would try to forecast a future value. Unlike futures contracts, however, Vol will settle to a calculated value of an underlying's realized over some predetermined time frame, as opposed to just the value at the end of the period. It can be created on any instrument with linear characteristics (e.g., futures, stock, index, currency, etc.). It would provide a way for market participants to speculate on, or hedge against, changes in perceived market volatility (during the anticipatory period) or against changes in actual volatility (during the realized volatility period).

ENDNOTES

[1]The CBOE market volatility index (or the VIX) was introduced based on the implied volatilities of the S&P 100 index options (no instruments were ever traded, though). France attempted to introduce the VX1 based on implied

volatilities of the CAC-40 index options, and Germany introduced the VDAX on the implied volatilities of the DAX30 index. The failure of several of these contracts to succeed will be addressed in the section entitled "Exchange-Traded Implied Volatility."

[2]Volatility Contract, Vol Contract, Vol, and all combinations, including abbreviations, of associated contracts with a specified time frame are trademarks of Event Capital Management Corp. (www.eventcm.com). Use is by permission only. Certain inventive aspects described in this article of the subject of application for letters patent filed with the United States Patent and Trademark Office. Copyright © 2000 by Event Capital Management Corp.

[3]Bridge/CRB identifies close to 700 active futures markets all over the world. Volatility Contracts could be made available on any or all of them or on any yet-to-be-listed derivatives market. Also, any listed stock, unlisted stock, physical commodity, physical asset, basket, index, currency, currency swap, and the like are all potential candidates.

[4]To start, exchanges may list just a couple: a one-month Vol (Monthly Vol, M-Vol, or Vol_1) and a three-month Vol (Quarterly Vol, Q-Vol, or Vol_3). For agricultural products, a twelve-month Vol (Annual Vol, A-Vol, Vol_{12}) could be added as well and may prove useful. Listing an A-Vol on most financials would not be needed because participants could achieve nearly the same volatility exposure by executing a series of Quarterly Vols (similar to the way Eurodollar "strips" are created). It would not make sense to similarly string together agricultural products because successive contracts have no mathematical arbitrage between them. Listing of intervening months probably would not be needed and, in fact, may be detrimental to the health of the market. See the section entitled "Design Considerations."

[5]Use of any other formula that attempts to measure the volatility of the underlying does not change the nature of the Vol concept.

[6]Although this contract value may appear low in notional amount, volatility normally has had much greater ranges in value than its corresponding underlying. It is also not unusual for volatility to "double overnight," whereas such a directional move for most assets is almost impossible.

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