

## Special Executive Report

**S-4684**

**March 7, 2008**

This CME Group Special Executive Report contains the following:

Section	Description	Page
1	CME Group Volatility-Quoted FX Options on Futures Launch on Sunday, March 9, 2008	1
2	Trading Hours (Central Time) for CME Volatility-Quoted FX Options on Futures	1
3	CME Group Contacts	1
4	New Volatility Quoting and Trading Convention	2
	Applicable Products	2
	Summary of the Initiative	2
	Volatility-Quoted FX Options Codes	3
	Available Strategies	2
	Option Premium Adjustment	3
	MPD Channel Information	4
5	Price Increments Rule Amendments for Vol-Quoted Options	4
6	New CME Rule 584	6
	Appendix A – Option Pricing Models: Black for European-Style & Whaley for American-Style	8
7	Exchange Fees and Market Maker Program	12
8	Selected Quote Vendor Symbols*	15

### 1. **CME GROUP VOLATILITY QUOTED FX OPTIONS ON FUTURES LAUNCH ON SUNDAY, MARCH 9, 2008**

**Launch Dates:** As you were notified previously in CME Member Update, March 2008, and in CME Group Special Executive Report, S-4673, dated Friday, February 15, 2008, CME Group approved rule amendments to allow for a new volatility quoting and trading convention for selected foreign exchange (FX) options on futures contracts in addition to the premium quoting and trading convention for these same contracts. Over-the-counter (OTC) FX options are traded in terms of volatility rather than premium. CME Group is introducing volatility quoting of its FX options products in order to appeal to OTC FX options market users. Volatility quoting will be offered on CME Globex in addition to and complimentary of its current and successful premium-quoted FX options. **Volatility quoting and trading for selected CME Group American- and European-Style Options on FX Futures contracts will begin Sunday, March 9, 2008.**

### 2.

#### **TRADING HOURS (CENTRAL TIME) FOR CME VOLATILITY-QUOTED FX OPTIONS ON FUTURES**

##### **CME Globex Platform (Sunday through Friday)**

5:00 p.m. (trading opens for the next trade date) to 4:00 p.m. the following day. On Friday CME Globex platform closes at 4:00 p.m. and reopens Sunday at 5:00 p.m.

### 3. **CME GROUP CONTACTS:**

**Derek Sammann, Managing Director, FX Group, at (312) 466-7454**

**Craig LeVeille, Director, FX Group, at (312) 930-5301**

**Steve Youngren, Associate Director, Research Department, at (312) 930-4583**

**4. NEW VOLATILITY QUOTING AND TRADING CONVENTION FOR SELECTED FX OPTIONS ON FUTURES CONTRACTS IN ADDITION TO THE PREMIUM QUOTING AND TRADING CONVENTION FOR THESE SAME CONTRACTS, EFFECTIVE SUNDAY, MARCH 9, 2008**

**Applicable Option Products:** Please note that the rule changes to allow for the volatility-quoted options convention were written generically to apply to any product group. However, initially, they will apply only to selected FX products. The CME Group volatility-quoted options convention will be eligible for CME Globex trading in outright options and straddles, strangles and vertical options spreads for the following contracts: American-style exercise Options on British Pound, Canadian Dollar, Japanese Yen, Euro, Swiss Franc and Australian Dollar Futures; and European-style exercise Options on British Pound, Canadian Dollar, Japanese Yen, Euro and Swiss Franc Futures. Please note that CME Group currently does not list European-style exercise Options on Australian Dollar Futures contracts.

**Summary of the Initiative:**

- The volatility-quoted instruments will initially be quoted and traded separately from premium-quoted products.
- Volatility-quoting will be available on six major American- and five European-style FX instruments currently listed on CME Globex.
- In addition to quoting single product type, volatility-quoting will be available for the following spreads using single volatility bid and offer inputs: straddles, strangles and verticals.
- Matching of volatility prices will occur on a first in and first out (FIFO) basis, with minimum price fluctuations of 0.025%. A refined tick pricing granularity (1/10<sup>th</sup> regular premium tick, 1/5<sup>th</sup> for British pound) will insure accuracy of the volatility-to-premium conversion.
- When a trade occurs, the volatility match will be reported, but customer accounts will only receive the individual option legs and associated futures hedge breakdown.
- The pricing engine will convert volatility matches using the Black model for European-style options and the Whaley (over Black) model for American-style options. A test sample from each model is available to customers for analysis and testing.
- Once assigned a premium by the CME Globex matching engine, the option leg will be treated and coded as a regular premium-quoted option, and thus available for offset through premium-based trading.
- The engine will also allocate a Delta-offsetting futures position to each party in the transaction based on the mid price of the underlying futures contract at the time of the match. This futures allocation will not be reported in Market Data as actual transactions (effect similar to covered transactions).
- Fees will be applied to the option legs only, and CME Group is providing early incentives for market-makers similar to those in place for premium-quoted options (see Section 7).
- Further details on this initiative are available in the "CME Globex Client System Impact" Volatility Quoted Options on Foreign Exchange (FX) Futures at the following link:

<http://cmegroup.com/globex/introduction/features-and-functionality/files/volquotedimpact.pdf>

The rule amendments to provide for trading via volatility quoting follow in Sections 5 and 6 with additions underlined and deletions bracketed and overstruck.

**Volatility-Quoted FX Options Codes:** The following table details product and group code information for each product.

Product	Expiration Style	Listing Term	Group Code	Strategy Group Code	Product Code
Australian Dollar Volatility-Quoted Options	American	Monthly	3A	4A	V6A
Australian Dollar Volatility-Quoted Options	American	Weekly	3A	4A	VA(1-5)
British Pound Volatility-Quoted Options	American	Monthly	B3	4B	V6B
British Pound Volatility-Quoted Options	American	Weekly	B3	4B	VB(1-5)
British Pound Volatility-Quoted Options	European	Monthly	B3	4B	VXB
British Pound Volatility-Quoted Options	European	Weekly	B3	4B	VB(A-E)
Canadian Dollar Volatility-Quoted Options	American	Monthly	3C	4C	V6C
Canadian Dollar Volatility-Quoted Options	American	Weekly	3C	4C	VC(1-5)
Canadian Dollar Volatility-Quoted Options	European	Monthly	3C	4C	VXC
Canadian Dollar Volatility-Quoted Options	European	Weekly	3C	4C	VC(A-E)
Euro FX Volatility-Quoted Options	American	Monthly	3E	4E	V6E
Euro FX Volatility-Quoted Options	American	Weekly	3E	4E	VE(1-5)
Euro FX Volatility-Quoted Options	European	Monthly	3E	4E	VXT
Euro FX Volatility-Quoted Options	European	Weekly	3E	4E	VT(A-E)
Japanese Yen Volatility-Quoted Options	American	Monthly	3Y	4J	V6J
Japanese Yen Volatility-Quoted Options	American	Weekly	3Y	4J	VJ(1-5)
Japanese Yen Volatility-Quoted Options	European	Monthly	3Y	4J	VXJ
Japanese Yen Volatility-Quoted Options	European	Weekly	3Y	4J	VJ(A-E)
Swiss Franc Volatility-Quoted Options	American	Monthly	S7	4S	V6S
Swiss Franc Volatility-Quoted Options	American	Weekly	S7	4S	VS(1-5)
Swiss Franc Volatility-Quoted Options	European	Monthly	S7	4S	VXS
Swiss Franc Volatility-Quoted Options	European	Weekly	S7	4S	VS(A-E)

**Available Strategy Types:** Initially the following strategy types will be available for trading in volatility terms:

Strategy	Strategy Type Code
Vertical	VT
Straddle	ST
Strangle	SG

**Option Premium Price Adjustment:** The following table provides an example of the Option Premium Price Adjustment CME Globex will perform for each volatility-quoted options product.

Option Premium Rounding Tick			
Product*	Minimum Tick	Half Tick	Option Premium Rounding Tick
EuroFX	0.0001 = \$12.50	0.00005 = \$6.25	0.00001 = \$1.25
British Pound	0.0001 = \$6.25	N/A	0.00002 = \$1.25
Japanese Yen	0.000001 = \$12.50	0.0000005 = \$6.25	0.0000001 = \$1.25
Canadian Dollar	0.0001 = \$10.00	0.00005 = \$5.00	0.00001 = \$1.00
Swiss Franc	0.0001 = \$12.50	0.00005 = \$6.25	0.00001 = \$1.25
Australia Dollar**	0.0001 = \$10.00	0.00005 = \$5.00	0.00001 = \$1.00

\*American and European style options

\*\*Only American style

**MDP Channel Information:** To simplify market data dissemination and processing, all market data for these new volatility-quoted options is segregated to new Market Data Platform channel 6. The market data for the equivalent premium legs is disseminated on channel 12, per current behavior.

Message Format	Products	MDP Channel
FIX/FAST	Vol-Quoted Options	6
FIX/FAST	Premium Options	12
FIX/FAST	Futures	11
ITC 2.1	Vol-Quoted Options	214
ITC 2.1	Premium Options	205
ITC 2.1	Futures	204
RLC	Vol-Quoted Options	6
RLC	Premium Options	12
RLC	Futures	11

**Volatility Pricing Conventions:** Please note that ITC 2.1 market data messages require no changes to support volatility-quoted options. Volatilities will be transmitted in the price field, and will be represented in decimal form; i.e. a volatility of 6 1/4% will be represented by .0625; this will be represented in the ITC 2.1 transmission format as 0006250, with a fractional indicator of 3, which will be interpreted as 6.250. For RLC messaging enhancements, please refer to the Volatility-Quoted Options Client Impact Assessment document.

5. **RULE AMENDMENTS TO THE “PRICE INCREMENTS” RULES WERE NECESSARY TO ACCOMMODATE QUOTING SELECTED FX OPTIONS IN VOLATILITY TERMS.**

Rule changes were required to allow volatility quoting and trading in six selected American-style and the five European-style FX options on futures contracts. The rule amendments follow with additions underlined and deletions bracketed and overstruck.

**251A01. OPTION CHARACTERISTICS**

**251A01.C. Price Increments**

The price of an option shall be quoted in U.S. dollars per pound sterling. Each \$0.0001 per pound sterling (one point) shall represent \$6.25. For example, a quote of .0070 represents an option price of \$437.50 (70 points x \$6.25 per point) of premium. The minimum fluctuation shall be one point (also known as one tick).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex® converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.00002 per pound sterling (equal to \$1.25).

Remainder of rules is unchanged.

## 252A01. OPTION CHARACTERISTICS

### 252A01.C. Price Increments

The price of an option shall be quoted in U.S. dollars per Canadian dollar. Each \$0.0001 per Canadian dollar (one point) shall represent \$10.00. For example, a quote of .0075 represents an option price of \$750.00 (75 points x \$10.00 per point) of premium. The minimum fluctuation shall be one point (also known as one tick). A trade may also occur at a price of \$.00005 (\$5, also known as one-half tick), \$.00015 (\$15, also known as one and one-half ticks), \$.00025 (\$25, also known as two and one-half ticks), \$.00035 (\$35, also known as three and one-half ticks), and \$.00045 (\$45, also known as four and one-half ticks).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.00001 per Canadian dollar (equal to \$1.00).

Remainder of rules is unchanged.

## 253A01. OPTION CHARACTERISTICS

### 253A01.C. Price Increments

The price of an option shall be quoted in U.S. dollars per Japanese yen. Each \$0.000001 per Japanese yen (one point) shall represent \$12.50. For example, a quote of .000075 represents an option price of \$937.50 (75 points x \$12.50 per point) of premium. The minimum fluctuation shall be one point (also known as one tick). A trade may also occur at a price of \$.0000005 (\$6.25, also known as one-half tick), \$.0000015 (\$18.75, also known as one and one-half ticks), \$.0000025 (\$31.25, also known as two and one-half ticks), \$.0000035 (\$43.75, also known as three and one-half ticks), and \$.0000045 (\$56.25, also known as four and one-half ticks).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.0000001 per Japanese yen (equal to \$1.25).

Remainder of rules is unchanged.

## 254A01. OPTION CHARACTERISTICS

### 254A01.C. Price Increments

The price of an option shall be quoted in U.S. dollars per Swiss franc. Each \$0.0001 per Swiss franc (one point) shall represent \$12.50. For example, a quote of .0075 represents an option price of \$937.50 (75 points x \$12.50 per point) of premium. The minimum fluctuation shall be one point (also known as one tick). A trade may also occur at a price of \$.00005 (\$6.25, also known as one-half tick), \$.00015 (\$18.75, also known as one and one-half ticks), \$.00025 (\$31.25, also known as two and one-half ticks), \$.00035 (\$43.75, also known as three and one-half ticks), and \$.00045 (\$56.25, also known as four and one-half ticks).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.00001 per Swiss franc (equal to \$1.25).

Remainder of rules is unchanged.

## 255A01. OPTION CHARACTERISTICS

### 255A01.C. Price Increments

The price of an option shall be quoted in U.S. dollars per Australian dollar. Each \$0.0001 per Australian dollar (one point) shall represent \$10.00. For example, a quote of .0075 represents an option price of \$750.00 (75 points x \$10.00 per point) of premium. The minimum fluctuation shall be one point (also known as one tick). A trade may also occur at a price of \$.00005 (\$5, also known as one-half tick), \$.00015 (\$15, also known as one and one-half ticks), \$.00025 (\$25, also known as two and one-half ticks), \$.00035 (\$35, also known as three and one-half ticks), and \$.00045 (\$45, also known as four and one-half ticks).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.00001 per Australian dollar (equal to \$1.00).

Remainder of rules is unchanged.

## 261A01. OPTION CHARACTERISTICS

### 261A01.C. Price Increments

The price of an option shall be quoted in U.S. dollars per Euro. Each \$0.0001 per Euro (one point) shall represent \$12.50. For example, a quote of .0075 represents an option price of \$937.50 (75 points x \$12.50 per point) of premium. The minimum fluctuation shall be one point (also known as one tick). A trade may also occur at a price of \$.00005 (\$6.25, also known as one-half tick), \$.00015 (\$18.75, also known as one and one-half ticks), \$.00025 (\$31.25, also known as two and one-half ticks), \$.00035 (\$43.75, also known as three and one-half ticks), and \$.00045 (\$56.25, also known as four and one-half ticks).

If options are quoted in volatility terms pursuant to Rule 584, the minimum fluctuation shall be 0.025 percent for the volatility quote. Also, following a volatility trade, when CME Globex converts the volatility-traded options position into a premium-based options position for clearing, the minimum price increment for the premium-based option position shall be \$0.00001 per Euro (equal to \$1.25).

Remainder of rules is unchanged.

## 6. NEW CME RULE 584 - CME GLOBEX OPTIONS VOLATILITY QUOTE TRADING AND ITS INTERPRETATION

CME Group has added CME Rule 584 and its Interpretation to Allow for Volatility Quoting and Trading in Selected CME Group Options on Futures Products Traded on CME Globex. The rule amendments follow with additions underlined and deletions bracketed and overstruck.

### 584. ~~[RESERVED]~~ CME GLOBEX OPTIONS VOLATILITY QUOTE TRADING.

For contracts deemed eligible by the exchange, CME Globex provides for quoting and trading of outright options and options strategies (e.g., options combinations such as straddles, strangles, verticals, and any other options strategies deemed approved by the exchange) in terms of volatility quotes in addition to premium quotes. Any outright option or option strategy so traded will be designated as a single instrument on the CME Globex system. Any outright option or options strategy may trade simultaneously as separate instruments on CME Globex using volatility quotes and premium quotes.

The options volatility quoting convention allows for bids and offers in terms of annualized implied volatility (e.g., 12.450% bid at 12.550% offer).

Volatility quoted option trades shall be matched at the option instrument level according to the first priority for best price and FIFO matching algorithm described in Rule 580 – **GLOBEX TRADE ALGORITHMS** and its Interpretation. Further, volatility quoted option bids shall be matched only with volatility quoted option offers (premium quoted options will not be matched with volatility quoted options). At the time of an options volatility match, CME Globex will utilize standard options pricing models to convert the options volatility trade into a premium quoted option for clearing, and where applicable, create accompanying risk reducing futures contracts as a delta-neutral hedge for the matched position.

For more details concerning volatility options quotes and trading, see the individual options contract Price Increments rules in applicable product chapters and the “Interpretations & Special Notices Relating to Chapter 5” at the end of Chapter 5.

### **INTERPRETATIONS & SPECIAL NOTICES RELATING TO CHAPTER 5**

#### **INTERPRETATION OF RULE 584.—CME GLOBEX OPTIONS VOLATILITY QUOTE TRADING**

**CME GLOBEX OPTIONS VOLATILITY TRADING MATCH.** Once a trade occurs in an outright option or combination quoted in volatility terms, this matched transaction will be assigned: (1) a price in premium terms for each option in the trade and (2) a delta-neutral hedge quantity assignment of futures contracts, if applicable, according to the following procedures:

1. The exchange will determine the option price in premium terms by inserting the following variables into the appropriate standard option pricing model:

- (a) matched implied volatility.
- (b) underlying futures price from CME Globex (see details below).
- (c) time to expiration in years (equals number of calendar days from option’s trade date to option’s expiration date divided by 365 days).
- (d) option strike price.
- (e) current interest rate (see details below).
- (f) whether a put or a call option.
- (g) option style, either European or American to determine the appropriate standard option pricing model as detailed in Appendix A.

The resulting premium price will be rounded to the appropriate minimum tick interval of the option according to the individual options’ Price Increments rules.

Where, the interest rate used will be the rate implied by the prior day’s settlement price of the nearest to expiration CME Group serial or quarterly Three-Month Eurodollar futures contract month (100.00 – 3-Month Eurodollar futures price = interest rate).

Where, the underlying futures price used will be based on the following tiered hierarchy:

Tier 1: Most recent **midpoint** of the nearest to expiration March quarterly cycle (“front month”) futures contract bid and ask spread on CME Globex is used as the basis for determining the underlying futures prices for all listed contract months.

- a. If the calculated midpoint is not on-a-tick, CME Globex will round to either the bid side or ask side whichever has the smallest quantity of contracts bid or offered.
- b. If the volatility quoted option being matched has an underlying futures contract other than the front month futures contract, then CME Globex will adjust the calculated price for the front month futures contract by the appropriate previous day’s settlement price spread differential to imply an appropriate underlying futures price.
- c. Normally, under Tier 1, the underlying futures price is based on the front-month future bid/ask spread. However, during the expiration week of the front month future, CME Globex compares the bid/ask spreads of the front month future and the next quarterly contract month and uses the instrument with the tightest bid/ask spread for the volatility to premium price conversion. However, if the next quarterly contract month bid/ask spread is used (tighter bid/ask spread), then CME Globex will imply the underlying futures price for the front month future from

the next quarterly contract month midpoint, adjusted by the appropriate spread differential from the respective previous day's settlement prices.

Tier 2: **Previous settlement price** (when no most recent bid/ask midpoint in the nearest to expiration March quarterly cycle futures contract is available).

2. When the outright option includes futures in a delta neutral ratio to the options, the delta will be calculated for European-style options from the standard Black option pricing model, and for the American-style options from the standard Whaley option pricing model. See Appendix A for details of these standard options pricing models.
3. The quantity ("Q<sub>fut</sub>") of futures contracts to be allocated in the delta-neutral hedge equals the product of the net delta in the options combination ("Δ") as determined by the applicable options pricing model, and the quantity of trades ("Q<sub>opt</sub>") triggered by the incoming options order. This resulting product is rounded to the nearest integer to determine the quantity of futures contracts allocated.

$$Q_{fut} = \Delta * Q_{opt}$$

In the event an incoming options order trading in volatility terms is matched by CME Globex to more than one resting order, the resulting allocation of futures contracts shall be as follows:

The incoming order is matched via the best price and FIFO matching algorithm to two or more resting orders. The quantity of each such allocation of futures contracts equals the quantity of that portion of the matched options trade times the net delta, rounded down to the nearest integer. The sum total of the futures contracts allocated to the resting options orders after this allocation may be less than the allocation of futures contracts originally defined for the incoming options order. This difference shall be allocated one futures contract at a time to the resting order portion that is the most under allocated (i.e., highest remainder given the product of the net delta and option order quantity), based on the extent of rounding down in the calculation above. If there is a tie in the amounts by which two or more resting orders are the most under allocated, then the residual futures contract shall be allocated to the oldest resting order (first order entered) that is matched to the incoming options order.

If the incoming options order is for a quantity larger than can be matched with resting orders at the same options volatility price, then the remaining quantity of the incoming options order becomes a resting limit order for the unmatched, remaining quantity at the same volatility price.

The price of futures contracts allocated by CME Globex shall be as determined in step 1 above. The following section provides a numerical example of CME Globex allocations of futures contracts, given a volatility-quoted option match.

#### **Match of Multiple Counterparties and Futures Contract Hedge Assignments**

The following example is for a European-style option:

Assume the Ask side order enters the market and sweeps the Bid side quantity in resting orders.

<b>1.7000 Call / Currency Option</b>			
<b>BID</b>		<b>ASK</b>	
<b>QTY</b>	<b>Volatility</b>	<b>Volatility</b>	<b>QTY</b>
40	1220	1220	100
30	1220		(incoming order)
20	1220		
10	1220		

The Black option pricing model outputs a computed net delta of 0.51.

The Bid side breakdown for assigned futures contracts is as follows:

<b>Bid Side QTY</b>	<b>Delta</b>	<b>Delta x QTY</b>	<b>Rounding Down</b>	<b>Residual</b>	<b>Total Assigned Futures Contracts</b>
40	0.51	20.4	20	1*	21
30	0.51	15.3	15	0	15
20	0.51	10.2	10	0	10
10	0.51	5.1	5	0	5



<u>Bid Side QTY</u>	<u>Delta</u>	<u>Delta x QTY</u>	<u>Rounding Down</u>	<u>Residual</u>	<u>Total Assigned Futures Contracts</u>
		Subtotals	50	1	51
100 matched to incoming order	0.51	Totals 51	51	Na	51

\* Remainder amount rounded down for this order = 0.40, which is the highest amount of all orders.  
Therefore, this order is the most under allocated and is allocated the residual futures contract.

#### **Appendix A: Option Pricing Models**

For the purposes of providing conversions of volatility to premium option prices and options deltas under Rule 584, CME Globex will use the following option pricing models for European- and American-style options.

#### **Black Option Pricing Model for European-Style Options**

##### **CME Assumptions**

- Applicable interest rate will be based on the nearest to expiration Eurodollar Time Deposit (ED) future contract month
- Price of the underlying futures contract from CME Globex as determined by the methodology detailed in this Interpretation
- Time to expiration in years is  $\frac{\# \text{ of days}}{365}$

##### **Abbreviations used in the formula**

$C$  = call premium  
 $P$  = put premium  
 $U$  = price of the underlying contract (future)  
 $E$  = expiration (strike) price  
 $t$  = time to expiration in years  
 $v$  = annual volatility expressed as a decimal  
 $r$  = interest rate assumption expressed in decimal  
 $e$  = base of the natural logarithm  
 $\ln$  = natural logarithm  
 $N$  = normal standard distribution  
 $h$  = calculated variable (see formula below)

##### **Equations\***

$$C = Ue^{-rt}N(h) - Ee^{-rt}N(h - v\sqrt{t})$$

$$P = -Ue^{-rt}N(-h) + Ee^{-rt}N(v\sqrt{t} - h)$$

$$\text{Where } h = \frac{\ln\left(\frac{U}{E}\right) + \frac{v^2}{2}t}{v\sqrt{t}}$$

$$\text{Call delta} = e^{-rt}N(h)$$

$$\text{Put delta} = -e^{-rt}N(-h)$$

\*Natenberg, S. (1994). *Option Volatility and Pricing*. New York: McGraw-Hill

#### **Whaley Option Pricing Model for American-Style Options**

The following model is based on the Barone-Adesi-Whaley model as described in the *Journal of Finance*, Vol. 42 No.2, pages 301-320. The model uses analytic approximation techniques to solve for the price of the American-style option. The model estimates a value for  $S^*$  which is the underlying price above which the option should be exercised. The value of  $S^*$  is then used to determine the value of the option. For call options, the model estimates  $S^*$  by satisfying the following equation:

$(LHS - RHS) / K < 0.00001$  (Please see notes 1-4 at the end of this section.)

Where

$$LHS = S^* - K$$

$$RHS = c(S, T) + [(1 - e^{(b-r)T}) N(d_1)] (S^* / q_2)$$

$$d_1 = [\ln(S^* / K) + (b + \sigma^2 / 2)T] / \sigma \sqrt{T}$$

$$d_2 = d_1 - \sigma \sqrt{T}$$

$$q_2 = [-(N - 1) + \sqrt{(N - 1)^2 + 4M / k}] / 2$$

$$M = 2 * r / \sigma^2$$

$$N = 2 * b / \sigma^2$$

$$k = 1 - e^{-rT}$$

$N(\cdot)$  is the cumulative univariate normal distribution.

$n(\cdot)$  is the univariate normal density function.

$\sigma$  = volatility (e.g. 10% per annum = 0.10)

$T$  = time until expiration in years (e.g. 90 days = 0.247)

$r$  = interest rate (e.g. 8% per annum = 0.08)

$b$  = cost of carry, assumed to be zero for the purposes of this calculation

$K$  = strike price

$S$  = underlying price

After each iteration, the estimate of  $S^*$  is adjusted by:

$$S_{i+1}^* = [K + RHS - b_i S_i^*] / (1 - b_i)$$

where

$$b_i = e^{(b-r)T} N[d_1(S_i^*)] (1 - 1/q_2) + [1 - e^{(b-r)T} n[d_1(S_i^*)] / \sigma \sqrt{T}] / q_2$$

Once the correct value of  $S^*$  is found, the value of the call and the call's delta are found by solving:

$$C(S, T) = C(S, T) + A_2 (S / S^*)^{q_2}$$

Where

$$A_2 = (S^* / q_2) (1 - e^{(b-r)T} N[d_1(S^*)])$$

$$\Delta = \Delta_e + A_2 * q_2 * (S / S^*)^{q_2} / S$$

$c(S, T)$  = the price of a European style call option.

$\Delta_e$  = the delta of the European style call option.

For put options, the model estimates  $S^*$  by satisfying:

$$(LHS - RHS) / K < 0.00001$$

where

$$LHS = K - S^*$$

$$RHS = p(S, T) - [(1 - e^{(b-r)T} - N(d_1)) * (S^* / q_1)]$$

$$d_1 = [\ln(S^* / K) + (b + \sigma^2 / 2)T] / \sigma \sqrt{T}$$

$$d_2 = d_1 - \sigma \sqrt{T}$$

$$q_1 = [(N - 1) - \sqrt{(N - 1)^2 + 4M / k}] / 2$$

$$M = 2 * r / \sigma^2$$

$$N = 2 * b / \sigma^2$$

$$k = 1 - e^{-rT}$$

N(.) is the cumulative univariate normal distribution.

n(.) is the univariate normal density function.

$\sigma$  = volatility (e.g. 10% per annum = 0.10)

T = time until expiration in years (e.g. 90 days = 0.247)

r = interest rate (e.g. 8% per annum = 0.08)

b = cost of carry, assumed to be zero for the purposes of this calculation

K = strike price

S = underlying price

After each iteration, the estimate of  $S^*$  is adjusted by:

$$S_{i+1}^* = [K - RHS + b_i S_i^*] / (1 + b_i)$$

where

$$b_i = -e^{(b-r)T} N[d_1(S_i^*)] / (1 - 1/q_1) - [1 + e^{(b-r)T} n[d_1(S_i^*)] / \sigma \sqrt{T}] / q_1$$

Once the correct value of  $S^*$  is found, the value of the put and the put's delta are found by solving:

$$P(S, T) = p(S, T) + A_1 (S / S^*)^{q_1}$$

where

$$A_1 = -(S^* / q_1) (1 - e^{(b-r)T} N[d_1(S^*)])$$

$$\Delta = \Delta_e + A_1 * q_1 * (S / S^*)^{q_1} / S$$

p(S, T) = the price of a European style put option.

$\Delta_e$  = the delta of the European style put option.

Note 1. CME Group's Falcon engine goes slightly further in its precision to 0.000001 (one more decimal place).

Note 2. CME Group's Falcon engine also has a maximum number of iterations that it will perform on the equation discussed in Note 1 to fall within the tolerance level. If after 10,000 iterations the Falcon engine calculation is not within a tolerance of 0.000001, it will fall back to the European model instead.

Note 3. CME Group's Falcon engine does not implement any notion of a carrying-cost or foreign interest rate. The  $b$  variable is always equal to zero in the equations. If for some reason the Falcon engine does start to use  $b$ , it is worth noting that if  $b$  is ever greater than or equal to the interest rate  $r$ , the Falcon engine automatically falls back to the European model.

Note 4. CME Group's Falcon engine uses the Black Option Pricing Model (see Appendix A) in place of the Merton Model referred to in the abstract of Giovanni Barone-Adesi and Robert E. Whaley's article in the June 1987 *Journal of Finance* (Volume XLII, No. 2).

End of Interpretation to Rule 584.

## **7. EXCHANGE FEES AND MARKET MAKER PROGRAM APPROVED FOR FX VOLATILITY QUOTED OPTION PRODUCTS, EFFECTIVE SUNDAY, MARCH 9, 2008**

CME Group is introducing a new volatility-quoting convention for FX options on futures contracts on Sunday, March 9, 2008. The exchange has approved its fees and market maker programs for this initiative. In summary,

### **1) FX Volatility Quoted overall all-in fee structure:**

To keep the Volatility-Quoted Options ("VQO") pricing competitive to costs in the OTC market, CME Group set pricing for VQOs at roughly 25% premium above the current FX CME Globex option all-in fees but include a waiver of all fees associated with the auto-hedge Futures leg involved in such transactions. Details of the pricing structure are found below.

### **2) FX Volatility Quoted Market Maker program:**

To help grow VQO liquidity, CME Group created a two-tier Market Maker (MM) program where the MMs will have waived or reduced Globex fees for their VQO trades --depending on the tier they fall in, while still paying the clearing fee component as applicable to their membership status. Additionally, this MM program will also include a waiver of all fees associated with the auto-hedge Futures leg involved in their (VQO) transactions. Details of the Market Maker program are found below.

### **Product Pricing Details:**

CME Group believes that pricing for VQO should be scaled up from current Premium-Quoted Options ("PQO") but include a waiver of all fees associated with the auto-hedge Futures leg involved in such transactions. Specifically the fee for the VQO trade will be as follows:

<b><i>Membership type</i></b>	<b><i>Clearing Fee</i></b>	<b><i>Globex Fee</i></b>	<b><i>All in fee</i></b>
Equity Members/	\$ 0.07	\$ 0.33	\$ 0.40
Rule 106.D Lessees / Rule 106.F Employees	\$ 0.27	\$ 0.23	\$ 0.50
Rule 106.R ECM H	\$ 0.10	\$ 0.45	\$ 0.55

Rule 106.R ECM W	\$ 0.10	\$ 0.64	\$ <b>0.74</b>
Rule 106.H and 106.N Firms	\$0.10/\$0.45	\$ 0.45	\$ <b>0.55</b>
AIP	\$0.10/\$0.45	\$ 0.64	\$ <b>0.74</b>
EIP	\$ 0.10	\$ 0.64	\$ <b>0.74</b>
eFX Bank Incentive Program Participants	\$ 0.10	\$ 0.64	\$ <b>0.74</b>
Korean Bank Incentive Program Participants	\$ 0.10	\$ 0.64	\$ <b>0.74</b>
Customers of Member Firms	\$ 0.60	\$ 0.40	\$ <b>1.00</b>

\*\* note all fees are on a per side basis

Assuming that an average option transaction has a delta of 25%, VQO pricing should be set 25% higher than equivalent rate PQO to compensate for the waiver of the futures fee.<sup>1</sup>

#### **Incentive Program Details:**

CME Group is implementing a Market Maker Incentive Program ("MMIP") for VQO. This program will help secure the participation of qualified market-makers to provide the early liquidity essential for a successful launch of the VQO product. The MMIP is also seen as necessary to mitigate some of the significant, firm-specific IT development costs incurred by the market-makers in order to participate using this new convention. Initially, the match engine for VQO will use a FIFO algorithm, so the MMIP incentives are based strictly on fee reductions or waivers.

The MMIP-VQO will be a two-tier program. The **first tier** will target qualified Lead Market-Makers ("LMM") holding membership status and will provide a limited number (10) of these market-makers with:

- 1) An allowance to submit quotes using the Mass Quote message under an assigned Session ID granted by CME Group staff
- 2) A waiver of all of the Market Maker's CME Globex execution fees for the products traded through the Market-Making Account(s) during the Term. Note Market Makers will still pay the Clearing Fee component for their membership type.

The **second tier** will target qualified Responding Market-Makers ("RMM") that may or may not be Members, and provide a limited number (20) of these market-makers with:

<sup>1</sup> This pricing structure of charging for the option but not the hedge also mirrors the structure used in the OTC and is thus beneficial from a marketing perspective. Using Member rates and a 25% delta option as a basis for comparison, an example follows:

**PQO – Option \$0.32** [Globex=\$0.25 + Clearing=\$0.07] **+ Hedge \$0.08** [0.25(delta)\*\$0.32(futures fee)] = **\$0.40**

**VQO - Option \$0.40** [Globex=\$0.31 + Clearing=\$0.09] **+ Hedge \$0.00** [0.25(delta)\*\$0(futures fee waiver)] = **\$0.40**

Although CME Group is not charging explicitly for the Futures options delta hedge, the exchange believes that VQO will contribute to new incremental Futures revenues as a portion of the accumulated delta hedges will be unwound and fee generating.

- 1) A discount of up to 50% of Market Maker's CME Globex execution fees for the products traded through the Market-Making Account(s) during the Term. Note Market Makers will still pay the Clearing Fee component for their membership type.

LMMs will be required to provide extensive streaming quote liquidity coverage; RMMs will be designated to provide targeted liquidity based on Request-For-Quotes ("RFQ") and specialized currency coverage capability (*i.e.*, a Canadian bank covering CD options).

CME Group Products and Services Division staff will qualify market-makers based on their financial and organizational ability to fulfill the performance obligations defined within the market-maker agreement, and will review such performance throughout the agreement period. The MMIP will be effective until December 31, 2008.

If you have any questions, please contact Craig LeVeille, Director, FX Group, at 312-930-5301 or via email at [Craig.LeVeille@cmegroup.com](mailto:Craig.LeVeille@cmegroup.com) or Steve Youngren, Associate Director, Financial Product Development, at 312-930-4583 or via e-mail at [Steve.Youngren@cmegroup.com](mailto:Steve.Youngren@cmegroup.com).

## 8. Volatility-Quoted FX Options

Launch date: March 9, 2008

Vendor Name	System Name											
		Australian Dollar (American) MONTHLY	Australian Dollar (American) WEEKLY	British Pound (American) MONTHLY	British Pound (American) WEEKLY	British Pound (European) MONTHLY	British Pound (European) WEEKLY	Canadian Dollar (American) MONTHLY	Canadian Dollar (American) WEEKLY	Canadian Dollar (European) MONTHLY	Canadian Dollar (European) WEEKLY	Euro FX (American) MONTHLY
		V6A	VA1 - VA5	V6B	VB1 - VB5	VXB	VBA – VBE	V6C	VC1 - VC5	VXC	VCA - VCE	V6E
Bloomberg	Bloomberg	VADA	N/A	VBPA	N/A	VBEA	N/A	VCDA	N/A	VCEA	N/A	VEUA
CQG Inc.	CQG for Windows	V6A	N/A	V6B	N/A	N/A	N/A	V6C	N/A	N/A	N/A	V6E
Data Transmission Network		@6A	N/A	@6B	N/A	N/A	N/A	@6C	N/A	N/A	N/A	@6E
E-Signal	eSignal	V6A	VA1 - VA5	V6B	VB1 - VB5	VXB	VBA – VBE	V6C	VC1 - VC5	VXC	VCA - VCE	V6E
Reuters	IDN (ETH)	0#VA+	0#VAW+	0#BV+	0#VBW+	0#VBE+	0#BEW+	0#CV+	0#VCW+	0#VCE+	0#VCE+	0#VE+
Bridge	BIS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Track Data	MX	V6A'	N/A	V6B'	N/A	VXB'	N/A	V6C'	N/A	VXC'	N/A	V6E'
TradeStation		V6A	VA1 - VA5	V6B	VB1 - VB5	VXB	VBA - VBE	V6C	VC1 - VC5	VXC	VCA - VCE	V6E

## 8. Volatility-Quoted FX Options (Continued)

Vendor Name	System Name											
		Euro FX (American) WEEKLY	Euro FX (European) MONTHLY	Euro FX (European) WEEKLY	Japanese Yen (American) MONTHLY	Japanese Yen (American) WEEKLY	Japanese Yen (European) MONTHLY	Japanese Yen (European) WEEKLY	Swiss Franc (American) MONTHLY	Swiss Franc (American) WEEKLY	Swiss Franc (European) MONTHLY	Swiss Franc (European) WEEKLY
		VE1 - VE5	VXT	VTA - VTE	V6J	VJ1 - VJ5	VXJ	VJA - VJE	V6S	VS1 - VS5	VXS	VSA - VSE
Bloomberg	Bloomberg	N/A	VEEA	N/A	VJYA	N/A	VJEA	N/A	VSFA	N/A	VSEA	N/A
CQG Inc.	CQG for Windows	N/A	N/A	N/A	V6J	N/A	N/A	N/A	V6S	N/A	N/A	N/A
Data Transmission Network		N/A	N/A	N/A	@6J	N/A	N/A	N/A	@6S	N/A	N/A	N/A
E-Signal	eSignal	VE1 - VE5	VXT	VTA - VTE	V6J	VJ1 - VJ5	VXJ	VJA - VJE	V6S	VS1 - VS5	VXS	VSA - VSE
Reuters	IDN (ETH)	0#VEW+	0#VEE+	0#VTW+	0#VJ+	0#VJW+	0#VJE+	0#JVW+	0#VSA+	0#VSW+	0#SVE+	0#SEW+
Bridge	BIS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Track Data	MX	N/A	VXT'	N/A	V6J'	N/A	VXJ'	N/A	V6S'	N/A	VXS'	N/A
TradeStation		VE1 - VE5	VXT	VTA - VTE	V6J	VJ1 - VJ5	VXJ	VJA - VJE	V6S	VS1 - VS5	VXS	VSA - VSE