Cboe
VIX

Volatility Index®Methodology:

Cboe Volatility Index®

Contents

Introduction

In 1993, Cboe Global Markets, Incorporated® (Cboe®) introduced the Cboe Volatility Index® (VIX® Index). Originally designed to measure the market's expectation of 30-day volatility implied by at-the-money S&P 100® Index (OEX® Index) option prices, the VIX Index soon became the premier benchmark for U.S. stock market volatility. It is regularly featured in the Wall Street Journal, Barron's, and other leading financial publications, as well as business news shows on CNBC, Bloomberg TV, and CNN/Money, where the VIX Index is often referred to as the "fear gauge."

Ten years later in 2003, Cboe collaborated with Goldman Sachs to update the VIX Index. The changes reflected a new way to measure expected volatility, a methodology that continues to be widely used by financial theorists, risk managers, and volatility traders alike. The new VIX Index is based on the S&P 500® Index, the core index for U.S. equities, and estimates expected volatility by aggregating the weighted prices of S&P 500 Index puts and calls (SPX™ options) over a wide range of strike prices. By supplying a script for replicating volatility exposure with a portfolio of SPX options, this new methodology transformed the VIX Index from an abstract concept into a practical standard for trading and hedging volatility.

Volatility as a Tradable Asset: VIX Futures & Options
On March 24, 2004, Cboe introduced the first exchange-traded VIX futures contract on its new, all-electronic Cboe Futures Exchange (CFE®). Two years later in February 2006, VIX options were launched for trading on Cboe Options Exchange (C1).

The negative correlation of volatility to stock market returns is well-documented and suggests a diversification benefit to including volatility in an investment portfolio. VIX futures and options are designed to isolate expected volatility exposure in a single, efficient package. C1 and CFE provide continuous, liquid, and transparent markets for VIX products that are available to investors.

The rules and procedures applied to calculate the final settlement value VIX derivatives vary slightly from that of the spot VIX Index calculation. For more information about those differences, refer to the section The Calculation of the Final Settlement Value for VIX Derivatives below.

Supporting Documents
This Methodology references and should be read in conjunction with the following document:

 Cboe Volatility Index Mathematics Methodology

The VIX Index Attributes
In this section, some of the configurations used for the Cboe Volatility Index® (VIX® Index) are provided.

Contracts Used for the Near and Next Terms and Their Selection Method

The table below provides the attributes used for the near and next term selection for the VIX Index.

Index	Constant Maturity	Set of Contracts Used for Constituent Series Selection	Selection Method
VIX	30 days	AM-settled SPX option contracts and PM-settled SPXW option contracts expiring at end of week, excluding the ones expiring on the same date as AM-settled SPX option contracts.	**30 Day Bracket Method**

Table Key
- Constant Maturity: reflects the target expected volatility term
- Set of Contracts Used for Constituent Series Selection: provides the initial set of series that are candidates for the near and next term selection

Market Data

The table below provides the source of the market data for all options series used in the VIX Index calculation. The market data used can be sourced from a specific exchange, from a subset of exchanges or from among all available exchanges or trading venues reflecting the (National) Best Bid/Offer ((N)BBO) quotes.

Index	Market data source
VIX	Cboe Options Exchange (C1) only

Calculation and Dissemination

The calculation and dissemination of volatility index values is determined by trading session, e.g., regular trading hours (RTH), global trading hours (GTH) or both. The trading session(s) and approximate dissemination and calculation time periods are listed below. These times may be modified due to shortened trading sessions, e.g., shortened holiday trading hours. Calculation and dissemination occur approximately four times per minute.

Index	Trading Session(s)	Approximate Calculation and Dissemination Time Period
VIX	RTH	Between 9:31 a.m. and 4:15 p.m. ET
	GTH	Between 3:15 a.m and 9:15 a.m. ET

The VIX Index Calculation: Step-by-Step

Stock indexes, such as the S&P 500 Index, are calculated using the prices of their component stocks. Each index employs rulesthat govern the selection of component securities and a formula to calculate index values.

The VIX Index is a volatility index comprised of options rather than stocks, with the price of each option reflecting the market's expectation of future volatility. Like conventional indexes, the VIX Index calculation employs rules for selecting component options and a formula to calculate index values.

The generalized formula used in the VIX Index calculation[§] is:

$$\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0}-1\right]^2$$

where

σ	$VIX\ index = \sigma \times 100$

T Time to expiration (in years)

F Option-implied forward price

K_0 First strike equal to or otherwise immediately below the forward index level, F

K_i Strike price of the ith out-of-the-money option; a call if $K_i > K_0$ and a put if $K_i < K_0$; both put and call if $K_i = K_0$.

ΔK_i Interval between strike prices – half the difference between the strike on either side of K_i:

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$$

R Risk-free interest rate to expiration

$Q(K_i)$ The midpoint of the bid-ask spread for each option with strike K_i.

[§] *Please see "More than you ever wanted to know about volatility swaps" by Kresimir Demeterfi, Emanuel Derman, Michael Kamal, and Joseph Zou, Goldman Sachs Quantitative Strategies Research Notes, March 1999.*

The VIX Index measures 30-day expected volatility of the S&P 500 Index. The calculation takes as input the market prices of SPX options and SPXW options as well as U.S. Treasury yield curve rates. The VIX Index value can be obtained by following the four steps below:

Step 1. Select the Near- and Next-Term

The inputs required for this step are provided in the above section, "Contracts Used and Exclusion Criteria for the Near and Next Terms." The universe of options that can be selected as components of the VIX Index are all AM-settled SPX option contracts and PM-settled SPXW option contracts expiring at end of week, excluding the ones expiring on the same date as AM-settled SPX option contracts. Using a constant maturity term of 30 days, apply the rules for selecting the correct near- and next-terms found in section 1(a) Bracket Method of the Cboe Volatility Index Mathematics Methodology document.

Step 2. Calculate the Interest Rates

The risk-free interest rates, R1 and R2, are based on U.S. Treasury yield curve rates (commonly referred to as "Constant Maturity Treasury" rates, or CMTs), to which a cubic spline is applied to derive yields on the expiration dates of relevant SPX options. As such, the VIX Index calculation may use different risk-free interest rates for near- and next-term options. The rules for calculating the interest rates for the near- and next-terms can be found in section 2(a) Interest Rate Calculation – Bounded Cubic Spline Interpolation of the Cboe Volatility Index Mathematics Methodology.

Step 3. Calculate the Near- and Next-Term Variances

The inputs for calculating the variances (σ^2) for both terms are based on the options series defined in Step 1 above. These include the corresponding bid, ask, and options price for each options series, where options price is defined as the midpoint of the bid / ask quotes, and the corresponding interest rates defined in Step 2 above. Given these inputs, the variances for the near- and next-terms can be calculated by following the steps outlined in section 3(a) Volatility Index Calculation – Single Term of the Cboe Volatility Index Mathematics Methodology.

Step 4. Calculate the VIX Index

The inputs for calculating the VIX Index are based on the near- and next-term expiration dates defined in Step 1 above, the variances for each term calculated in Step 3 above, and the constant maturity term of 30 days. Given these inputs, the VIX Index can be calculated by following the steps outlined in section 3(b) Volatility Index Calculation – Constant Maturity Term of the Cboe Volatility Index Mathematics Methodology.

Sample Calculation for the VIX Index

In this section, we implement a sample calculation for the VIX Index using the process outlined above.

- **Select the Near- and Next-Term Constituent Series**
  In this hypothetical example, assume that the calculation is performed on trade date of September 27th, 2022 at 10:45:15 a.m. ET. Given the inputs described in the Step 1 above, and the methodology in section 1(b) of the Cboe Volatility Index Mathematics Methodology, the selected terms for this calculation are the "standard" SPX options expiring on October 21st, 2022 for the near term and the P.M.-settled SPX Weeklys expiring on the following week (October 28, 2022) for the next term. In this example, the near-term SPX constituent series expire in 24 calendar days and the next-term SPXW constituent series expire in 31 calendar days.

- **Calculate the Interest Rates**

  Assume that the yield curve rates provided below are available on September 26th, 2022 at the end of the day.

Date	1 Mo	2 Mo	3 Mo	6 Mo	1 Yr	2 Yr	3 Yr	5 Yr	7 Yr	10 Yr	20 Yr	30 Yr
9/26/2022	0.03	0.02	0.04	0.05	0.08	0.11	0.22	0.59	1	1.37	2.03	2.21

  Given these yield curve rates, and the rules outlined in the section 2(a) of the Cboe Volatility Index Mathematics Methodology, the results are R_1 = 0.031664% for the near-term options and R_2 = 0.028797% for the next-term options.

- **Calculate the Single Term Variances**

  Time to Expiration

  Note that "standard" SPX options are deemed to expire at the open of trading (i.e., 9:30 a.m. ET) on their expiration date (the third Friday of the month or the day before if Holiday). "Weekly" SPXW options are deemed to expire at the close of trading (i.e., 4:00 p.m. ET) on their expiration dates (typically every Friday except third Fridays of the month or the day before if Holiday).

  Following the steps in Time to Expiration of section 3(a)(i) Volatility Index Calculation – Single Term in the Cboe Volatility Index Mathematics Methodology and applying 10:45:15 a.m. ET as the time of the calculation, the time to expiration for the near-term and next-term options, T_1 and T_2, respectively, are:

$$T_1 = 34{,}484 \ / \ 525{,}600 = \ 0.0656088$$

$$T_2 = 44{,}954 \ / \ 525{,}600 = \ 0.0855289$$

  Forward Price and K_0

  Using the call and put prices for the near-term and next-term options below and following the steps in **Forward Price and K_0** in section 3(a)(ii) Volatility Index Calculation – Single Term of the Cboe Volatility Index Mathematics Methodology, we can calculate the forward price and K_0.

Near-Term Options			
Strike Price	Call	Put	Difference
1940	38.45	15.25	23.20
1945	34.70	16.55	18.15
1950	31.10	18.25	12.85
1955	27.60	19.75	7.85
1960	24.25	21.30	2.95
1965	**21.05**	**23.15**	**2.10**
1970	18.10	25.05	6.95
1975	15.25	27.30	12.05
1980	12.75	29.75	17.00

Next-Term Options			
Strike Price	Call	Put	Difference
1940	41.05	18.80	22.25
1945	37.45	20.20	17.25
1950	34.05	21.60	12.45
1955	30.60	23.20	7.40
1960	**27.30**	**24.90**	**2.40**
1965	24.15	26.90	2.75
1970	21.10	28.95	7.85
1975	18.30	31.05	12.75
1980	15.70	33.50	17.80

  The ATM strike for the near-term options is **1965** and the ATM strike for the next-term options is **1960**. Applying their respective call and put prices to the formula

$$F = \text{Strike Price} \ + \ e^{RT} \ \times (\text{Call Price} - \text{Put Price})$$

gives that the forward index prices, F_1 and F_2, for the near- and next-term options, respectively, are:

$$F_1 = 1965 + e^{(0.000317 \times 0.0656088)} \times (21.05 - 23.15) = 1962.89996$$

$$F_2 = 1960 + e^{(0.000288 \times 0.0855289)} \times (27.30 - 24.90) = 1962.40006$$

We have then that K_0, the strike price equal to or immediately below the forward index level F, is **1960** for the near-term options and **1960** for the next-term options.

Strike Selection

To determine the strikes to be included in this calculation, refer to the steps in Strike Selection of section 3(a)(iii) Volatility Index Calculation – Single Term in the Cboe Volatility Index Mathematics Methodology.

First, for each term, select out-of-the-money put options with strike prices less than K_0. Start with the put strike immediately lower than K_0 and move to successively lower strike prices. Exclude any put option that has a bid price equal to zero (i.e., no bid). As shown below, once two puts with consecutive strike prices are found to have zero bid prices, exclude the observed put(s) and consider no puts with lower strikes for inclusion. (Note that the 1350 and 1355 put options are not included despite having non-zero bid prices.)

Put Strike	Bid	Ask	Include?
1345	0	0.15	Not considered following two zero bids
1350	**0.05**	**0.15**	
1355	**0.05**	**0.35**	
1360	0	0.35	No
1365	0	0.35	No
1370	0.05	0.35	Yes
1375	0.1	0.15	Yes
1380	0.1	0.2	Yes

Next, select out-of-the-money call options with strike prices greater than K_0. Start with the call strike immediately higher than K_0 and move to successively higher strike prices, excluding call options that have a bid price of zero (i.e., no bid). As with the puts, once two call options with consecutive strike prices are found to have zero bid prices, exclude the observed call(s) and consider no calls with higher strikes for inclusion. (Note that the 2225 call option is not included despite having a non-zero bid price.)

Call Strike	Bid	Ask	Include?
2095	0.05	0.35	Yes
2100	0.05	0.15	Yes
2120	0	0.15	No
2125	0.05	0.15	Yes
2150	0	0.1	No
2175	0	0.05	No
2200	0	0.05	Not considered following two zero bids
2225	**0.05**	**0.1**	
2250	0	0.05	

Finally, select **both** the put and call with strike price K_0. Notice that two options are selected at K_0, while a single option, either a put or a call, is used for every other strike price.

The following tables contain the options used to calculate the VIX Index in this example. This calculation uses the midpoint of quoted bid and ask prices for each option selected. The K_0 put and call prices are averaged to produce a single value. The price used for the 1960 strike in the near-term is, therefore, (24.25 + 21.30) / 2 = 22.775. The price used for the 1960 strike in the next term is (27.30 + 24.90) / 2 = 26.10.

Near-Term Strike	Option Type	Midpoint Price
1370	Put	0.2
1375	Put	0.125
1380	Put	0.15
.	.	.
1950	Put	18.25
1955	Put	19.75
1960	**Put/Call Average**	**22.775**
1965	Call	21.05
1970	Call	18.1
.	.	.
2095	Call	0.2
2100	Call	0.1
2125	Call	0.1

Next-Term Strike	Option Type	Midpoint Price
1275	Put	0.075
1325	Put	0.15
1350	Put	0.15
.	.	.
1950	Put	21.60
1955	Put	23.20
1960	**Put/Call Average**	**26.10**
1965	Call	24.15
1970	Call	21.10
.	.	.
2125	Call	0.1
2150	Call	0.1
2200	Call	0.08

Calculating Volatility

The VIX Index is an amalgam of the information reflected in the prices of all of the selected options. The contribution of a single option to the VIX Index value is proportional to ΔK and the price of that option, and inversely proportional to the square of the option's strike price.

Referring to Calculating Volatility of section 3(a)(iv) Volatility Index Calculation – Single Term of the Cboe Volatility Index Mathematics Methodology, we generally have that ΔK_i is half the difference between the strike prices on either side of K_i. For example, the ΔK for the next-term 1325 Put is 37.5: $\Delta K_{1325\,Put} = (1350 - 1275) / 2$. At the upper and lower edges of any given strip of options, ΔK_i is simply the difference between K_i and the adjacent strike price. In this example, the 1370 Put is the lowest strike in the strip of near-term options and 1375 is the adjacent strike. Therefore, $\Delta K_{1370\,Put} = 5$ (i.e., 1375 – 1370).

The contribution of the near-term 1370 Put is given by:

$$\frac{\Delta K_{1370\,Put}}{K_{1370\,Put}^2}\, e^{R_1 T_1} Q(1370\,Put)$$

$$\frac{\Delta K_{1370\,Put}}{K_{1370\,Put}^2}\, e^{R_1 T_1} Q(1370\,Put) = \frac{5}{(1370)^2}\, e^{0.000317\,(0.0656088)}(0.2) = 0.0000005328$$

A similar calculation is performed for each option. The resulting values for the near-term options are then summed and multiplied by $2/T_1$. Likewise, the resulting values for the next-term options are summed and multiplied by $2/T_2$. The tables below summarize the results for each set of options.

Near-Term Strike	Option Type	Midpoint Price	Contribution by Strike
1370	Put	0.2	0.0000005328
1375	Put	0.125	0.0000003306
1380	Put	0.15	0.0000003938
.	.	.	.
1950	Put	18.25	0.0000239979
1955	Put	19.75	0.0000258376
1960	**Put/Call Average**	**22.775**	**0.0000296432**
1965	Call	21.05	0.0000272588
1970	Call	18.1	0.0000233198
.	.	.	.
2095	Call	0.2	0.0000002278
2100	Call	0.1	0.0000003401
2125	Call	0.1	0.0000005536
$\frac{2}{T_1}\sum_i \frac{\Delta K_i}{K_i^2} e^{R_1 T_1} Q(K_i)$			**0.019267**

Next-Term Strike	Option Type	Midpoint Price	Contribution by Strike
1275	Put	0.075	0.0000023069
1325	Put	0.15	0.0000032041
1350	Put	0.15	0.0000020577
.	.	.	.
1950	Put	21.6	0.0000284031
1955	Put	23.2	0.0000303512
1960	**Put/Call Average**	**26.1**	**0.0000339711**
1965	Call	24.15	0.0000312732
1970	Call	21.1	0.0000271851
.	.	.	.
2125	Call	0.1	0.0000005536
2150	Call	0.1	0.0000008113
2200	Call	0.075	0.0000007748
$\frac{2}{T_2}\sum_i \frac{\Delta K_i}{K_i^2} e^{R_2 T_2} Q(K_i)$			**0.019441**

Next calculate $\frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2$ for the near-term (T_1) and next-term (T_2):

$$\frac{1}{T_1}\left[\frac{F_1}{K_{0,1}} - 1\right]^2 = \frac{1}{0.0656088}\left[\frac{1962.89996}{1960} - 1\right]^2 = 0.00003337$$

$$\frac{1}{T_2}\left[\frac{F_2}{K_{0,2}} - 1\right]^2 = \frac{1}{0.0855289}\left[\frac{1962.40006}{1960} - 1\right]^2 = 0.00001753$$

Now calculate σ^2_1 and σ^2_2:

$$\sigma_1^2 = \frac{2}{T_1}\sum_i \frac{\Delta K_i}{K_i^2} e^{R_1 T_1} Q(K_i) - \frac{1}{T_1}\left[\frac{F_1}{K_{0,1}} - 1\right]^2 = 0.019267 - 0.00003337 = 0.019233906$$

$$\sigma_2^2 = \frac{2}{T_2}\sum_i \frac{\Delta K_i}{K_i^2} e^{R_2 T_2} Q(K_i) - \frac{1}{T_2}\left[\frac{F_2}{K_{0,2}} - 1\right]^2 = 0.019441 - 0.00001753 = 0.019423884$$

- **Calculate the VIX Index**

The VIX Index value is now calculated by following section 3(b) Volatility Index Calculation – Constant Maturity Term of the Cboe Volatility Index Mathematics Methodology. First, calculate the 30-day weighted average of σ^2_1 and σ^2_2. Then take the square root of that value and multiply by 100:

$$VIX = 100 \times \sqrt{\left\{0.0656088 \times 0.019233906 \times \left[\frac{44,954 - 43,200}{44,954 - 34,484}\right] + 0.0855289 \times 0.019423884 \times \left[\frac{43,200 - 34,484}{44,954 - 34,484}\right]\right\} \times \frac{525,600}{43,200}}$$

VIX = 100 × 0.13927842 = 13.93

Volatility Index Filtering Algorithm

As described above, "spot" VIX Index values are based on the average of SPX/SPXW option bid / ask quotes ("mid-quote" prices), and only options that have a non-zero bid price are included. The bid-ask spread is generally accepted as a current indication of market price, and the average of the bid and ask quotes can be thought of as an indication of "fair" value. Spot VIX Index values are calculated using mid-quote options prices.

From time to time, options price quotations widen due to changing market conditions, technology failures, or other reasons. When this occurs, options that were previously included in a VIX Index value calculation might be excluded due to them now having a zero bid price. In other instances, the mid-quote prices of one or more SPX/SPXW options might materially change.This can result in a VIX Index value that, while accurately reflecting SPX/SPXW options quotes at the time, may not reflect the expected volatility of the S&P 500 Index. Cboe uses a filtering algorithm to address these circumstances.

For the rules that guide this filtering process, refer to the details given in section "Index Level Filtering Algorithm" of the Cboe Volatility Index Mathematics Methodology. At a minimum annually, we review the thresholds used in the Index Level Filtering Algorithm to consider their reflection of market conditions, and may, in our discretion, change these thresholds as a result, by notice to clients from time to time. The inputs itemized below apply to the VIX Index:

Index	Session	Threshold Level (x)	Threshold Period
VIX	RTH	0.50 volatility points	2 minutes
VIX	GTH	0.50 volatility points	5 minutes

Exception When VIX Index Cannot be Calculated

In the event the VIX Index cannot be calculated, the last calculated and disseminated spot VIX Index value is republished until a new valid spot VIX Index can be calculated. The conditions that would prevent the VIX Index from being calculated can be found in sections 3(a) (ii) and (iii) Volatility Index Calculation – Single Term of the Cboe Volatility Index Mathematics Methodology. A summary can also be found in the section 4(b) Volatility Index Cannot be Calculated of the Cboe Volatility Index Mathematics Methodology.

The Calculation of the Final Settlement Value for VIX Derivatives

The final settlement value for VIX futures and options is determined on the morning of their expiration date (usually a Wednesday) through a Special Opening Quotation ("SOQ") of the VIX Index. There are several ways in which the calculation of the SOQ of the VIX Index differs from the calculation of the spot VIX Index at all other times.

- The SOQ calculation uses SPX, or SPXW, options from a single expiration 30 calendar days for the subject settlement day. Unlike the spot VIX Index calculation at other times, the SOQ calculation does not involve theinterpolation of volatility calculated with near-term and next-term options.

- Unlike the spot VIX Index calculation at other times, the determination of the strike range used for the SOQ calculation does not depend on whether options with consecutive strikes have zero bid prices. Cboe determines and announces the highest call strike and the lowest put strike that establish the "strike range" to be used in the SOQ calculation. It does so by using an algorithm to determine the call with the highest strike and the put with the lowest strike to be used in that calculation. The strike prices used in the SOQ calculation include all put options within the strike range that have a strike price less than K_0, all call options within the strike range that have a strike price greater than K_0, and both the put and call options that have a strike price

equal to K_0. Importantly, options within the Cboe-determined strike range with a zero bid price are eligible to be included in the SOQ calculation, which also differs from the calculation of the spot VIX Index at other times.

- The SOQ calculation uses the "opening trade price" of each of the selected options, as determined pursuant to Cboe's rules during the special opening auction that Cboe conducts on days when VIX derivatives settle. This approach is different from the mid-quote prices that are used to calculate the spot VIX Index at all other times. Cboe uses the mid-quote price in the SOQ calculation only if a selected option does not have an opening price, in which case Cboe uses the midpoint price of the highest bid and lowest offer at the time of the opening. When calculating the forward index price, the mid-quote price is based on the best-bid and best-offer (BBO).

For more information about VIX Derivatives settlement, visit http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/vix-faqs.

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Appendix 1: Complete SPX/SPXW Option Data Used in Sample VIX Index Calculation

Option series included in the VIX Index calculation are highlighted.

Near-Term Options				
Strike	Calls		Puts	
	Bid	Ask	Bid	Ask
800	1160.90	1164.40	0.00	0.10
900	1060.90	1064.50	0.00	0.10
1000	961.00	964.50	0.00	0.10
1050	911.00	914.50	0.00	0.10
1100	861.00	864.60	0.00	0.05
1125	836.00	839.60	0.00	0.05
1150	811.00	814.60	0.00	0.05
1175	786.10	789.60	0.00	0.05
1200	761.10	764.60	0.00	0.05
1220	741.10	744.60	0.00	0.10
1225	736.10	739.60	0.00	0.05
1240	721.10	724.60	0.00	0.10
1250	711.10	714.60	0.00	0.05
1260	701.10	704.60	0.00	0.10
1270	691.10	694.60	0.00	0.10
1275	686.10	689.60	0.00	0.10
1280	681.10	684.60	0.00	0.10
1290	671.10	674.70	0.00	0.10
1300	661.10	664.70	0.05	0.10
1305	656.10	659.70	0.00	0.10
1310	651.10	654.70	0.00	0.10
1315	646.10	649.70	0.00	0.10
1320	641.20	644.70	0.00	0.10
1325	636.20	639.70	0.05	0.10
1330	631.20	634.70	0.00	0.10
1335	626.20	629.70	0.00	0.15
1340	621.20	624.70	0.00	0.15
1345	616.20	619.70	0.00	0.15
1350	611.20	614.70	0.05	0.15
1355	606.20	609.70	0.05	0.35
1360	601.20	604.70	0.00	0.35
1365	596.20	599.70	0.00	0.35
1370	591.20	594.70	0.05	0.35
1375	586.20	589.70	0.10	0.15
1380	581.20	584.70	0.10	0.20
1385	576.20	579.70	0.10	0.35
1390	571.20	574.70	0.10	0.35
1395	566.20	569.70	0.10	0.15
1400	561.20	564.80	0.10	0.15
1405	556.20	559.80	0.00	0.35
1410	551.20	554.80	0.05	0.40
1415	546.20	549.80	0.00	0.40
1420	541.20	544.80	0.05	0.40
1425	536.30	539.80	0.15	0.20

Next-Term Options				
Strike	Calls		Puts	
	Bid	Ask	Bid	Ask
1225	735.90	738.80	0.00	0.10
1250	710.80	713.80	0.00	0.10
1275	686.00	688.70	0.05	0.10
1300	660.90	663.80	0.00	0.10
1325	635.90	638.60	0.10	0.20
1350	610.90	613.60	0.10	0.20
1375	585.90	588.70	0.10	0.25
1400	561.00	563.70	0.15	0.25
1425	536.00	538.80	0.20	0.30
1450	511.10	513.80	0.25	0.35
1475	486.10	488.90	0.30	0.40
1500	461.20	464.00	0.35	0.45
1510	451.30	454.00	0.35	0.50
1520	441.30	444.00	0.40	0.50
1525	436.30	439.10	0.40	0.55
1530	431.30	434.10	0.45	0.55
1540	421.40	424.10	0.45	0.60
1550	411.40	414.20	0.50	0.60
1555	406.40	409.20	0.50	0.65
1560	401.40	404.20	0.55	0.65
1565	396.50	399.20	0.55	0.70
1570	391.20	394.00	0.60	0.70
1575	386.50	389.30	0.60	0.75
1580	381.50	384.30	0.60	0.75
1585	376.60	379.30	0.65	0.75
1590	371.30	374.10	0.65	0.80
1595	366.60	369.40	0.70	0.80
1600	361.60	364.40	0.70	0.85
1605	356.70	359.40	0.75	0.85
1610	351.70	354.50	0.75	0.90
1615	346.70	349.50	0.80	0.90
1620	341.80	344.50	0.80	0.95
1625	336.80	339.50	0.85	0.95
1630	331.80	334.60	0.90	1.00

	Near-Term Options (cont.)			
Strike	**Calls**		**Puts**	
	Bid	**Ask**	**Bid**	**Ask**
1430	531.30	534.80	0.05	0.40
1435	526.30	529.80	0.15	0.40
1440	521.30	524.80	0.05	0.30
1445	516.30	519.80	0.05	0.40
1450	511.30	514.80	0.15	0.25
1455	506.30	509.80	0.05	0.45
1460	501.30	504.80	0.05	0.45
1465	496.30	499.80	0.05	0.45
1470	491.30	494.80	0.05	0.45
1475	486.30	489.90	0.15	0.25
1480	481.30	484.90	0.05	0.45
1485	476.30	479.90	0.20	0.50
1490	471.30	474.90	0.05	0.30
1495	466.40	469.90	0.05	0.50
1500	461.40	464.90	0.25	0.40
1505	456.40	459.90	0.30	0.35
1510	451.40	454.90	0.05	0.55
1515	446.40	449.90	0.05	0.55
1520	441.40	445.00	0.10	0.60
1525	436.40	440.00	0.30	0.40
1530	431.40	435.00	0.05	0.60
1535	426.40	430.00	0.10	0.65
1540	421.40	425.00	0.10	0.65
1545	416.50	420.00	0.10	0.65
1550	411.50	415.00	0.30	0.70
1555	406.50	410.10	0.15	0.70
1560	401.50	405.10	0.15	0.70
1565	396.50	400.10	0.15	0.70
1570	391.50	395.10	0.20	0.75
1575	386.50	390.10	0.35	0.75
1580	381.50	385.10	0.25	0.80
1585	376.60	380.20	0.25	0.80
1590	371.60	375.20	0.25	0.80
1595	366.60	370.20	0.25	0.80
1600	361.60	365.20	0.50	0.85
1605	356.60	360.30	0.30	0.85
1610	351.60	355.30	0.35	0.90
1615	346.70	350.30	0.35	0.90
1620	341.70	345.30	0.35	0.90
1625	336.70	340.40	0.40	0.95
1630	331.70	335.40	0.40	0.95
1635	326.70	330.40	0.45	1.00
1640	321.80	325.40	0.45	1.00
1645	316.80	320.50	0.50	1.05
1650	311.80	315.50	0.50	0.85
1655	306.80	310.50	0.55	1.10
1660	301.90	305.60	0.55	1.10
1665	296.90	300.60	0.60	1.15

	Next-Term Options (cont.)			
Strike	**Calls**		**Puts**	
	Bid	**Ask**	**Bid**	**Ask**
1635	326.90	329.60	0.90	1.05
1640	321.90	324.70	0.95	1.05
1645	316.90	319.70	0.95	1.10
1650	312.00	314.70	1.00	1.15
1655	307.00	309.80	1.05	1.15
1660	302.10	304.80	1.10	1.20
1665	297.10	299.90	1.15	1.25
1670	292.20	294.90	1.15	1.30
1675	287.20	289.90	1.20	1.35
1680	282.30	285.00	1.25	1.40
1685	277.30	280.10	1.30	1.45
1690	272.40	275.10	1.35	1.50
1695	267.40	270.20	1.40	1.55
1700	262.50	265.20	1.45	1.60
1705	257.50	260.30	1.50	1.70
1710	252.60	255.30	1.60	1.75
1715	247.70	250.40	1.65	1.80
1720	242.70	245.50	1.70	1.90
1725	237.80	240.60	1.75	1.95
1730	232.90	235.60	1.85	2.00
1735	228.00	230.70	1.90	2.10
1740	223.40	225.30	2.00	2.20
1745	218.50	220.40	2.10	2.25
1750	213.60	215.50	2.20	2.35
1755	208.70	210.60	2.30	2.45
1760	203.80	205.70	2.40	2.55
1765	198.90	200.80	2.50	2.65
1770	194.00	195.90	2.65	2.80
1775	189.20	191.10	2.75	2.90
1780	184.30	185.80	2.90	3.10
1785	179.40	180.90	3.00	3.20
1790	174.60	176.10	3.10	3.40
1795	169.70	171.20	3.30	3.60
1800	164.90	166.40	3.50	3.70
1805	160.10	161.60	3.70	3.90
1810	155.30	156.70	3.80	4.10
1815	150.50	152.00	4.10	4.30
1820	145.70	147.20	4.30	4.50
1825	140.90	142.40	4.50	4.80
1830	136.20	137.70	4.80	5.00
1835	131.50	132.90	5.00	5.30
1840	126.80	128.20	5.30	5.60
1845	122.10	123.50	5.60	5.90
1850	117.40	118.80	5.90	6.20
1855	112.80	114.20	6.30	6.60
1860	108.20	109.60	6.60	6.90
1865	103.60	105.00	7.00	7.30
1870	99.00	100.40	7.50	7.80

Near-Term Options (cont.)

Strike	Calls		Puts	
	Bid	Ask	Bid	Ask
1670	291.90	295.70	0.60	1.15
1675	287.00	290.70	0.65	1.20
1680	282.00	285.70	0.70	1.25
1685	277.00	280.80	0.75	1.30
1690	272.10	275.80	0.75	1.30
1695	267.10	270.90	0.80	1.35
1700	262.10	265.90	0.85	1.40
1705	257.20	261.00	0.85	1.40
1710	252.20	256.00	0.90	1.45
1715	247.30	251.10	0.95	1.50
1720	242.30	246.10	1.00	1.55
1725	237.40	241.20	1.05	1.60
1730	232.40	236.30	1.10	1.65
1735	227.50	231.30	1.15	1.70
1740	222.50	226.40	1.20	1.75
1745	217.60	221.50	1.25	1.85
1750	212.60	216.60	1.30	1.90
1755	207.70	211.60	1.40	1.95
1760	202.80	206.70	1.45	2.05
1765	197.80	201.80	1.50	2.15
1770	192.90	196.90	1.60	2.20
1775	188.00	192.00	1.65	2.35
1780	183.10	187.10	1.75	2.40
1785	178.20	182.20	1.85	2.50
1790	173.30	177.30	1.90	2.60
1795	168.40	172.40	2.00	2.75
1800	163.50	167.50	2.15	2.90
1805	158.60	162.60	2.25	3.00
1810	153.80	157.80	2.35	3.20
1815	148.90	152.90	2.50	3.40
1820	144.10	148.10	2.65	3.50
1825	139.20	143.30	3.00	3.60
1830	134.40	138.40	3.00	3.90
1835	129.60	133.60	3.20	4.10
1840	124.80	128.80	3.40	4.40
1845	120.10	124.10	3.60	4.60
1850	115.40	119.30	3.80	4.90
1855	110.60	114.60	4.10	5.20
1860	105.90	109.90	4.40	5.50
1865	101.30	105.20	4.70	5.80
1870	96.60	100.50	5.00	6.20
1875	92.00	95.90	5.40	6.60
1880	87.40	91.30	5.80	7.00
1885	82.90	86.70	6.20	7.50
1890	78.40	82.20	6.70	8.00
1895	74.00	77.70	7.20	8.60
1900	69.60	73.20	7.80	8.80
1905	66.00	68.50	8.50	9.50

Next-Term Options (cont.)

Strike	Calls		Puts	
	Bid	Ask	Bid	Ask
1875	94.50	95.90	8.00	8.30
1880	90.00	91.40	8.40	8.80
1885	85.50	86.90	9.00	9.40
1890	81.10	82.50	9.50	10.00
1895	76.80	78.10	10.20	10.60
1900	72.40	73.70	10.90	11.30
1905	68.20	69.40	11.60	12.00
1910	64.00	65.20	12.40	12.80
1915	59.80	61.10	13.20	13.70
1920	55.70	57.00	14.20	14.60
1925	51.70	53.00	15.20	15.60
1930	47.80	49.10	16.20	16.60
1935	44.60	45.10	17.40	17.80
1940	40.80	41.30	18.60	19.00
1945	37.20	37.70	20.00	20.40
1950	33.70	34.40	21.40	21.80
1955	30.30	30.90	23.00	23.40
1960	27.00	27.60	24.70	25.10
1965	23.80	24.50	26.50	27.30
1970	20.80	21.40	28.50	29.40
1975	18.00	18.60	30.50	31.60
1980	15.50	15.90	33.00	34.00
1985	13.10	13.50	35.50	36.60
1990	10.90	11.30	38.40	39.50
1995	9.00	9.30	41.30	42.50
2000	7.20	7.60	44.50	45.80
2005	5.70	6.00	48.10	49.30
2010	4.50	4.80	51.70	53.00
2015	3.40	3.70	55.80	57.00
2020	2.60	2.80	59.90	61.70
2025	1.95	2.15	64.10	66.10
2030	1.45	1.65	68.60	70.60
2035	1.05	1.25	73.30	75.20
2040	0.80	0.95	78.00	80.00
2045	0.60	0.75	82.00	84.80
2050	0.50	0.65	86.90	89.60
2060	0.30	0.40	96.60	99.40
2070	0.20	0.30	106.70	109.50
2075	0.15	0.25	111.70	114.50
2100	0.10	0.20	136.30	139.10
2125	0.05	0.15	161.50	164.30
2150	0.05	0.15	186.30	189.00
2175	0.00	0.10	211.30	214.00
2200	0.05	0.10	236.30	239.00
2225	0.00	0.10	261.30	264.00
2250	0.00	0.10	286.30	289.00

	Near-Term Options (cont.)			
	Calls		Puts	
Strike	Bid	Ask	Bid	Ask
1910	61.60	64.10	9.10	10.20
1915	57.40	59.80	9.90	11.30
1920	53.30	55.60	10.70	12.10
1925	49.10	51.20	11.60	12.60
1930	45.20	47.30	12.50	14.00
1935	41.20	43.40	13.60	14.70
1940	37.40	39.50	14.70	15.80
1945	33.70	35.70	15.90	17.20
1950	30.10	32.10	17.70	18.80
1955	26.70	28.50	19.00	20.50
1960	23.40	25.10	20.60	22.00
1965	20.30	21.80	22.30	24.00
1970	17.40	18.80	24.30	25.80
1975	14.60	15.90	26.50	28.10
1980	12.20	13.30	28.90	30.60
1985	9.90	11.00	31.40	33.20
1990	7.90	9.00	34.30	36.50
1995	6.20	7.10	37.40	39.70
2000	4.70	5.20	40.70	43.20
2005	3.40	4.20	44.00	47.70
2010	2.65	3.10	48.00	51.40
2015	1.75	2.30	52.20	56.00
2020	1.20	1.70	56.60	60.40
2025	1.00	1.25	61.20	65.00
2030	0.45	1.00	65.90	69.70
2035	0.25	0.80	70.70	74.40
2040	0.35	0.65	75.60	79.30
2045	0.20	0.60	80.50	84.10
2050	0.20	0.30	85.40	89.00
2055	0.15	0.50	90.40	94.00
2060	0.15	0.30	95.30	98.90
2065	0.15	0.20	100.30	103.90
2070	0.10	0.20	105.30	108.90
2075	0.10	0.20	110.30	113.80
2080	0.05	0.45	115.30	118.80
2085	0.05	0.40	120.30	123.80
2090	0.05	0.15	125.30	128.80
2095	0.05	0.35	130.30	133.80
2100	0.05	0.15	135.30	138.80
2120	0.00	0.15	155.30	158.80
2125	0.05	0.15	160.30	163.80
2150	0.00	0.10	185.20	188.80
2175	0.00	0.05	210.20	213.70
2200	0.00	0.05	235.20	238.70
2225	0.05	0.10	260.20	263.70
2250	0.00	0.05	285.20	288.70

Appendix 2: Individual Contributions — K_0 = 1960

Near-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike	Next-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike
1370	Put	0.2	5	0.0000005328	1275	Put	0.075	50	0.0000023069
1375	Put	0.125	5	0.0000003306	1325	Put	0.15	37.5	0.0000032041
1380	Put	0.15	5	0.0000003938	1350	Put	0.15	25	0.0000020577
1385	Put	0.225	5	0.0000005865	1375	Put	0.175	25	0.0000023141
1390	Put	0.225	5	0.0000005823	1400	Put	0.2	25	0.0000025511
1395	Put	0.125	5	0.0000003212	1425	Put	0.25	25	0.0000030779
1400	Put	0.125	7.5	0.0000004783	1450	Put	0.3	25	0.0000035673
1410	Put	0.225	10	0.0000011318	1475	Put	0.35	25	0.0000040219
1420	Put	0.225	7.5	0.0000008369	1500	Put	0.4	17.5	0.0000031112
1425	Put	0.175	5	0.0000004309	1510	Put	0.425	10	0.0000018640
1430	Put	0.225	5	0.0000005502	1520	Put	0.45	7.5	0.0000014608
1435	Put	0.275	5	0.0000006677	1525	Put	0.475	5	0.0000010213
1440	Put	0.175	5	0.0000004220	1530	Put	0.5	7.5	0.0000016020
1445	Put	0.225	5	0.0000005388	1540	Put	0.525	10	0.0000022137
1450	Put	0.2	5	0.0000004756	1550	Put	0.55	7.5	0.0000017170
1455	Put	0.25	5	0.0000005905	1555	Put	0.575	5	0.0000011890
1460	Put	0.25	5	0.0000005864	1560	Put	0.6	5	0.0000012328
1465	Put	0.25	5	0.0000005824	1565	Put	0.625	5	0.0000012759
1470	Put	0.25	5	0.0000005785	1570	Put	0.65	5	0.0000013185
1475	Put	0.2	5	0.0000004596	1575	Put	0.675	5	0.0000013606
1480	Put	0.25	5	0.0000005707	1580	Put	0.675	5	0.0000013520
1485	Put	0.35	5	0.0000007936	1585	Put	0.7	5	0.0000013932
1490	Put	0.175	5	0.0000003941	1590	Put	0.725	5	0.0000014339
1495	Put	0.275	5	0.0000006152	1595	Put	0.75	5	0.0000014741
1500	Put	0.325	5	0.0000007222	1600	Put	0.775	5	0.0000015137
1505	Put	0.325	5	0.0000007174	1605	Put	0.8	5	0.0000015528
1510	Put	0.3	5	0.0000006579	1610	Put	0.825	5	0.0000015914
1515	Put	0.3	5	0.0000006535	1615	Put	0.85	5	0.0000016295
1520	Put	0.35	5	0.0000007575	1620	Put	0.875	5	0.0000016671
1525	Put	0.35	5	0.0000007525	1625	Put	0.9	5	0.0000017042
1530	Put	0.325	5	0.0000006942	1630	Put	0.95	5	0.0000017878
1535	Put	0.375	5	0.0000007958	1635	Put	0.975	5	0.0000018237
1540	Put	0.375	5	0.0000007906	1640	Put	1	5	0.0000018591
1545	Put	0.375	5	0.0000007855	1645	Put	1.025	5	0.0000018940
1550	Put	0.5	5	0.0000010406	1650	Put	1.075	5	0.0000019743
1555	Put	0.425	5	0.0000008788	1655	Put	1.1	5	0.0000020081
1560	Put	0.425	5	0.0000008732	1660	Put	1.15	5	0.0000020867
1565	Put	0.425	5	0.0000008676	1665	Put	1.2	5	0.0000021644
1570	Put	0.475	5	0.0000009635	1670	Put	1.225	5	0.0000021963
1575	Put	0.55	5	0.0000011086	1675	Put	1.275	5	0.0000022723
1580	Put	0.525	5	0.0000010515	1680	Put	1.325	5	0.0000023474
1585	Put	0.525	5	0.0000010449	1685	Put	1.375	5	0.0000024215
1590	Put	0.525	5	0.0000010384	1690	Put	1.425	5	0.0000024947
1595	Put	0.525	5	0.0000010319	1695	Put	1.475	5	0.0000025670
1600	Put	0.675	5	0.0000013184	1700	Put	1.525	5	0.0000026385
1605	Put	0.575	5	0.0000011161	1705	Put	1.6	5	0.0000027520
1610	Put	0.625	5	0.0000012056	1710	Put	1.675	5	0.0000028642
1615	Put	0.625	5	0.0000011982	1715	Put	1.725	5	0.0000029325

Individual Contributions (Cont.)						Individual Contributions (Cont.)				
Near-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike		Next-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike
1620	Put	0.625	5	0.0000011908		1720	Put	1.8	5	0.0000030423
1625	Put	0.675	5	0.0000012781		1725	Put	1.85	5	0.0000031087
1630	Put	0.675	5	0.0000012703		1730	Put	1.925	5	0.0000032160
1635	Put	0.725	5	0.0000013561		1735	Put	2	5	0.0000033221
1640	Put	0.725	5	0.0000013478		1740	Put	2.1	5	0.0000034682
1645	Put	0.775	5	0.0000014320		1745	Put	2.175	5	0.0000035715
1650	Put	0.675	5	0.0000012397		1750	Put	2.275	5	0.0000037144
1655	Put	0.825	5	0.0000015060		1755	Put	2.375	5	0.0000038556
1660	Put	0.825	5	0.0000014970		1760	Put	2.475	5	0.0000039951
1665	Put	0.875	5	0.0000015782		1765	Put	2.575	5	0.0000041330
1670	Put	0.875	5	0.0000015688		1770	Put	2.725	5	0.0000043491
1675	Put	0.925	5	0.0000016485		1775	Put	2.825	5	0.0000044833
1680	Put	0.975	5	0.0000017273		1780	Put	3	5	0.0000047344
1685	Put	1.025	5	0.0000018051		1785	Put	3.1	5	0.0000048648
1690	Put	1.025	5	0.0000017944		1790	Put	3.25	5	0.0000050718
1695	Put	1.075	5	0.0000018709		1795	Put	3.45	5	0.0000053539
1700	Put	1.125	5	0.0000019464		1800	Put	3.6	5	0.0000055557
1705	Put	1.125	5	0.0000019350		1805	Put	3.8	5	0.0000058319
1710	Put	1.175	5	0.0000020092		1810	Put	3.95	5	0.0000060287
1715	Put	1.225	5	0.0000020825		1815	Put	4.2	5	0.0000063749
1720	Put	1.275	5	0.0000021549		1820	Put	4.4	5	0.0000066419
1725	Put	1.325	5	0.0000022265		1825	Put	4.65	5	0.0000069808
1730	Put	1.375	5	0.0000022972		1830	Put	4.9	5	0.0000073160
1735	Put	1.425	5	0.0000023670		1835	Put	5.15	5	0.0000076474
1740	Put	1.475	5	0.0000024360		1840	Put	5.45	5	0.0000080490
1745	Put	1.55	5	0.0000025452		1845	Put	5.75	5	0.0000084461
1750	Put	1.6	5	0.0000026123		1850	Put	6.05	5	0.0000088388
1755	Put	1.675	5	0.0000027192		1855	Put	6.45	5	0.0000093724
1760	Put	1.75	5	0.0000028248		1860	Put	6.75	5	0.0000097557
1765	Put	1.825	5	0.0000029292		1865	Put	7.15	5	0.0000102785
1770	Put	1.9	5	0.0000030324		1870	Put	7.65	5	0.0000109385
1775	Put	2	5	0.0000031740		1875	Put	8.15	5	0.0000115914
1780	Put	2.075	5	0.0000032746		1880	Put	8.6	5	0.0000121664
1785	Put	2.175	5	0.0000034132		1885	Put	9.2	5	0.0000129463
1790	Put	2.25	5	0.0000035112		1890	Put	9.75	5	0.0000136478
1795	Put	2.375	5	0.0000036856		1895	Put	10.4	5	0.0000144809
1800	Put	2.525	5	0.0000038967		1900	Put	11.1	5	0.0000153743
1805	Put	2.625	5	0.0000040286		1905	Put	11.8	5	0.0000162582
1810	Put	2.775	5	0.0000042353		1910	Put	12.6	5	0.0000172697
1815	Put	2.95	5	0.0000044776		1915	Put	13.45	5	0.0000183386
1820	Put	3.075	5	0.0000046417		1920	Put	14.4	5	0.0000195317
1825	Put	3.3	5	0.0000049541		1925	Put	15.4	5	0.0000207797
1830	Put	3.45	5	0.0000051511		1930	Put	16.4	5	0.0000220146
1835	Put	3.65	5	0.0000054200		1935	Put	17.6	5	0.0000235034
1840	Put	3.9	5	0.0000057598		1940	Put	18.8	5	0.0000249767
1845	Put	4.1	5	0.0000060224		1945	Put	20.2	5	0.0000266989

Individual Contributions (Cont.)				
Near-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike
1850	Put	4.35	5	0.0000063551
1855	Put	4.65	5	0.0000067568
1860	Put	4.95	5	0.0000071542
1865	Put	5.25	5	0.0000075471
1870	Put	5.6	5	0.0000080073
1875	Put	6	5	0.0000085335
1880	Put	6.4	5	0.0000090541
1885	Put	6.85	5	0.0000096393
1890	Put	7.35	5	0.0000102883
1895	Put	7.9	5	0.0000109999
1900	Put	8.3	5	0.0000114961
1905	Put	9	5	0.0000124003
1910	Put	9.65	5	0.0000132263
1915	Put	10.6	5	0.0000144526
1920	Put	11.4	5	0.0000154626
1925	Put	12.1	5	0.0000163269
1930	Put	13.25	5	0.0000177861
1935	Put	14.15	5	0.0000188962
1940	Put	15.25	5	0.0000202603
1945	Put	16.55	5	0.0000218745
1950	Put	18.25	5	0.0000239979
1955	Put	19.75	5	0.0000258376
1960	Put/Call Average	22.775	5	0.0000296432
1965	Call	21.05	5	0.0000272588
1970	Call	18.1	5	0.0000233198
1975	Call	15.25	5	0.0000195486
1980	Call	12.75	5	0.0000162614
1985	Call	10.45	5	0.0000132609
1990	Call	8.45	5	0.0000106691
1995	Call	6.65	5	0.0000083544
2000	Call	4.95	5	0.0000061876
2005	Call	3.8	5	0.0000047264
2010	Call	2.875	5	0.0000035582
2015	Call	2.025	5	0.0000024938
2020	Call	1.45	5	0.0000017768
2025	Call	1.125	5	0.0000013718
2030	Call	0.725	5	0.0000008797
2035	Call	0.525	5	0.0000006339
2040	Call	0.5	5	0.0000006007
2045	Call	0.4	5	0.0000004782
2050	Call	0.25	5	0.0000002974
2055	Call	0.325	5	0.0000003848
2060	Call	0.225	5	0.0000002651
2065	Call	0.175	5	0.0000002052
2070	Call	0.15	5	0.0000001750
2075	Call	0.15	5	0.0000001742

Individual Contributions (Cont.)				
Next-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike
1950	Put	21.6	5	0.0000284031
1955	Put	23.2	5	0.0000303512
1960	Put/Call Average	26.1	5	0.0000339711
1965	Call	24.15	5	0.0000312732
1970	Call	21.1	5	0.0000271851
1975	Call	18.3	5	0.0000234584
1980	Call	15.7	5	0.0000200240
1985	Call	13.3	5	0.0000168776
1990	Call	11.1	5	0.0000140151
1995	Call	9.15	5	0.0000114952
2000	Call	7.4	5	0.0000092502
2005	Call	5.85	5	0.0000072763
2010	Call	4.65	5	0.0000057549
2015	Call	3.55	5	0.0000043718
2020	Call	2.7	5	0.0000033086
2025	Call	2.05	5	0.0000024997
2030	Call	1.55	5	0.0000018807
2035	Call	1.15	5	0.0000013885
2040	Call	0.875	5	0.0000010513
2045	Call	0.675	5	0.0000008070
2050	Call	0.575	7.5	0.0000010262
2060	Call	0.35	10	0.0000008248
2070	Call	0.25	7.5	0.0000004376
2075	Call	0.2	15	0.0000006968
2100	Call	0.15	25	0.0000008504
2125	Call	0.1	25	0.0000005536
2150	Call	0.1	37.5	0.0000008113
2200	Call	0.075	50	0.0000007748

Individual Contributions (Cont.)				
Near-Term Strike	Option Type	Midpoint Price	Delta-K	Contribution by Strike
2080	Call	0.25	5	0.0000002889
2085	Call	0.225	5	0.0000002588
2090	Call	0.1	5	0.0000001145
2095	Call	0.2	5	0.0000002278
2100	Call	0.1	15	0.0000003401
2125	Call	0.1	25	0.0000005536

Sum of Individual Contributions for near term: 0.0006320516

$$\frac{2}{T_1} \sum_i \frac{\Delta K_i}{K_i^2} \, e^{R_1 T_1} Q(K_i) = 0.019267$$

Sum of Individual Contributions for next term: 0.0008314016

$$\frac{2}{T_2} \sum_i \frac{\Delta K_i}{K_i^2} \, e^{R_2 T_2} Q(K_i) = 0.019441$$

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