THE USE OF OPTIONS FOR TAX DEFERRAL

by

HARVEY WILLENSKY

B.S., Cornell University
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M.S., University of Illinois
(1973)

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Signature of Author.......................
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Certified by.......................
Thesis Supervisor

Accepted by.......................
Chairman, Department Committee

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HARVEY WILLENSKY

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ABSTRACT

This thesis has presented three strategies for deferring capital gains income from one year to the next for income tax purposes. All three strategies involved the establishment of neutral spreads using options. As the price of the underlying stock changes, losses will occur on one side of the spread and gains on the other side of the spread. The losses should be recognised for tax purposes in the current year and the gains in the following year.

Techniques have been developed for adjusting all of the possible spreads so that they can be compared at a constant risk level. The metric used to compare the spreads is the dollar volatility of each side of the spreads. This is an indicator of the likely tax deduction which an investor can expect.

At the time that the spread is established, it is not possible to know what the price of the stock will be in the future. Analyses have been presented to illustrate the potential outcomes of the spreads for a variety of stock prices.

The precise amount of tax savings which an investor can realize for a given short term capital loss will depend on the investor's tax bracket and the type of gains, that is, short term or long term, which are being offset. The tables and analyses which have been presented in this paper provide a framework which may be helpful in evaluating spreads for use as a tax planning tool. However, this information does not specify which strategy is the best choice for a particular investor.

ADVISOR: Fischer Black
TITLE: Professor of Finance

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1.0 INTRODUCTION

The Chicago Board Options Exchange (CBOE) began operations on April 26, 1973. Since that time options trading has been introduced on the American Stock Exchange, the Pacific Stock Exchange, and the Midwest Exchange. Plans are currently being made to trade options on the New York Stock Exchange. Presently, these exchanges deal exclusively with call options, however, trading in put options will begin in the near future.

The volume of call options traded has soared since 1973. Prior to the opening of the CBOE, all options were individually negotiated and offered very little liquidity. The CBOE increased the liquidity of call options by standardizing the terms of the contract, severing the link between the buyer and seller by substituting the Options Clearing Corporation as the primary obligor in all CBOE options, introducing a secondary market for the options, and eliminating adjustments for cash payments of dividends. The new options exchanges have followed the example of the CBOE and provide an active secondary market in options.

Because options trading has become so popular it is important to know what the tax effects of various transactions are. This will affect the use of options as a tax planning tool, and will affect the profitability of various types of transactions.

This thesis analyzes a set of option trading techniques which postpone the recognition of income from one year to the next. This process may be repeated in consecutive years so that tax payment is deferred indefinitely. The funds, which would have been used to pay taxes, may be reinvestigated to earn additional income. The process may be terminated in any year in which the investor wishes to recognize the income. For example, if substantial losses are incurred in a particular year it may be appropriate to recognize the income which has been deferred. When the tax is finally paid, it will be paid in a year of lower income so the average tax rate will be lower than in prior years for the investor.

There are risks involved in these tax strategies. First, there are commission costs which the investor must pay to establish the position. Before entering a position it must be determined that the tax savings will exceed the cost of the transaction with reasonable certainty. Second, there is always the possibility of capital losses when investing in capital markets. The objective of this paper is to provide a framework in which to choose the transaction which provides the maximum tax benefit for a given level of risk, and to illustrate the potential outcomes of the transaction. Once the investor has the alternatives and potential consequences he is in a better position to make an intelligent choice as to whether or not to utilize these tax deferral techniques.

The strategies presented in this paper make use of puts, calls, and the underlying stock. The strategies assume efficient stock markets. That is, the stocks are properly priced and the investor has no way of knowing in which direction the prices will move. The option markets are assumed to be less efficient. This leads to option prices which differ from the values predicted by the formula. Although several different trading techniques are presented, which assume efficient markets, they all are based on the same concept. A neutral spread is established. When the prices of the securities change, the net effect on the position will be zero. Gains on one side of the transaction merely offset losses on the other side of the transaction. The key to this set of techniques is that the losses are recognized in the current year, and the gains are recognized in the following year. This provides a capital loss in the current year and a capital gain of the same amount in the next year.

The first three chapters of the thesis are devoted to background information. Section 2 presents a series of definitions which are commonly used in the field of options. It then elaborates on the definitions, attempting to present an overview of the major relationships between stocks and options which are used in formulating the trading strategies. The next section discusses some of the tax consequences of options trading. The information presented in these two sections establishes the foundation for the understanding of the strategies which are presented in Section 4.

2.0 BACKGROUND

2.1 Definitions

An option is a contract which gives its owner the right to buy or sell a stock. Since the introduction of auction markets for options, such as the CBOE, the characteristics of options have become standard. The following list of definitions refers to options which are traded on these new exchanges.

Call option-A call option is a contract which gives its owner the right to buy a specified number of shares of a particular stock within a stated period of time. Currently the CBOE, American Stock Exchange (AMEX), Philadelphia Exchange (PHLX), Midwest Exchange (MWE), and Pacific Exchange (PSE) list options which may be traded.

Put option-A put option is a contract which gives its owner the right to sell a specified number of shares of a particular stock at a specified price within a stated period of time. Although put options are not currently traded on any of the four option exchanges, they will be introduced early in 1977.

Contract Size-The standard size of an option contract is 100 shares.

Expiration Date-The expiration date is the date by which an option must be exercised. If it is not exercised by the expiration date it becomes worthless. There are two sets of expiration dates which are commonly used. The first set has expiration dates of the third Saturday of January, April, July and October. The second set has expiration dates of the third Saturday of February, May, August and November. Options are originally listed with nine month maturities. As time passes, the duration of the options decreases. After three months another set of options with nine months duration is listed. There would now be two sets of options, one with six months left until expiration and one with nine months left until expiration.

Exercise Price-The exercise price of an option is the price for which the option owner has the right to call or put the stock. This price is often referred to as the strike price or striking price. For stocks with market prices less than $50 at the time the options are listed the strike prices are in increments of $5. For stocks with market prices between $50 and $200 per share the strike prices are in increments of $10. And for stocks with market prices in excess of $200 per share the strike prices are in increments of $20. As the market price of the stock increases above the highest existing option exercise price, a new option is introduced.

Premium-The premium is the total price of the option. It is higher for options with long durations than for options which are about to expire. Assume that the current price of the stock is less than the exercise price of the option. If there is a long time left before the stock option expires, the option will have some value because the stock may go up. If the stock is volatile, the option premium will be higher. As the expiration date approaches, it becomes less likely that the option will be exercised since the stock is lower than the exercise price. Consequently the value of the option declines and approaches zero. If the stock price is higher than the exercise price, the premium is equal to the difference between the stock price and the exercise plus an additional amount to account for the time remaining before expiration. As the expiration date approaches, the premium approaches the difference between the stock price and the exercise price.

Out of the Money Option-An out of the money call option exists when the exercise price is higher than the stock price. An out of the money put option exists when the exercise price is lower than the stock price.

In the money option-An in the money option exists when the exercise price for a call is lower than the stock price or when the exercise price for a put is higher than the stock price.

Covered option-A covered option exists when the seller has 100 shares of the stock for each contract.

Naked option-A seller is said to be writing options naked when he sells options for which he has no corresponding stock.

Spreads-Spreads are combination of options of the same basic type but with different exercise prices or expiration dates. One option is purchased and the other is sold. A vertical spread is a pair of options on the same stock with different exercise prices. For example, the investor might but a Digital Equipment January call with a strike price of $50 and sell a January call with a strike price of $60. This would be a bearish vertical spread; if the stock price goes down, the investor makes money. If the positions were reversed, it would be a bullish spread. A calendar spread is constructed by purchasing an option with one expiration date and selling another option with an identical exercise price but a different expiration date.

Straddle-A straddle is a combination of a put and a call, both exercisable at the same market price and for the same period.

Strip-A strip is a straddle with a second put component.

Strap-A strap is a straddle with a second call component.

2.2 Basic Options Relationships

The Black-Scholes option pricing formula is a mathematical model which estimates the value of an option based on the volatility of the underlying stock, the strike price of the option, the market price of the underlying stock, the duration of the option, and the interest rate.[9] The value which the formula predicts will often differ from the market value of the option. If we assume that the basic formula is correct, these differences may be explained by errors in the market or errors in the inputs to the model.

This paper will not deal with the derivation of the model. Rather, the model will be treated as both given and valid; the inputs are provided and option values are predicted. A detailed discussions of the model is provided in several papers published by Black and Scholes.[1],[9]

In this paper it will be assumed that the values predicted by the model are correct and that the market will eventually adjust prices to match values. Under this assumption it is possible to identify options which are underpriced and options which are overpriced. One of the criteria used in choosing the appropriate spread for the tax strategies will be the difference between the values and prices of the options to be used in the spread.

The formula may be used to demonstrate some of the basic relationships in options pricing. The next section provides an overview of the sensitivity of the formula to its inputs and of the dependence of option values on the input parameters. International Business Machines (IBM) has been chosen as the underlying stock to illustrate these relationships. IBM has two sets of call options which are traded. One set has an exercise price of $260. The other set has an exercise price of $280. The termination dates of the options are in January, April, August and October. At any time there will be three options traded in each set; the maximum duration is nine months. It is assumed, for this set of examples, that there exist put options with the same strike prices and termination dates as the call options.

2.2.1 Call Options

Figure 1 illustrates the value of the call options with a strike price of $260. In this diagram it is assumed that the interest rate is 6% and that the stock volatility (the annual standard deviation of the return on the stock) is .17. The interest rate is a reasonable approximation of the return on short term government notes. The volatility estimate was provided by Fischer Black.

The starting point for understanding the pricing of call options is to look at their value at the time of expiration. At expiration the options only have value if the stock has a market price which exceeds the strike price. If the stock price is less than $260, an option to buy the stock at $260 is worthless. If the stock price is above $260, that option is worth the difference between the stock price and the strike price. For example, if the stock were selling for $280 per share when the option expired, an option to buy the stock at $260 per share would be worth exactly $20.

When there remains time before the option expires, the option will have some value even if the stock price is below the strike price. There is the possibility that the stock price will increase before the option expires. The value of the option increases with the duration of the option. The lines labeled "t=3 months" and "t=6 months" indicate the effect of the duration on the value of the option.

Figure 1

Call Option Values as a Function of Stock
Price for Different Durations

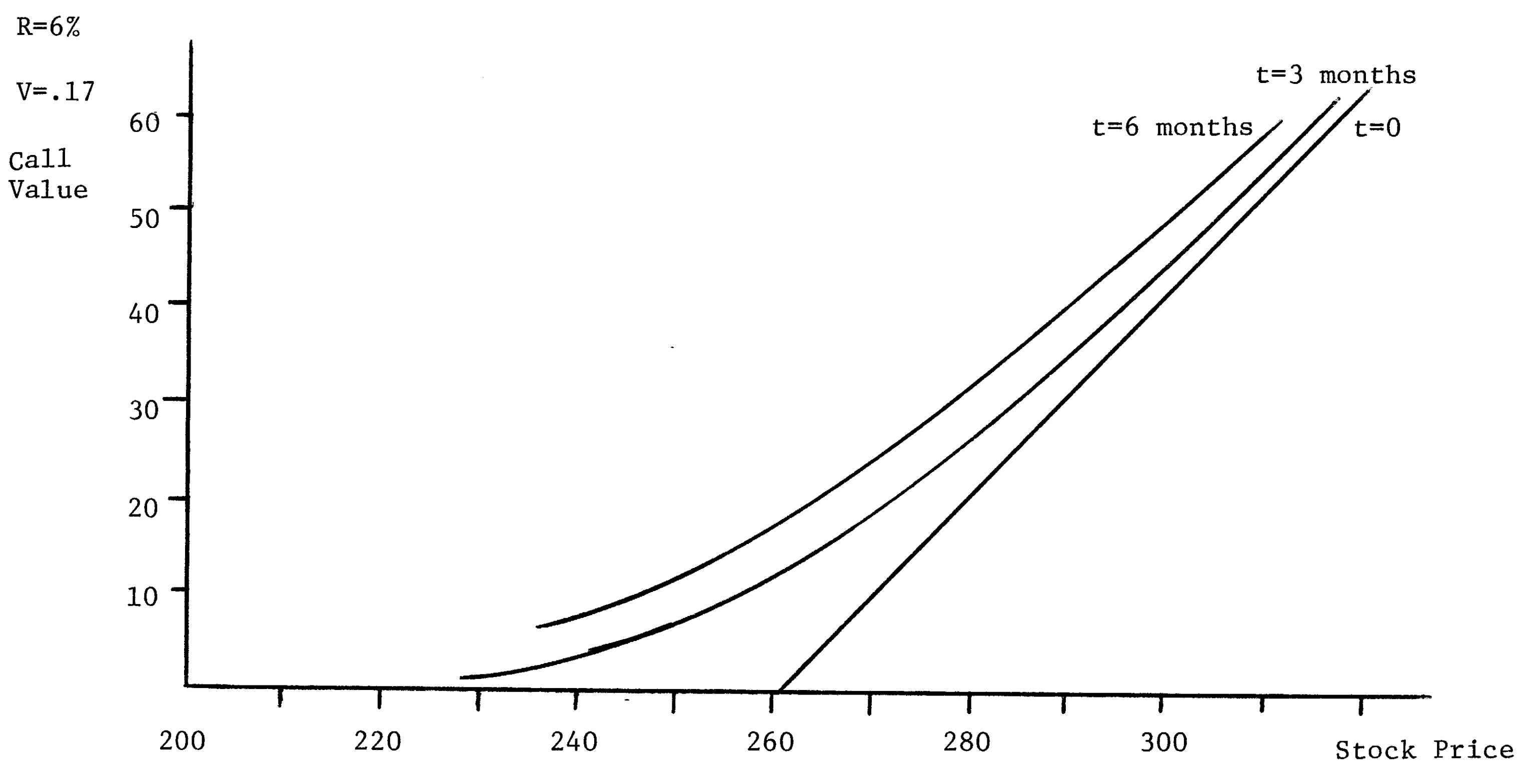


Figure 2 illustrates that the interest rates does not substantially affect the price of an option. This diagram shows the value of a call option under the assumptions that the interest rate is 2%, 6%, and 10%. For stock prices in the vicinity of the strike price, a different in interest rates of 400% (2% to 10%) results in an option value difference of less than 50%. This indicates that the value used for the interest rate in the option pricing formula does not have to be extremely accurate.

Figure 3 illustrates the value of three month call options as a function of stock price for two assumptions of stock volatility. The first assumption is that the volatility is 0.50. For a stock price equal to the strike price, this 200% increase in the volatility resulted in approximately a 200% increase in the value of the option. Clearly the stock volatility estimate is more crucial in the option valuation than the interest rate. This emphasizes the importance of accurately estimating the volatility of the underlying stock.

Figure 4 illustrates the value of the delta for the IBM 260 call options with three month duration as a function of the stock price. [The delta is the ratio of the change in the option value to the change in the stock price, for very small changes in the stock price.] For stock prices far below the exercise price, a small change in the stock price will not change the option value significantly. Therefore, the delta is much less than one in this range. For stock prices far above the strike price, the portion of the premium which is due to the duration of the option has almost disappeared. The major factor in the premium is the difference between the stock price and the exercise price. The option price follows the stock price approximately point for point. Therefore, the delta approaches unity in this range.

Figure 2

Call Option Values as a Function of Stock Price
for Different Interest Rates

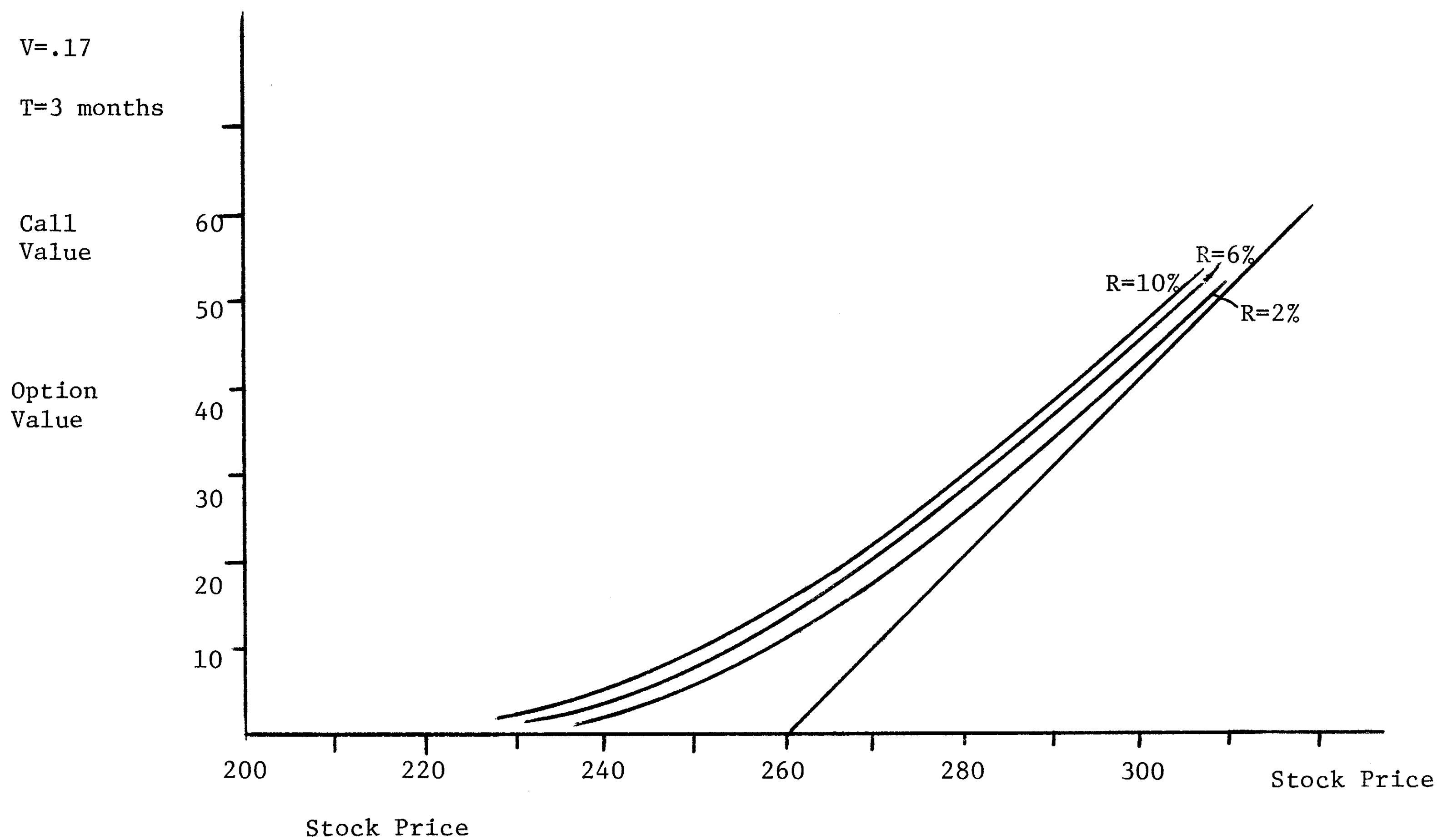


Figure 3

Call Option Values as a Function of Stock Price
for Different Stock Volatilities

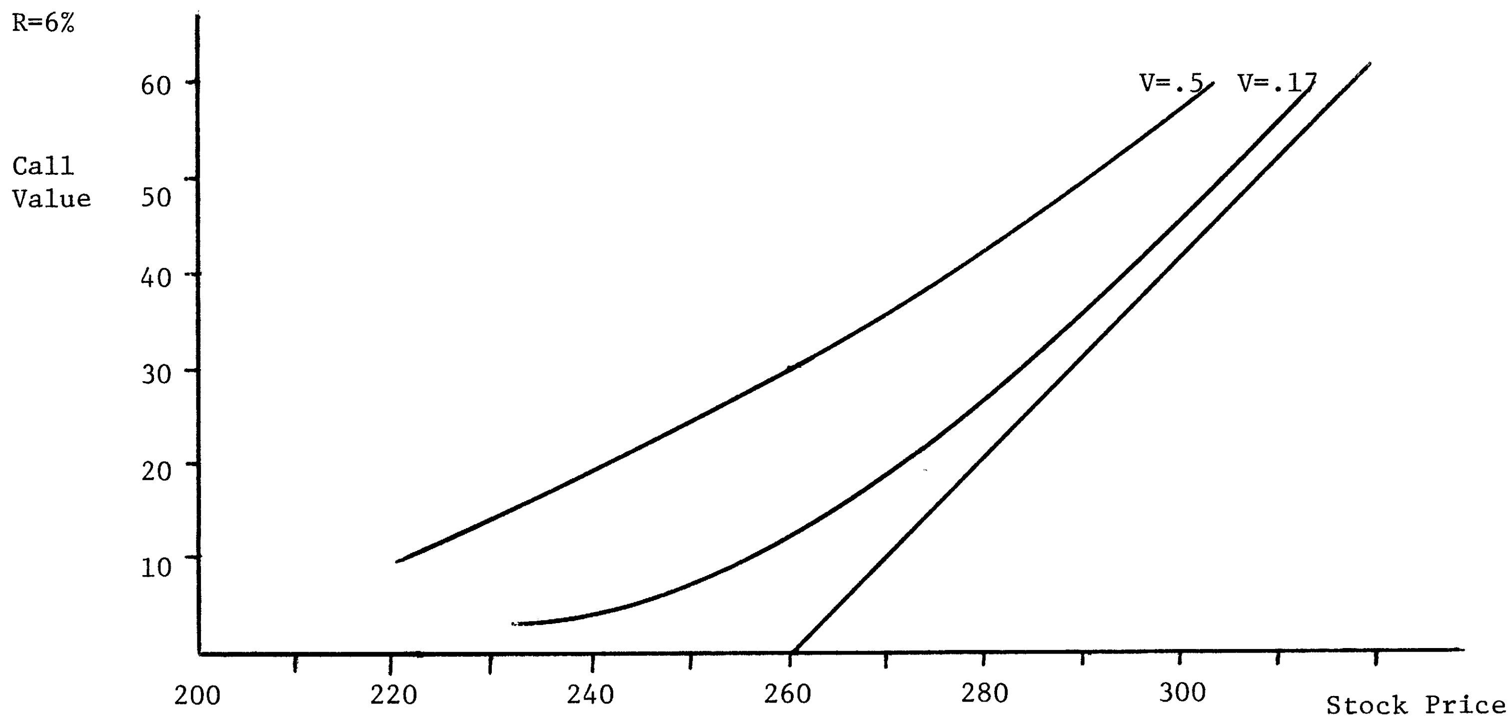


Figure 4

Call Option Deltas as a Function of Stock Price
for Different Durations

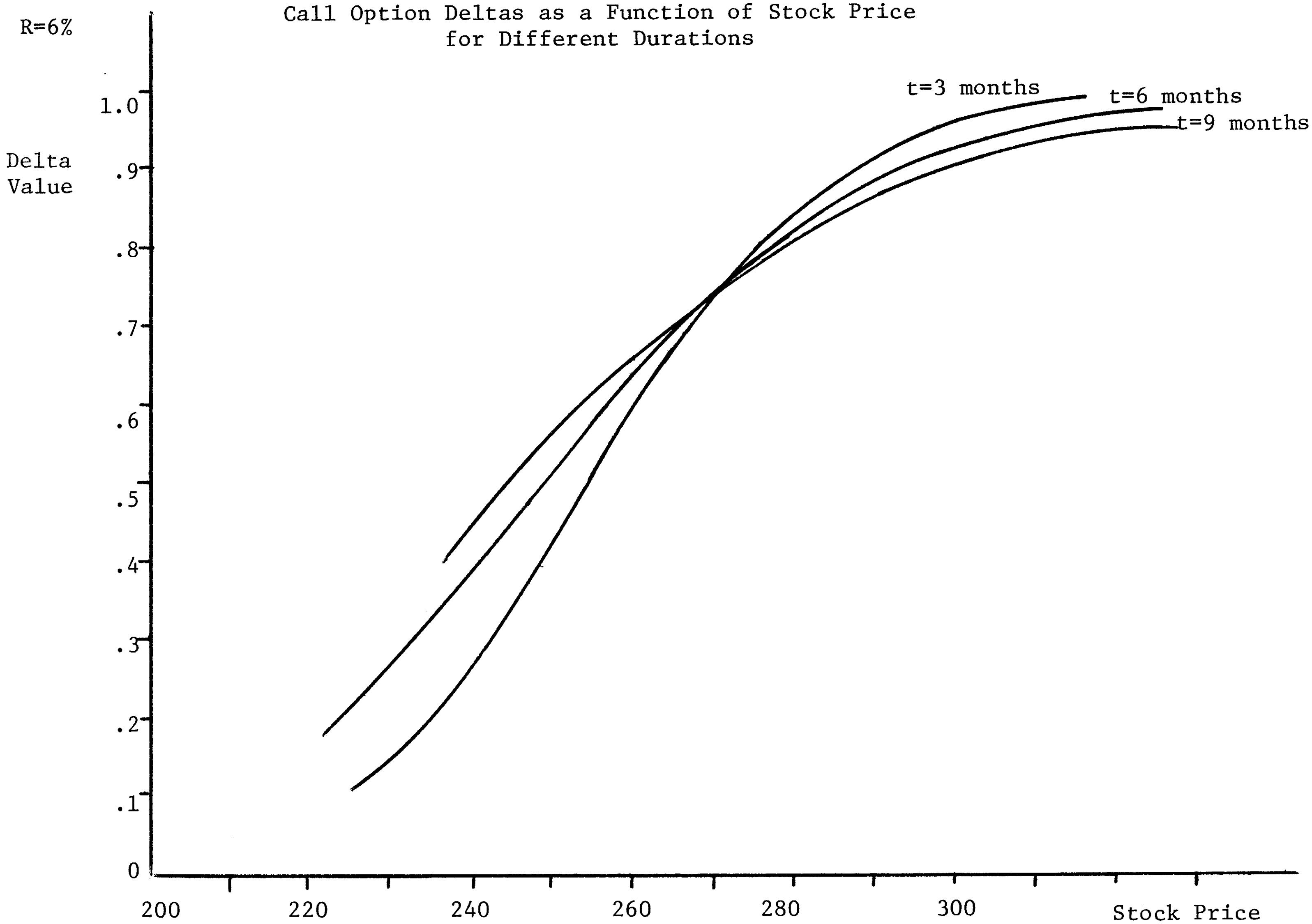


Figure 4 also illustrates the value of the six and nine month call option deltas as a function of stock price. For options which are deep in-the-money, the longer durations results in higher deltas. However, for options which are out-of-the-money, the shorter durations result in higher deltas.

Figure 5 illustrates the value of a vertical spread between the IBM options with exercise prices of $260 and $280. In this case it is assumed that the options with the $260 exercise price are bought and the options with a $280 exercise price are sold. This results in a positive cost to the investor. Each of the spreads shown consists of two options with the same expiration date. The limiting case occurs when the options are about to expire. This is shown by the line labeled "t=0". For stock prices below $260 both options are worthless. For stock prices between $260 and $280, the option with the $260 strike price increases in value point for point with the stock. And for prices above $280 both options increase in value point for point with the stock; therefore, the value of the spread remains fixed at $20.

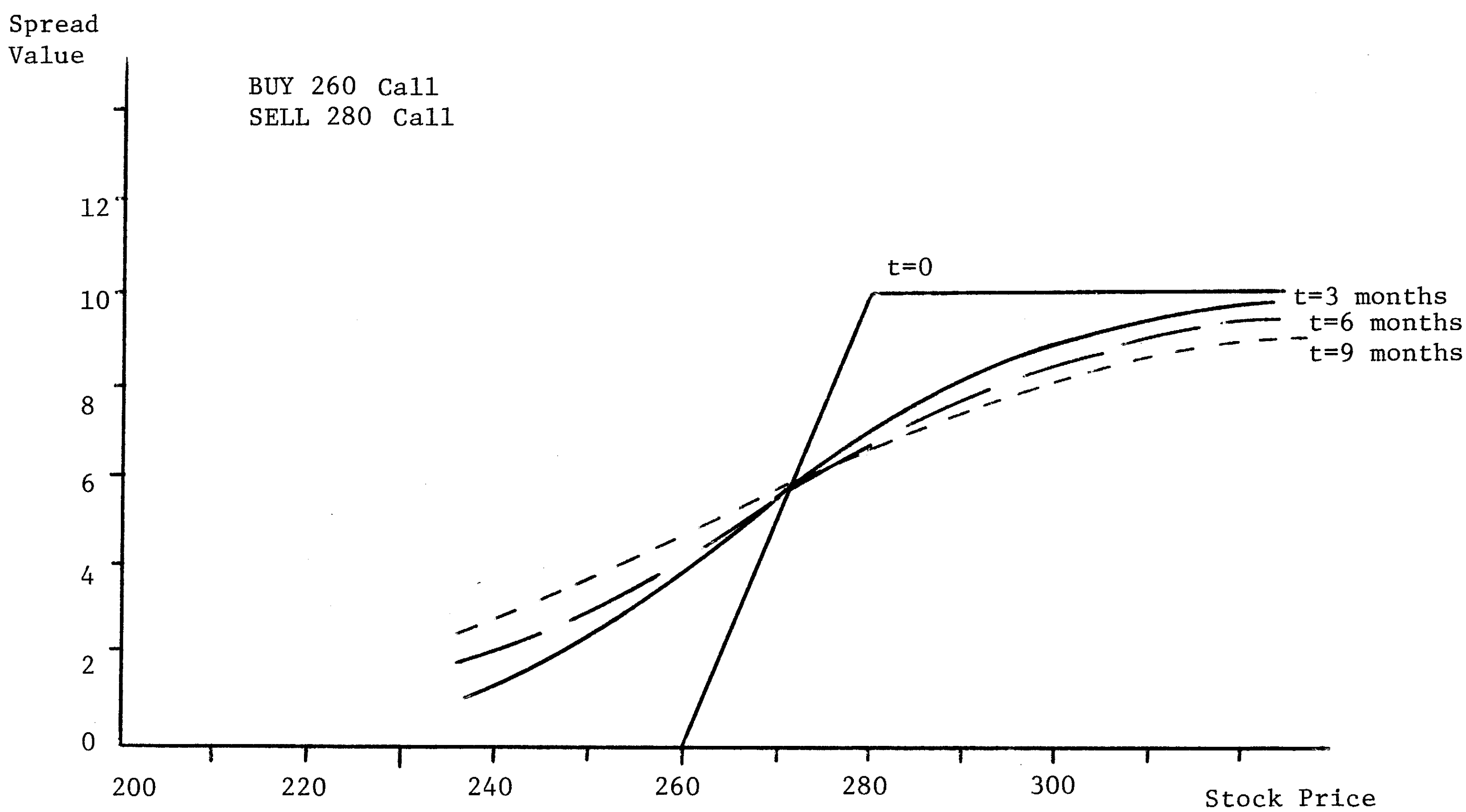
As the duration of the options increases above zero, the situation becomes more complex. The two options no longer move point for point with the stock. Nor do they move point for point with one another. The relationships are shown by the lines labeled "t=3 months", "t=6 months" and "t=9 months". The duration has the same effect on the spreads as it did on the delta of an individual option. This is because the difference between the values of the two options varies directly with their deltas.

2.2.2 Put Options

The value of put options depends on the input parameters in much the same way as the value of call options. This section illustrates that the

Figure 5

Call Option Vertical Spread Values as a Function of
Stock Price for Different Durations



effects of duration, interest rate and stock volatility are directly analogous to their effects on calls.

Figure 6 illustrates the value of an IBM put with a strike price of $260, for several different durations. As with calls, the limiting case occurs at expiration. If the stock price is greater than $260 at the time of expiration, the value of an option to sell the stock at $260 per share is zero. If the stock price is below $260, the value of this option increases one point for each one point decrease in the stock. This is shown by the line labeled "t=0".

As the duration of the option is increased, its value becomes greater. This is because the option assumes a time premium in excess of the amount by which the strike price exceeds the stock price. If the stock price is far less than the strike price, the relative importance of this time premium diminishes. The value of the put approaches the difference between the strike and stock prices.

Figure 7 illustrates that the interest rate does not substantially effect the value of the put. This is the same conclusion that was drawn for the effect of interest rate on the value of call options.

Figure 8 shows the relationship between the stock volatility and the value of the put. Just as with calls, the stock volatility has a major impact on the put value. Consequently, it is important to have an accurate estimate of the stock volatility.

Figure 9 illustrates the value of the option delta as a function of the stock price for put options. It is important to note that the delta for a put is negative; the value of the put increases when the stock price declines. The magnitude of the delta has the same characteristics as the magnitude of the call delta. For stock prices far above the exercise price, a change in

Figure 6

Put Option Values as a Function of Stock Price for Different Durations

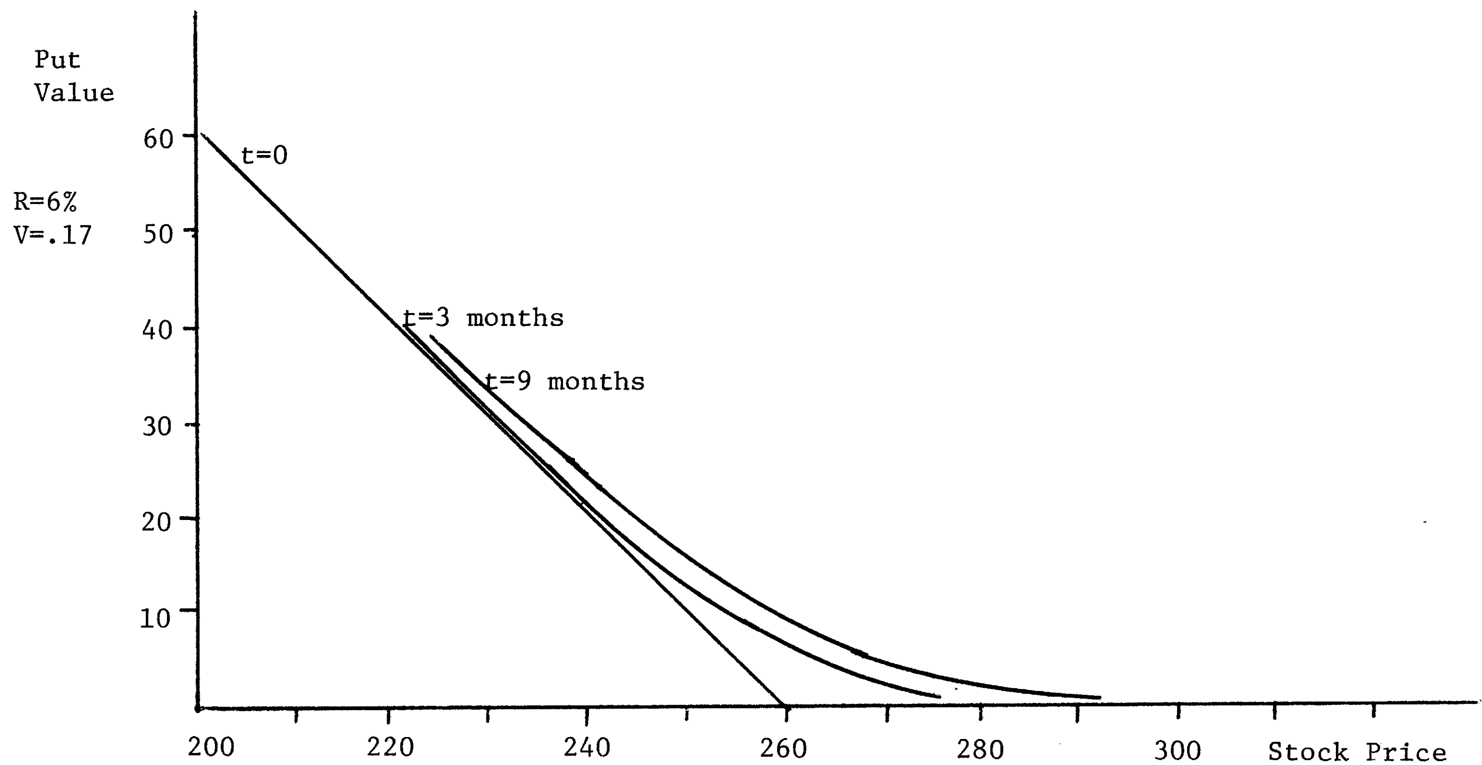


Figure 7

Put Option Values as a Function of Stock Price for Different Interest Rates

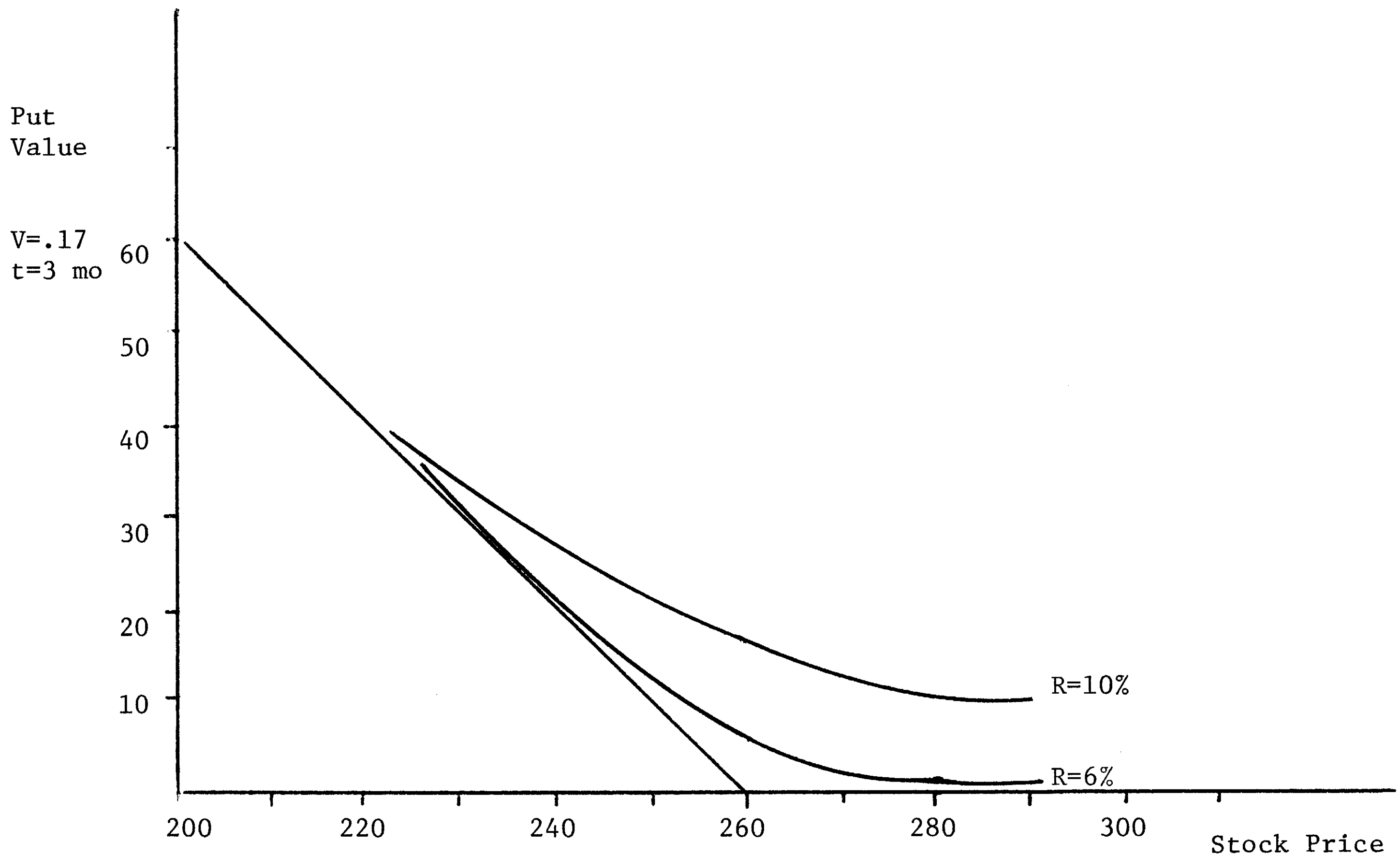


Figure 8

Put Option Values as a Function of Stock
Price for Different Volatilities

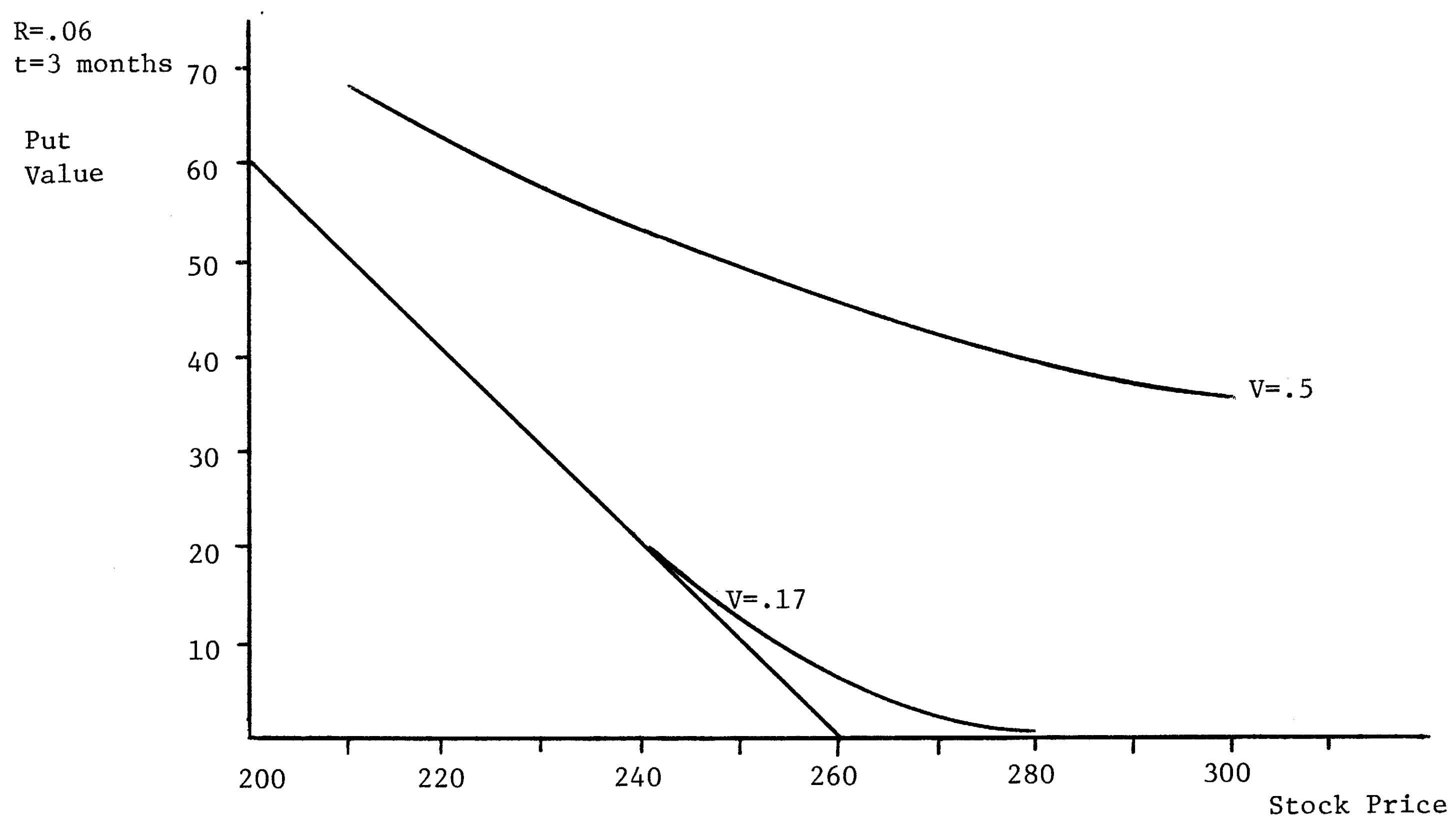
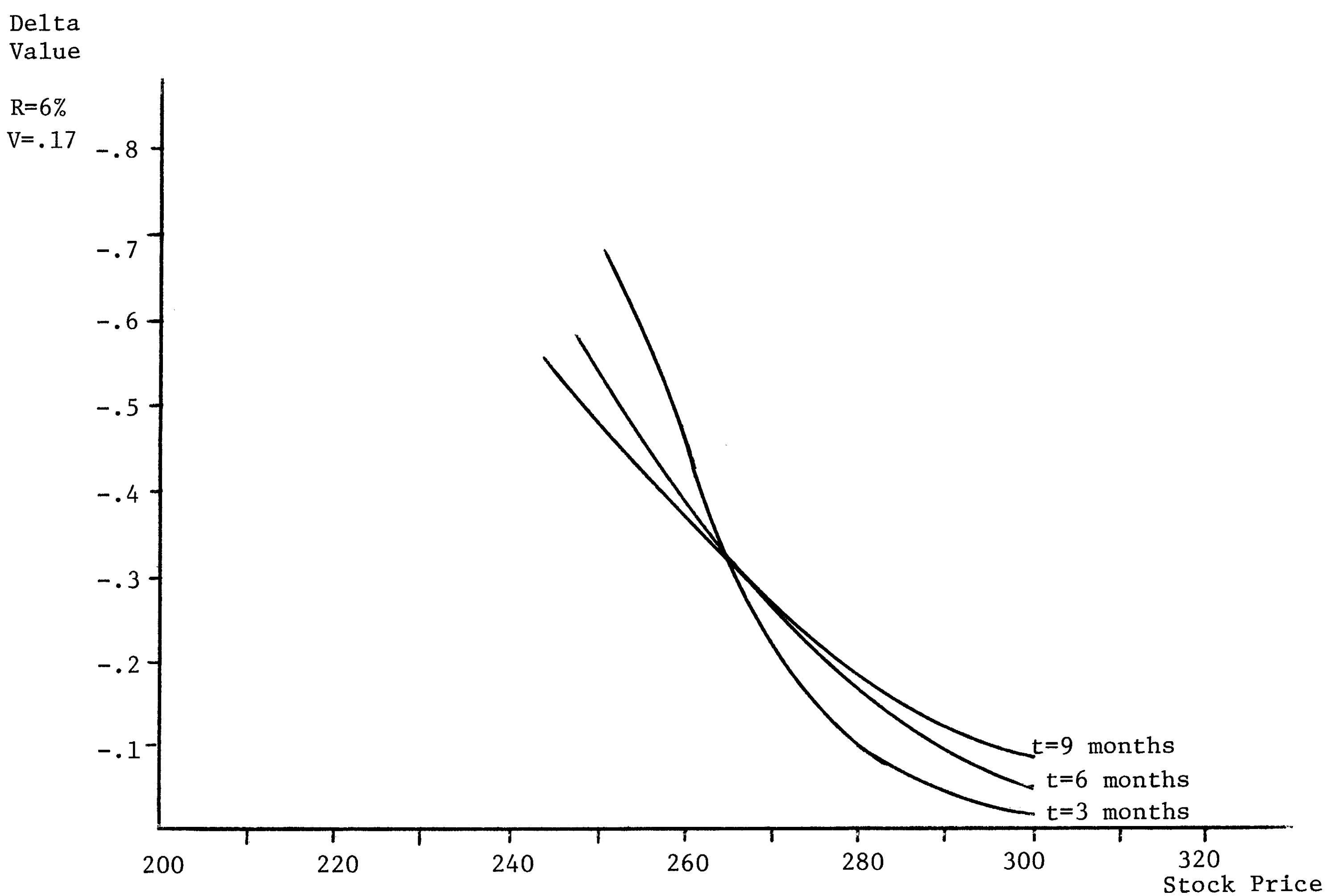


Figure 9

Put Option Deltas as a Function of Stock Price for Different Durations



the stock price will have very little effect on the value of the put. And, for stock prices well below the strike price, the value of the option is heavily dependent on changes in the stock price; the delta approaches unity.

Figure 9 also illustrates the values of deltas for options with longer durations. The deltas for put options have the same characteristics as the deltas for call options. For options which are deep in-the-money, the longer durations yield higher deltas. For options which are out of the money, the shorter durations yield higher deltas. And the effect of duration disappears at the extremes; the delta approaches zero for options which are very far out-of-the-money and unity for options which are very deep in-the-money.

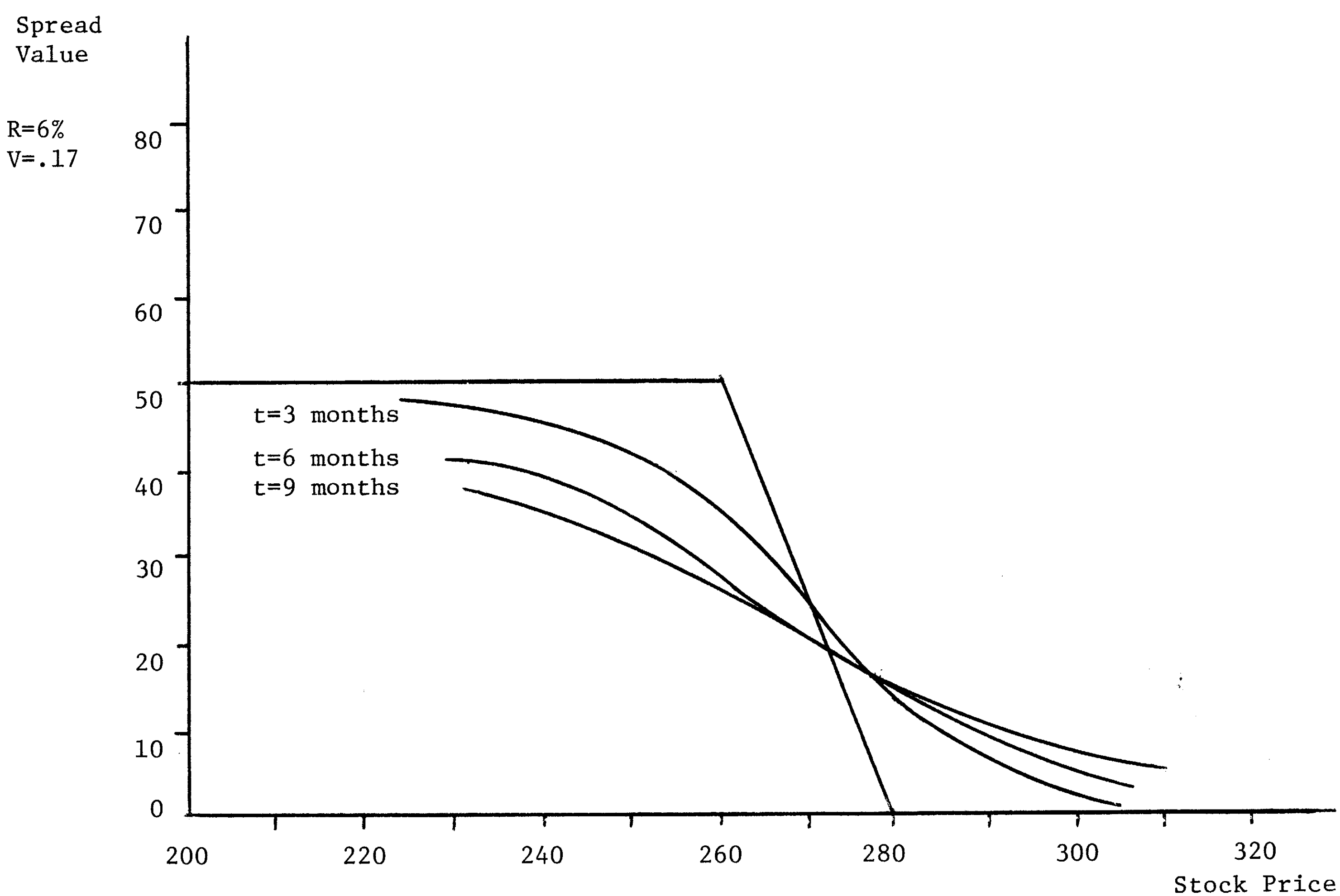
Figure 10 illustrates the value of vertical put spreads. It is assumed that the put with a strike price of $280 is long and the put with a strike price of $260 is short. This leads to a positive value for the spread. The value of the spread is the mirror image of the call spread discussed previously.

The limiting case for the put spread occurs at expiration. For stock prices above $280, both options are worth zero so the spread is worthless. For stock prices between $260 and $280, the options with a strike price of $280 begin to assume a value, but the other options remain worthless. The value of the spread increases point for point with decreases in the price of the stock. And, when the stock price is below $260, both options increase in value with decreases in the stock price; the value of the spread remains constant at $20.

As the duration of the options increases, the situation becomes more complex. The two options no longer move point for point with decreases in the stock price. Nor do they move point for point with one another. The relationships are shown by the lines labeled "t=3 months", "t=6 months" and "t=9 months". Notice that the duration has the same effect on the spreads as it did on the magnitude of the delta of an individual put.

Figure 10

Put Option Vertical Spread Values as a Function of Stock Price for Different Durations



2.2.3 Straddles

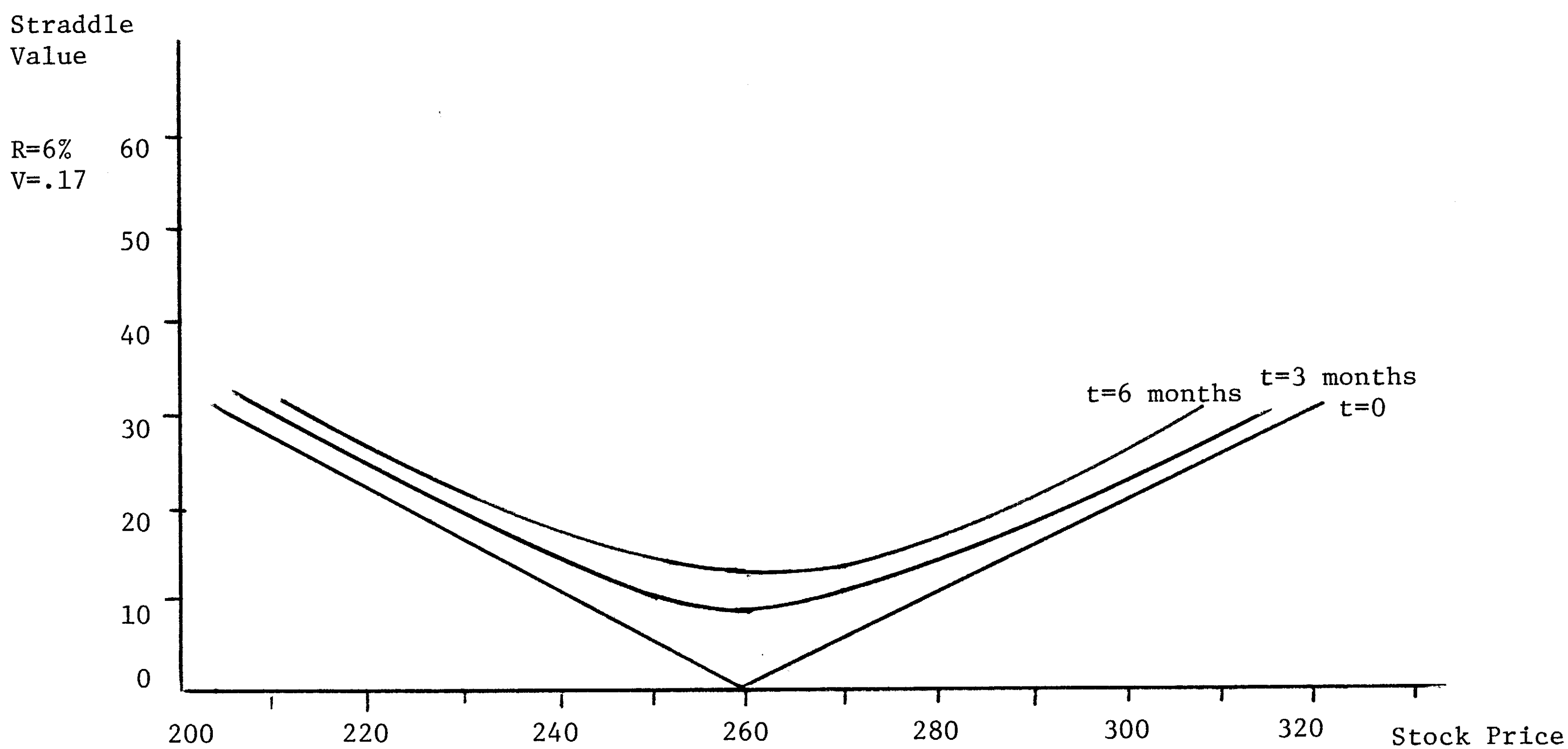
Figure 11 illustrates the value of straddles consisting on an IBM call and an IBM put, each having a strike price of $260. The simplest case is when both options are about to expire. This is shown by the line labeled "t=0". When the stock price equals the strike price, both the put and call are worthless. Below the strike price the put increases in value point for point with decreases in the stock price, and the call remains worthless. Above the exercise price the call increases in value point for point with the stock price and the put remains worthless.

As the duration of the options increases, the v-shape of the curve flattens out. The value of the straddle increases near the strike price faster than it increases either above or below the strike price. This is because both the put and call are increasing in value in the vicinity of the strike price. However, as the stock price differs from the strike price only one of the options increases in value.

As the stock price moves farther from the strike price, in either direction, the value of the straddle approaches its value at expiration. However, the value of a straddle always varies directly with its duration.

Figure 11

Straddle Values as a Function of
Stock Price for Different Durations



3.0 TAX TREATMENT OF OPTIONS TRANSACTIONS

The purchase and sale of options contracts are considered to be capital transactions for income tax purposes, just as the purchase and sale of common stock are capital transactions. However, the tax consequences of options trading are more complex than stock trading because of the possibilities of exercise and expiration.

Capital gains or losses may be long or short term, depending on the length of time that the asset was held. For transactions which are completed during 1977, the holding period requirement for long term capital gains or losses is nine months and one day. Beginning in 1978 this period is extended to one year and one day. When computing personal income tax, long and short term capital gains and losses may be used to offset one another. However, long term gains in excess of all losses are taxed at half the rate of short term gains. Similarly, long term losses provide half the deduction of short term losses. This gives the investor an incentive to have long term gains rather than short term gains, and it gives the investor an incentive to have short term losses rather than long term losses.

Since options, which are traded on the exchanges, have a maximum duration of only nine months, all simple options transactions will result in short term gains or losses. However, if the option is exercised, the holding period is measured by the length of time that the stock is held. This opens the possibility of achieving long term holdings.

3.1 Simple Purchase and Sale of Options

Assume that on January first the price of IBM stock is $270 per share. An investor purchases a call option to buy 100 shares of IBM with a strike price of $260 and expiration date in April. The price of the option would be approximately $1850. If the stock price increases to $300 in the next few days, the option would be worth about $4500. Assuming that the investor sells the option, he will realize a short term capital of $2650. If the stock price had declined to $250 per share, the option would have declined to about $675. If the investor sold the option at this price, he would realize a short term capital loss of $1175. The writer of these options would have exactly the opposite results. When the stock went up he would experience a short term capital loss and when the stock went down he would experience a short term capital gain.

If the investor had bought a put option to sell 100 shares of IBM with a strike price of $260 and expiration in April, he would have paid about $500. If the stock price rose to $300, the option would decline to about $30. Sale of the option would result in a short term capital loss of $470. If the stock price declined to $250 per share, the option would rise to $1400. If the option were sold, a short term gain of $900 would be realized. As before, the writer of the option would experience exactly the opposite results.

3.2 Purchasing Options and Exercising Them

When an option is exercised, the premium which was paid is used to adjust the tax basis of the stock. For example, suppose an investor paid $1850 for a three month call on IBM with a strike price of $260 when the stock was selling for $270 per share. If, at the end of the three months, the stock price was above the strike price, the investor may decide to exercise his option. If the stock price was below the strike price, the investor would not exercise the option because he could purchase the stock on the open market for less than the strike price. When the call is exercised, the investor purchases 100 shares of IBM for $26,000, which is less than the current market price. When computing the cost of this stock for tax purposes, the $1850 premium is added, bringing the total to $27850. The holding period for the stock begins when the option is exercised. No gain or loss is recognized for the option.

If the investor had purchased a put and exercised it, the tax treatment would be analogous to the treatment of a call. In this case the stock would have to be below the strike price in order for the put to be exercised. The holder of the option receives an amount equal to the strike price for each share he delivers. The tax basis for the individual delivering of the stock is equal to the strike price less the premium. The holding period is determined by the length of time that the stock was owned. Again, no gain or loss is recognized for the option.

3.3 Purchasing Options and Allowing Them to Expire

If an option expires, the holder may write off the entire premium as a capital loss. A call option will expire worthless if the stock price is below the strike price at the termination date. A put option will expire worthless if the stock price is greater than the strike price at the termination date.

3.4 Writing Options and Having Them Exercised

The writer of an option receives a premium. This premium is held in a "deferred suspense account" for tax purposes until the entire transaction is completed. No tax effects are recognized at the time the option is written.

The writer of a call option must deliver the stock at the strike price if the option is exercised. The tax basis for the sake of the stock is adjusted by the amount which the investor receives for the option. For example, the writer of the three month call on IBM received an $1850 premium in a previous example. When the option is exercised, this investor must deliver the stock at a total price of $26,000 for the 100 shares, even though the stock may be selling for a much higher price. The option writer records the sale price of the stock as the sum of the $26,000 received for the stock plus the $1850 received for the option, a total of $27,850.

If the call writer had owned the underlying stock, he could deliver from his inventory or he could purchase new shares on the open market and deliver them. If the calls had been written naked, the writer would be forced to purchase shares on the market for delivery. The holding period for capital gain or loss on the entire transaction is determined by the amount of time that the stock was held prior to exercise of the option.

The writer of a put option must purchase the stock at the strike price if the option is exercised. The cost basis for the stock is adjusted by the premium received for the option. For example, the writer of the three month put on IBM in a previous example received a $500 premium. When the put is exercised, the writer must purchase 100 shares of IBM for $26,000, even if the stock price is substantilly lower. The option writer records his cost basis as the $26,000 paid for the stock less the $500 received for the option, a total of $25,500.

The put writer may have sold the stock short. In this case the exercise of the put would serve to cover his short position. If the option writer did not have a short position in the stock, he would simply be forced to buy the stock from the option holder. In the first case, a short term capital gain or loss would be recognized at the time of exercise. In the latter case, the holding period of the transaction would depend on the time the stock was owned before it was sold.

3.5 Writing Options and Having Them Expire

If an option expires, the writer records the entire premium as a short term capital gain. A call option will expire worthless if the stock price is below the strike price at the termination date. A put option will expire worthless if the stock price is higher than the strike price at the termination date. The writer's position in the underlying stock has no effect on this transaction.

3.6 Straddles

The tax code defines a straddle as a simultaneous combination of an option to buy and an option to sell the same quantity of a security at the same price during the same period of time. The tax treatment for the purchaser of a straddle is the same as if he had purchased a put and call separately. The writer, however, has two alternatives for allocating the premium received between the put and the call for tax purposes. The premium may be allocated based on the respective market values of the two parts of the straddle. (Rev. Rul. 65-31, 1965-1 CB 365) Or, the writer may allocate 55% of the total premium to the call and 45% of the premium to the put. The latter alternative is only permitted if the writer uses it for all straddles that are written. (Rev. Rul. 65-29, 1965-2 CB 1023)

Usually the writer of a straddle will only have to fulfill one side of the straddle contract. If either or both sides of the contract are exercised, the writer must pay taxes on the premium allocated to the exercised part as if it were a put or call not sold as part of a straddle. The unexercised part is treated as a short term capital gain at expiration. If the straddle expires wholly unexercised, the entire premium is treated as a short term capital gain.

To illustrate the taxation of straddles, consider the investor who writes the put and call used in previous examples. He receives $1850 for the call and $500 for the put. He has two alternatives for allocating the joint premium. He can allocate the premiums based on their market values, or he can allocate $1292.50 to the call and $1057.50 to the put. The writer faces four possible outcomes from this transaction. The first possibility is that the call is exercised and the put expires. This would occur if the price of the underlying stock was about $260 at expiration. If the percentage allocation approach is chosen, the $1292.50 would be added to the exercise price received for the stock and is taxed as if the call had been written independently of the put. The $1057.50 allocated to the put is taxed as a short term capital gain.

The second alternative is that the price of the underlying stock is below $260 at expiration. In this case the premium allocated call is realized as a short term capital gain, and the premium allocated to the put is subtracted from the price paid for the stock. The put side of the contract is taxed as if it were written independently of the call.

If the put and call are both exercised, each option is treated as if it were written separately. This could happen if one of the options was prematurely exercised and then the stock price changed allowing profitable exercise of the other option.

The final possibility is that neither side of the straddle is exercised. This would occur if the stock price exactly equalled the strike price at the time of expiration and in this case, the entire premium, $2350, would be taxed as a short term capital gain.

Previously, it was necessary for the writer to identify which parts of the transaction comprised the straddle and which are independent options. This is no longer true for straddle strips or straps. This was necessary to determine which parts of the combined option were qualified to receive capital gains treatment upon expiration, and which would be taxed as ordinary income. This is no longer necessary because all unexercised options are now treated as short term capital gains.

4.0 TAX STRATEGIES

The intent of the following tax strageties is to defer the recognition of capital gains from one year to the next for income tax reporting purposes. It is assumed that the capital markets are efficient, and that the transactions which comprise the strategy are short term capital events. The objective is to establish a loss in the current year and recognize the offsetting gain in the following year. The losses may be used to offset capital gains which were recognized during the current year for tax reporting.

The following sections discuss three basic strategies. The first strategy involves setting up neutral spreads between options of the same kind. That is, the investor would buy one set of calls and sell another set. Or, the investor would buy one set of puts and sell another set of puts.

The second strategy involves spreads between options and the underlying stock. Here, the investor would establish a position in the stock and take a position in the option which would neutralize the net holdings. For example, the investor might purchase stock. To neutralize this position he could either write calls or purchase puts. Alternatively, if the investor sold the stock, the situation could be neutralized by buying calls or writing puts. It is important to note that the ratio of stock to options will not necessarily be one in order to have a neutral spread. This would only be true if the delta of the option were unity. Since this is not usually the case, a neutral spread will be composed of more options than shares of stock. The exact ratio is determined by the option's delta.

The third strategy consists of spreads between puts and calls. A neutral spread is established by either buying puts and calls or selling puts and calls. The ratio of puts to calls is determined by the deltas of the options which comprise the spread.

The neutrality of a spread is guaranteed by setting the delta of the spread equal to zero. However, the delta of an option changes with changes in the price of the underlying stock. As the stock price varies, the ratio of the number of options on each side of the neutral spread changes. This introduces a risk into the transaction. The risk may be measured by the gamma of the spread. This is the change in the spread's delta divided by the change in the underlying stock price for small moves in the stock in the short run. A gamma of zero would mean that the spread's delta was independent of the stock price. Therefore, the spread would remain neutral (delta equal to zero) no matter what happened to the stock price.

Gamma is an adequate measure of risk if the comparisons are being made among spreads on a single stock. However, if it is necessary to compare a spread on IBM with a spread on Digital Equipment Corporation, it is necessary to take into account the variability of the stock because it affects the variability in the delta of the spread. This is accomplished by constructing the dollar curvature of the spread. The dollar curvature is equal to the gamma times the stock price squared times the stock volatility squared. It is a measure of the frequency with which the spread must be adjusted in order to keep it neutral. The dollar curvature may be positive or negative. In either case, lower magnitudes of the dollar curvature imply lesser adjustments to maintain neutrality and, therefore, less risk in the spread.

The actual number of option contracts or shares of stock which are used in a spread is determined by the delta of the spread being confined to zero and the magnitude of the dollar curvature being confined to unity. The former constraint is required in order to have a neutral spread. The latter constraint is arbitrary. As long as all spreads have the same dollar curvature, they will have equal risk. The value of unity was chosen because of its computational convenience. The algebra used to derive the actual numbers is quite simple, and will be provided in the discussions of the individual spread strategies.

The decision of which options to buy and sell is determined by the excess value of the spread. The excess value is the difference between the market price of the spread and the estimated value of the spread. All spreads are defined so that they have a positive excess value. The sign of the excess value may be reversed by reversing the buy and sell decisions on the options which comprise the spread. For example, if option A has a price which is less than its value and option B has a price which is greater than its value, it would be reasonable to purchase option A and sell option B. This spread would have a positive excess value. If the buy and sell decisions are reversed, the excess value becomes negative.

The commissions charged by a brokerage house are part of the costs of establishing the spreads. As an approximation, these are calculated using costs of $0.375 per share of stock and $8.50 per option contract. These are fairly representative of actual costs.

The cash outlay for a spread depends on the margin requirements as well as the particular options involved. The margin requirements are fairly complex. The purchase or short sale of stock requires margin of

50% of the market price of the stock. The purchase of an option requires the full option price as margin. There are several different cases to consider on the sale of an option. Naked options have a margin requirement of 30% of the stock price. This is reduced by the funds received on sale of the option and by the difference between the stock price and exercise price of the option. For in-the-money options the absolute value of the difference between stock price and strike price is added to the margin required. For out-of-the money options, this amount is subtracted from the margin requirement.

Covered options do not have the same margin requirements as naked options. If the short option is covered by stock, the margin is equal to the difference between the stock and exercise prices. In this case, the investor has purchased stock. Part of the outlay for the stock is offset by the income from the option premium. If the option is in the money, the difference between the stock price and the strike price is added to the funds required. If the option is out of the money, this difference will be negative. It then serves to reduce the margin requirement.

If the short option is covered by another option with a shorter duration, the short option is considered to be naked. If, however, the long option has a longer duration than the short option, the margin requirements are similar to the normal covered option case. The investor has an outlay for the long option and receives income from the premium of the short option. This is adjusted by the difference between the strike prices of the two options. For calls, the long option's strike price less the short option's strike price is added to the cash required. Therefore, if the short option has a higher strike price than the long option, the difference will be negative, and will reduce the cash required. The case is reversed for put spreads. The difference between the short option's strike price and the long option's strike price is added to the cash required. In this case, if the short option has a higher strike price than the long option, the cash required will be increased.

Spreads between puts and calls are treated as if they were independent transactions. If the options were purchased, the cash required would equal the sum of the premiums. If the options were written, they would be treated as if they were naked.

The option pricing formula includes interest income on the value of the option. This means that if two options, or two spreads, have the same risk, the difference in their values ought not to be a consideration in choosing between them.

The investor will often have to leave margin money with the broker. Frequently, the broker declines to pay interest on this money. This lost interest is an opportunity cost of leaving the money with the broker. For example, if an investor sells stock short for $1000 and has to put up $500 margin, interest is being lost on $1500. Interest is being lost on the proceeds of the sale and on the cash being left with the broker. It does appear, however, that the importance of this lost income is decreasing, because brokers are beginning to pay interest on account balances in excess of $2000.

The dollar volatility of an option is a measure of how much the option position is expected to change. It is equal to the number of options times the delta times the stock price times the stock volatility. For a neutral spread, the dollar volatilities of the two sides will be equal. However, they predict price movements in different directions. In order to achieve the greatest impact of the spreads for the purposes of the following strategies, one ought to choose the spreads which consist of option positions with the greatest dollar volatility.

4.1 Option Spread Strategies

The establishment of the spreads is based on two conditions. First, the spread's delta is zero. And second, the dollar curvature of the spread is unity. These two conditions defined the size of the position on each side of the spreads.

Let:

D1= delta of one option 1

D2= delta of option 2

G1= gamma of option 1

G2= gamma of option 2

P= stock price

V= stock volatility

N1= number of contracts of option 1

N2= number of contracts of option 2

DC- dollar curvature

The variable P is determined from market data. D1, D2, G1, and G2 are determined by the Black-Scholes pricing formula. The volatility, V, is determined by historical price movements of the stock. The dollar curvature is a function of the other variables and will be set equal to unity. Thus, N1 and N2 are to be determined.

Option 1 has a delta equal to D1. If the position consists of N1 options, the delta of the entire position is N1 times D1. Similarly, a position consisting of N2 options, having a delta of D2, would have an aggregate delta of N2 times D2. If a spread were to be formed between these two positions, the spread's delta would be:

$$Delta=N1*D1-N2*D2$$

In order for the spread to be neutral, the spread's delta must be zero. This leads to the following relationship between N1 and N2:

$$N1=\frac{D2}{D1}N2$$

Using the same line of reasoning, the gamma of the spread, GS, is equal to N1*G1-N2*G2. Recall that the dollar curvature is defined to be the spread's gamma times the stock price squared times the volatility squared:

$$DC=GS*P^2*V^2=1$$

After a little algebraic manipulation, this information leads to concise expressions for N1 and N2:

$$N1=\frac{D2}{(G1*D2+G2*D1)*P^2V^2}$$

$$N2=\frac{D1}{(G1*D2+G2*D1)*P^2V^2}$$

4.1.1 Call Option Spreads

IBM stock has six call options associated with it. Table I lists the values and deltas of these options for several different strike prices. There are several assumptions underlying this presentation. The stock volatility is assumed to be 0.17. The interest rate is assumed to be 6%. And the date is assumed to be December 5, 1977. On that date there will be options outstanding with termination dates in January, April and July 1978.

Table I also lists the values and deltas of options on Digital Equipment Corporation (DEC). Although DEC has more than fifteen option

TABLE 1

Call Option Prices for IBM and DEC

```
12 05 .06

WHICH SUBROUTINE DO YOU WANT
3
STOCK:
IBM
LOWER PRICE:
250
UPPER PRICE:
300
```

CALL PRICES

	STRIKE PRICE	JAN		APR		JUL	
PRICE: 250							
	260.000	3.032	0.32	8.267	0.45	13.048	0.52
	280.000	0.283	0.05	2.733	0.20	6.115	0.31
PRICE: 260							
	260.000	7.411	0.56	13.560	0.60	18.823	0.63
	280.000	1.181	0.15	5.328	0.32	9.721	0.42
PRICE: 270							
	260.000	14.185	0.78	20.288	0.74	25.685	0.73
	280.000	3.514	0.33	9.256	0.46	14.455	0.53
PRICE: 280							
	260.000	22.727	0.91	28.188	0.84	33.455	0.82
	280.000	7.981	0.56	14.603	0.60	20.270	0.63
PRICE: 290							
	260.000	32.211	0.97	36.943	0.91	41.935	0.88
	280.000	14.681	0.77	21.285	0.73	27.098	0.73
PRICE: 300							
	260.000	42.068	0.99	46.259	0.95	50.942	0.92
	280.000	23.080	0.90	29.077	0.83	34.781	0.81

WHICH SUBROUTINE DO YOU WANT

TABLE 1 (Continued)

```
3
STOCK:
DEC
LOWER PRICE:
30
UPPER PRICE:
60
```

CALL PRICES

	STRIKE PRICE	JAN		APR		JUL	
PRICE: 30							
	45.000	0.000	0.00	0.013	0.01	0.103	0.04
	50.000	0.000	0.00	0.001	0.00	0.026	0.01
PRICE: 40							
	45.000	0.237	0.13	1.087	0.30	1.967	0.38
	50.000	0.016	0.01	0.326	0.11	0.879	0.21
PRICE: 50							
	45.000	5.598	0.89	6.838	0.81	7.996	0.79
	50.000	2.068	0.55	3.661	0.59	4.964	0.61
PRICE: 60							
	45.000	15.352	1.00	16.045	0.98	16.881	0.95
	50.000	10.431	0.98	11.465	0.92	12.606	0.88

WHICH SUBROUTINE DO YOU WANT

currently outstanding, only six have been included in this table. This is a sufficient number of options to illustrate the use of the strategies.

Table II illustrates the potential spreads which may be formed among the IBM call options and the spreads which may be formed among the DEC call options. Since each stock is assumed to have six options, there will be a total of fifteen possible spreads for each stock. The spreads are formed on December 5, 1977.

All of the spreads shown in Table II have dollar curvature equal to unity. All of the spreads are also neutral. The sign of the dollar curvature depends on which option is bought and which is sold.

The excess value of the spread is the difference between the market price of the spread and the model price of the spread. It depends on which option is bought and which is sold. The spreads are defined by the excess value always being positive. The excess value of the spread is merely the excess value of the long position minus the excess value of the short position. The first spread in Table II has an excess value of \$58.71. This means that the cost of the spread is less than the value of the spread. If the buy and sell decisions were reversed, the spread would have a negative excess value.

The rightmost column is the dollar volatility of each side of the spread. The dollar volatility is equal to the number of options in the position times the option's delta times the stock price times the stock volatility. It provides a measure of how much price variation can be expected in the position. Both sides of a neutral spread must have the same dollar volatility. The price changes on each side offset one another.

TABLE 2

Call Spreads

```
12 05 .06

WHICH SUBROUTINE DO YOU WANT
4
NUMBER OF STOCKS:
2
STOCK:
IBM
ENTER CURRENT PRICES
STOCK:
280.
JAN 260.000:
24.
APR 260.000:
29.
JUL 260.000:
34.
JAN 280.000:
8.5
APR 280.000:
14.75
JUL 280.000:
20.5
STOCK:
DEC
ENTER CURRENT PRICES
STOCK:
50.
JAN  45.000:
6.
APR  45.000:
7.5
JUL  45.000:
8.5
JAN  50.000:
2.
APR  50.000:
4.
JUL  50.000:
5.
```

Table 2 (Continued)

CALL SPREADS

	LONG	SHORT	EXCESS	COMMISSION	CASH	LOST INT	DOL. VOL.
IBM	2.059 APR 260.000	-1.888 JAN 260.000	58.71	33.545	1473.64	2.01	8221.432
DEC	6.821 JAN 45.000	-7.508 APR 45.000	233.94	121.800	13599.87	908.30	7944.828
IBM	0.458 JUL 260.000	-0.409 JAN 260.000	21.13	7.366	584.27	0.44	1779.410
IBM	0.377 JUL 260.000	-0.366 APR 260.000	6.92	6.315	224.34	0.38	1462.807
DEC	1.242 JUL 45.000	-1.203 APR 45.000	15.43	20.784	174.21	1.25	1273.073
DEC	0.942 JAN 45.000	-1.071 JUL 45.000	19.01	17.107	1813.47	129.49	1097.250
DEC	0.518 JUL 50.000	-0.353 JAN 45.000	10.67	7.406	231.14	11.04	411.383
DEC	0.493 JUL 50.000	-0.370 APR 45.000	21.66	7.329	161.22	11.53	391.130
IBM	0.120 JUL 280.000	-0.091 APR 260.000	3.50	1.797	166.82	11.02	363.263
IBM	0.115 JUL 280.000	-0.080 JAN 260.000	5.83	1.659	206.16	9.68	347.891
IBM	0.114 APR 280.000	-0.109 JUL 280.000	1.35	1.897	861.78	54.98	328.349
DEC	0.412 JUL 50.000	-0.429 APR 50.000	12.68	7.149	67.82	2.02	326.862
DEC	0.377 JUL 50.000	-0.292 JUL 45.000	12.94	5.684	91.92	9.10	299.205
IBM	0.096 JUL 280.000	-0.075 JUL 260.000	1.42	1.457	94.36	9.08	290.998
DEC	0.156 JAN 45.000	-0.239 APR 50.000	2.34	3.363	360.39	21.74	182.142
DEC	0.234 APR 50.000	-0.168 APR 45.000	2.95	3.419	54.91	5.25	178.060
IBM	0.060 APR 280.000	-0.043 APR 260.000	2.37	0.877	50.56	5.24	172.462
IBM	0.059 APR 280.000	-0.039 JAN 260.000	3.52	0.830	72.05	4.70	168.919
DEC	0.205 APR 50.000	-0.152 JUL 45.000	0.70	3.040	260.39	18.47	156.211
IBM	0.054 APR 280.000	-0.040 JUL 260.000	1.39	0.794	358.01	24.83	154.274
IBM	0.039 APR 280.000	-0.042 JAN 280.000	1.40	0.692	46.88	1.49	112.843
DEC	0.157 JAN 50.000	-0.148 APR 50.000	6.26	2.593	196.74	13.47	112.617
IBM	0.028 JUL 280.000	-0.031 JAN 280.000	0.69	0.503	60.53	1.81	83.981
DEC	0.117 JAN 50.000	-0.105 JUL 50.000	1.40	1.890	130.74	9.61	83.759
DEC	0.097 JAN 50.000	-0.060 JAN 45.000	2.97	1.333	14.77	1.87	69.590
DEC	0.096 JAN 50.000	-0.065 APR 45.000	4.98	1.372	102.11	7.91	68.986
IBM	0.025 JAN 280.000	-0.017 APR 260.000	0.09	0.362	150.13	10.68	68.212
IBM	0.025 JAN 280.000	-0.016 JAN 260.000	0.58	0.347	15.61	1.88	67.650
DEC	0.091 JAN 50.000	-0.064 JUL 45.000	3.93	1.319	93.00	7.74	65.440
IBM	0.017 JUL 260.000	-0.024 JAN 280.000	0.22	0.350	66.70	1.82	65.173

WHICH SUBROUTINE DO YOU WANT

The objective of this strategy is to establish the largest possible loss in the current year and offset it with a gain in the following year. This is accomplished by choosing an options position with the greatest dollar volatility. This position has the greatest expected price fluctuation. This does not imply additional risk because all of the spreads are constructed to have the same dollar curvature, and, therefore, the same risk. High dollar volatility simply means that both sides of the spread have large price variations. However, the price changes always neutralize one another.

The column labeled "commission" lists the transaction costs required to establish the spread. The investor must have a reasonable probability of obtaining a tax advantage which exceeds this cost.

The column labeled "cash" is the sum of the margin requirement and the commission cost. This is the amount of money which would be required to enter the position. The investor could either pay this amount in cash or leave stock or treasury bill with the broker as security.

The column labeled "lost int" is the amount of interest income which is foregone if the spread is held for one year. This figure is determined by applying the 6% interest rate to the difference between the margin held by the broker and the price of the spread. For example, if the spread costs $800 and the broker a total outlay of $1000, the lost interest is based on a pricipal amount of $200. However, if the investor sells the spread, in the sense that he ought to receive $800, and the broker requires $200 margin, the lost interest would be based on a priciple amount of $1000.

Table III illustrates the possible outcomes of an investment in one of the spreads shown in Table II. This Table is included to show the results predicted by the model if the investment could be sold immediately for the value specified by the model. Since the pricing formula predicts option values which do not equal the market prices, the model predicts profits or losses even if the stock price does not move.

This example examines the behavior of a spread formed between two sets of IBM options. The spread is established on December 5, 1977. The stock price is assumed to be $280 per share. It consists of the purchase of 2.059 contracts of the April 260 option and the sale of 1.888 contracts of the January 260 option. The value of the April 260 option is $28.19, according to the model, however, the market price is assumed to be $29.00. This assumption is arbitrary. It has been made for the purpose of demonstrating the use of the models. The value of the January 260 option is $22.73. Its price is $24.00. Consequently, both options are overpriced by the market.

Table III contains a variety of information related to the profitability of the spread. The rightmost column lists the assumed price of the stock at the time the spread is ended. The remaining columns list the results of the spread for each of the assumed prices. This gives the investor the opportunity to see how much of a tax gain he will have, and how much his expenses can be.

The second and third columns state the configuration of the spread being examined. The number of option contracts being bought and their expiration date are listed in the second column. The number of option contracts being sold and their expiration date are listed in the third column.

TABLE 3

Results of Call Spreads If Sold Immediately

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
7
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
LONG OPTION
NUMBER:
2.059
I:
2
PRICE PAID:
29.
SHORT OPTION
NUMBER SOLD:
1.888
I:
1
PRICE PAID:
24.
```

RESULTS OF CALL SPREADS

STOCK PRICE	LONG CALL	SHORT CALL	COMMISSIONS PAID	LONG CHANGE	SHORT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1817.67	-1863.41	-21.36	151.67	147.47
271.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1664.73	-1714.27	-17.56	154.08	150.76
272.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1509.42	-1561.93	-14.59	156.42	153.89
273.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1351.82	-1406.55	-12.37	158.70	156.84
274.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1191.98	-1248.33	-10.75	160.91	159.61
275.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1029.97	-1087.42	-9.64	163.06	162.21
276.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-865.85	-924.01	-8.94	165.13	164.64
277.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-699.72	-758.24	-8.58	167.13	166.91
278.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-531.60	-590.30	-8.40	169.07	169.01
279.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-361.60	-420.33	-8.37	170.94	170.95
280.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-189.77	-248.50	-8.37	172.73	172.75
281.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-16.19	-74.94	-8.35	174.47	174.40
282.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	159.10	100.21	-8.21	176.13	175.91
283.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	336.02	276.80	-7.88	177.73	177.29
284.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	514.49	454.71	-7.32	179.26	178.55
285.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	694.47	633.83	-6.46	180.73	179.69
286.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	875.87	814.05	-5.28	182.14	180.73
287.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1058.66	995.24	-3.68	183.48	181.66
288.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1242.76	1177.33	-1.67	184.77	182.50
289.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1428.11	1360.22	0.79	185.99	183.26
290.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1614.66	1543.82	3.75	187.16	183.94

```
WHICH SUBROUTINE DO YOU WANT
```

The fourth column lists the commission costs for the entire transaction. This includes buying and selling costs for the options shown in the previous column. Since the commissions are assumed to depend only on the number of options in the position, the costs are constant.

The next column lists the changes in the predicted value of the long position. This is determined by multiplying the excess value of the option times the number of options in the position. If the options were correctly priced, the change ought to be zero when the stock price is assumed to be $280, in this example. However, the option was overpriced. If it is assumed that the option were to suddenly become correctly priced, the price of the long position would decline $189.77.

The sixth column lists the changes in the predicted value of the short position. This is determined in the same manner as the previous case. In this example, the price of the short option would decline $248.50.

The column labeled "profit" lists the net change in the spread's price minus the commission costs. This is an indication of how much the investor can expect to show as a capital gain or loss on the position if the entire position were liquidated. However, the strategy is not to liquidate the entire position in the current year. Only one side of the spread is to be liquidated. The fifth and sixth columns indicate which side should be liquidated and what potential deductions can be achieved.

If the stock price remained at $280, the model predicts that the long position would decline in value by $189.77. This would result in a loss on this side of the spread. The model also predicts that the short side of the spread would decline $248.50. This would result in a gain equal to the excess value listed in Table II. The strategy, in this case, would be to sell the long position and recognize the loss in the current year.

At this point the investor would have two alternatives. He could either re-establish a neutral hedge of allow the short position to remain uncovered. In either case, the margin requirements would change. The last two columns in Table III indicate the deltas of each side of the original spread. This figure is arrived at by multiplying the number of options times its delta. For the example being considered, the investor would have 1.888 January 260 contracts naked. For each one point movement in the stock, the value of the option position could be expected to vary $172.75. This information should be helpful in deciding whether or not to accept the market risk until the second leg of the spread is lifted.

Table III provides insight into the differences between market conditions and predicted conditions. It demonstrates that as the price of the underlying stock varies, the potential of the strategy increases significantly because both sides of the spread change in price. For stock prices below the initial price, losses will occur on the long side of the spread. For stock prices above the initial price, the losses will occur on the short side of the spread. In either case, the losses are offset by gains on the other side.

The spread remains fairly neutral over a wide range of stock prices. This can be seen by observing that the position deltas offset one another over the range of stock prices listed in the table. At a stock price of $280, the deltas are essentially equal. This was specified in the construction of the spread. As the stock price is varied, both the long and short deltas move. However, they move more or less in tandem. If the stock price were to increase to $290, the deltas would not be equal. The long delta would be $187.16 and the short delta would be $183.94. This means that for small stock price movements around $290, each one point change in the stock would have only a $3.22 effect on the value of the entire spread.

The preceding discussion was intended to illustrate the differences between the market conditions and forecast conditions at the time the spread is established. It is unlikely that the stock price would vary significantly enough during the initial day to warrant selling one side of the spread. In addition to the lack of price movement, there is a second reason for delaying the closing of one side of the spread. It is preferable to leave the remaining side naked to avoid paying commissions for the options required to form the new neutral spread. If the action can be delayed to the last day of the year, the risk can be reduced. The loss can be established on the last day of the year and gain the recognized on the first trading day of the new year.

Table IV presents the same analysis as Table III. However, in this case it is assumed that the position was held from December 5, 1977 until December 31, 1977. Because both of the options have come closer to expiration, their values and deltas have changed. The spread is no longer neutral. If the stock price was $280 on December 31, the same price as on December 5, the spread would no longer be neutral. This can be seen by observing that the deltas of the positions are no longer equal. The long position has a delta of 175.55 and the short position has a delta of 183.65. As the stock price rises, the spread becomes more neutral. The spread is

TABLE 4

Results of Call Spreads If Held Until December 31

```
ENTER DATE,  INTEREST RATE
12 31 .06

WHICH SUBROUTINE DO YOU WANT
7
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
LONG OPTION
NUMBER:
2.059
I:
2
PRICE PAID:
29.
SHORT OPTION
NUMBER SOLD:
1.888
I:
1
PRICE PAID:
24.
```

RESULTS OF CALL SPREADS

STOCK PRICE	LONG CALL	SHORT CALL	COMMISSIONS PAID	LONG CHANGE	SHORT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-2168.92	-2307.58	71.56	152.73	160.22
271.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-2014.81	-2145.44	63.53	155.39	164.05
272.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1858.08	-1979.66	54.48	157.97	167.50
273.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1698.81	-1810.62	44.71	160.47	170.58
274.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1537.12	-1638.68	34.46	162.88	173.31
275.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1373.05	-1464.16	24.01	165.20	175.71
276.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1206.72	-1287.40	13.59	167.44	177.80
277.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-1038.19	-1108.68	3.39	169.60	179.62
278.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-867.56	-928.27	-6.39	171.67	181.18
279.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-694.91	-746.41	-15.60	173.65	182.52
280.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-520.32	-563.31	-24.11	175.55	183.65
281.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-343.88	-379.16	-31.82	177.37	184.60
282.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	-165.66	-194.14	-38.61	179.11	185.40
283.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	14.26	-8.39	-44.45	180.76	186.06
284.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	195.78	177.96	-49.28	182.34	186.61
285.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	378.85	364.81	-53.06	183.84	187.06
286.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	563.37	552.07	-55.80	185.26	187.42
287.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	749.29	739.65	-57.45	186.61	187.72
288.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	936.52	927.50	-58.07	187.90	187.95
289.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1125.00	1115.55	-57.65	189.11	188.14
290.000	2.059 APR 260.000	1.888 JAN 260.000	67.10	1314.66	1303.77	-56.21	190.25	188.29

WHICH SUBROUTINE DO YOU WANT

essentially neutral when the stock price is $288. Above that price, the spread is no longer neutral. The spread is still fairly neutral over the entire range of stock prices shown in this table.

The use of this strategy may be illustrated using Table IV. Assume that on December 5, 1977 an investor is considering entering into the spread shown in the table. At that time he has no idea what the stock price will be at the end of the year. The investor does believe that the option prices will adjust to the values predicted by the model, or at least come closer to these values, as the expiration dates approach. Table IV provides all of the information this investor requires to make an intelligent decision whether or not to enter the spread. If the stock price remains unchanged, the investor will have a deduction of $520.32. His remaining option will move $183.65 for every one point change in the price of the underlying stock. It the price declines to $270, the investor will have a $2148.92 deduction and the remaining option position will have a price change of about $160.22 for every one point change in the underlying stock. In this case the investor would have invested $1473.64 to achieve a $2148.72 deduction in the current year, and he would have achieved a $471.56 capital gain after commissions.

4.1.2 Put Option Spreads

Puts are not currently traded on any of the organized option exchanges, however, they will be actively traded in the near future. When these options are traded, they will offer the same tax opportunities as the calls which were just discussed.

The tax strategy for using spreads between puts is exactly analogous to the strategy involving call options. Table V shows the values and deltas of hypothetical put options. It has been assumed that the puts

TABLE 5

Put Option Prices For IBM and DEC

```
ENTER DATE,   INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
3
STOCK:
IBM
LOWER PRICE:
250
UPPER PRICE:
300
```

PUT PRICES

	STRIKE PRICE	JAN		APR		JUL	
PRICE: 250							
	260.000	11.003	0.68	12.652	0.55	13.604	0.48
	280.000	28.098	0.95	26.686	0.80	25.944	0.69
PRICE: 260							
	260.000	5.382	0.44	7.945	0.40	9.378	0.37
	280.000	18.996	0.85	19.281	0.68	19.550	0.58
PRICE: 270							
	260.000	2.156	0.22	4.672	0.26	6.241	0.27
	280.000	11.329	0.67	13.209	0.54	14.284	0.47
PRICE: 280							
	260.000	0.699	0.09	2.573	0.16	4.010	0.18
	280.000	5.796	0.44	8.556	0.40	10.100	0.37
PRICE: 290							
	260.000	0.183	0.03	1.328	0.09	2.491	0.12
	280.000	2.496	0.23	5.238	0.27	6.928	0.27
PRICE: 300							
	260.000	0.039	0.01	0.644	0.05	1.497	0.08
	280.000	0.896	0.10	3.030	0.17	4.610	0.19

```
WHICH SUBROUTINE DO YOU WANT
```

TABLE 5 (Continued)

```
3
STOCK:
DEC
LOWER PRICE:
30
UPPER PRICE:
60
```

PUT PRICES

	STRIKE PRICE	JAN		APR		JUL	
PRICE: 30							
	45.000	14.649	1.00	14.041	0.99	13.469	0.96
	50.000	19.610	1.00	18.922	1.00	18.210	0.99
PRICE: 40							
	45.000	4.885	0.87	5.116	0.70	5.332	0.62
	50.000	9.625	0.99	9.247	0.89	9.062	0.79
PRICE: 50							
	45.000	0.246	0.11	0.866	0.19	1.361	0.21
	50.000	1.678	0.45	2.581	0.41	3.148	0.39
PRICE: 60							
	45.000	0.001	0.00	0.073	0.02	0.246	0.05
	50.000	0.041	0.02	0.385	0.08	0.790	0.12

WHICH SUBROUTINE DO YOU WANT

will have the same strike prices as the calls which are currently traded. This table includes values for options on IBM and DEC.

IBM and DEC.

Table VI is directly analogous to Table II. It lists all possible neutral spreads on the two stocks and provides information concerning the excess value, commission costs, margin requirements, lost interest and dollar volatility. Market prices for the puts have been arbitrarily chosen to illustrate the approach used to apply this strategy. These prices are shown at the top of Table VI.

The spreads are ranked according to the dollar volatility of each side. Recall that the spreads are neutral. Therefore, the dollar volatility of the entire spread is zero. The dollar volatility shown in this table applies to each side of the spread. It is an indication of how much one can expect the price of one side of the spread to fluctuate during a one year period. Naturally, the spread will not be held for more than a few weeks, so this is merely a convenient method of ranking the spreads.

The examples listed in Table VI are based on the assumptions that the price of IBM is $280 a share and the price of DEC is $50 per share. The spreads are initiated on December 5, 1977.

Table VII shows the predicted results of a spread if it could be sold immediately for the value predicted by the model. The spread consists of a long position in 2.097 contracts of IBM January 280 puts and a short position in 5.697 IBM 260 puts. Referring to the line corresponding to a stock price of $280, it can be seen that the long position was overpriced by $49.60 and the short position was overpriced by $262.50. If the option prices are adjusted to the values, the result would be a potential tax deduction of $49.60 in the current year.

TABLE 6

Put Spreads

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
4
NUMBER OF STOCKS:
2
STOCK:
IBM
ENTER CURRENT PRICES
STOCK:
280.
JAN 260.000:
.75
APR 260.000:
3.
JUL 260.000:
4.
JAN 280.000:
6.
APR 280.000:
8.5
JUL 280.000:
10.
STOCK:
DEC
ENTER CURRENT PRICES
STOCK:
50.
JAN  45.000:
.25
APR  45.000:
1.
JUL  45.000:
1.5
JAN  50.000:
1.75
APR  50.000:
2.5
JUL  50.000:
3.25
```

TABLE 6 (Continued) PUT SPREADS

	LONG	SHORT	EXCESS	COMMISSION	CASH	LOST INT	DOL.VOL.
IBM	2.097 JAN 280.000	-5.697 APR 260.000	212.90	66.253	36077.45	2191.69	4368.130
DEC	3.125 JAN 50.000	-7.533 APR 45.000	83.42	90.586	7416.68	457.39	1821.815
DEC	1.006 APR 50.000	-1.970 JUL 45.000	36.94	25.292	1951.07	119.71	541.809
IBM	0.229 APR 280.000	-0.493 JUL 260.000	1.84	6.137	3159.75	189.75	431.774
IBM	0.188 JUL 280.000	-0.173 APR 280.000	0.85	3.071	43.38	0.18	327.464
DEC	0.606 APR 50.000	-0.645 JUL 50.000	11.63	10.631	919.94	58.69	326.356
DEC	0.403 JUL 50.000	-0.740 JUL 45.000	6.63	9.716	166.16	8.78	203.674
IBM	0.107 JUL 280.000	-0.213 JUL 260.000	1.28	2.716	488.76	28.02	186.227
DEC	0.560 JUL 45.000	-0.637 APR 45.000	0.66	10.177	107.38	5.22	154.087
IBM	0.174 JUL 260.000	-0.073 JAN 280.000	1.21	2.104	174.38	8.92	152.579
IBM	0.168 JUL 260.000	-0.192 APR 260.000	8.36	3.066	165.61	9.36	147.429
DEC	0.244 JAN 50.000	-0.517 JUL 45.000	5.90	6.462	488.15	31.38	142.071
DEC	0.223 APR 50.000	-0.496 APR 45.000	8.69	6.109	174.19	10.09	119.968
IBM	0.060 APR 280.000	-0.054 JAN 280.000	1.38	0.968	19.26	0.06	112.739
DEC	0.209 APR 50.000	-0.193 JAN 50.000	3.00	3.417	21.86	0.21	112.557
IBM	0.058 APR 280.000	-0.143 APR 260.000	6.70	1.713	436.47	25.80	109.903
DEC	0.173 JUL 50.000	-0.363 APR 45.000	3.23	4.557	127.27	6.43	87.722
IBM	0.048 JUL 280.000	-0.040 JAN 280.000	1.24	0.751	24.68	0.05	83.866
DEC	0.144 JAN 50.000	-0.165 JUL 50.000	0.75	2.626	222.10	15.04	83.692
IBM	0.047 JUL 280.000	-0.107 APR 260.000	5.23	1.313	306.80	17.51	82.286
DEC	0.311 JAN 45.000	-0.072 JAN 50.000	0.32	3.253	34.44	2.36	42.015
DEC	0.304 JAN 45.000	-0.170 APR 45.000	2.19	4.024	164.44	10.43	41.068
IBM	0.096 JAN 260.000	-0.051 APR 260.000	1.69	1.249	318.16	19.57	38.926
IBM	0.019 JAN 280.000	-0.095 JAN 260.000	0.20	0.968	459.43	27.33	38.582
DEC	0.240 JAN 45.000	-0.118 JUL 45.000	1.59	3.040	109.24	7.26	32.426
IBM	0.035 JUL 260.000	-0.076 JAN 260.000	0.41	0.946	271.15	15.77	30.795
DEC	0.057 APR 50.000	-0.226 JAN 45.000	0.58	2.405	151.95	8.60	30.595
IBM	0.015 APR 280.000	-0.071 JAN 260.000	0.50	0.733	334.97	19.64	28.745
DEC	0.207 JAN 45.000	-0.055 JUL 50.000	0.46	2.228	72.36	5.11	27.973
IBM	0.015 JUL 280.000	-0.065 JAN 260.000	0.53	0.684	301.52	17.48	26.425

WHICH SUBROUTINE DO YOU WANT

TABLE 7

Results of Put Spreads If Sold Immediately

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
8
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
LONG OPTION
NUMBER:
2.097
I:
4
PRICE PAID:
6.
SHORT OPTION
NUMBER SOLD:
5.697
I:
2
PRICE PAID:
3.
```

RESULTS OF PUT SPREADS

STOCK PRICE	LONG PUT	SHORT PUT	COMMISSIONS PAID	LONG CHANGE	SHORT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	1113.20	930.29	50.42	140.43	150.06
271.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	975.02	783.75	58.77	135.77	143.38
272.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	841.55	643.77	65.28	131.01	136.89
273.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	712.91	510.15	70.26	126.19	130.59
274.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	589.15	382.72	73.93	121.30	124.47
275.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	470.40	261.28	76.63	116.38	118.54
276.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	356.69	145.67	78.52	111.43	112.81
277.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	248.12	35.67	79.95	106.48	107.26
278.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	144.42	-68.90	80.82	101.53	101.91
279.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	44.91	-168.23	80.64	96.62	96.74
280.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-49.60	-262.50	80.40	91.75	91.76
281.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-139.11	-351.90	80.30	86.95	86.97
282.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-223.73	-436.61	80.38	82.23	82.37
283.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-303.63	-516.81	80.68	77.59	77.95
284.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-378.90	-592.70	81.30	73.06	73.71
285.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-449.66	-664.43	82.27	68.64	69.64
286.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-516.07	-732.20	83.63	64.36	65.75
287.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-578.27	-796.16	85.39	60.20	62.03
288.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-636.39	-856.47	87.59	56.20	58.47
289.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-690.59	-913.32	90.23	52.34	55.08
290.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-741.03	-966.84	93.31	48.64	51.84

```
WHICH SUBROUTINE DO YOU WANT
```

As in Table III, it can be seen that the position remains fairly neutral over a wide range of stock prices; the delta of the long position is approximately equal to the delta of the short position. It can also be seen that the potential deductions grow as the stock price varies. However, the side of the spread which will be used for the deduction is reversed from the previous case. Here, for increases in stock price, the deduction is obtained by selling the long position rather than repurchasing the short position. For decreases in the stock price, the deduction is obtained by repurchasing the short position.

Table VIII shows the results of the put spread on December 31, 1977. Because both options have come closer to expiration, their values and deltas have changed. The spread is no longer neutral. It is assumed that the prices have adjusted to equal the values.

The investor has used \$36077.45 as margin to enter this spread. The cash outlay is high because of the large number of naked April 260 options. Each naked option contract requires approximately \$8400 in margin. If the stock price declines to \$270, the investor will have the opportunity to deduct \$579.33 for tax purposes. In addition, the investor would theoretically have a \$203.26 profit. If the stock price increased to \$290, a \$1033.43 deduction would result.

The decision of whether or not to establish the neutral spread is supported by the information provided about the delta of the remaining side of the spread. For the latter case, when the stock price increases to \$290, the long option would be sold to recognize a loss. The remaining short position would have a delta of \$43.29. Each one point change in the stock price would cause a \$43.29 change in the value of the short position.

TABLE 8

Results of Put Spreads If Held Until December 31

```
ENTER DATE,  INTEREST RATE
12 31 .06

WHICH SUBROUTINE DO YOU WANT
8
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
LONG OPTION
NUMBER:
2.097
I:
4
PRICE PAID:
6.
SHORT OPTION
NUMBER SOLD:
5.697
I:
2
PRICE PAID:
3.
```

RESULTS OF PUT SPREADS

STOCK PRICE	LONG PUT	SHORT PUT	COMMISSI_NS PAID	LONG CHANGE	SHORT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	915.09	579.33	203.26	164.47	147.12
271.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	753.45	436.06	184.89	158.71	139.75
272.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	597.73	300.02	165.21	152.59	132.61
273.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	448.27	170.97	144.79	146.16	125.71
274.000	2.097 JAN 280.000	5.697 APR 260.000	132.5_	305.36	48.66	124.21	139.45	119.04
275.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	169.29	-67.08	103.86	132.50	112.60
276.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	40.30	-176.55	84.35	125.37	106.40
277.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-81.42	-279.99	66.07	118.11	100.44
278.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-195.64	-377.55	49.41	110.77	94.72
279.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-302.28	-469.54	34.76	103.40	89.23
280.000	2.097 JAN 280.000	5.697 APR 260.000	132.5_	-402.43	-556.19	21.27	96.08	83.97
281.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-495.10	-637.69	10.08	88.85	78.94
282.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-580.44	-714.28	1.34	81.76	74.14
283.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-658.71	-786.18	-5.02	74.87	69.56
284.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-730.16	-853.61	-9.05	68.22	65.19
285.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-795.09	-916.79	-10.80	61.84	61.04
286.000	2.097 JAN 280.000	5.697 APR 260.000	132.5_	-853.81	-975.94	-10.37	55.78	57.10
287.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-906.65	-1031.23	-7.92	50.05	53.36
288.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-953.95	-1082.88	-3.57	44.68	49.82
289.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-996.09	-1131.07	2.48	39.67	46.46
290.000	2.097 JAN 280.000	5.697 APR 260.000	132.50	-1033.43	-1176.00	10.07	35.04	43.29

WHICH SUBROUTINE DO YOU WANT

4.2 Spreads Between Stock and Options

The same line of reasoning which was applied to spreads betwen options can be applied to spreads between stock and options. A neutral spread is constructed by setting the delta of the stock position equal to the delta of the option position. The size of each side is determined by setting the dollar curvature equal to unity.

The delta of a stock is identically equal to one. The gamma of a stock is equal to zero. The other variables required to define the spreads are:

D2= delta of the option

G2= gamma of the option

P= stock price

V= stock volatility

N1= number of shares of stock in the spread

N2= number of options in the spread

DC= dollar curvature=1

The delta of the spread becomes:

DS=N1-N2*D2

In order for the spread to be neutral, the spread's delta must be equal to zero. This leads to the following relationship between N1 and N2:

N1-D2*N2

Since the gamma of the stock is equal to zero, the spread's gamma simply equals the gamma of the option position, N2*G2. The dollar curvature is equal to the gamma times the stock price squared times the volatility squared, and is defined to be unity. This leads to concise expressions for N1 and N2:

$$N1=D2/G2*P^2*V^2$$

$$N2=1\ /G2*P^2*V^2$$

4.2.1 Spreads Between Call Options and Stock

Table IX lists the spreads which can be formed between IBM and its call options, and the spreads which can be formed between DEC and its call options. The spreads are formed on December 5, 1977. The price of IBM is assumed to be $280 per share. The price of DEC is assumed to be $50 per share.

When forming these spreads, the investor can either buy the stock and sell the calls, or sell the stock and buy the calls. If the options are overpriced, they ought to be sold. If they are underpriced, they ought to be bought. The column labeled "excess" indicates how far the option prices differ from their model values.

The column labeled "lost int" lists the amount of interest that would be lost on money held by the broker. Although this figure is not directly relevant to the establishment of the spreads, it is of interest because it specifies an opportunity cost for this strategy.

The rightmost column lists the dollar volatility of the spreads. As previously stated, this is a measure of the expected price fluctuation of each side of the spread and is therefore an appropriate quantity by which to rank the spreads.

Table X illustrates the possible outcomes of one of the spreads if it were liquidated on December 5, 1977, the same day it was initiated. It has been assumed that the option prices adjusted to equal their values. This table provides information about the differences between the market conditions and the predicted conditions. The results of this table are straightforward and directly analogous to those of Tables III and VII.

TABLE 9

Call Option - Stock Spreads

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
5
NUMBER OF STOCKS:
2
STOCK:
IBM
ENTER CURRENT PRICES
STOCK:
280.
JAN 260.000:
24.
APR 260.000:
29.
JUL 260.000:
34.
JAN 280.000:
8.5
APR 280.000:
14.75
JUL 280.000:
20.5
STOCK:
DEC
ENTER CURRENT PRICES
STOCK:
50.
JAN  45.000:
6.
APR  45.000:
7.5
JUL  45.000:
8.5
JAN  50.000:
2.
APR  50.000:
4.
JUL  50.000:
5.
```

TABLE 9 (Continued)

CALL OPTION-STOCK SPREADS

	LONG	SHORT	EXCESS	COMMISSION	CASH	LOST INT	DOL. VOL.
IBM	5.03 SHARES	-0.062 JUL 260.000	4.391	2.41	519.47	1.50	239.31
DEC	16.34 SHARES	-0.207 JUL 45.000	11.205	7.89	262.16	1.79	212.43
IBM	4.43 SHARES	-0.048 JAN 260.000	6.375	2.07	514.49	0.62	210.94
IBM	4.32 SHARES	-0.052 APR 260.000	4.747	2.06	474.19	1.12	205.67
DEC	14.00 SHARES	-0.172 APR 45.000	11.809	6.71	243.78	1.36	182.05
DEC	13.69 SHARES	-0.153 JAN 45.000	6.303	6.43	264.96	0.86	177.97
IBM	2.76 SHARES	-0.044 JUL 280.000	1.767	1.40	298.38	0.08	131.32
DEC	9.56 SHARES	-0.156 JUL 50.000	1.179	4.91	165.59	0.29	124.23
IBM	1.97 SHARES	-0.033 APR 280.000	0.878	1.02	228.74	0.06	93.80
DEC	6.92 SHARES	-0.118 APR 50.000	4.346	3.60	129.41	0.22	90.02
IBM	1.08 SHARES	-0.019 JAN 280.000	1.113	0.57	134.96	0.03	51.22
DEC	0.070 JAN 50.00	-3.85 SHARES	0.364	2.04	112.20	11.67	50.03

WHICH SUBROUTINE DO YOU WANT

TABLE 10

Results of Call Option - Stock Spreads If Sold Immediately

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
10
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
STOCK
NUMBER OF SHARES:
5.03
PRICE PAID:
280.
OPTION
NUMBER OF OPTIONS:
-.062
I:
3
PRICE PAID:
34.
```

RESULTS OF CALL OPTION-STOCK SPREADS

STOCK PRICE	STOCK	OPTION	COMMISSIONS PAID	STOCK CHANGE	OPTION CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-50.30	-52.60	-2.00	5.03	4.55
271.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-45.27	-48.01	-1.56	5.03	4.61
272.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-40.24	-43.37	-1.16	5.03	4.66
273.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-35.21	-38.68	-0.83	5.03	4.72
274.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-30.18	-33.94	-0.54	5.03	4.77
275.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-25.15	-29.14	-0.31	5.03	4.82
276.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-20.12	-24.29	-0.13	5.03	4.87
277.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-15.09	-19.39	0.00	5.03	4.92
278.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-10.06	-14.45	0.09	5.03	4.97
279.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-5.03	-9.46	0.13	5.03	5.01
280.000	5.030 SHARES	-0.062 JUL 260.000	4.30	0.00	-4.42	0.12	5.03	5.06
281.000	5.030 SHARES	-0.062 JUL 260.000	4.30	5.03	0.66	0.07	5.03	5.10
282.000	5.030 SHARES	-0.062 JUL 260.000	4.30	10.06	5.79	-0.03	5.03	5.15
283.000	5.030 SHARES	-0.062 JUL 260.000	4.30	15.09	10.95	-0.16	5.03	5.19
284.000	5.030 SHARES	-0.062 JUL 260.000	4.30	20.12	16.16	-0.34	5.03	5.23
285.000	5.030 SHARES	-0.062 JUL 260.000	4.30	25.15	21.41	-0.56	5.03	5.27
286.000	5.030 SHARES	-0.062 JUL 260.000	4.30	30.18	26.69	-0.81	5.03	5.30
287.000	5.030 SHARES	-0.062 JUL 260.000	4.30	35.21	32.02	-1.10	5.03	5.34
288.000	5.030 SHARES	-0.062 JUL 260.000	4.30	40.24	37.37	-1.43	5.03	5.38
289.000	5.030 SHARES	-0.062 JUL 260.000	4.30	45.27	42.77	-1.80	5.03	5.41
290.000	5.030 SHARES	-0.062 JUL 260.000	4.30	50.30	48.19	-2.19	5.03	5.44

```
WHICH SUBROUTINE DO YOU WANT
```

Table XI lists the results of the same spread if it is held until December 31, 1977. Assume that an investor bought 5.03 shares of IBM stock on December 5, 1977 and simultaneously sold .062 July 260 call contracts. The cash outlay was $519.47. The possible outcomes which the investor would face on December 31, 1977 are listed in this table. If the stock price declined to $270 per share, the investor would have a deduction of $50.30, and a net capital gain of $6.99. Alternatively, if the stock price increased to $290, the investor would have a deduction of $39.65 and a net gain of $6.35.

The investor could realize his losses in the current year in exactly the same way he did in the previous strategy. That is, the investor could simply liquidate one side of the spread in the current year and delay liquidation of the other side until the following year. However, if the spread shows a loss in the option side of the spread and a gain in the stock side of the spread, the investor has another alternative for ending the spread. Payment dates for stock transactions are five business dates following the purchase or sale. However, payment dates for option transactions are the following day. Consequently, if the investor closes both the option and stock positions on the second to last trading day of the year, the losses on the options would be recognized in the current year and the gains on the stock would be recognized in the following year. This eliminates the market risk associated with holding an uncovered position into the new year.

4.2.2 Spreads Between Put Options and Stock

When constructing spreads between stock and put options, the investor will either buy both the stock and options or sell both. Table XII lists the put option-stock spreads which can be formed for IBM and DEC.

```
ENTER DATE,  INTEREST RATE
12 31 .06

WHICH SUBROUTINE DO YOU WANT
10
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
STOCK
NUMBER OF SHARES:
5.03
PRICE PAID:
280.
OPTION
NUMBER OF OPTIONS:
-.062
I:
3
PRICE PAID:
34.
```

TABLE 11

Results of Call Option - Stock Spreads If Held Until December 31

RESULTS OF CALL OPTION-STOCK SPREADS

STOCK PRICE	STOCK	OPTION	COMMISSIONS PAID	STOCK CHANGE	OPTION CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-50.30	-61.59	6.99	5.03	4.55
271.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-45.27	-57.01	7.44	5.03	4.61
272.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-40.24	-52.37	7.83	5.03	4.67
273.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-35.21	-47.67	8.16	5.03	4.72
274.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-30.18	-42.92	8.44	5.03	4.78
275.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-25.15	-38.11	8.66	5.03	4.83
276.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-20.12	-33.25	8.83	5.03	4.89
277.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-15.09	-28.34	8.95	5.03	4.94
278.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-10.06	-23.37	9.01	5.03	4.99
279.000	5.030 SHARES	-0.062 JUL 260.000	4.30	-5.03	-18.36	9.03	5.03	5.04
280.000	5.030 SHARES	-0.062 JUL 260.000	4.30	0.00	-13.30	9.00	5.03	5.08
281.000	5.030 SHARES	-0.062 JUL 260.000	4.30	5.03	-8.19	8.92	5.03	5.13
282.000	5.030 SHARES	-0.062 JUL 260.000	4.30	10.06	-3.04	8.80	5.03	5.18
283.000	5.030 SHARES	-0.062 JUL 260.000	4.30	15.09	2.16	8.63	5.03	5.22
284.000	5.030 SHARES	-0.062 JUL 260.000	4.30	20.12	7.40	8.42	5.03	5.26
285.000	5.030 SHARES	-0.062 JUL 260.000	4.30	25.15	12.68	8.17	5.03	5.30
286.000	5.030 SHARES	-0.062 JUL 260.000	4.30	30.18	18.00	7.88	5.03	5.34
287.000	5.030 SHARES	-0.062 JUL 260.000	4.30	35.21	23.36	7.55	5.03	5.38
288.000	5.030 SHARES	-0.062 JUL 260.000	4.30	40.24	28.75	7.19	5.03	5.41
289.000	5.030 SHARES	-0.062 JUL 260.000	4.30	45.27	34.18	6.79	5.03	5.45
290.000	5.030 SHARES	-0.062 JUL 260.000	4.30	50.30	39.65	6.35	5.03	5.48

WHICH SUBROUTINE DO YOU WANT

TABLE 12

Put Option - Stock Spreads

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
5
NUMBER OF STOCKS:
2
STOCK:
IBM
ENTER CURRENT PRICES
STOCK:
280.
JAN 260.000:
.75
APR 260.000:
3.
JUL 260.000:
4.
JAN 280.000:
6.
APR 280.000:
8.5
JUL 280.000:
10.
STOCK:
DEC
ENTER CURRENT PRICES
STOCK:
50.
JAN  45.000:
.25
APR  45.000:
1.
JUL  45.000:
1.5
JAN  50.000:
1.75
APR  50.000:
2.5
JUL  50.000:
3.25
```

TABLE 12 (Continued)

PUT OPTION-STOCK SPREADS

	STOCK		PUTS			EXCESS	COMMISSION	CASH	LOST INT	DOL. VOL.
DEC	-6.09	SHARES	-0.156	JUL	50.000	1.833	3.61	350.04	33.19	79.16
IBM	1.60	SHARES	0.044	JUL	280.000	0.262	0.97	267.81	0.06	75.92
DEC	4.90	SHARES	0.118	APR	50.000	0.795	2.84	154.93	0.17	63.71
IBM	1.29	SHARES	0.033	APR	280.000	0.052	0.76	209.80	0.05	61.63
DEC	-4.39	SHARES	-0.207	JUL	45.000	3.175	3.41	285.61	25.58	57.01
IBM	-1.13	SHARES	-0.062	JUL	260.000	0.184	0.95	483.33	40.00	53.93
DEC	-3.20	SHARES	-0.172	APR	45.000	2.495	2.66	223.93	19.27	41.61
DEC	-3.13	SHARES	-0.070	JAN	50.000	0.577	1.77	149.94	14.42	40.68
IBM	-0.84	SHARES	-0.019	JAN	280.000	0.453	0.48	219.55	20.89	39.85
IBM	-0.83	SHARES	-0.052	APR	260.000	2.373	0.75	392.28	31.43	39.49
DEC	-1.59	SHARES	-0.153	JAN	45.000	0.135	1.90	174.42	13.08	20.67
IBM	-0.41	SHARES	-0.048	JAN	260.000	0.326	0.57	337.24	23.91	19.60

WHICH SUBROUTINE DO YOU WANT

The spreads are formed on December 5, 1977. The assumptions used in this example are identical to the assumptions in the previous examples.

Tables XIII and XIV list the possible outcomes for a particular spread. Table XIII is based on closing the position on December 5. It assumes that the option prices adjust to their values immediately. Table XIV is based on holding the spread until December 31. If the price of the stock declines, the value of the puts will increase. Since this spread has a short position in the puts, losses will occur on the put side and gains will occur on the stock side. If the stock price rises, the situation is reversed.

The decision to sell the puts was made because they were overpriced when the spread was established. However, by setting up the spread in this manner, the result will be a capital loss on the spread for all of the stock prices shown. If the stock and puts had been purchased, the excess value of the spread would have been negative and the profits on the spread would have been even more negative than shown in the table.

4.3 Spreads Between Puts and Calls

Spreads can be formed between puts and calls on a stock. The spread is constructed by either purchasing both sets of options or writing both sets. A straddle is a spread consisting of one put and one call, each of which has the same strike price and expiration date. However, many other spreads can be formed between the options. IBM has six call options. It will soon have six put options. It is therefore possible to form a total of thirty-six unique spreads.

The spreads formed in this strategy are neutral and have a dollar curvature equal to unity. The number of options on each side of the spread is determined by the same equations that were used in the first strategy.

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
11
STOCK:
DEC
LOWER PRICE:
40
UPPER PRICE:
60
STOCK
NUMBER OF SHARES:
-6.09
PRICE PAID:
50.
OPTION
NUMBER OF OPTIONS:
-.156
I:
6
PRICE PAID:
3.25
```

TABLE 13

Results of Put Option - Stock Spreads If Sold Immediately

RESULTS OF PUT OPTION-STOCK SPREADS

STOCK PRICE	STOCK	OPTION	COMMISSIONS PAID	STOCK CHANGE	OPTION CHANGE	PROFIT	STOCK DELTA	PUT DELTA
40.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	60.90	-90.75	-35.74	6.09	-12.38
41.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	54.81	-78.65	-29.73	6.09	-11.81
42.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	48.72	-67.13	-24.30	6.09	-11.21
43.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	42.63	-56.23	-19.49	6.09	-10.58
44.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	36.54	-45.97	-15.32	6.09	-9.93
45.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	30.45	-36.37	-11.81	6.09	-9.27
46.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	24.36	-27.43	-8.96	6.09	-8.61
47.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	18.27	-19.16	-6.79	6.09	-7.95
48.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	12.18	-11.55	-5.27	6.09	-7.30
49.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	6.09	-4.56	-4.36	6.09	-6.68
50.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	0.00	1.83	-4.07	6.09	-6.07
51.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-6.09	7.61	-4.37	6.09	-5.50
52.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-12.18	12.83	-5.24	6.09	-4.95
53.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-18.27	17.52	-6.64	6.09	-4.44
54.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-24.36	21.72	-8.53	6.09	-3.97
55.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-30.45	25.46	-10.88	6.09	-3.53
56.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-36.54	28.78	-13.65	6.09	-3.13
57.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-42.63	31.72	-16.80	6.09	-2.76
58.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-48.72	34.31	-20.30	6.09	-2.42
59.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-54.81	36.58	-24.12	6.09	-2.12
60.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-60.90	38.57	-28.22	6.09	-1.85

```
WHICH SUBROUTINE DO YOU WANT
```

TABLE 14

Results of Put Option - Stock Spreads If Held Until December 31

```
ENTER DATE,  INTEREST RATE
12 31 .06

WHICH SUBROUTINE DO YOU WANT
11
STOCK:
DEC
LOWER PRICE:
40
UPPER PRICE:
60
STOCK
NUMBER OF SHARES:
-6.09
PRICE PAID:
50.
OPTION
NUMBER OF OPTIONS:
-.156
I:
6
PRICE PAID:
3.25
```

RESULTS OF PUT OPTION-STOCK SPREADS

STOCK PRICE	STOCK	OPTION	COMMISSIONS PAID	STOCK CHANGE	OPTION CHANGE	PROFIT	STOCK DELTA	PUT DELTA
40.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	60.90	-91.40	-36.39	6.09	-12.76
41.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	54.81	-78.92	-30.00	6.09	-12.19
42.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	48.72	-67.03	-24.20	6.09	-11.58
43.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	42.63	-55.77	-19.03	6.09	-10.94
44.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	36.54	-45.16	-14.51	6.09	-10.26
45.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	30.45	-35.24	-10.68	6.09	-9.57
46.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	24.36	-26.01	-7.55	6.09	-8.87
47.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	18.27	-17.49	-5.12	6.09	-8.18
48.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	12.18	-9.68	-3.40	6.09	-7.49
49.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	6.09	-2.53	-2.33	6.09	-6.82
50.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	0.00	3.98	-1.91	6.09	-6.17
51.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-6.09	9.85	-2.13	6.09	-5.56
52.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-12.18	15.12	-2.96	6.09	-4.98
53.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-18.27	19.81	-4.35	6.09	-4.43
54.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-24.36	23.99	-6.27	6.09	-3.93
55.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-30.45	27.68	-8.66	6.09	-3.47
56.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-36.54	30.93	-11.50	6.09	-3.04
57.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-42.63	33.78	-14.75	6.09	-2.66
58.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-48.72	36.26	-18.35	6.09	-2.31
59.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-54.81	38.42	-22.28	6.09	-2.01
60.000	-6.090 SHARES	-0.156 JUL 50.000	5.89	-60.90	40.29	-26.50	6.09	-1.73

WHICH SUBROUTINE DO YOU WANT

All of the possible spreads are listed in Table XV. This table contains the same information that was provided in Table II, VI, IX, and XII.

Tables XVI and XVII list the possible outcomes of a spread if the positions are closed on December 5 and December 31, respectively. The analysis of these tables is exactly the same as their counterparts in previous strategies.

4.4 Comparison of the Strategies

The examples provided for each of the three strategies have all used the same stocks, the same time interval, and the same risk (dollar curvature). Each of the strategies has the same objective, that is, to defer income. Consequently, the examples provide a convenient medium for comparing the effectiveness of the strategies.

On December 5, 1977, the investor is faced with the problem of establishing a spread to defer income. He realizes that there are a total of 78 possible spreads that he can construct between the calls, puts and stock if he restricted himself to IBM and DEC. The best spread for any situation will depend on potential tax savings, the investor's risk aversion, and potential capital gains. In the series of examples which have been presented in this thesis, it is clear that the best spread is between the IBM April 260 and January 260 call options. This spread provides the highest potential tax deduction for the risk. However, a different spread might be chosen if the investor has a cash constraint.

TABLE 15

Put-Call Spreads

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
6
NUMBER OF STOCKS:
1
STOCK:
IBM
ENTER CURRENT PRICES
STOCK:
280.
JAN 260.000CALL:
24.
JAN 260.000 PUT:
.75
APR 260.000CALL:
29.
APR 260.000 PUT:
3.
JUL 260.000CALL:
34.
JUL 260.000 PUT:
4.
JAN 280.000CALL:
8.5
JAN 280.000 PUT:
6.
APR 280.000CALL:
14.75
APR 280.000 PUT:
8.5
JUL 280.000CALL:
20.5
JUL 280.000 PUT:
10.
```

TABLE 15 (Continued)

PUT-CALL SPREADS

	CALL	PUT	EXCESS	COMMISSION	CASH	LOST INT	DOL. VOL.
IBM	-0.381 JAN 280.000	-1.164 JUL 260.000	25.61	13.126	9868.21	639.43	1018.765
IBM	-0.139 APR 280.000	-0.228 JUL 280.000	2.35	3.120	2653.65	185.20	398.321
IBM	-0.113 JAN 280.000	-0.161 APR 280.000	6.33	2.328	2070.56	138.20	303.250
IBM	-0.060 JUL 280.000	-0.103 JUL 280.000	1.80	1.385	1144.07	82.18	179.983
IBM	-0.063 APR 280.000	-0.095 APR 280.000	1.53	1.341	1153.49	79.60	179.717
IBM	-0.067 JAN 280.000	-0.086 JAN 280.000	5.94	1.302	1179.45	77.29	179.456
IBM	-0.064 JAN 280.000	-0.225 APR 260.000	14.10	2.458	1859.97	118.93	172.374
IBM	-0.059 JAN 280.000	-0.090 JUL 280.000	2.88	1.267	1113.40	75.22	157.446
IBM	-0.044 APR 280.000	-0.145 JUL 260.000	1.62	1.608	1177.22	78.02	126.898
IBM	-0.030 APR 260.000	-0.069 JUL 280.000	2.36	0.843	737.60	53.64	120.353
IBM	-0.027 JAN 260.000	-0.068 JUL 280.000	3.18	0.810	722.04	51.33	118.616
IBM	-0.039 JUL 280.000	-0.062 APR 280.000	1.46	0.850	709.98	50.47	116.146
IBM	-0.029 JUL 260.000	-0.064 JUL 280.000	1.66	0.785	673.07	50.05	111.203
IBM	-0.030 JUL 280.000	-0.105 JUL 260.000	1.54	1.147	821.11	55.51	91.526
IBM	-0.022 APR 260.000	-0.047 APR 280.000	1.96	0.584	517.92	37.29	88.007
IBM	-0.020 JAN 260.000	-0.046 APR 280.000	2.56	0.562	508.82	35.76	87.075
IBM	-0.021 JUL 260.000	-0.044 APR 280.000	1.45	0.555	482.21	35.54	83.013
IBM	-0.018 APR 260.000	-0.084 JUL 260.000	1.94	0.865	639.20	43.54	73.106
IBM	-0.017 JAN 260.000	-0.083 JUL 260.000	2.44	0.845	630.57	42.22	72.462
IBM	-0.018 JUL 260.000	-0.080 JUL 260.000	1.52	0.828	603.48	41.77	69.627
IBM	-0.024 APR 280.000	-0.033 JAN 280.000	1.43	0.488	426.96	28.95	69.279
IBM	-0.024 APR 280.000	-0.089 APR 260.000	4.74	0.958	707.95	46.18	68.198
IBM	-0.019 JUL 280.000	-0.027 JAN 280.000	1.42	0.395	335.09	23.43	57.209
IBM	-0.019 JUL 280.000	-0.074 APR 260.000	4.15	0.785	568.94	37.76	56.469
IBM	-0.012 APR 260.000	-0.024 JAN 280.000	1.70	0.307	278.23	19.70	49.425
IBM	-0.011 JAN 260.000	-0.024 JAN 280.000	2.04	0.296	274.53	18.95	49.130
IBM	-0.012 APR 260.000	-0.064 APR 260.000	4.06	0.646	481.26	32.15	48.872
IBM	-0.011 JAN 260.000	-0.063 APR 260.000	4.39	0.633	476.40	31.33	48.583
IBM	-0.012 JUL 260.000	-0.023 JAN 280.000	1.42	0.300	265.50	19.27	47.810
IBM	-0.012 JUL 260.000	-0.062 APR 260.000	3.71	0.628	462.10	31.32	47.292
IBM	-0.012 JAN 280.000	-0.078 JAN 260.000	1.22	0.768	586.58	36.15	31.755
IBM	-0.009 APR 280.000	-0.061 JAN 260.000	0.64	0.594	447.61	27.90	24.781
IBM	-0.008 JUL 280.000	-0.057 JAN 260.000	0.69	0.549	409.16	25.75	23.042
IBM	-0.005 APR 260.000	-0.054 JAN 260.000	0.86	0.501	379.82	23.97	21.668
IBM	-0.005 JAN 260.000	-0.053 JAN 260.000	1.01	0.496	377.92	23.63	21.611
IBM	-0.005 JUL 260.000	-0.053 JAN 260.000	0.75	0.495	372.65	23.72	21.352

WHICH SUBROUTINE DO YOU WANT

```
ENTER DATE,  INTEREST RATE
12 05 .06

WHICH SUBROUTINE DO YOU WANT
9
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
CALL OPTION
NUMBER:
-.381
I:
4
PRICE PAID:
8.5
 PUT OPTION
NUMBER:
-1.164
I:
3
PRICE PAID:
4.
```

TABLE 16

Results of Put-Call Spreads If Sold Immediately

RESULTS OF PUT-CALL SPREADS

STOCK PRICE	CALL	PUT	COMMISSIONS PAID	CALL CHANGE	PUT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	191.89	256.01	-90.39	12.59	30.92
271.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	178.89	225.66	-73.03	13.43	29.86
272.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	165.05	196.35	-57.57	14.30	28.83
273.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	150.32	168.05	-44.00	15.17	27.82
274.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	134.70	140.76	-32.32	16.06	26.83
275.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	118.18	114.42	-22.51	16.96	25.87
276.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	100.74	89.04	-14.57	17.85	24.93
277.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	82.36	64.58	-8.48	18.75	24.02
278.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	63.10	41.03	-4.19	19.65	23.12
279.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	43.08	18.34	-1.52	20.55	22.25
280.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	22.16	-3.48	-0.63	21.43	21.41
281.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	0.32	-24.48	-1.47	22.30	20.59
282.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-22.41	-44.67	-4.01	23.16	19.79
283.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-45.99	-64.07	-8.19	24.00	19.01
284.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-70.41	-82.71	-13.97	24.83	18.26
285.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-95.66	-100.60	-21.32	25.63	17.52
286.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-121.69	-117.78	-30.17	26.41	16.82
287.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-148.49	-134.27	-40.49	27.16	16.13
288.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-176.03	-150.07	-52.22	27.89	15.46
289.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-204.28	-165.23	-65.32	28.59	14.82
290.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-233.22	-179.75	-79.74	29.26	14.20

```
WHICH SUBROUTINE DO YOU WANT
```

```
ENTER DATE,  INTEREST RATE
12 31 .06

WHICH SUBROUTINE DO YOU WANT
9
STOCK:
IBM
LOWER PRICE:
270
UPPER PRICE:
290
CALL OPTION
NUMBER:
-.381
I:
4
PRICE PAID:
8.5
 PUT OPTION
NUMBER:
-1.164
I:
3
PRICE PAID:
4.
```

TABLE 17

Results of Put-Call Spreads If Held Until December 31

RESULTS OF PUT-CALL SPREADS

STOCK PRICE	CALL	PUT	COMMISSIONS PAID	CALL CHANGE	PUT CHANGE	PROFIT	LONG DELTA	SHORT DELTA
270.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	273.22	212.17	34.79	8.22	31.00
271.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	264.49	181.76	56.46	9.26	29.88
272.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	254.68	152.46	75.96	10.38	28.78
273.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	243.74	124.24	93.23	11.54	27.71
274.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	231.60	97.08	108.26	12.76	26.66
275.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	218.23	70.95	121.01	14.03	25.64
276.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	203.57	45.82	131.48	15.32	24.65
277.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	187.58	21.67	139.65	16.64	23.68
278.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	170.23	-1.53	145.50	17.98	22.74
279.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	151.51	-23.81	149.06	19.31	21.83
280.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	131.60	-45.19	150.53	20.64	20.94
281.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	110.34	-65.70	149.77	21.96	20.08
282.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	87.74	-85.36	146.84	23.24	19.24
283.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	63.86	-104.20	141.80	24.50	18.43
284.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	38.75	-122.24	134.72	25.71	17.64
285.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	12.44	-139.51	125.69	26.86	16.88
286.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-14.99	-156.04	114.78	27.97	16.15
287.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-43.49	-171.84	102.09	29.01	15.44
288.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-72.99	-186.95	87.69	29.98	14.75
289.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-103.44	-201.38	71.68	30.89	14.09
290.000	-0.381 JAN 280.000	-1.164 JUL 260.000	26.26	-134.75	-215.17	54.15	31.73	13.45

```
WHICH SUBROUTINE DO YOU WANT
```

5.0 APPENDIX

A variety of computer programs have been written to support the analyses performed in this study. These programs were designed to be interactive. The programs prompt the user for any data which are required.

The programs have been loaded in two modules due to the core limitations of the computer being used. These modules are named *MA1 and *MA2. The data file is named DASTA. All of the subprogram codes are presented at the end of this paper.

The program *MA1 provides analyses of the call spreads, and the call option-stock spreads. After date and interest rate information is input, the program asks for a subroutine request. This informs the program which analysis is desired. The following is a list of available subroutines for use in *MA1:

Subroutine	
1	terminates program execution
2	supplies the call values and deltas for a single stock price
3	supplies the call values and delta for a range of stock prices
4	presents an analysis of all possible spreads between call options on a particular stock
5	presents an analysis of all spreads between the stock and the call options.

The program *MA2 provides analyses of the put spreads and the put option-stock spreads. It also has subroutines which present an analysis of spreads between put options and call options. In addition, *MA2 has subroutines which present the possible outcomes of any spread for a range of possible prices of the underlying stock. The subroutines are:

1 terminates program execution

2 supplies put values and deltas for a single stock price

3 supplies the put values and deltas for a range of stock prices

4 presents an analysis of all possible spreads between put options on a particular stock

5 presents an analysis of all possible spreads between put options and stock

6 presents an analysis of all possible spreads between put options and call options on a particular stock

7 presents the possible outcomes of spreads between put options

8 presents the possible outcomes of spreads between put options

9 presents the possible outcomes of spreads between call options and stock

10 presents the possible outcomes of spreads between put options and stock

11 presents the possible outcomes of spreads between put options and call options.

PROGRAM: *MA1

```
      INTEGER NOP, SR, H,ENT,EXP,CYC
      DIMENSION NAME(10), VOL(10), NOP(10)
      DIMENSION EXP(2,3),OP(10,9), TD(10,9)
      DOUBLE PRECISION NAME
      EXP(1,1)=386
      EXP(1,2)=470
      EXP(1,3)=561
      EXP(2,1)=414
      EXP(2,2)=505
      EXP(2,3)=596
      DO 20 I=1,10
      READ (5,30,END=25) NAME(I), VOL(I), NOP(I),CYC
      J=NOP(I)
      DO 10 K=1,J,3
      READ (5,40) OP(I,K)
      L=K+1
      OP(I,L)=OP(I,K)
      L=L+1
      OP(I,L)=OP(I,K)
      TD(I,K)=EXP(CYC,1)
      TD(I,K+1)=EXP(CYC,2)
      TD(I,K+2)=EXP(CYC,3)

10    CONTINUE
20    CONTINUE
25    ENT=I
30    FORMAT(A3,1X,F3.2,1X,I2,1X,I2)
40    FORMAT(F6.3)
45    WRITE(1,50)
      READ(1,60) MONTH, DAY, R
46    WRITE (1,70)
      READ(1,80) SR
50    FORMAT('ENTER DATE,  INTEREST RATE')
60    FORMAT (I2,1X,I2,1X,F3.2)
70    FORMAT(/,'WHICH SUBROUTINE DO YOU WANT')
80    FORMAT(I2)
      IF (MONTH. EQ. 1) JD=DAY
      IF (MONTH. EQ. 2) JD=DAY+31
      IF (MONTH. EQ. 3) JD=DAY+59
      IF (MONTH. EQ. 4) JD=DAY+90
      IF (MONTH. EQ. 5) JD=DAY+120
      IF (MONTH. EQ. 6) JD=DAY+151
      IF (MONTH. EQ. 7) JD=DAY+181
      IF (MONTH. EQ. 8) JD=DAY+212
      IF (MONTH. EQ. 9) JD=DAY+243
      IF (MONTH. EQ. 10) JD=DAY+273
      IF (MONTH. EQ. 11) JD=DAY+304
      IF (MONTH. EQ. 12) JD=DAY+334
      GO TO (201,202,203,204,205), SR
202   CALL PRICE(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
203   CALL VARY(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
204   CALL OPSPR(NAME,OP,NOP,VOL,TD,JD,R,ENT)
```

```
      GO TO 46
205   CALL SSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
201   CALL EXIT
      END
```

SUBROUTINE 2

```
      SUBROUTINE PRICE(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER H,ENT
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('PRICE:')
      READ(1,55) X
55    FORMAT(F7.3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,100)
100   FORMAT(32X,'CALL PRICES')
      WRITE (1,60) CD1,CD2,CD3
60    FORMAT(/,'STRIKE PRICE',6X,A4,15X,A4,15X,A4)
      DO 80 I=1,N,3
      T=(TD(H,I)-JD)/365
      CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
      T=(TD(H,I+1)-JD)/365
      CALL VAL(V,X,OP(H,I+1),T,R,V2,D2,G2)
      T=(TD(H,I+2)-JD)/365
      CALL VAL(V,X,OP(H,I+2),T,R,V3,D3,G3)
      WRITE(1,70) OP(H,I),V1,D1,V2,D2,V3,D3
70    FORMAT(F7.3,3(4X,F6.3,4X,F4.2))
80    CONTINUE
      RETURN
      END
```

SUBROUTINE 3

```
      SUBROUTINE VARY(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,200)
200   FORMAT(42X,'CALL PRICES')
      WRITE (1,60) CD1,CD2,CD3
60    FORMAT(/,15X,'STRIKE PRICE',6X,A4,15X,A4,15X,A4)
      DO 100 X=I1,I2,10
      WRITE(1,110) X
110   FORMAT('PRICE:',1X,I3)
      Y=X
      DO 80 I=1,N,3
      T=(TD(H,I)-JD)/360
      CALL VAL(V,Y,OP(H,I),T,R,V1,D1,G1)
      T=(TD(H,I+1)-JD)/360
      CALL VAL(V,Y,OP(H,I+1),T,R,V2,D2,G2)
      T=(TD(H,I+2)-JD)/360
      CALL VAL(V,Y,OP(H,I+2),T,R,V3,D3,G3)
      WRITE(1,70) OP(H,I),V1,D1,V2,D2,V3,D3
70    FORMAT(15X,F7.3,3(4X,F6.3,4X,F4.2))
80    CONTINUE
100   CONTINUE
      RETURN
      END
```

SUBROUTINE 4

```
      SUBROUTINE OPSPR(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION A(18),NOP(10),OP(10,18),TD(10,18),N1(3,18,18)
      DIMENSION VOL(10),NAME(10),EXS(3,18,18),N2(3,18,18)
      DIMENSION P(18),EX(18),DELS(3,18,18),RANK(3,18,18)
      DIMENSION CASH(3,18,18),ALI(3,18,18)
      DIMENSION COM(3,18,18)
      INTEGER H,ENT
      REAL P
      REAL N1,N2
      DOUBLE PRECISION CD,CD1,CD2,NAME,STOCK
      NUM=0
      NDS=3
      DO 600 K=1,ENT
      DO 5 I=1,18
      DO 6 J=1,18
      N1(K,I,J)=0
      N2(K,I,J)=0
      EXS(K,I,J)=0
      DELS(K,I,J)=0
      RANK(K,I,J)=0
6     CONTINUE
5     CONTINUE
600   CONTINUE
      WRITE(1,500)
500   FORMAT('NUMBER OF STOCKS:')
      READ(1,510) NS
510   FORMAT(I2)
      DO 1000 INDEX=1,NS
101   WRITE(1,1)
1     FORMAT('STOCK:')
      READ(1,2) STOCK
2     FORMAT(A3)
      DO 8 I=1,ENT
      IF (STOCK. EQ. NAME(I)) GO TO 9
15    FORMAT(A3)
8     CONTINUE
      WRITE(1,16)
16    FORMAT('STOCK NOT IN DATA SET')
      GO TO 101
9     H=I
      N=NOP(H)
      V=VOL(H)
      WRITE(1,10)
10    FORMAT('ENTER CURRENT PRICES')
      WRITE(1,1)
      READ(1,11) X
11    FORMAT(F8.4)
      DO 20 I=1,N
      CD=CALD(TD(H,I))
      WRITE(1,30) CD,OP(H,I)
30    FORMAT(A4,1X,F7.3,':')
      READ(1,40) P(I)
40    FORMAT(F7.4)
20    CONTINUE
```

```
      DO 70 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
      EX(I)=V1-P(I)
70    CONTINUE
      NN=N-1
      DO 50 I=1,NN
      T=(TD(H,I)-JD)/365
      CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
      II=I+1
      DO 60 J=II,N
      T=(TD(H,J)-JD)/365
      CALL VAL(V,X,OP(H,J),T,R,V2,D2,G2)
      N1(H,I,J)=(D2/((G1*D2-G2*D1)*(X*V)**2))
      IF (N1(H,I,J). LT. 0) N1(H,I,J)=-N1(H,I,J)
      N2(H,I,J)=(D1/((G1*D2-G2*D1)*(X*V)**2))
      IF (N2(H,I,J). LT. 0) N2(H,I,J)=-N2(H,I,J)
      DELS(H,I,J)=N1(H,I,J)*D1*100*X*V
      EXI=EX(I)*N1(H,I,J)
      EXJ=EX(J)*N2(H,I,J)
      IF (EXI. GE. EXJ) N2(H,I,J)=-N2(H,I,J)
      IF (EXJ. GT. EXI) N1(H,I,J)=-N1(H,I,J)
      GO TO 280
3000  ALI(H,I,J)=(CASH(H,I,J)-100*(N1(H,I,J)
     C*P(I)+N2(H,I,J)*P(J)))*R
60    CONTINUE
50    CONTINUE
      DO 80 I=1,NN
      II=I+1
      DO 90 J=II,N
      EXS(H,I,J)=(N1(H,I,J)*EX(I)+N2(H,I,J)*EX(J))*100
90    CONTINUE
80    CONTINUE
1000  CONTINUE
      DO 1500 H=1,ENT
      IF (N1(H,1,2). EQ. 0) GO TO 1500
      DO 1400 M=H,ENT
      IF (N1(M,1,2). EQ. 0) GO TO 1400
      N=NOP(H)
      NN=N-1
      DO 150 I=1,NN
      II=I+1
      DO 160 J=II,N
      NT=NOP(M)
      NNT=NT-1
      IF (H. EQ. M) I2=I
      IF (H. LT. M) I2=1
      DO 170 K=I2,NNT
      IF (K. EQ. I2) KK=J
      IF (K. GT. I2) KK=K+1
      IF (H. LT. M) KK=K+1
      DO 180 L=KK,NT
      IF (DELS(H,I,J). LE. DELS(M,K,L))
     CRANK(H,I,J)=RANK(H,I,J)+1
```

```
      IF (DELS(M,K,L). LT. DELS(H,I,J))
     CRANK(M,K,L)=RANK(M,K,L)+1
180   CONTINUE
170   CONTINUE
160   CONTINUE
150   CONTINUE
      A(1)=1
      DO 200 I=2,N
      A(I)=I*A(I-1)
200   CONTINUE
1400  CONTINUE
      NUM=A(N)/(2*A(N-2))+NUM
1500  CONTINUE
      WRITE(1,650)
650   FORMAT(50X,'CALL SPREADS',/)
      WRITE(1,290)
290   FORMAT(/,13X,'LONG',21X,'SHORT',13X,'EXCESS',3X,
     C'COMMISSION',5X,'CASH',6X,'LOST INT',2X,'DOL. VOL.')
      DO 250 I=1,NUM
      DO 255 H=1,ENT
      IF (N1(H,1,2). EQ. 0) GO TO 255
      N=NOP(H)
      NN=N-1
      DO 260 J=1,NN
      JJ=J+1
      DO 270 K=JJ,N
      IF (I. EQ. RANK(H,J,K)) GO TO 630
      GO TO 270
280   BULL=0
      COM(H,I,J)=(ABS(N1(H,I,J))+ABS(N2(H,I,J)))*8.5
      BEAR=0
      IF (N1(H,I,J)) 525,550,550
525   BN=N2(H,I,J)
      SN=-N1(H,I,J)
      BS=OP(H,J)
      SS=OP(H,I)
      BP=P(J)
      SP=P(I)
      TB=TD(H,J)
      TS=TD(H,I)
      GO TO 625
550   BN=N1(H,I,J)
      SN=-N2(H,I,J)
      BS=OP(H,I)
      SS=OP(H,J)
      BP=P(I)
      SP=P(J)
      TB=TD(H,I)
      TS=TD(H,J)
625   IF (TB. LT. TS) GO TO 575
      BC=COM(H,I,J)+(BN*BP-SN*SP)*100
      IF (BN. LT. SN) GO TO 2000
      CASH(H,I,J)=BC+(BS-SS)*SN*100
2000  IF (BN. LT. SN) CASH(H,I,J)=BC+((BS-SS)*BN+(SN-BN)
```

```
     C*(1.3*X-SS))*100
      GO TO 3000
575   CASH(H,I,J)=COM(H,I,J)+(BN*BP+SN*(1.3*X-SS-SP))*100
      GO TO 3000
630   CD1=CALD(TD(H,J))
      CD2=CALD(TD(H,K))
      IF (N1(H,J,K). GT. 0) WRITE(1,300)
     CNAME(H),N1(H,J,K),CD1,OP(H,J),N2(H,J,K),
     CCD2,OP(H,K),EXS(H,J,K),COM(H,J,K),CASH(H,J,K),ALI(H,J,K),
     CDELS(H,J,K)
      IF (N2(H,J,K). GT. 0) WRITE (1,300)
     CNAME(H),N2(H,J,K),CD2,OP(H,K),N1(H,J,K),
     CCD1,OP(H,J),EXS(H,J,K),COM(H,J,K),CASH(H,J,K),ALI(H,J,K),
     CDELS(H,J,K)
300   FORMAT(A3,1X,2(F9.3,1X,A4,1X,F7.3,4X),F8.2,4X,F7.3,4X,F8.2,
     C4X,F8.2,3X,F8.3)
270   CONTINUE
260   CONTINUE
255   CONTINUE
250   CONTINUE
      RETURN
      END
```

SUBROUTINE 5

```
      SUBROUTINE SSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION A(18),NOP(10),OP(10,18),TD(10,18),N1(10,18)
      DIMENSION VOL(10),NAME(10),EXS(10,18),N2(10,18)
      DIMENSION P(18),EX(18),DELS(10,18),RANK(10,18)
      DIMENSION ALI(10,18),COM(10,18),CASH(10,18)
      INTEGER H,ENT
      REAL P
      REAL N1,N2
      DOUBLE PRECISION CD,CD1,CD2,NAME,STOCK
      NDS=3
      DO 600 K=1,ENT
      DO 5 I=1,18
      N1(K,I)=0
      N2(K,I)=0
      EXS(K,I)=0
      DELS(K,I)=0
      RANK(K,I)=0
5     CONTINUE
600   CONTINUE
      WRITE(1,500)
500   FORMAT('NUMBER OF STOCKS:')
      READ(1,510) NS
510   FORMAT(I2)
      DO 1000 INDEX=1,NS
101   WRITE(1,1)
1     FORMAT('STOCK:')
      READ(1,2) STOCK
2     FORMAT(A3)
      DO 8 I=1,ENT
      IF (STOCK. EQ. NAME(I)) GO TO 9
15    FORMAT(A3)
8     CONTINUE
      WRITE(1,16)
16    FORMAT('STOCK NOT IN DATA SET')
      GO TO 101
9     H=I
      N=NOP(H)
      NN=N-1
      V=VOL(H)
      WRITE(1,10)
10    FORMAT('ENTER CURRENT PRICES')
      WRITE(1,1)
      READ(1,11) X
11    FORMAT(F8.4)
      DO 20 I=1,N
      CD=CALD(TD(H,I))
      WRITE(1,30) CD,OP(H,I)
30    FORMAT(A4,1X,F7.3,':')
      READ(1,40) P(I)
40    FORMAT(F7.4)
20    CONTINUE
      DO 70 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
```

```
      EX(I)=V1-P(I)
70    CONTINUE
      DO 50 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
      N1(H,I)=D1/(G1*(X*V)**2)
      IF (N1(H,I). LT. 0) N1(H,I)=-N1(H,I)
      N2(H,I)=1/(G1*(X*V)**2)
      IF (N2(H,I). LT. 0) N2(H,I)=-N2(H,I)
      DELS(H,I)=100*X*V*N1(H,I)
      IF (EX(I). LE. 0) N2(H,I)=-N2(H,I)
      IF (EX(I). GT. 0) N1(H,I)=-N1(H,I)
      EXS(H,I)=100*N2(H,I)*EX(I)
      CD1=CALD(TD(H,I))
      A1=100*N1(H,I)
      A2=100*N2(H,I)
      COM(H,I)=.375*ABS(A1)+.085*ABS(A2)
      IF (A1) 800,850,850
800   CASH(H,I)=COM(H,I)-(A1/2)*X+A2*P(I)
      GO TO 51
850   Y1=A1+A2
      XA=X-OP(H,I)
      IF (Y1) 900,950,950
900   CASH(H,I)=COM(H,I)+(A1*X)/2+A2*P(I)
     C+ABS(A1+A2)*ABS(XA)
      GO TO 51
950   CASH(H,I)=(X*A1/2)+A2*(P(I)+OP(H,I)-X)+COM(H,I)
51    ALI(H,I)=(CASH(H,I)-A1*X/2-A2*P(I))*R
50    CONTINUE
1000  CONTINUE
      NUM=0
      DO 700 H=1,ENT
      IF (N1(H,1). EQ. 0) GO TO 700
      N=NOP(H)
      NUM=NUM+N
      DO 770 K=H,ENT
      IF (N1(K,1). EQ. 0) GO TO 770
      DO 750 I=1,N
      IF (H. EQ. K) L=I
      IF (H. LT. K) L=1
      DO 760 J=L,N
      IF (DELS(H,I). LE. DELS(K,J))
     SRANK(H,I)=RANK(H,I)+1
      IF (DELS(K,J). LT. DELS(H,I))
     SRANK(K,J)=RANK(K,J)+1
760   CONTINUE
750   CONTINUE
770   CONTINUE
700   CONTINUE
      WRITE(1,2000)
2000  FORMAT(44X,'CALL OPTION-STOCK SPREADS')
      WRITE(1,290)
290   FORMAT(/,13X,'LONG',21X,'SHORT',13X,'EXCESS',3X,'COMMISSION',3X,
     C'CASH',7X,'LOST INT',
```

```
     C2X,'DOL. VOL.')
      DO 250 I=1,NUM
      DO 255 H=1,ENT
      IF (N1(H,1). EQ. 0) GO TO 255
      N=NOP(H)
      NN=N-1
      DO 260 J=1,N
      IF (I. EQ. RANK(H,J)) GO TO 975
      GO TO 260
975   CD1=CALD(TD(H,J))
      N1(H,J)=100*N1(H,J)
      IF (N1(H,J). GT. 0) WRITE(1,300)
     CNAME(H),N1(H,J),N2(H,J),
     CCD1,OP(H,J),EXS(H,J),COM(H,J),CASH(H,J),ALI(H,J)
     C,DELS(H,J)
      IF (N2(H,J). GT. 0) WRITE (1,350)
     CNAME(H),N2(H,J),CD1,OP(H,J),N1(H,J),
     CEXS(H,J),COM(H,J),CASH(H,J),ALI(H,J)
     C,DELS(H,J)
300   FORMAT(A3,1X,F10.2,1X,'SHARES',8X,F9.3,1X,A4,1X,F7.3,4X,F7.3,
     C4X,F7.2,4X,F7.2,4X,F7.2,4X,F7.2)
350   FORMAT(A3,1X,F9.3,1X,A4,1X,F8.2,4X,F10.2,1X,'SHARES',7X,
     CF7.3,4X,F7.2,4X,F7.2,4X,F7.2,4X,F7.2)
260   CONTINUE
255   CONTINUE
250   CONTINUE
      RETURN
      END
```

PROGRAM: *MA2

```
      INTEGER NOP, SR, H,ENT,EXP,CYC
      DIMENSION NAME(10), VOL(10), NOP(10)
      DIMENSION EXP(2,3),OP(10,9), TD(10,9)
      DOUBLE PRECISION NAME
      EXP(1,1)=386
      EXP(1,2)=470
      EXP(1,3)=561
      EXP(2,1)=414
      EXP(2,2)=505
      EXP(2,3)=596
      DO 20 I=1,10
      READ (5,30,END=25) NAME(I), VOL(I), NOP(I),CYC
      J=NOP(I)
      DO 10 K=1,J,3
      READ (5,40) OP(I,K)
      L=K+1
      OP(I,L)=OP(I,K)
      L=L+1
      OP(I,L)=OP(I,K)
      TD(I,K)=EXP(CYC,1)
      TD(I,K+1)=EXP(CYC,2)
      TD(I,K+2)=EXP(CYC,3)

10    CONTINUE
20    CONTINUE
25    ENT=I
30    FORMAT(A3,1X,F3.2,1X,I2,1X,I2)
40    FORMAT(F6.3)
45    WRITE(1,50)
      READ(1,60) MONTH, DAY, R
46    WRITE (1,70)
      READ(1,80) SR
50    FORMAT('ENTER DATE,  INTEREST RATE')
60    FORMAT (I2,1X,I2,1X,F3.2)
70    FORMAT(/,'WHICH SUBROUTINE DO YOU WANT')
80    FORMAT(I2)
      IF (MONTH. EQ. 1) JD=DAY
      IF (MONTH. EQ. 2) JD=DAY+31
      IF (MONTH. EQ. 3) JD=DAY+59
      IF (MONTH. EQ. 4) JD=DAY+90
      IF (MONTH. EQ. 5) JD=DAY+120
      IF (MONTH. EQ. 6) JD=DAY+151
      IF (MONTH. EQ. 7) JD=DAY+181
      IF (MONTH. EQ. 8) JD=DAY+212
      IF (MONTH. EQ. 9) JD=DAY+243
      IF (MONTH. EQ. 10) JD=DAY+273
      IF (MONTH. EQ. 11) JD=DAY+304
      IF (MONTH. EQ. 12) JD=DAY+334
      GO TO (201,206,207,208,209,210,
     C211,212,213,214,215), SR
206   CALL PRIP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
207   CALL VARP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
```

```
208   CALL POSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
209   CALL PSSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
210   CALL STRAD(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
211   CALL RES(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
212   CALL RESP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
213   CALL RESS(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
214   CALL RECS(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
215   CALL REPS(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      GO TO 46
201   CALL EXIT
      END
```

SUBROUTINE 2

```
      SUBROUTINE PRIP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER H,ENT
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('PRICE:')
      READ(1,55) X
55    FORMAT(F7.3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,100)
100   FORMAT(32X,'PUT PRICES')
      WRITE (1,60) CD1,CD2,CD3
60    FORMAT(/,'STRIKE PRICE',6X,A4,15X,A4,15X,A4)
      DO 80 I=1,N,3
      T=(TD(H,I)-JD)/365
      CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
      T=(TD(H,I+1)-JD)/365
      CALL VALP(V,X,OP(H,I+1),T,R,V2,D2,G2)
      T=(TD(H,I+2)-JD)/365
      CALL VALP(V,X,OP(H,I+2),T,R,V3,D3,G3)
      WRITE(1,70) OP(H,I),V1,D1,V2,D2,V3,D3
70    FORMAT(F7.3,3(4X,F6.3,4X,F4.2))
80    CONTINUE
      RETURN
      END
```

SUBROUTINE 3

```
      SUBROUTINE VARP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,2000)
2000  FORMAT(42X,'PUT PRICES')
      WRITE (1,60) CD1,CD2,CD3
60    FORMAT(/,15X,'STRIKE PRICE', 6X,3(A4,15X))
      DO 100 X=I1,I2,10
      WRITE(1,110) X
110   FORMAT('PRICE:',1X,I3)
      Y=X
      DO 80 I=1,N,3
      T=(TD(H,I)-JD)/360
      CALL VALP(V,Y,OP(H,I),T,R,V1,D1,G1)
      T=(TD(H,I+1)-JD)/360
      CALL VALP(V,Y,OP(H,I+1),T,R,V2,D2,G2)
      T=(TD(H,I+2)-JD)/360
      CALL VALP(V,Y,OP(H,I+2),T,R,V3,D3,G3)
      WRITE(1,70) OP(H,I),V1,D1,V2,D2,V3,D3
70    FORMAT(15X,F7.3,3(4X,F6.3,4X,F4.2))
80    CONTINUE
100   CONTINUE
      RETURN
      END
```

SUBROUTINE 4

```
      SUBROUTINE POSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION A(18),NOP(10),OP(10,18),TD(10,18),N1(3,18,18)
      DIMENSION VOL(10),NAME(10),EXS(3,18,18),N2(3,18,18)
      DIMENSION P(18),EX(18),DELS(3,18,18),RANK(3,18,18)
      DIMENSION CASH(3,18,18),ALI(3,18,18)
      DIMENSION COM(3,18,18)
      INTEGER H,ENT
      REAL P
      REAL N1,N2
      DOUBLE PRECISION CD,CD1,CD2,NAME,STOCK
      NUM=0
      NDS=3
      DO 600 K=1,ENT
      DO 5 I=1,18
      DO 6 J=1,18
      N1(K,I,J)=0
      N2(K,I,J)=0
      EXS(K,I,J)=0
      DELS(K,I,J)=0
      RANK(K,I,J)=0
6     CONTINUE
5     CONTINUE
600   CONTINUE
      WRITE(1,500)
500   FORMAT('NUMBER OF STOCKS:')
      READ(1,510) NS
510   FORMAT(I2)
      DO 1000 INDEX=1,NS
101   WRITE(1,1)
1     FORMAT('STOCK:')
      READ(1,2) STOCK
2     FORMAT(A3)
      DO 8 I=1,ENT
      IF (STOCK. EQ. NAME(I)) GO TO 9
15    FORMAT(A3)
8     CONTINUE
      WRITE(1,16)
16    FORMAT('STOCK NOT IN DATA SET')
      GO TO 101
9     H=I
      N=NOP(H)
      V=VOL(H)
      WRITE(1,10)
10    FORMAT('ENTER CURRENT PRICES')
      WRITE(1,1)
      READ(1,11) X
11    FORMAT(F8.4)
      DO 20 I=1,N
      CD=CALD(TD(H,I))
      WRITE(1,30) CD,OP(H,I)
30    FORMAT(A4,1X,F7.3,':')
      READ(1,40) P(I)
40    FORMAT(F7.4)
20    CONTINUE
```

```
      DO 70 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
      EX(I)=V1-P(I)
70    CONTINUE
      NN=N-1
      DO 50 I=1,NN
      T=(TD(H,I)-JD)/365
      CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
      II=I+1
      DO 60 J=II,N
      T=(TD(H,J)-JD)/365
      CALL VALP(V,X,OP(H,J),T,R,V2,D2,G2)
      N1(H,I,J)=(D2/((G1*D2-G2*D1)*(X*V)**2))
      IF (N1(H,I,J). LT. 0) N1(H,I,J)=-N1(H,I,J)
      N2(H,I,J)=(D1/((G1*D2-G2*D1)*(X*V)**2))
      IF (N2(H,I,J). LT. 0) N2(H,I,J)=-N2(H,I,J)
      DELS(H,I,J)=N1(H,I,J)*D1*100*X*V
      EXI=EX(I)*N1(H,I,J)
      EXJ=EX(J)*N2(H,I,J)
      IF (EXI. GE. EXJ) N2(H,I,J)=-N2(H,I,J)
      IF (EXJ. GT. EXI) N1(H,I,J)=-N1(H,I,J)
      GO TO 280
3000  ALI(H,I,J)=(CASH(H,I,J)-100*(N1(H,I,J)*
     CP(I)+N2(H,I,J)*P(J)))*R
60    CONTINUE
50    CONTINUE
      DO 80 I=1,NN
      II=I+1
      DO 90 J=II,N
      EXS(H,I,J)=(N1(H,I,J)*EX(I)+N2(H,I,J)*EX(J))*100
90    CONTINUE
80    CONTINUE
1000  CONTINUE
      DO 1500 H=1,ENT
      IF (N1(H,1,2). EQ. 0) GO TO 1500
      DO 1400 M=H,ENT
      IF (N1(M,1,2). EQ. 0) GO TO 1400
      N=NOP(H)
      NN=N-1
      DO 150 I=1,NN
      II=I+1
      DO 160 J=II,N
      NT=NOP(M)
      NNT=NT-1
      IF (H. EQ. M) I2=I
      IF (H. LT. M) I2=1
      DO 170 K=I2,NNT
      IF (K. EQ. I2) KK=J
      IF (K. GT. I2) KK=K+1
      IF (H. LT. M) KK=K+1
      DO 180 L=KK,NT
      IF (DELS(H,I,J). LE. DELS(M,K,L))
     CRANK(H,I,J)=RANK(H,I,J)+1
```

```
      IF (DELS(M,K,L). LT. DELS(H,I,J))
     CRANK(M,K,L)=RANK(M,K,L)+1
180   CONTINUE
170   CONTINUE
160   CONTINUE
150   CONTINUE
      A(1)=1
      DO 200 I=2,N
      A(I)=I*A(I-1)
200   CONTINUE
1400  CONTINUE
      NUM=A(N)/(2*A(N-2))+NUM
1500  CONTINUE
      WRITE(1,650)
650   FORMAT(50X,'PUT SPREADS',/)
      WRITE(1,290)
290   FORMAT(/,13X,'LONG',21X,'SHORT',13X,'EXCESS',3X,
     C'COMMISSION',5X,'CASH',6X,'LOST INT',2X,'DOL.VOL.')
      DO 250 I=1,NUM
      DO 255 H=1,ENT
      IF (N1(H,1,2). EQ. 0) GO TO 255
      N=NOP(H)
      NN=N-1
      DO 260 J=1,NN
      JJ=J+1
      DO 270 K=JJ,N
      IF (I. EQ. RANK(H,J,K)) GO TO 630
      GO TO 270
280   BULL=0
      COM(H,I,J)=(ABS(N1(H,I,J))+ABS(N2(H,I,J)))*8.5
      BEAR=0
      IF (N1(H,I,J)) 525,550,550
525   BN=N2(H,I,J)
      SN=-N1(H,I,J)
      BS=OP(H,J)
      SS=OP(H,I)
      BP=P(J)
      SP=P(I)
      TB=TD(H,J)
      TS=TD(H,I)
      GO TO 625
550   BN=N1(H,I,J)
      SN=-N2(H,I,J)
      BS=OP(H,I)
      SS=OP(H,J)
      BP=P(I)
      SP=P(J)
      TB=TD(H,I)
      TS=TD(H,J)
625   IF (TB. LT. TS) GO TO 575
      BC=COM(H,I,J)+(BN*BP-SN*SP)*100
      IF (BN. LT. SN) GO TO 2000
      CASH(H,I,J)=BC+(SS-BS)*SN*100
2000  IF (BN. LT. SN) CASH(H,I,J)=BC+((SS-BS)*BN+(SN-BN)
```

```
      C*(SS-.7*X))*100
       GO TO 3000
575    CASH(H,I,J)=COM(H,I,J)+(BN*BP+SN*(SS-.7*X-SP))*100
       GO TO 3000
630    CD1=CALD(TD(H,J))
       CD2=CALD(TD(H,K))
       IF (N1(H,J,K). GT. 0) WRITE(1,300)
      CNAME(H),N1(H,J,K),CD1,OP(H,J),N2(H,J,K),
      CCD2,OP(H,K),EXS(H,J,K),COM(H,J,K),CASH(H,J,K),ALI(H,J,K),
      CDELS(H,J,K)
       IF (N2(H,J,K). GT. 0) WRITE (1,300)
      CNAME(H),N2(H,J,K),CD2,OP(H,K),N1(H,J,K),
      CCD1,OP(H,J),EXS(H,J,K),COM(H,J,K),CASH(H,J,K),ALI(H,J,K),
      CDELS(H,J,K)
300    FORMAT(A3,1X,2(F9.3,1X,A4,1X,F7.3,4X),F8.2,4X,F7.3,4X,F8.2,
      C4X,F8.2,3X,F8.3)
270    CONTINUE
260    CONTINUE
255    CONTINUE
250    CONTINUE
       RETURN
       END
```

SUBROUTINE 5

```
      SUBROUTINE PSSP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION A(9),NOP(10),OP(10,9),TD(10,9),N1(10,9)
      DIMENSION VOL(10),NAME(10),EXS(10,9),N2(10,9)
      DIMENSION P(9),EX(9),DELS(10,9),RANK(10,9)
      DIMENSION ALI(10,9),COM(10,9),CASH(10,9)
      INTEGER H,ENT
      REAL P
      REAL N1,N2
      DOUBLE PRECISION CD,CD1,CD2,NAME,STOCK
      NDS=3
      DO 600 K=1,ENT
      DO 5 I=1,9
      N1(K,I)=0
      N2(K,I)=0
      EXS(K,I)=0
      DELS(K,I)=0
      RANK(K,I)=0
5     CONTINUE
600   CONTINUE
      WRITE(1,500)
500   FORMAT('NUMBER OF STOCKS:')
      READ(1,510) NS
510   FORMAT(I2)
      DO 1000 INDEX=1,NS
101   WRITE(1,1)
1     FORMAT('STOCK:')
      READ(1,2) STOCK
2     FORMAT(A3)
      DO 8 I=1,ENT
      IF (STOCK. EQ. NAME(I)) GO TO 9
15    FORMAT(A3)
8     CONTINUE
      WRITE(1,16)
16    FORMAT('STOCK NOT IN DATA SET')
      GO TO 101
9     H=I
      N=NOP(H)
      NN=N-1
      V=VOL(H)
      WRITE(1,10)
10    FORMAT('ENTER CURRENT PRICES')
      WRITE(1,1)
      READ(1,11) X
11    FORMAT(F8.4)
      DO 20 I=1,N
      CD=CALD(TD(H,I))
      WRITE(1,30) CD,OP(H,I)
30    FORMAT(A4,1X,F7.3,':')
      READ(1,40) P(I)
40    FORMAT(F7.4)
20    CONTINUE
      DO 70 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
```

```
      EX(I)=V1-P(I)
70    CONTINUE
      DO 50 I=1,N
      T=(TD(H,I)-JD)/365
      CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
      N1(H,I)=D1/(G1*(X*V)**2)
      IF (N1(H,I). LT. 0) N1(H,I)=-N1(H,I)
      N2(H,I)=1/(G1*(X*V)**2)
      IF (N2(H,I). LT. 0) N2(H,I)=-N2(H,I)
      DELS(H,I)=100*X*V*N1(H,I)
      IF (EX(I). LE. 0) N2(H,I)=-N2(H,I)
      IF (EX(I). LE. 0) N1(H,I)=-N1(H,I)
      EXS(H,I)=100*N2(H,I)*EX(I)
      CD1=CALD(TD(H,I))
      A1=100*N1(H,I)
      A2=100*N2(H,I)
      COM(H,I)=.375*ABS(A1)+.085*ABS(A2)
      IF (A1) 800,850,850
800   AA1=ABS(A1)
      AA2=ABS(A2)
      BC=COM(H,I)+(AA1*X/2)+AA2*P(I)
      IF (AA1. GE. AA2) CASH(H,I)=BC+AA2*(OP(H,I)-X)
      IF (AA2. GT. AA1) CASH(H,I)=BC+AA1*(OP(H,I)-X)
     C+(AA2-AA1)*(OP(H,I)-.7*X)
      GO TO 51
850   CASH(H,I)=COM(H,I)+(A1*X/2)+A2*P(I)
51    ALI(H,I)=(CASH(H,I)-A1*X/2-A2*P(I))*R
50    CONTINUE
1000  CONTINUE
      NUM=0
      DO 700 H=1,ENT
      IF (N1(H,1). EQ. 0) GO TO 700
      N=NOP(H)
      NUM=NUM+N
      DO 770 K=H,ENT
      IF (N1(K,1). EQ. 0) GO TO 770
      DO 750 I=1,N
      IF (H. EQ. K) L=I
      IF (H. LT. K) L=1
      DO 760 J=L,N
      IF (DELS(H,I). LE. DELS(K,J))
     CRANK(H,I)=RANK(H,I)+1
      IF (DELS(K,J). LT. DELS(H,I))
     CRANK(K,J)=RANK(K,J)+1
760   CONTINUE
750   CONTINUE
770   CONTINUE
700   CONTINUE
      WRITE(1,2000)
2000  FORMAT(44X,'PUT OPTION-STOCK SPREADS')
      WRITE(1,290)
290   FORMAT(/,14X,'STOCK',21X,'PUTS',13X,'EXCESS',3X,'COMMISSION',3X,
     C'CASH',5X,'LOST INT',
     C2X,'DOL. VOL.')
```

```
      DO 250 I=1,NUM
      DO 255 H=1,ENT
      IF (N1(H,1). EQ. 0) GO TO 255
      N=NOP(H)
      NN=N-1
      DO 260 J=1,N
      IF (I. EQ. RANK(H,J)) GO TO 975
      GO TO 260
975   CD1=CALD(TD(H,J))
      N1(H,J)=100*N1(H,J)
      WRITE(1,300)
     CNAME(H),N1(H,J),N2(H,J),
     CCD1,OP(H,J),EXS(H,J),COM(H,J),CASH(H,J),ALI(H,J)
     C,DELS(H,J)
300   FORMAT(A3,1X,F10.2,1X,'SHARES',9X,F9.3,1X,A4,1X,F7.3,4X,F7.3,
     C4X,F7.2,4X,F7.2,4X,F7.2,4X,F7.2)
260   CONTINUE
255   CONTINUE
250   CONTINUE
      RETURN
      END
```

SUBROUTINE 6

```
      SUBROUTINE STRAD(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION PEX(9),CEX(9),NOP(10),OP(10,9),TD(10,9),N1(3,9,9)
      DIMENSION VOL(10),NAME(10),EXS(3,9,9),N2(3,9,9)
      DIMENSION PC(9),PP(9),EX(9),DELS(3,9,9),RANK(3,9,9)
      DIMENSION CASH(3,9,9),ALI(3,9,9),COM(3,9,9)
      INTEGER H,TB,TS,ENT
      REAL P
      REAL N1,N2
      DOUBLE PRECISION CD,CD1,CD2,NAME,STOCK
      NUM=0
      NDS=3
      DO 600 K=1,ENT
      DO 5 I=1,9
      DO 6 J=1,9
      N1(K,I,J)=0
      N2(K,I,J)=0
      EXS(K,I,J)=0
      DELS(K,I,J)=0
      RANK(K,I,J)=0
6     CONTINUE
5     CONTINUE
600   CONTINUE
      WRITE(1,500)
500   FORMAT('NUMBER OF STOCKS:')
      READ(1,510) NS
510   FORMAT(I2)
      DO 1000 INDEX=1,NS
101   WRITE(1,1)
1     FORMAT('STOCK:')
      READ(1,2) STOCK
2     FORMAT(A3)
      DO 8 I=1,ENT
      IF (STOCK. EQ. NAME(I)) GO TO 9
15    FORMAT(A3)
8     CONTINUE
      WRITE(1,16)
16    FORMAT('STOCK NOT IN DATA SET')
      GO TO 101
9     H=I
      N=NOP(H)
      V=VOL(H)
      WRITE(1,10)
10    FORMAT('ENTER CURRENT PRICES')
      WRITE(1,1)
      READ(1,11) X
11    FORMAT(F8.4)
      DO 20 I=1,N
      CD=CALD(TD(H,I))
      WRITE(1,30) CD,OP(H,I)
30    FORMAT(A4,1X,F7.3,'CALL:')
      READ(1,40) PC(I)
      WRITE(1,35) CD,OP(H,I)
35    FORMAT(A4,1X,F7.3,1X,'PUT:')
      READ(1,40) PP(I)
```

```
40      FORMAT(F7.4)
20      CONTINUE
        DO 70 I=1,N
        T=(TD(H,I)-JD)/365
        CALL VAL(V,X,OP(H,I),T,R,V1,D1,G1)
        CEX(I)=V1-PC(I)
        CALL VALP(V,X,OP(H,I),T,R,V1,D1,G1)
        PEX(I)=V1-PP(I)
70      CONTINUE
        NN=N-1
        DO 50 I=1,N
        DO 60 J=1,N
        TI=(TD(H,I)-JD)/365
        CALL VAL(V,X,OP(H,I),TI,R,V1,D1,G1)
        TJ=(TD(H,J)-JD)/365
        CALL VALP(V,X,OP(H,J),TJ,R,V2,D2,G2)
        N1(H,I,J)=(D2/((G1*D2-G2*D1)*(X*V)**2))
        IF (N1(H,I,J). LT. 0) N1(H,I,J)=-N1(H,I,J)
        N2(H,I,J)=(D1/((G1*D2-G2*D1)*(X*V)**2))
        IF (N2(H,I,J). LT. 0) N2(H,I,J)=-N2(H,I,J)
        DELS(H,I,J)=N1(H,I,J)*D1*100*X*V
        EXS(H,I,J)=(CEX(I)*N1(H,I,J)+PEX(J)*N2(H,I,J))*100
        IF (EXS(H,I,J). GE. 0) GO TO 59
        N1(H,I,J)=-N1(H,I,J)
        N2(H,I,J)=-N2(H,I,J)
        EXS(H,I,J)=-EXS(H,I,J)
59      COM(H,I,J)=(ABS(N1(H,I,J))+ABS(N2(H,I,J)))*8.5
        IF (N1(H,I,J)) 525,550,550
525     CASH(H,I,J)=(N1(H,I,J)*PC(I)+N2(H,I,J)*PP(J)
       C-.3*X*(N1(H,I,J)+N2(H,I,J))-N1(H,I,J)*(X-OP(H,I))
       C-N2(H,I,J)*(OP(H,J)-X))*100+COM(H,I,J)
        GO TO 61
550     CASH(H,I,J)=COM(H,I,J)+(N1(H,I,J)*PC(I)+N2(H,I,J)*
       CPP(J))*100
61      ALI(H,I,J)=(CASH(H,I,J)-100*(N1(H,I,J)*
       CPC(I)+N2(H,I,J)*PP(J)))*R
60      CONTINUE
50      CONTINUE
1000    CONTINUE
        DO 1500 H=1,ENT
        IF (N1(H,1,2). EQ. 0) GO TO 1500
        N=NOP(H)
        DO 150 I=1,N
        DO 160 J=1,N
        DO 1400 M=H,ENT
        NT=NOP(M)
        IF (N1(M,1,2). EQ. 0) GO TO 1400
        L1=1
        L2=1
        IF (M. EQ. H) L1=I
        IF (M. EQ. H) L2=J
        DO 170 K=L1,NT
        IF (K. GT. I) L2=1
        DO 180 L=L2,NT
```

```
       IF (DELS(H,I,J). LE. DELS(M,K,L))
      CRANK(H,I,J)=RANK(H,I,J)+1
       IF (DELS(M,K,L). LT. DELS(H,I,J))
      CRANK(M,K,L)=RANK(M,K,L)+1
180    CONTINUE
170    CONTINUE
       A=NT*N
1400   CONTINUE
160    CONTINUE
150    CONTINUE
       NUM=NUM+A
1500   CONTINUE
       DO 1501 H=1,ENT
       IF (N1(H,1,2). EQ. 0) GO TO 1501
       N=NOP(H)
       DO 1502 I=1,N
       DO 1503 J=1,N
1503   CONTINUE
1502   CONTINUE
1501   CONTINUE
       WRITE(1,2000)
2000   FORMAT(50X,'PUT-CALL SPREADS')
       WRITE(1,290)
290    FORMAT(/,13X,'CALL',21X,' PUT ',13X,'EXCESS',3X,
      C'COMMISSION',5X,'CASH',6X,'LOST INT',
      C2X,'DOL. VOL.')
       DO 250 I=1,NUM
       DO 255 H=1,ENT
       IF (N1(H,1,2). EQ. 0) GO TO 255
       N=NOP(H)
       DO 260 J=1,N
       DO 270 K=1,N
       IF (I. EQ. RANK(H,J,K)) GO TO 280
       GO TO 270
280    CD1=CALD(TD(H,J))
       CD2=CALD(TD(H,K))
630    WRITE(1,300)
      CNAME(H),N1(H,J,K),CD1,OP(H,J),N2(H,J,K),
      CCD2,OP(H,K),EXS(H,J,K),COM(H,J,K),CASH(H,J,K),ALI(H,J,K)
      C,DELS(H,J,K)
300    FORMAT(A3,1X,2(F9.3,1X,A4,1X,F7.3,4X),F8.2,4X,F7.3,4X,F8.2,
      C4X,F8.2,4X,F8.3)
270    CONTINUE
260    CONTINUE
255    CONTINUE
250    CONTINUE
       RETURN
       END
```

SUBROUTINE 7

```
      SUBROUTINE RES(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      REAL N1,N2
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,60)
60    FORMAT('LONG OPTION')
      WRITE(1,70)
70    FORMAT('NUMBER:')
      READ(1,80) N1
80    FORMAT(F7.4)
      WRITE(1,90)
90    FORMAT('I:')
      READ(1,100) J1
100   FORMAT(I2)
      WRITE(1,115)
115   FORMAT('PRICE PAID:')
      READ(1,80) P1
      WRITE(1,110)
110   FORMAT('SHORT OPTION')
      WRITE(1,120)
120   FORMAT('NUMBER SOLD:')
      READ(1,80) N2
      WRITE(1,90)
      READ(1,100) J2
      WRITE(1,115)
      READ(1,80) P2
      WRITE(1,2000)
      CD1=CALD(TD(H,J1))
      CD2=CALD(TD(H,J2))
2000  FORMAT(55X,'RESULTS OF CALL SPREADS')
```

```
      WRITE(1,150)
150   FORMAT(/,1X,'STOCK',12X,'LONG',19X,'SHORT',9X,
     C'COMMISSIONS',3X,'LONG',5X,'SHORT',9X,'PROFIT',5X,
     C'LONG',6X'SHORT')
      WRITE(1,160)
160   FORMAT(1X,'PRICE',12X,'CALL',19X,'CALL',14X,'PAID',
     C5X,'CHANGE',4X,'CHANGE',19X,'DELTA',5X,'DELTA',/)
      DO 200 X=I1,I2
      Y=X
      T=(TD(H,J1)-JD)/365
      CALL VAL(V,Y,OP(H,J1),T,R,V1,D1,G1)
      T=(TD(H,J2)-JD)/365
      CALL VAL(V,Y,OP(H,J2),T,R,V2,D2,G2)
      A=(ABS(N1)+ABS(N2))*17.
      B=(100*N1)*(V1-P1)
      BB=(100*N2)*(V2-P2)
      C=B-BB-A
      D1=D1*N1*100
      D2=D2*ABS(N2)*100
      WRITE(1,210) X,N1,CD1,OP(H,J1),N2,CD2,OP(H,J2),
     CA,B,BB,C,D1,D2
210   FORMAT(F7.3,3X,2(F7.3,1X,A3,1X,F7.3,4X),6(F8.2,3X))
200   CONTINUE
      RETURN
      END
```

SUBROUTINE 8

```
      SUBROUTINE RESP(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      REAL N1,N2
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,60)
60    FORMAT('LONG OPTION')
      WRITE(1,70)
70    FORMAT('NUMBER:')
      READ(1,80) N1
80    FORMAT(F7.4)
      WRITE(1,90)
90    FORMAT('I:')
      READ(1,100) J1
100   FORMAT(I2)
      WRITE(1,115)
115   FORMAT('PRICE PAID:')
      READ(1,80) P1
      WRITE(1,110)
110   FORMAT('SHORT OPTION')
      WRITE(1,120)
120   FORMAT('NUMBER SOLD:')
      READ(1,80) N2
      WRITE(1,90)
      READ(1,100) J2
      WRITE(1,115)
      READ(1,80) P2
      WRITE(1,2000)
      CD1=CALD(TD(H,J1))
      CD2=CALD(TD(H,J2))
2000  FORMAT(50X,'RESULTS OF PUT SPREADS')
```

```
      WRITE(1,150)
150   FORMAT(/,1X,'STOCK',12X,'LONG',19X,'SHORT',9X,
     C'COMMISSIONS',4X,'LONG',5X,'SHORT',8X,'PROFIT',5X,'LONG',
     C6X,'SHORT')
      WRITE(1,160)
160   FORMAT(1X,'PRICE',13X,'PUT',19X,' PUT',14X,'PAID',
     C5X,'CHANGE',4X,'CHANGE',19X,'DELTA',5X,'DELTA',/)
      DO 200 X=I1,I2
      Y=X
      T=(TD(H,J1)-JD)/365
      CALL VALP(V,Y,OP(H,J1),T,R,V1,D1,G1)
      T=(TD(H,J2)-JD)/365
      CALL VALP(V,Y,OP(H,J2),T,R,V2,D2,G2)
      A=(N1+N2)*17.
      B=100*(N1)*(V1-P1)
      BB=100*(N2)*(V2-P2)
      C=B-BB-A
      D1=D1*N1*100
      D2=D2*ABS(N2)*100
      WRITE(1,210) X,N1,CD1,OP(H,J1),N2,CD2,OP(H,J2),
     CA,B,BB,C,D1,D2
210   FORMAT(F7.3,3X,2(F7.3,1X,A3,1X,F7.3,4X),6(F8.2,3X))
200   CONTINUE
      RETURN
      END
```

SUBROUTINE 9

```
      SUBROUTINE RECS(NAME,OP;NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      REAL N1,N2
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,60)
60    FORMAT('STOCK')
      WRITE(1,70)
70    FORMAT('NUMBER OF SHARES:')
      READ(1,80) N1
80    FORMAT(F7.4)
90    FORMAT('I:')
100   FORMAT(I2)
      WRITE(1,115)
115   FORMAT('PRICE PAID:')
      READ(1,80) P1
      WRITE(1,110)
110   FORMAT('OPTION')
      WRITE(1,120)
120   FORMAT('NUMBER OF OPTIONS:')
      READ(1,80) N2
      WRITE(1,90)
      READ(1,100) J2
      WRITE(1,115)
      READ(1,80) P2
      WRITE(1,2000)
2000  FORMAT(55X,'RESULTS OF CALL OPTION-STOCK SPREADS')
      WRITE(1,150)
150   FORMAT(/,1X,'STOCK',12X,'STOCK',17X,'OPTION',8X,
     C'COMMISSIONS',5X,'STOCK',6X,'OPTION',5X,'PROFIT',5X,
     C'LONG',6X'SHORT')
```

```
      WRITE(1,160)
160   FORMAT(1X,'PRICE',53X,'PAID',
     C6X,'CHANGE',6X,'CHANGE',16X,'DELTA',5X,'DELTA',/)
      DO 200 X=I1,I2
      Y=X
      T=(TD(H,J2)-JD)/365
      CD2=CALD(TD(H,J2))
      CALL VAL(V,Y,OP(H,J2),T,R,V2,D2,G2)
      A=ABS(N1)*.75+ABS(N2)*8.5
      B=(N1)*(X-P1)
      BB=(100*N2)*(P2-V2)
      C=B-BB-A
      D1=ABS(N1)
      D2=D2*ABS(N2)*100
      WRITE(1,210) X,N1,N2,CD2,OP(H,J2),
     CA,B,BB,C,D1,D2
210   FORMAT(F7.3,6X,F7.3,1X,'SHARES',6X,
     CF7.3,1X,A3,1X,F7.3,4X,6(F8.2,3X))
200   CONTINUE
      RETURN
      END
```

SUBROUTINE 10

```
      SUBROUTINE REPS(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      REAL N1,N2
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,60)
60    FORMAT('STOCK')
      WRITE(1,70)
70    FORMAT('NUMBER OF SHARES:')
      READ(1,80) N1
80    FORMAT(F7.4)
90    FORMAT('I:')
100   FORMAT(I2)
      WRITE(1,115)
115   FORMAT('PRICE PAID:')
      READ(1,80) P1
      WRITE(1,110)
110   FORMAT('OPTION')
      WRITE(1,120)
120   FORMAT('NUMBER OF OPTIONS:')
      READ(1,80) N2
      WRITE(1,90)
      READ(1,100) J2
      WRITE(1,115)
      READ(1,80) P2
      WRITE(1,2000)
2000  FORMAT(55X,'RESULTS OF PUT OPTION-STOCK SPREADS')
      WRITE(1,150)
150   FORMAT(/,1X,'STOCK',12X,'STOCK',17X,'OPTION',8X,
     C'COMMISSIONS',5X,'STOCK',7X,'OPTION',4X,'PROFIT',5X,
     C'STOCK',7X'PUT')
```

```
      WRITE(1,160)
160   FORMAT(1X,'PRICE',53X,'PAID',
     C6X,'CHANGE',6X,'CHANGE',16X,'DELTA',5X,'DELTA',/)
      DO 200 X=I1,I2
      Y=X
      T=(TD(H,J2)-JD)/365
      CALL VALF(V,Y,OP(H,J2),T,R,V2,D2,G2)
      CD2=CALD(TD(H,J2))
      A=ABS(N1)*.75+ABS(N2)*8.5
      B=(N1)*(X-P1)
      BB=(100*N2)*(V2-P2)
      C=B+BB-A
      D1=ABS(N1)
      D2=-ABS(N2)*D2*100
      WRITE(1,210) X,N1,N2,CD2,OP(H,J2),
     CA,B,BB,C,D1,D2
210   FORMAT(F7.3,6X,F7.3,1X,'SHARES',6X,
     CF7.3,1X,A3,1X,F7.3,4X,6(F8.2,3X))
200   CONTINUE
      RETURN
      END
```

SUBROUTINE 11

```
      SUBROUTINE RESS(NAME,OP,NOP,VOL,TD,JD,R,ENT)
      DIMENSION NAME(10),NOP(10),OP(10,18), VOL(10),TD(10,18)
      DOUBLE PRECISION NAME,CD1,CD2,CD3,STOCK
      INTEGER X,H,ENT
      REAL N1,N2
      WRITE(1,10)
10    FORMAT('STOCK:')
      READ(1,20) STOCK
20    FORMAT(A3)
      DO 30 I=1,ENT
      IF (NAME(I). EQ. STOCK) GO TO 40
30    CONTINUE
      WRITE(1,35)
35    FORMAT('STOCK NOT IN DATA SET')
      GO TO 10
40    H=I
      WRITE(1,50)
50    FORMAT('LOWER PRICE:')
      READ(1,55) I1
      WRITE(1,51)
51    FORMAT('UPPER PRICE:')
      READ(1,55) I2
55    FORMAT(I3)
      N=NOP(H)
      V=VOL(H)
      CD1=CALD(TD(H,1))
      CD2=CALD(TD(H,2))
      CD3=CALD(TD(H,3))
      WRITE(1,60)
60    FORMAT('CALL OPTION')
      WRITE(1,70)
70    FORMAT('NUMBER:')
      READ(1,80) N1
80    FORMAT(F7.4)
      WRITE(1,90)
90    FORMAT('I:')
      READ(1,100) J1
100   FORMAT(I2)
      WRITE(1,115)
115   FORMAT('PRICE PAID:')
      READ(1,80) P1
      WRITE(1,110)
110   FORMAT(' PUT OPTION')
      WRITE(1,120)
120   FORMAT('NUMBER:')
      READ(1,80) N2
      WRITE(1,90)
      READ(1,100) J2
      WRITE(1,115)
      READ(1,80) P2
      WRITE(1,2000)
2000  FORMAT(55X,'RESULTS OF PUT-CALL SPREADS')
      WRITE(1,150)
150   FORMAT(/,1X,'STOCK',12X,'CALL',19X,' PUT ',9X,
```

```
     C'COMMISSIONS',3X,'CALL',7X,'PUT',8X,'PROFIT',7X,'LONG',6X,'SHORT
)
      WRITE(1,160)
160   FORMAT(1X,'PRICE',52X,'PAID',
     C6X,'CHANGE',6X,'CHANGE',17X,'DELTA',5X,'DELTA',/)
      DO 200 X=I1,I2
      Y=X
      T=(TD(H,J1)-JD)/365
      CALL VAL(V,Y,OP(H,J1),T,R,V1,D1,G1)
      T=(TD(H,J2)-JD)/365
      CALL VALP(V,Y,OP(H,J2),T,R,V2,D2,G2)
      A=ABS(N1+N2)*17.
      B=(100*N1)*(V1-P1)
      BB=(100*N2)*(P2-V2)
      C=B-BB-A
      D1=ABS(N1)*D1*100
      D2=ABS(N2)*D2*100
      CD1=CALD(TD(H,J1))
      CD2=CALD(TD(H,J2))
      WRITE(1,210) X,N1,CD1,OP(H,J1),N2,CD2,OP(H,J2),
     CA,B,BB,C,D1,D2
210   FORMAT(F7.3,3X,2(F7.3,1X,A3,1X,F7.3,4X),6(F8.2,3X))
200   CONTINUE
      RETURN
      END
```

SUPPORT FUNCTION PROGRAMS

```
SUBROUTINE VAL(V,X,C,T,R,W,ND,G)
REAL N,ND
S2=V**2
B=SQRT(S2*T)
A=ALOG(X/C)
D1=(ALOG(X/C)+((R+S2/2)*T))/SQRT(S2*T)
D2=D1-SQRT(S2*T)
PI=3.142
G=EXP(-(D1**2)/2)/(X*V*SQRT(2*PI*T))
W=X*N(D1)-C*EXP(-R*T)*N(D2)
ND=N(D1)
RETURN
END
```

```
      FUNCTION N(X)
      REAL M,N
      P=.47047
      A1=.3480242
      A2=-.0958798
      A3=.7478556
      Y=X/SQRT(2.)
      IF (Y) 100,200,200
100   Y=-Y
      M=1/(1+(P*Y))
      Z=(((A1*M)+(A2*M**2)+(A3*M**3))*EXP(-Y**2))-1
      N=(Z+1)/2
      RETURN
200   M=1/(1+(P*Y))
      Z=1-((A1*M)+(A2*M**2)+(A3*M**3))*EXP(-Y**2)
      N=(1+Z)/2
      RETURN
      END
```

```
      FUNCTION CALD(X)
      DOUBLE PRECISION CALD
      DOUBLE PRECISION MON(12)
      REAL MON
      DATA MON/'DEC','NOV','OCT','SEPT','AUG','JULY',
     C'JUNE','MAY','APR','MAR','FEB','JAN'/
      Y=X-365.
      IF (Y. LT. 365) CALD=MON(1)
      IF (Y. LT. 334) CALD=MON(2)
      IF (Y. LT. 304) CALD=MON(3)
      IF (Y. LT. 273) CALD=MON(4)
      IF (Y. LT. 243) CALD= MON(5)
      IF (Y. LT. 212) CALD=MON(6)
      IF (Y. LT. 181) CALD=MON(7)
      IF (Y. LT. 151) CALD=MON(8)
      IF (Y. LT. 120) CALD=MON(9)
      IF (Y. LT. 90) CALD=MON(10)
      IF (Y. LT. 59) CALD=MON(11)
      IF (Y. LT. 31) CALD=MON(12)
      RETURN
      END
```

```
SUBROUTINE VALP(V,X,C,T,R,W,ND,G)
REAL N,ND
S2=V**2
B=SQRT(S2*T)
A=ALOG(X/C)
D1=(ALOG(X/C)+((R+S2/2)*T))/SQRT(S2*T)
D2=D1-SQRT(S2*T)
PI=3.142
G=EXP(-(D1**2)/2)/(X*V*SQRT(2*PI*T))
DD1=-D1
W=-X*N(DD1)+C*EXP(-R*T)*N(-D2)
ND=N(DD1)
RETURN
END
```

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