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The Stock Market and the Worldwide Web: Mathematics or Gambling?

An Interactive Qualifying Project

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by

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Abstract

This project deals with the use of mathematics to model the modern day stock market, and also the influence of online trading on the financial community. With the hopes of better understanding option investing, a computer program was created to calculate the prices of options. The program was developed in Java so that it could be placed online to better educate people in their investing. Lastly, an analysis of how the Internet impacts the market was conducted.

1.0 Executive Summary

The purpose of this project was to use mathematical models to better understand option pricing. The second objective was to research the effects of the emerging online brokerages on the stock market and the investor.

The review of the literature involves the discussion of two different sources that presented mathematical models to aid in the programming of the option-pricing program. Two models are described from concept to final equation to help better explain how integration of these models into software can be done.

The first model that was used to price options is the binomial model. The review explains how the pieces of the model are put together to form the completed multi-period binomial model adjusted for dividends to calculate European option prices. Later in the chapter, the Black-Scholes Model is introduced and compared with the multi-period binomial model.

The methodology chapter explains how the models are integrated into JAVA. The binomial and Black-Scholes models are programmed into JAVA with a user-friendly interface. The user has the option to calculate the price of a put, or a call, with the option of including dividends in either.

The final chapter involves the effects of online trading on the market. A comparison of the top ten online brokerages was performed. Since the online market is contributing more and more to the total volume in the stock markets, this comparison indicates factors that influence these markets.

The final chapter also explains the effects of ECNs (electronic communication networks) on the NASDAQ market. Also, how the integration of the online brokerages into the market contribute to the market's volatility. This chapter also explains the dangers of online trading and recent scams that cause the market to drop.

2.0 Introduction

With the ever-increasing technological advances in the computer world, more and more opportunities are becoming available. The world is at the tips of our fingers, with the touch of a few keys, one can shop on-line, check the local weather or find who won the baseball game. The Worldwide Web has even drawn brokers to the on-line world so that people can buys stocks, options and bonds just as easily. However, many problems and issues have risen regarding the impact of online brokerages on the market. The purpose of this project is to analyze some of the problems with the integration of online brokers into the market, and develop a JAVA-based option-pricing program using certain mathematical models.

To develop an option-pricing program, certain mathematical models must be used, such as the Multi-Period Binomial and the Black-Scholes models. Chapter three focuses on developing these models and the results are compared and contrasted to better understand how the models work.

The next step for the project is to integrate the Multi-Period Binomial and the Black-Scholes models into a computer program that is available on the web. The program has the option to compute the Black-Scholes or the Binomial model with various different inputs, such as dividends, calculation of a put or call, and the option for European or American options. The software was developed using JAVA to insure very user-friendly interface. The program has been placed on the web so that any type of audience, young and old alike can use the program for educational purposes or for guidance in an investment.

Chapter 5 looks into the issues at hand with the impact of the worldwide web on the market. It is divided into three sections; the first section takes a look at what online brokerages are, the second section focuses on the impact of the Worldwide Web on the investor, while the third section investigates the impact of the online brokerages on the market.

3.0 Option Pricing Models

The purpose of this chapter is to introduce the reader to basic background information to aid in the explanation of the project. Introduction of several models to calculate option prices will also be explained.

Two major sources were used to introduce the background information and the two models. The Options Primer by Robert W. Kolb [20] contained much information about how options are created, how they are used together in option combinations, calculating the binomial model, and how to calculate the Black-Scholes model.

The second source is Stochastic Calculus Models for Finance by Steven E. Shreve [30]. This source was used primarily for the binomial model. Though The Options Primer contained information about the binomial model, the one in Steven E. Shreve's book is easier to integrate into JAVA.

3.1 What is an Option?

Options are special types of financial contracts that are created between two parties. Until recently, the option market was limited to only options traded on stocks. However, today there are many exchanges that offer options on a wide variety of goods, bonds, future contracts, and foreign currencies [20, pg. 2].

3.2 Calls and Puts

Every option is either a call option or a put option. For purposes of explanation we will refer to stocks only, although other goods may be substituted in its place. When one purchases a call option the owner has the right, but not the obligation to *purchase* the stock at a specific price. The owner only has this right for a set amount of time. On the other hand, the owner of a put option has the right to *sell* the stock at a specific price. Therefore, the owner of a call can force the option writer to sell him/her the stock and the owner of a put can force the option writer to buy his/her stock [20, pg.3].

Options are unlike stocks because the process of buying and selling create them. This is where the option writer comes into the picture. The buyer of a call option pays the option writer the specific price of the option agreement at that time in exchange for the right to purchase the stock at that price until expiration of the call. However, the buyer of a put is different, the writer agrees to buy the stock at a specific price if the put option buyer chooses to exercise the option.

3.3 Basics of Option Pricing

There are certain terms that need to be explained in order to understand the entire process of option pricing. One of these is the Exercise Price (or Striking Price); this is a fixed price that the owner of a call must pay to acquire the stock. Another important term is Option Premium. An option premium is the price of the option agreement. At no time will this premium be refunded to the buyer. An example will help show the differences and purposes to these terms [20, pg. 3].

A given stock, named C, has a current price of $60. The owner of a call purchased the right to the stock at a strike price of $50, and also paid an option premium of $5. Disregarding the option premium, the owner of the call has the right to purchase the stock for $60, making a profit of $10. The owner of a put would receive a profit of -

$10 if he/she exercised. If the owner never exercises the option, it expires worthless. In this case the option writer only keeps the option premium of $5.

There are many different types of options, however, for this project only two distinct types of options will be used, European and American. European options follow the same procedures described except that they may only be executed on the expiration date. American options differ from European options because they can be executed on any date before expiration [20, pp 5,6].

3.4 Why not just purchase the stock?

There are many advantages to purchasing options over stocks. For starters, the stock does not have to be bought in an option agreement. Options only require that an option premium be paid, which usually is a few dollars per share of stock purchased. However, the number of shares purchased for an option agreement must be 100. So to buy a call option with an option premium of $5 the buyer would have to pay $500 dollars. Thus, options are considerably cheaper than purchasing the actual stock.

3.5 Arbitrage

With a basic understanding of the option lingo, more in-depth mathematical models and concepts can be explained. For example, the concept of arbitrage, which means that there is a situation where a trade can be made without risk and with no initial investment. Take this case for example: Say a stock is trading on one market for 35 dollars, while the same stock is trading on a different market for $35.50. If there is no transaction fee, then an investor can purchase the stock for $35 and then sell the stock in the other market for $35.50. The profit is $0.50. This is an example of arbitrage. Because there are transaction costs, and regulations for such events, there are very few instances where arbitrage is implemented.

3.6 Notation for Option Pricing

The following notation for option pricing was taken from the book The Options Primer by Robert W. Kolb [20] to explain the models.

S_t = price of the underlying stock at time t

X = the exercise price for the option

T = the expiration date of the option

c_t = the price of a European call at time n

p_t = the price of a European put at time n [20, pg. 43]

3.7 Option Calculation at Time of Expiration

It is now time to introduce an equation that determines whether to exercise a call option. It would seem prudent to let the option agreement expire if the net yield is negative. So an equation can be formulated to help maximize profit. This equation is only relevant when the option is at the time of expiration.

$$c_T = MAX\{0, S_T - X\}$$ [20, pg. 43]

This states that if the stock price minus the exercise price is positive, then exercise the option. If the option is less than zero, do not exercise the option and just let it expire. So this would be very easy to apply to the example above.

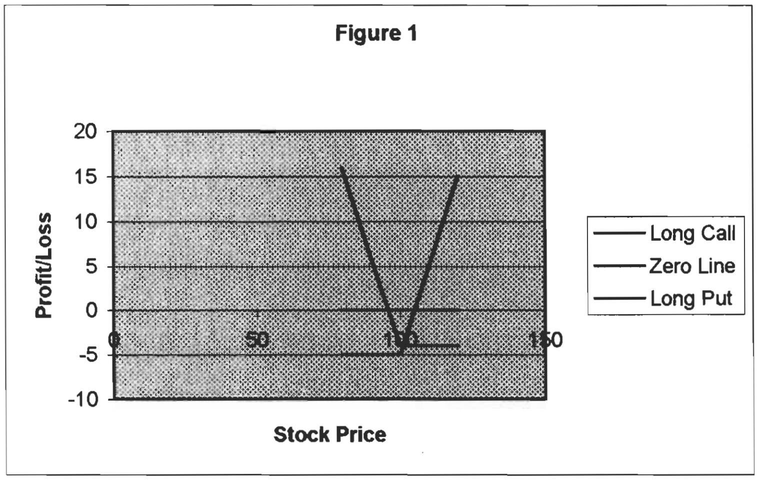
The stock price of C is $60, while the strike price of the call is $50. At the time of expiration the value of the call can be calculated. Substituting these numbers into the equations gives the following: $c_T = MAX\{0, 60 - 50\} = 10$. However, if the strike price and stock price were switched in this example, then $c_T = MAX\{0, 50 - 60\} = 0$. Likewise for a put, except the exercise price and stock price would be switched. Creating an equation that looks like this: $p_T = MAX\{0, X - S_T\}$.

3.8 Option Combinations

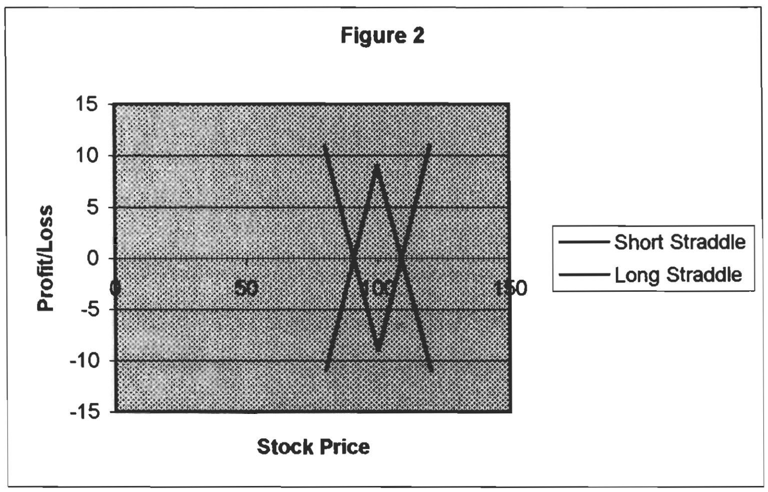
Now that a basic foundation has been laid, option combinations can be used to maximize profits. There are many different option combinations that can be used; however, just a few basic examples will be given. The two most basic option combinations are called the straddle and the strangle.

3.8a. The Straddle and Strangle

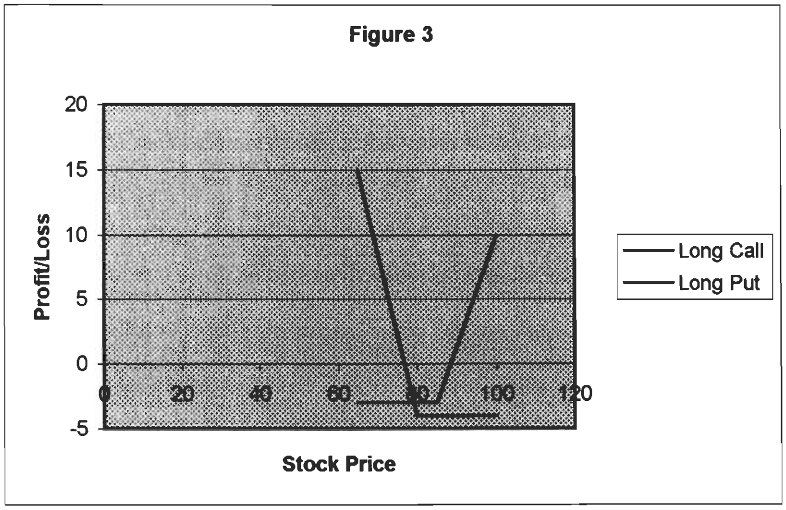
The straddle's basic idea is to purchase a call and a put with the same exercise price and expiration date. For the buyer to make profit the stock must either rise or fall, otherwise the owner's loss will be the cost of the two options. While the strangle's basic idea is to purchase a call and a put with the same expiration date, but different exercise prices. The buyer purchases a put with an exercise price below the stock price and a call with an exercise price above the stock price. This way the buyer will profit if the stock falls significantly lower than the exercise price of the put, or if the stock rises significantly above the exercise price of the call.



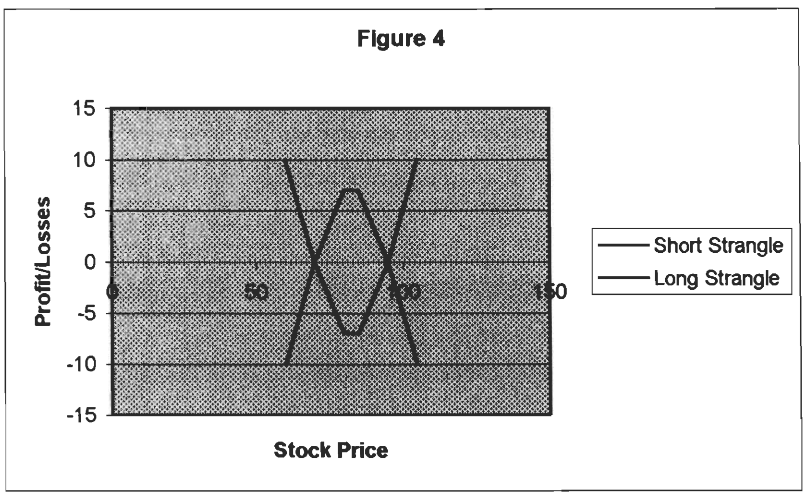
Profits and Losses at Expiration from the options in a straddle



Profits and losses at expiration from a straddle



Profits and losses at expiration from the options in a strangle

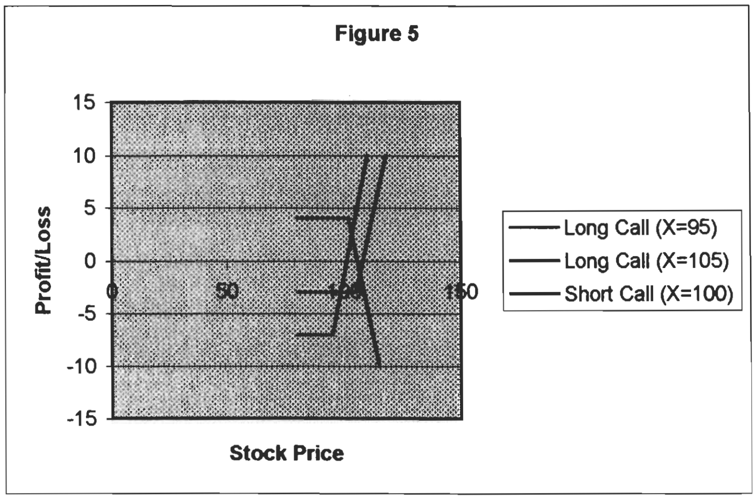


Profits and losses at expiration from a strangle

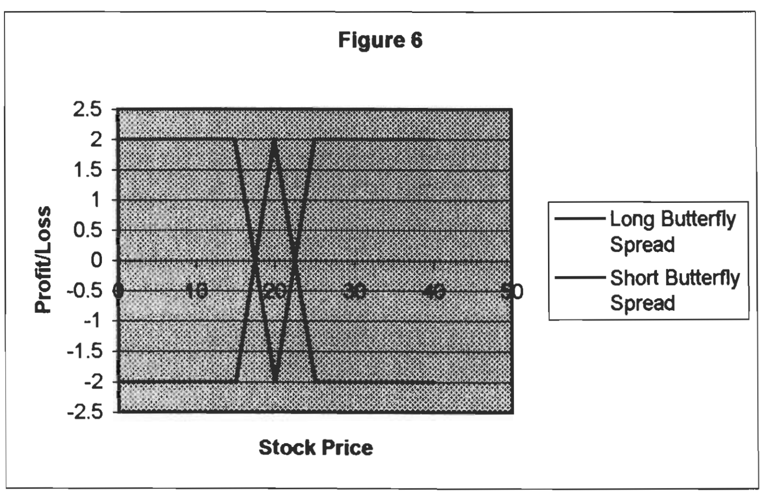
3.8b. The Butterfly Spread

The next example of an option combination is called the butterfly spread. However, to explain the butterfly spread, long and short calls and long and short puts must first be defined. A long call is an exercised call in which the owner has the stock. The same is true for a long put. A short call and put are when the owner does not have the stock. The butterfly uses three calls on the same stock with the same expiration date.

For the butterfly spread buyer, profit will occur when the stock prices do not increase or decrease significantly. A long trader sets this up by purchasing one call with a high exercise price, one call with a low exercise price, and sells two calls at the intermediate exercise price. While a short trader sets this up by selling one call with a high exercise price, one call with a low exercise price, and buys two calls at the intermediate exercise price [20, pg. 70].



Profits and losses at Expiration for the options in a butterfly spread



Profits and losses at expiration for a butterfly spread

3.9 Mimicking Stock

Another type of option combination is the mimicking stock, which is the combination of a long call and a short put. Therefore, if the stock price increases, the short put is worth nothing, while the call is worth the expiration stock price minus the initial stock price. So, if the stock price drops, then the long call is worth nothing, while the short put is worth the initial stock price minus the expiration stock price. Thus, this is very similar to actually owning the stock [20, pp. 91-96].

Another way to mimic stock with the use of options is to add another variable, which, in this case is a bond. Basically, the owner would follow the same outline as discussed before, by purchasing a short put and a long call. This is where the bond comes into play. The bond is purchased so that at expiration of the options, it will be equal to the option premium at expiration. But, this model only works for European options.

3.10 The Put-Call Parity

This leads to the put-call parity. Which is defined in The Options Primer as: "the relationship between put, call, stock, and bond prices" [20, pg. 97]. This can be put into the notation described above to formulate an equation. $p_n = c_n - S_n + Xe^{-r(N-n)}$ [20, pg. 97]. Where r is the risk-free interest rate (sometimes called treasury bill rate). This equation will become very handy with the models used to make the computer program.

3.11 The Single-Period Binomial Model

Now is the time to introduce the single period binomial call pricing model. It is used to calculate an option that expires in one period. A few more variables are needed to formulate the equations.

PORT is the portfolio value.

PORT = NS_t-B_t

N = the number of shares

B_t = the amount of money borrowed from bonds [20, pp. 148-149]

The debt is equaled to the amount borrowed (B_t) times the interest rate. Since this is a binomial model there can be one of two possible outcomes, either the stock can go up or the stock can go down. Thus, we can remodel our previous equation to include this up and down movement. If the stock price rises then the equation will be:

$PORT_{U,T} = NUS_T - RB_t$ [19, pp. 148-149]

U= 1+ the percentage of stock price increase

R= 1+r [20, pg. 148]

In the case of the stock price falling, the equation would be $PORT_{D,T} = NDS_T - RB_t$

D= 1- the percentage of stock price increase

To help simplify the equations above, the equation for the instance of an upward-movement is equal to c_U and the instance of a downward-movement is c_D.

Therefore if the price rises:

$$PORT_{U,T} = NUS_T - RB_t = c_U$$ [20, pg. 148]

And thus if the stock price falls:

$$PORT_{D,T} = NDS_T - RB_t = c_D$$ [20, pg. 148]

Then the equations can be solved to satisfy the two unknowns N and B_t.

$$N = \frac{(c_U - c_D)}{(U - D)S_t}$$

$$B_t = \frac{(c_U D - c_D U)}{(U - D)R}$$

$$c_t = NS_t - B_t \qquad [20, pg. 149]$$

3.12 The Multi-Period Binomial Model

This is the multi-period binomial model and will be used to further the progress of one of the final model used in the computer program.

$$\sum_{j=0}^{n} \frac{(\frac{n!}{j!(n-j)!})[\pi_U^j \pi_D^{n-j}]MAX[0, U^j D^{n-j} S_t - X]}{R^n} \qquad [20, pg. 153]$$

The whole equation is summed from when j=0 until it equals n, which is the number of periods until expiration. While j is equal to the number of price rises in the stock.

The part of the equation described below, computes the number of possible combinations of j rises until the expiration date at time n.

$$\left(\frac{n!}{j!(n-j)!}\right) \qquad [20, pg. 154]$$

The π_U and the π_D are equal to the two quotients in this equation:

$$c_t = \frac{\left(\frac{R-D}{U-D}\right)c_U + \left(\frac{U-R}{U-D}\right)c_D}{R} \qquad [20, pg. 150].$$

π_U and π_D are the instances of the upward and downward movement.

The part of the equation beginning with MAX is just the same as the first equation introduced, it takes the maximum value, may it be 0 or the stock price minus the exercise price in the event of j upward movements and n-j downward movements. And finally, the R is the discount factor, which is raised to the nth power.

Once this is equation has been understood, it would seem that instead of having the variable j represent the number of upward movements, have another variable equal the number of upward movement to be in-the-money. The book The Options Primer uses the variable m to define the number of j's until the call option is in-the-money. Substituting this into the equation the MAX function is removed.

$$\sum_{j=m}^{n} \frac{(\frac{n!}{j!(n-j)!})(\pi_U^j \pi_D^{n-j})[U^j D^{n-j} S_t - X]}{R^n} \quad [20, pg. 156]$$

3.12a. Adjusting the Multi-Period Binomial Model For the Put-Call Parity

This equation can then be split into two parts, so that it resembles the original single period binomial model.

$$c_t = S_t\left[\sum_{j=m}^{n}\left(\frac{n!}{j!(n-j)!}\right)\left(\pi_U^j \pi_D^{n-j}\right)\left(\frac{U^j D^{n-j}}{R^n}\right)\right] - XR^{-n}\left[\sum_{j=m}^{n}\left(\frac{n!}{j!(n-j)!}\right)\pi_U^j \pi_D^{n-j}\right]$$

[20, pg. 156]

This can also be applied to the calculations of puts, because of the put-call parity.

$$p_t = XR^{-n}\left[\sum_{j=0}^{m-1}\left(\frac{n!}{j!(n-j)!}\right)\pi_U^j \pi_D^{n-j}\right] - S_t\left[\sum_{j=0}^{m-1}\left(\frac{n!}{j!(n-j)!}\right)\left(\pi_U^j \pi_D^{n-j}\right)\left(\frac{U^j D^{n-j}}{R^n}\right)\right]$$

[20, pg. 158]

It can be seen that from this equation much calculations and time are involved. It would seem easy enough to apply this to a computer program and let it do all the work, however this is not so. For large n, there are too many computations and the computer runs out memory. Therefore, it was a good idea to look to a different source for a different way of computing the binomial model. The source used is Stochastic Calculus Models for Finance.

3.13 Applying the Single-Period Binomial Model Using Stochastic Calculus

The one-period binomial model is as follows: The beginning period is considered time 0. So the stock price at time zero will be labeled S_0 [30]. From this two possible outcomes are possible. The stock price can either go up or down. So this can be written as an equation in which U and D are defined:

$$U = \frac{S_{t+1}(H)}{S_t}, D = \frac{S_{t+1}(T)}{S_t}.$$

This is then placed into a binomial tree, which is the heart of how this method works far better than the former binomial model. To construct a binomial tree, the S_0 is placed first, then the path diverges into two possibilities. One would be if the stock price increases, while the other is if it decreases. An example of how the binomial tree is drawn is shown here:

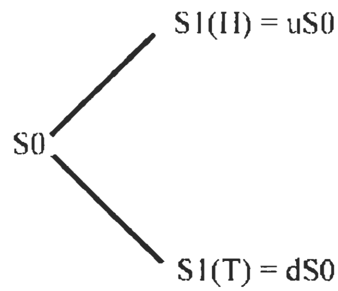


Figure 7

It is fairly obvious that the u means up and the d is the down. It can also be assumed that the chance of an increase in stock is equal to π_U. And thus the chance of a decrease is equal to $1-\pi_U$. These variables are not the true probabilities, if they were, many people would be very rich. These variables are simply ways to enumerate the different upward and downward movement possible in the stock market.

Also included in this model is the assumption that borrowing from the money market is to occur, due to the negativity of the equation. This would then become another variable, which would have to be multiplied by the exercise price minus the stock price, like so:

$$PORT_0 = NS_t + B_t \qquad [30, pg. 5]$$

Where the r is the interest rate and N is the amount of stocks at time zero.

Therefore

$$PORT_1(H) = NS_{t+1}(H) + RB_t \qquad [30, pg. 6]$$

It then can be assumed that $PORT_1(T) = V_1(T)$,where $V_1(T)$ is an unknown until time one. V is equal to the value of the option in question. So the equation can now be written as:

$$PORT_0 + N\left(\frac{1}{R}S_{t+1}(H) - S_t\right) = V_1(H)$$

$$PORT_0 + N\left(\frac{1}{R}S_{t+1}(T) - S_t\right) = \frac{1}{R}V_1(T)$$ [30, pg. 7]

by multiplying these by π_U and the second by 1-π_U and then add them.

$$PORT_0 + N\left(\frac{1}{R}\left[\pi_U S_{t+1}(H) + \pi_D S_{t+1}(T)\right] - S_t\right) = \frac{1}{R}\left[\pi_U V_1(H) + \pi_D V_1(T)\right]$$

[30, pg. 7]

This can then be manipulated so that the term that is multiplied by N is zero.

$$S_t = \frac{1}{R}\left[\pi_U S_{t+1}(H) + \pi_D S_{t+1}(T)\right]$$ [30, pg. 7]

This then leads to a much more simplified form for X_0:

$$PORT_0 = \frac{1}{R}[\pi_U V_1(H) + \pi_D V_1(T)]$$ [30, pg. 7]

This then can be solved for π_U and for π_D to give the equations:

$$\pi_U = \frac{R-D}{U-D}, \pi_D = \frac{U-R}{U-D}$$ [30, pg. 7]

This then leads to the "delta-hedging formula:"

$$N = \frac{V_1(H) - V_1(T)}{S_{t+1}(H) - S_{t+1}(T)}$$ [30, pg. 7]

Once this has been calculated to determine what V_1 pays at time one, it should be priced at:

$$V_0 = \frac{1}{R}\left[\pi_U V_1(H) + \pi_D V_1(T)\right]$$ [30, pg. 8]

3.14 Applying the Multi-Period Binomial Model Using Stochastic Calculus

Now that a single period model has been explained, a more realistic model can now be formulated called, the Multi-Period Binomial Model. For each branch in the tree there is another binomial splitting until the end period is reached. For example:

$S_{t+3}(HHH) = u^3S_t$

$S_{t+2}(HH) = u^2S_t$

$S_{t+1}(H) = uS_t$ $\quad$ $S_{t+3}(HHT) = S_{t+3}(HTH) = S_{t+3}(THH) = u^2dS_t$

S_t $\quad$ $S_{t+2}(HT) = S_{t+2}(TH) = udS_t$

$S_{t+1}(T) = dS_t$ $\quad$ $S_{t+3}(HTT) = S_{t+3}(THT) = S_{t+3}(TTH) = ud^2S_t$

$S_{t+2}(TT) = d^2S_t$

$S_{t+3}(TTT) = d^3S_t$ [30, pg. 10]

In this example the following applies: a European call option, with strike price X dollars. This is a right, not an obligation to buy. Expiration payoff depends on the previous two coin tosses. This payoff would be $V_2 = (S_{t+2} - X)^+$ [30, pg. 10]. Now the real answer needed is the price at time zero, V_0. If the price is V_0, then the amount of shares purchased would be N multiplied by the price of the stock, S_t. Total investment is equal to the option price minus the number of shares times the share price, or simply $V_0 - NS_t$ [30, pg. 10]. This quantity is negative so buyer must borrow $NS_t - V_0$. The portfolio is now worth $PORT_1$, where $PORT_1 = NS_{t+1} + (R)(V_0 - NS_t)$ [30, pg. 10]. Since there are two possible outcomes of rolls at this point, there are two distinct equations for each roll. They are:

$$PORT_1(H) = NS_{t+1}(H) + (R)(V_0 + NS_t) \text{ for a roll of HEADS} \quad [30, pg. 11]$$

$$PORT_1(T) = NS_{t+1}(T) + (R)(V_0 + NS_t) \text{ for a roll of TAILS} \quad [30, pg. 11]$$

The investor can now hold a different amount of shares, known as N_1, because he/she has seen the outcome of coin toss one. The investor now has the value of the portfolio at time one, minus the new stock purchases, left to invest; or the equation $PORT_1 - N_1 S_{t+1}$ [30, pg. 11]. The wealth for time two has a value, $V_2 = N_1 S_{t+2} + (R)(PORT_1 - N_1 S_{t+1})$ [30, pg. 11]. This wealth now depends on the first two coin tosses; because of this there are four separate equations. They are:

$V_2(HH) = N_1(H)S_{t+2}(HH) + (R)(PORT_1(H) - N_1(H)S_{t+1}(H))$

for a roll of a HEAD-HEAD

$V_2(HT) = N_1(H)S_{t+2}(HT) + (R)(PORT_1(H) - N_1(H)S_{t+1}(H))$

for a roll of a HEAD-TAIL

$V_2(TH) = N_1(T)S_{t+2}(TH) + (R)(PORT_1(T) - N_1(H)S_{t+1}(T))$

for a roll of TAIL-HEAD

$V_2(TT) = N_1(T)S_{t+2}(TT) + (R)(PORT_1(T) - N_1(H)S_{t+1}(T))$

for a roll of TAIL-TAIL [30, pg.11]

Subtracting the last two equations, $V_2(TH) - V_2(TT)$, dividing by $S_{t+2}(TH) - S_{t+2}(HH)$, and solving for $N_1(T)$ gives the delta-hedging formula [30, pg.12]. After going through some substitution and rearranging the result is:

$$PORT_1(T) = \frac{1}{R}[\pi_U V_2(TH) + \pi_D V_2(TT)]$$

[30, pg.12]

This is the result from an initial toss of TAILS. Using the first two equations in the same manner the result is:

$$PORT_1(H) = \frac{1}{R}[\pi_U V_2(HH) + \pi_D V_2(HT)]$$

[30, pg. 12]

This is the result from an initial toss of HEADS. This is wonderful for three periods, but it is more practical to have an equation for any amount of terms. The wealth equation takes care of this problem:

$$PORT_{n+1} = (N_n S_{t+n+1}) + (RB_n) \qquad [30, pg. 13]$$

3.15 The Black-Scholes Model

The next type of model that is used in the final program is called the Black-Scholes model. This equation is effective as the Multi-Period Binomial Model. However, there are major differences, which make it a totally different way to compute option prices.

There are a few assumptions that must be true in order for this equation to work. One of these being that there is no arbitrage, the second being that the stock prices change continuously, and the third assumption is that the stock returns follow a log-normal distribution, and the final assumption rests on the fact that the interest rate and the volatility of the stock remain constant. Also, this equation holds true for options on stocks with no dividends, however, there is a way to adjust for dividends, but this will be covered later.

The Black-Scholes Formula for a call is as follows:

$$c_t = S_t N(d_1) - Xe^{-r(T-t)} N(d_2) \qquad [20, pg. 168]$$

And by applying the put-call parity, one can calculate the value of a put:

$$p_t = c_t - S_t + Xe^{-r(T-t)} \qquad [20, pg. 171]$$

Substituting the value of a call and simplifying, the final equation for a put is:

$$p_t = S_t [N(d_1) - 1] + Xe^{-r(T-t)} [1 - N(d_2)] \qquad [20, pg. 171]$$

To define the d_1 and the d_2, another variable must be defined. This variable is called the volatility of the underlying stock, represented by the symbol σ. Also, a function must be used to compute the cumulative normal distribution. In the above equation, it is represented as N(*). This function is also known as 1 minus the error function divided by two. The following approximation can be used to complete N(x) with good accuracy:

For x>0, $N(x) = 1 - \frac{1}{\sqrt{2\pi}} e^{\left(\frac{-x^2}{2}\right)} \left(a \times d + b \times d^2 + c \times d^3\right)$

$$d = \frac{1}{(1 + 0.33267 \times x)}$$

$b = -0.1201676$

$a = 0.4361836$

$c = 0.937298$

For x<0, use the fact that N(x)+N(-x)=1

3.15a. Calculating Sigma For Input Into Black-Scholes

The sigma variable is also known as the volatility of the stock at any given time. It is the most important variable in the model. The more accurate the sigma value, the more accurate the Black-Scholes model can be. The sigma value is estimated by historical data. It requires the stock price of any number of days. Too few data points and the volatility will not be correct; the same is true for too many data points. It is hard to determine the correct number. By following the examples that were printed in The Options Primer by Robert W. Kolb, a few more terms must be defined. The first term is

PR_t. PR_t represents the price for a day t divided by the previous day. $PR_t = \frac{P_t}{P_{t-1}}$. Some other equations are needed in order to calculate the sigma value.

This is the equation, which calculates the average of the stock prices.

$$\overline{PR} = \frac{1}{T}\sum_{t=1}^{T} \ln PR_t$$

This equation is used to calculate the final value of sigma^2.

$$VAR(PR) = \frac{1}{T-1}\sum_{t=1}^{T} (\ln PR_t - \overline{PR})^2 \qquad [20, pg. 174]$$

Using these equations, a table can be constructed to determine the value of σ and σ^2. A similar table can be seen in Chapter 4 of The Option Primer [20].

Day	**P_t**	**PR_t**	**$\ln(PR_t)$**	**$[\ln PR_t - PR_\mu]^2$**
0	50			
1	49.25	0.985	-0.01511	0.00000166
2	51.5	1.045	0.044	0.00334
3	51.25	0.9951	-0.049	0.00123
4	51	0.9951	-0.049	0.00123
5	51	1.0	0.0	0.000191
		Sums	-0.06911	0.007711
		PR_μ	-0.01382	

$\sigma^2 = 0.007711/4 = 0.001927$
$\sigma = 0.0439$

Now that the sigma value has been calculated, it is now time to consider the other variables that are needed for the rest of the Black-Scholes model. The next variable is the risk-free rate of interest. The Treasury bill is also a good estimate for the risk-free interest rate. However, there must be consideration for the maturity of the treasury bills, it must be compounded continuously, so a bill must be chosen to mature when the option expires. To compute the price of a T-bill an equation must be taken from Kolb's book.

$$P_{TB} = 1 - 0.01\left(\frac{BID + ASK}{2}\right)\left(\frac{DaysUntilMaturity}{360}\right) \qquad [20, pg. 172]$$

To solve for the bill in a continuous compounded rate, another formula must be used.

$$e^{r(T-t)} = \frac{1}{P_{TB}} \qquad [20, pg. 173]$$

By inserting all the calculated values into this equation, r can be calculated leaving us with another input for the Black-Scholes Model.

Now that all the inputs are defined, d_1 and d_2 can now be defined.

$$d_1 = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r + .5\sigma^2\right)(T-t)}{\sigma\sqrt{T-t}}$$

$$d_2 = d_1 - \sigma\sqrt{T-t} \qquad [20, pg. 168]$$

3.15b. Adjusting the Black-Scholes for Dividends

As mentioned before, dividends can be included in the model. This is a problem for the Black-Scholes Model because one of the model's assumptions is that the stock pays no dividends. Dividends can be thought of as a repayment of a portion of the share's price to the shareholder. So, the stock price falls by the amount of the dividend.

This discrepancy in the price of the stock will affect the price of the option. For a call it will decrease the value, while the price of a put will increase. This is so because the value of a call is the stock price minus the exercise price. However, the opposite is true for the value of a put because it is priced by the exercise price minus the stock price. Taking an example, such as:

c_T = MAX{0, \$60-\$50} = \$10

p_T = MAX{0, \$50-\$60} = \$0

However, if before the expiration of the option, a dividend of $11 is paid, and then the price of the stock is now $54. This is a problem, because now the value of the call is worth zero, while the put is worth $6.

A simple subtraction of the dividend from the stock price is sufficient enough to adjust the option price. Using the equation below, the present value of the dividend payment of the stock can be calculated. Using the value of the dividend of $11, the risk-free interest rate, r, and a dividend payoff in 90 days, the present value of the dividend is:

$$\$11e^{-r(90/365)} = presentvalue$$

3.16 Merton's Model

This leads to implementing adjustments for continuous dividends, called Merton's Model. This focuses on continuous dividend payment instead of quarterly payment. The adjustment factor is basically a negative interest rate. The symbol used for the negative interest rate is δ, delta.

So, to adjust the Black-Scholes Model for a non-continuous dividend payment, substitute the following in the place of S_t:

$$e^{-\delta(T-t)}S_t \qquad [20, pg. 181]$$

However, to adjust for a continuous model, the equation must be changed to this form:

$$c_t^M = e^{-\delta(T-t)}S_t N(d_1^M) - Xe^{-r(T-t)}N(d_2^M)$$

$$d_1^M = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r - \delta + .5\sigma^2\right)(T-t)}{\sigma\sqrt{T-t}}$$

$$d_2^M = d_1^M - \sigma\sqrt{T-t} \qquad [20, pg. 181]$$

A similar formula can be derived for the put by implementing the put-call parity.

3.17 Adjusting the Binomial Model for Dividends

To incorporate the dividend correction in the binomial model, there are three different approaches. The first one is the same as the continuous dividend model by Merton. The second approach considers stock that will pay a known dividend at a certain time. The third approach considers the possibility that a known dollar amount will occur at a specific time. The binomial model is much more flexible when compared to the Black-Scholes Model in the dividend incorporation aspect. There are also advantages that the binomial model has over others when it comes to American Options.

3.17a. Continuous Dividends and the Binomial Model

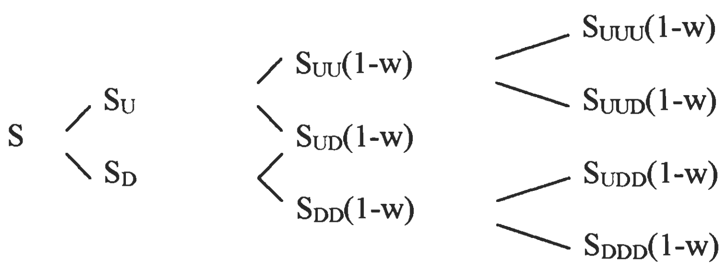
Just as the Black-Scholes model corrects for dividends by a continuous leakage, the same is true for the binomial model. To account for dividends in the Merton model, a dividend rate δ was subtracted from the risk-free interest rate. The same is true for the binomial model. This δ value is inserted into the U, D, and π_U to account for the dividend leakage.

$$U = e^{\sigma\sqrt{\Delta t}}$$

$$D = \frac{1}{U}$$

$$\pi_U = \frac{e^{(r-\delta)\Delta t} - D}{U - D} \qquad [20, pg. 183]$$

This only accounts for a continuously paid dividend yield. When the dividends are paid periodically, there are different ways to accommodate them. If the dividend is to be paid at a certain time, then it can be treated as discounting the stock by a fixed factor. This factor can be taken to be (1-w), where w is the percent value of the stock that is paid as dividend. So, if the dividend were paid at time two in the binomial model, then the value of at time two of the stock would be $S_t UU(1-w)$ for two increases.



[20, pg. 184]

So, therefore, if there were two dividends that were known to happen at time two and time three, then the value at time three for a stock that had three consecutive increases would have the value of $S_{UUU}(1-w)^2$.

When the dividend id paid fixed dollar amount, like in most real-life situations, problems arise in the binomial tree. In a regular tree, $S_tUD = S_tDU$, however, this is not the case when a fixed dividend is involved. This can be easily adjusted by computing the value of all the dividends to be paid by the options. Then by subtracting the value from the current stock price and then creating the binomial tree as usual. After the tree has been generated, the dividend can be added to each of the nodes during the life of the options. For more details, reference [20].

4.0 The Option Pricing Calculator

Part of the intent of this project was to develop a program that would calculate the price of an option. The price of the option is calculated through a multitude of variables, which are input from the user. The secondary purpose is to calculate option prices through 2 different models. These models include the Black Scholes model, and the Binomial Model. The program will use both these mathematical models to calculate calls and puts.

This program is intended to be placed online, where people will be able to access it at their will. Therefore, the graphical interface is important, so that the user will not be confused so much as to not be able to utilize the program for its given goal.

Overall, this program is meant to coincide with the description of the models and what options are, so that a person can learn what options are, and how to utilize them. After a user learns what an option is, they can use the program to calculate what a decent price is for the option, and compare this to the online price quoted from online brokerages.

4.1 Programming Language Choice

There are many different choices of programming languages to choose from when deciding to write a program for some specific reason. There are probably more choices for a language then there is space to type them all. Some of the major languages that are useful nowadays are as listed:

C

C++

Java

JavaScript

Visual Basic

VBScript

Perl

Pascal

With all of these choices, there are certain aspects to take into account. Some of these things to take into account are the interface for the user, and the mathematical functions built in to the language. Each of the above languages has fairly strong mathematical functions built in, but most of them vary greatly in user interface. Because graphical interface was a large consideration, the best choice was Java. Although the choice made was Java, the choice to begin development was also made because of the familiarity with that language and the ease to output variables to the screen during debugging. Another large consideration for choosing these languages was the similarities between the two languages, therefor allowing for a quick port from language to language.

4.1.a C++ Description

C++ is a widely used programming language and is used for most applications that people use today on their desktop PC's. The reason for the wide usage of C++ is the similarities to other beginning languages that are taught through school curriculums.

C++ also has an extensive library of built in functions, ranging from mathematical to graphical interface. This allows for extensive programs, without the need to code everything from scratch.

C++ is also a cross platform language, as long as there is a compiler available for whatever platform one is using. This allows for someone to port their programs to different platforms and allowing for a larger pool of potential users. Although the basic code functions are cross platform, the graphical interface libraries are not. These require a new build for each platform that one is using. In this sense, C++ was a bad choice for this program.

Although C++ is not a cross platform language, in the sense of graphically, it is not impossible to write a new set of code for all the major platforms. But, since we wanted to write this program to exist in an online forum, it makes matters more difficult. The only way to port C++ to a world of HTML, we must use CGI (common gateway interface), which allows HTML data acquired from text fields to be parsed into a C++ program. Although this isn't overly difficult, it does lead to certain security issues, and also leads to difficulty of coding. It isn't a very efficient manner in which to proceed with this project. Enter Java…

4.1.b Java Description

Java was built not too many years ago in order to develop programs that were truly system independent. This means that they will run on any system no matter what operating system, or system architecture the person is running. Like C++, Java is an object orientated programming language, and is used mainly for internet ready applications. Because of the need to have this program be accessible to the masses and the ease of integrating a Java program onto a web page, Java seems to be a shoe in for which language to use.

One of the strong points of Java, aside from the cross platform ability, is the ease of developing a GUI (graphical user interface). Java makes the task of creating buttons and text fields simple when compared to many other languages. One of the strongest issues with this program is the GUI. To make sure that a user has little difficulty using the program, the GUI must be made as simple and easily usable as possible. One rule in programming is "Never underestimate the stupidity of the user". With this rule in place, a strong effort was made for simplicity.

One of Java's shortcomings is the speed at which Java programs run. Because a virtual machine must be set up on a client, and the entire program must be loaded every time the user wants to use it. If the user has a slow computer, or a slow internet connection, this may lead to frustration.

Although Java has its downfalls, they are far outweighed by the benefits. All of the previous reasons are why we chose Java, as opposed to all the other languages out there.

4.2 Program Description

The actual implementation of the program meant determining how the logic worked for each function, and how to implement this using the Java language. It also encompassed determining how best to layout a GUI, so that the user would have as little difficulty using the program.

4.2.a Graphical User Interface

Although a lot of thought went into the layout of this part of the program, most of the effort went into the layout and not into the coding. The layout was set up using labels to indicate what each text field input should contain for data and what each button functioned as. To input numbers, the user simply types the number into a text field and the string is then converted to a variable type double, which can then be used in the equations. After entering the data, the user can choose from six buttons, which act as a call and put function for each model.

The implementation of the conversion from strings to doubles, which is needed to parse the data from the text fields, was not difficult to implement because Java has built in functions to do such actions. Thus, the code for each conversion just consisted of using Java's toDouble function.

To construct a function that triggered when the button was pressed involved setting up action listeners for each button. What an action listener does is execute a given segment of code when the specified action occurs. The action that was set up for a button is being pressed, so when the user pressed the button, the action listener executed the function that calculated the option price and displayed it to the result text field.

4.2.b Model Calculations

The next step was to determine the logic for each function and write the code to calculate the option price. The coding process was very different for the Black Scholes model then it was for the binomial model.

The Black Scholes model was easy to set up. The only work that had to be done is type in the equation using Java's built in math functions. These included the sqrt(), pow(), and exp() functions. The sqrt() functions simply computes the square root of a number within the parenthesis. The pow() function raises a number to the nth power, given that in a code segment pow(x, n), x is raised to the nth power. Lastly, the exp() function raised the number e to whatever number resides within the parentheses.

The binomial model required a lot more thought as to the logic of how to create the tree structure. In order to compute the European Price using the binomial model, only the end nodes of the tree must be constructed. To do this, a single loop structure can be used to make each node, raising each node's ups and downs to the power of the number of steps. After building the node structure, which was stored in an array of doubles, the basic European Binomial-pricing model. A double nested loop can function to calculate this, because in order to compute this, we must step down through each height level of the tree, and then step back through depth level of the tree. The height level length is one less then the depth level that the code is currently at. Within the inner most loop, we can calculate the V(w) and then store it in the previous depth level. After executing through each loop increment, the code finally ends with the first node, and the price.

To calculate the American Binomial-pricing model, we implement the same procedure from the European, but change it slightly in the construction of the tree. In order to calculate the American price, a comparison must be made between the V(w) computed, and the previous tree. So in construction of the tree, the whole tree, meaning every node must be determined. This requires a double nested loop structure in the making of the tree. Then, within the calculating of the V(w), a simple comparison to see which node is larger, the calculated V(w), or the previous node is needed. This is done with a simple if/then/else clause, and the larger is stored in the node.

Each of the end results are then converted back to strings using Java's toString function, and displayed in the result text field. After this, all is said and done.

4.3 Difficulties Encountered

By far, the largest obstacle to this program was the process of learning Java, a completely new language to the programmer, who had extensive knowledge in C++. This made for a smoother transition into Java. Although there was existing knowledge of a similar language, it required extensive reading and practice to acquire a firm grasp on how to code in Java. Because of the lack of understanding, there were many problems that arose.

The first problem that was encountered was the lack of a normalization function in either C++ or Java. When the program was in it's infancy, it existed in C++ only, and a normalization function was derived using the error function built in to C++'s math.h. But, when the code evolved to Java, there was no such function, and a completely new approximation had to be derived. Although a new equation was had, it was not as accurate as the error function, and may have led to a less accurate approximation of an option price.

The first problem that occurred, when coding in Java, was obtaining a numerical value from the text fields in the GUI. Because a text field returns a string value, it must be converted to a numerical variable type. A crucial step was converting a variable type string to a variable type double, which is used for all the math functions. This task took quite a while to determine how it would be accomplished. Eventually, after consulting with the Java tutorial books, a method was found. The manner in which to do this was converting the string taken to a class type string, and then it could be converted to a class type double, then converted to a variable type double.

The next difficult task that was encountered was the logic behind looping structures within the program. In order to calculate the Binomial model, next loops were necessary, and the exact number of times each loop executed was crucial. Although, normally, this is not an overly difficult task, there are slight nuances involved in the construct. After careful analysis of each loop, and how it was computing the variables, a correct looping structure was devised, and the problem was solved.

One of the most important aspects of the program was the GUI, which was mentioned previously. Also, as stated before, Java has excellent built in support for GUI development. There are different types of layout managers that can be utilized, and for this project, the built in generic layout manager was chosen. The reason for this decision was the fact that the Java compiler automatically spaces and places all of the graphical components for the programmer, thus lessening the development time needed. Like most functions within computer programs, if the program is left to deal with a function on its own, it tends to have small glitches, and some tweaking is needed. With a little thought put into the size of each component, and size of the window with which the program would be displayed in, these glitches were resolved, and the GUI was finalized.

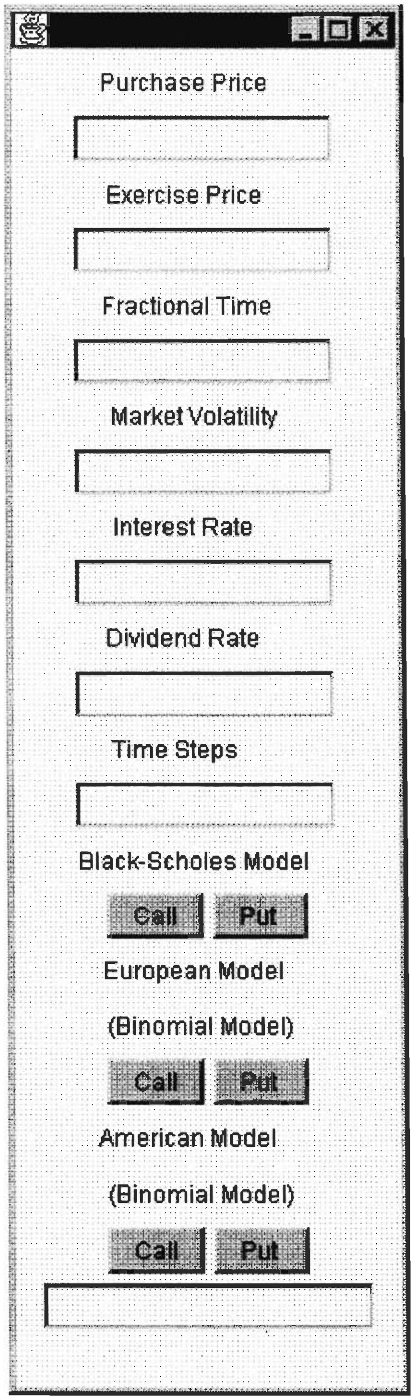
One of the largest problems encountered encompassing the entire program, was one of the functions for the processing of the data. In order to calculate the Black

Scholes model, a Normalization function was necessary. Within C++, there was an Error function that could be used to return a normalized value for a given number. Although this was included in C++, it was not part of the Java library. The way to work around this was to use an approximated equation using constants that were defined beforehand. Although this method worked well, it did not give as accurate of a number as an actual Normalization function would, leading to a less accurate calculation of the option prices, but within a certain degree of accuracy that did not seem more then negligible.

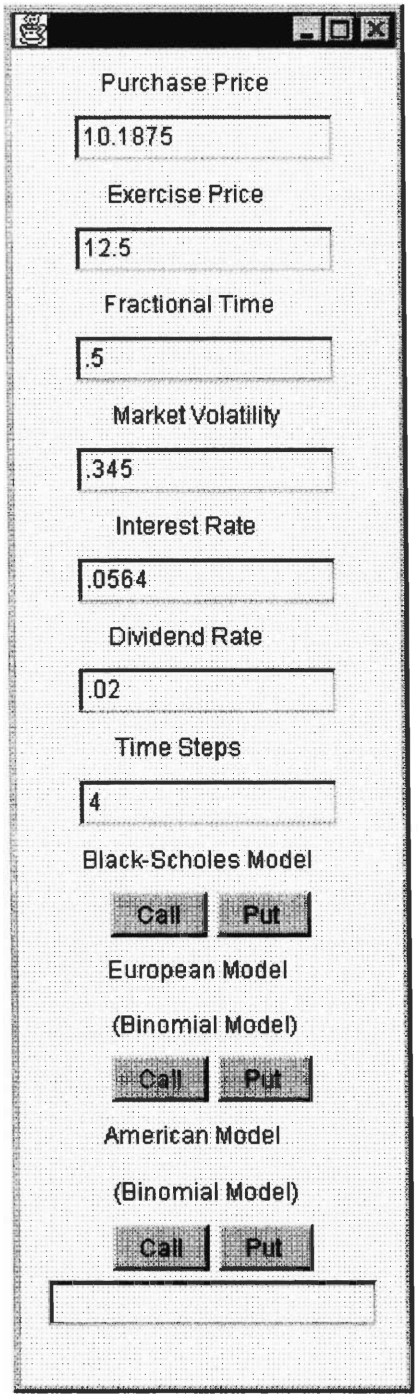
Although many problems were encountered during the development of the program, each one was carefully considered and dealt with in a manner that didn't have a large negative impact on the usability and accuracy of the program. This resulted in a product that was useful and overall an accurate representation of the intended goal.

4.4 Usage Case

To demonstrate the function of this program, an example scenario will be shown. In this scenario, a user will be attempting to price out a given option type, with data obtained from any given online brokerage. The sample stock is from TDFX or 3DFX, which is a computer video chip company. The asking price for the stock is 10 3/16 for each stock, with a bill rate of 5.64%. The market volatility is roughly .345, and the strike price is 12 ½. The time incurred on the option is 6 months, or ½ a year. For the sake of dividends, we can assume a 2% earning in that period. When the program executes, it brings up the following:



Each of the fields has been accounted for in the previous paragraph, all obtained from an online brokerage, this one being E*Trade. Filling in the fields resulted in the following:



Depending upon which type of option the person wants to price, the results will vary. If the person we to price out, a call type option, there are three different models with which they could approximate the price. These include the Black Scholes, the

European Binomial, and the American Binomial model. The results for each of these models are as follows:

Black Scholes: 0.3444260665827965

European Binomial (Time step 4): 0.342381979157879

American Binomial (Time step 4): 0.342381979157879

As seen above, with a low number of time steps, the Binomial model tends to be far less accurate then the Black Scholes. If we increase the number of time steps we can see that it approaches that of the Black Scholes.

European Binomial (Time step 200): 0.34356320873966095

American Binomial (Time step 200): 0.3435632086657005

If we were to price out a put option with these parameters, the following results would appear.

Black Scholes: 2.4107172424426153

European Binomial (Time step 4): 2.016551779769183

American Binomial (Time step 4): 1.9920245546591238

European Binomial (Time step 200): 2.489965729830898

American Binomial (Time step 200): 2.4098543845254756

Because we have an exercise price that is higher then the purchase price, a put is not a valid choice for pricing with these parameters. We can see that the returns are much different then for the call. For this case, we can see that a person must know whether or not they want to price a call or a put before using the program.

5.0 The Effects of Online Trading

The invention of the Internet and World-Wide Web changed dramatically the ways people communicate. It has become so easy to buy merchandise, check the weather or balance your bank account on-line. So it seemed inevitable that even the stock market would be integrated into the World-Wide Web. The impact of the World-Wide Web on society is huge, affecting everything from the personal level to the global community. In this chapter, we will look at the impact of the World-Wide Web on investors and on the market.

The presentation of this evidence will be divided into three sections. We first take a look at what online brokerages are. The second section focuses on the impact of the World-Wide Web on the investor. Lastly, the third section investigates the impact of the online brokerages on the market.

5.1 What are Online Brokerages?

The way that the stock market is integrated into the World-Wide Web is by online brokerages. These companies utilize the lightning fast connections of the Web to make real-time trading possible. This allows people with a computer, an Internet connection, and money to invest, to access the market and make trades.

Real-time trading means just what it says, market trades can be done at the same speed as if you dialed up your broker and asked to trade a stock. With the ease and affordability of such trades, more and more people are deciding to use online trading instead of the traditional route with a broker.

To start online trading, the investor simply signs on to the desired brokerage and registers for an account. The account is usually the same as a bank account where money can be deposited, withdrawn and some companies even have the option of writing checks directly from the account. A minimum investment is most common throughout the online brokerages, and must be deposited before trading is allowed.

Some online trading companies give the option for marginal investing, where the actual cash amount for the stock is not available, but the customer already has a stock or security, which is equal to that value. Thus, it is the same as considering stock as liquid as cash. This has posed some problems which will be shown later in the text

The investor then is assigned a screen name, similar to America Online® and other member sites. When the customer logs on, there are many options available. Some online sites contain research available, real-time quotes and account balances and information. When the investor finds a stock, bond or security that he/she would like to trade, a number of different kinds of orders are available.

5.1.a. Types of Orders

The most basic type of order is a market order. When a market order is placed, it will be executed at the best price available when it reaches the market maker. Thus, there is a good chance that the price that you specify to buy or sell at could be very different from the actual execution price. The only guarantee with a market order is that it will be executed for the market price.

The next type of order is the limit order. This type of order guarantees the price of the stock that will be bought or sold, but does not guarantee the execution of the order.

If a limit order for a sell is placed on an underlying stock, when and if the stock reaches that price, the limit order will be executed and the price will be what was specified in the limit order.

A third type of order is a stop order. A stop order is used to limit the loss of a stock or security held. This type of order is very similar to a limit order, except for one key feature. When a stop order is placed and the stock reaches the stop price, the stop order becomes a market order to be executed at the best price available. This has some beneficial features, but can also leave the possibility for loss. When the stop order becomes a market order, there is a chance that the stock price will be higher than the stop order's price. However, there is also the case where the stock price falls considerably lower before the market order is executed.

The final type of order that will be presented in this report is the stop limit order. This is the same as a stop order, except that when the stop order reaches the stock price, it is changed to a limit order instead of a market order.

Another type of option that many online companies offer is called "good till canceled" order (GTC). This gives the investor the chance to accommodate some expected change in the stock price without monitoring the stock everyday. A "good until cancelled order" is an order which gives any order a certain number of days until it expires, (usually 60 days).

However, there is the possibility that when the order is executed, that there are not enough shares to fulfill the order. Thus, many online brokerages have another option, which gives the investor the option to have a GTC order, which will not be executed unless the entire order can be executed. This is called, "all or none" order.

5.2 Impact of the Worldwide Web on the Investor

To analyze the impact, a scope of analysis must first be created. When considering the impact of the World-Wide Web on the investor, a few factors are relevant. The first and foremost factor is how the online brokerages attract the customer. If the online brokerages are attracting younger, inexperienced investors, this would have a different impact on the market than if the brokerages were attracting experienced investors.

Another factor that deserves recognition is the presence of investing information on the web. There is much information on the web, which can be interpreted in different ways and thus investors online are subjected to such information. This information can either be true or false. Either way, it has an impact on the investor and how he/she invests.

To draw conclusions from these factors, a measured analysis was preformed on the top ten online brokerages. This data is presented in section 5.2.c. In section 5.2.a., the research of who the target customers are in the online brokerages today is presented.

5.2.a. Target Customers

Recent commercials on television depict the investors to be wacky, frenetic people such as "Stuart" from AmeriTrade. Who is a 20 something year old with spiky hair and invests online. It may seem that the target customers are young inexperienced investors who want to gamble on the stock market, however, this is not entirely true. The main on-line investors are not as loony as Stuart. They are middle-aged Americans that are revolutionizing the way of investing in the digital era [1, A43].

In the <u>Boston Globe</u> article by Lynnley Browning [1, A43], Kenneth Clemmer, an analyst at Forrester Research, actually expects the older citizens with sizeable incomes and middle-aged people with very careful investing habits to be the majority of the on-line investors in the new millennium.

However, it was not always like this, in the early days of online investing, most of the traders were young, active investors [1, A43]. They were the start of the web investing revolution, which now is geared down. The early days also involved "day-traders" who buy and sell stocks numerous times within a trading day, never holding onto the stock for more than a day [1, A43]. Nowadays, the bulk of the ads are directed to the more stable groups who rely on good research, data and sometimes even advice. This seems to be the focus of the on-line trading sites currently.

5.2.b. Ways to Attract Customers

Today there are about five million on-line brokerages. Since their success depends on the number of customers, each online site has different kinds of ways to entice the customer, but they all fall into a set of basic categories, which will be discussed below.

To attract more customers brokerages try to have a large amount of data available on stocks and current events. Many of the large companies plot the data for each of the companies that can be traded. Graphs such as the trend of the prices, the trend of the volume, net revenues, and 52-week highs can be easily accessed.

Another type of attraction that seems to becoming more predominant is real-time quotes, which means that the price displayed is the actual price of the stock. So there is no ambiguity whether or not the stock price has dropped since the last update. This gives the customer a sense of security.

Some sites, such as E*Trade, have help sessions were advice is given and even basic terminology is explained. There are help sessions on how to maintain an account, how to make trades for bonds, options, and mutual funds. The amount of help is almost endless. There is even an option to contact the company for questions and comments.

With all of these different types of services offered, it is hard for the investors to decide what criteria to use in the comparison between the companies. One of the criteria is the minimum price to register for an account. This is an important determining factor for people to consider the site.

One of the major reasons why on-line sites make trading accessible to all types of people is by keeping the trading fees low. The competition between companies has lowered trading costs down to about five dollars for some sites. There also are sites that have free sign-up gifts to entice their possible customers more. Gifts such as free access to Internet providers, free cars, trips, and sometimes even million-dollar prizes are common for on-line investing sign-up perks. This attracts people of all types, willing to try investing, but who did not want the high cost and burden of brokers. The customers do not have to worry about commission, or calling up the broker to make a trade. They can just log onto the net, point, and click. This has some effect on the market because there is now an opportunity for people with little or no experience with trading to experiment with the stock market.

However, one could argue that this could have a beneficial effect on the market since volume could potentially go up, thanks to the low transaction rates. So a scenario like the following could occur: A trader that was once hesitant about buying a stock because of the commission that would be due with a brokerage, might now buy the stock. With the wide variety of on-line brokerages, cheap market orders are a dime a dozen. However, finding an excellent brokerage with inexpensive commissions is not as easy to find. Thus this is a good idea to include in the comparison of the online brokerages.

5.2.c. Research of the Top 10 Online Brokerages

To get a basic idea about how companies are trying to attract steady customers today, ten on-line trading sites were researched.

1. E*Trade
2. Charles Schwab
3. Fidelity Investments
4. DLJDirect
5. TD Waterhouse
6. National Discount Brokers
7. My Discount Broker
8. A. B. Watley
9. Morgan Stanley Dean Witter Online
10. Suretrade

5.2.c.i. Top Ten Online Brokerages

After looking through various studies done on on-line trading brokerages, we have found the most comprehensive one to be that of the Internet Site: www.gomez.com. Gomez bases their overall score (from 1-10) on these five criteria: Ease of Use, Customer Confidence, On-Site Resources, Relationship Services, and Overall Costs. Ease of use refers to the tutorials, account demos, the ability to access sign up forms quickly, and customization capability of the site. Customer confidence is based upon a large capital base, web site availability, phone response time, and a well-trained staff. On-Site resources are mainly based on the data that the site provides like charts, news, and quotes. Relationship services are defined from the site's ability to personalize its site to the customer. Educational content, advanced alert programs, and real-time account information helps in this category. Overall cost is based on the price of the sites transactions, for example, limit and market orders [6].

Gomez.com provides a comment about each of the brokerages, speaking of these criteria. By investing each site, data on the costs for each brokerage was collected.

E*Trade (www.etrade.com)

Costs:	
Market order:	$14.95
Limit Order:	$19.95
Initial Investment:	
E*Trade requires an initial balance of	$1,000

"E*Trade regains the blue ribbon! While E*Trade may have made a limited number of enhancements to its site, the firm took a quality not quantity approach and the results speak for themselves. E*Trade added tax information in the form of online 1099s, improved its Knowledge Center and completed its acquisition of Telebank. E*Trade continues to offer one of the most feature packed and easy to use Web sites of all the online brokers: institutional research, NASDAQ Level II quotes, IPOs, portfolio analytics and real-time account information. E*Trade just needs to improve its financial planning tools, telephone customer service and its ability to respond to customer service e-mails going forward." [7]

Special Offers:

Opening an account through www.gomez.com qualifies the investor to receive $150 cash back. Though the main site the investor receives free S&P stock reports (a $120 annual value).

Charles Schwab (www.schwab.com)

Costs:	
Market order:	$29.95
Limit Order:	$29.95
Initial Investment:	
Schwab requires a minimum balance of	$5,000

“"Thank you for calling Charles Schwab. The next available operator...." Charles Schwab, a historical leader in customer service lost its hold on the number-one ranking it held last quarter, mainly due to poor performance in telephone and e-mail customer service requests. Despite these customer service setbacks, Charles Schwab is still the place to be for the Life Goal Planner and One-Stop Shopper. Leading financial and tax planning tools, a sophisticated portfolio performance tool and Web Shop seminars held at Schwab`s national network of branch offices combine to offer the widest breadth of planning and educational content. Moreover, Schwab`s acquisition of private bank, USTrust, will allow the firm to further its ability to serve high net worth investors in the near future. In addition, Schwab`s acquisition of CyberCorp will further its ability to serve active traders above and beyond its present ability to offer profit and loss by security and account, IPOs, online after-hours trading and institutional research.” [8]

Special Offers:

Opening an account today qualifies the person for four free months of The Wall Street Journal Interactive Edition.

Fidelity (www.fidelity.com)

Costs:	
Market order:	$25.00
Limit Order:	Standard Commission + $5.00
Initial Investment:	
Fidelity requires a minimum balance of	$0

“"I once was lost but now am found..." Fidelity responded to our concern last quarter by tightening up its site design. New users of PowerStreet will find a much-improved interface as they wind their way through the active trading area. Fidelity`s brokerage offering is loaded with features: 24x7 telephone customer service, after-hours trading powered by REDIbook, tax and financial planning, personalized

Fidelity My View homepage powered by Lycos, Lehman Brothers IPOs, wireless trading and dedicated service teams for premium accounts. If you`re an active trader, you may qualify to utilize the site`s active trader workstation, PowerStreet Pro, and enjoy reduced commissions, advanced options trading and portfolio analytics. This quarter`s notable additions include a tax center and an estate-planning calculator." [9]

Special Offers:
By opening an account now, the investor gets a free $100 deposited into their account.

DLJDirect (www.dljdirect.com)

Costs:

Market order:	$20.00
Limit Order:	$20.00

Initial Investment:

DLJDirect requires a minimum balance of	$0

"DLJdirect aced our customer service calls and e-mails last quarter but was not so fortunate this quarter. As a result, DLJdirect fell back to fourth place. The firm continues to focus on the Serious Investor and targets the majority of its services toward this profile: online IPO process, institutional research, online fixed income center and tiered levels of accounts with special segmented services for the affluent. The challenge will be for DLJdirect to take its financial planning tools to the next level to satisfy the affluent investors it seeks." [10]

Special Offers:
None

Waterhouse (www.waterhouse.com)

Costs:

Market order:	$12.00
Limit Order:	$12.00

Initial Investment:

Waterhouse requires a minimum balance of	$1,000

"TD Waterhouse came out running this quarter. In a quarter where most brokers limited innovation due to Y2K concerns, TD Waterhouse rolled out a series of new services including: a trading demo, tax information, *Ask Jeeves* technology for site searches and general help, new quick quotes, balances and holdings, 1099`s online, statements online and a community in partnership with

MetaMarkets.com. All these additions helped TD Waterhouse climb up to the number-five position despite poor telephone customer service." [11]

Special Offers:
None

National Discount Brokers (www.ndb.com)

Costs:	
Market order:	$14.75
Limit Order:	$14.75
Initial Investment:	
NDB requires a minimum balance of	$0

"Still keeping pace with the big players...NDB drops a notch to number six despite making some notable additions such as Stockpulse, an impressive streaming tool that shows real-time quotes and *iAnswer*, a live customer service chat offering. But NDB dropped out of the top five for the first time in a year as it struggled to provide timely telephone customer service this quarter. Attention active traders! NDB allows multiple trades of the same stock, on the same side of the market, on the same day, for one commission. Going forward, NDB needs to improve its financial planning and add premium products such as IPOs, institutional research and cash management functionality to keep pace with the Scorecard leaders." [12]

Special Offers:
Opening an account through www.gomez.com qualifies the investor to receive $75 back on trade commissions.

My Discount Broker (www.mydiscountbroker.com)

Costs:	
Market order:	$12.00
Limit Order:	$12.00
Initial Investment:	
MDB requires a minimum balance of	$0

"Sitting pretty. My Discount Broker (MDB) didn`t budge this quarter, holding tight to the number-seven spot this quarter . MDB added a learning and planning center, as well as an improved interactive application process. The site also offers "InvestorView," a free software based account management tool, automated portfolio analytics and a competitive commission schedule. MDB customer service -- telephone and e-mail -- was only average this quarter." [13]

Special Offers:

None

A. B. Watley (www.abwatley.com)

Costs:

Market order:	$9.95
Limit Order:	$9.95
Initial Investment:	
A. B. Watley requires a minimum balance of	$3,000

"AB Watley's Watley Trader landed once again in the top 10, though falling two slots to number eight, mainly due to few enhancements made during the period. Watley Trader is geared toward the active trader and accordingly offers fully interactive charts, automated profit and loss by security and after-hours trading (offline). " [14]

Special Offers:

Opening an account through www.gomez.com qualifies the investor to receive $100 cash back.

Morgan Stanley Dean Witter Online (www.msdw.com)

Costs:

Market order:	$9.99
Limit Order:	$9.99
Initial Investment:	
Datek requires a minimum balance of	$2,000

"Morgan Stanley Dean Witter Online (formerly Discover Brokerage) moves up to the ninth position in the Scorecard. MSDW essentially doubled its commissions from the old Discover Brokerage commission schedule, but MSDW Online counters with excellent telephone customer service this quarter. The industry stock analyzer lets investors know if they are in the right stock within the right sector. A new tax center and CD center have been developed but CDs can only be purchased offline. Going forward, MSDW Online will need to provide better financial planning tools and a more competitive commission schedule." [15]

Special Offers:

Opening an account through www.gomez.com qualifies the investor to receive $75 cash back.

Suretrade (www.suretrade.com)

Costs:	
Market order:	$7.95
Limit Order:	$9.95
Initial Investment:	
Suretrade requires a minimum balance of	$0

"Rounding out the top ten. Suretrade turned in another respectable quarter, adding wireless trading; mortgage and insurance quotes provided by MortgageIT and Quotesmith respectively; Internet telephony, to let users contact customer service without losing their existing phone connection; and an online calendar tool to help customers track important financial dates. Despite these notable additions, Suretrade lost ground in the rankings due to difficulties it had in providing timely telephone customer service this quarter." [16]

Special Offers:
None

5.2.c.ii. Online Company Comparison

To compare these companies it would make sense to take an overall look at the on-line market and its growth. Going back to data collected in 1998, there is a definite rise in on-line trading volume. From the second quarter of 1998 to the third quarter of 1998 there was an increase in trading through on-line sites by 14% [18]. That same year the market rose 40% from the third quarter to the fourth quarter [25]. It was this time when the on-line trading reached a record high trades per day of 340,000 [25]. From the fourth quarter of 1998 to the first quarter of 1999, again the market soared 30-35% [25]. The old record of 340,000 trades per day also grew to an average of 450,000 [24]. Just by taking a glance at this data there is no doubt that the on-line market is growing. This growth has slowed down though. Market increases for the second quarter of 1999 dropped down to 20-25% [18]. The table below lists the percentage rise in trading volume on-line, what year and quarter, and the trades per day ratio.

Quarter	Year	to	Quarter	Year	% Rise in Volume	Trades/Day
2nd	98		3rd	98	14	250,000
3rd	98		4th	98	40	340,000
4th	98		1st	99	30-35	450,000
1st	99		2nd	99	50	630,000
2nd	99		3rd	99	20-25	770,000

What must be looked at though is the each individual brokerage's contribution to the market to understand the bigger picture. Below is a chart from 1998, which gives the percentage of the on-line trading market for the top ten brokerages.

#	Brokerage		%
1	Charles Schwab	....	27
2	E*Trade	....	12
3	DLJ Direct	....	4
4	National Discount Brokerage	....	*
5	Fidelity Investments	....	9
6	TD Waterhouse	....	12
7	Suretrade	....	3
8	My Discount Broker	....	*
9	Morgan Stanley Dean Witter	....	3
10	A. B. Watley	....	*

* Data Unavailable

Each brokerage has its own effect on the market. Older brokers differ from newer ones, but both have their advantages.

Charles Schwab stands out at the top as of 1998, and is still amongst the top ten. The reason why companies like Schwab hold such large percentages is because they have such a large clientele. This is the older broker advantage. Consider the clientele a reserve of customers that can be channeled into on-line trading. This secures their future to a degree but because an older company like Schwab has older clients it must try to gain a younger, Internet-inclined generation to join it's ranks. Newly founded companies like E*Trade and Ameritrade deal almost exclusively with this generation.

Being a newly founded on-line brokerage has its difficulties. E*Trade has done a lot to surpass these challenges. E*Trade's plan in the beginning was to cash in on the booming Internet age; it's advantage rising from the new, eager investing generation willing to do business over this new medium. Their customers were mainly small investors looking to make big on a couple of stocks. Today E*Trade focuses on getting a more stable group of investors. It is better to have a customer base that will not go under by Microsoft dropping two points. So basically E*Trade is looking for people with more money.

On-line brokerages like E*Trade, National Discount Brokers, and My Discount Broker, who are fairly new companies, introduce their own little volatility to the market. This comes about through those new, eager investors. So basically the new players to the game make some new player mistakes; but this is understood. So with numerous new on-line brokers come numerous new players or mistakes. This is what ultimately affects the market.

5.3 The Impact of Online Brokerages on the Market

The information described above dealt mostly with how the Worldwide Web affects the investors. However, there are two sides to this coin. Whatever impacts the investor ultimately affects the market. The following section attempts to explain this and also how online brokerages impact the market.

5.3.a. The Effects of Purchasing by Margin on the Market

Investors commonly rely on investing in stocks with borrowed money, also known as buying on margin. This is an acceptable way to help boost profit with money that is not available at the time.

With the introduction of online-trading, there is an ever-increasing amount of people buying on margin. This problem is worrying Federal Reserve Chairman Alan Greenspan. According to the New York Stock Exchange, the amount of margin debt has increased sixty-percent to 240.49 billion [2].

Many fear that the growing margin debt is the sign of a market crash. This could happen if people sell their stock just to cover the margin stocks that they own. This would lead to large amounts of market volatility and ultimately a crash.

However, many online brokerages are restricting the margin requirements for some of the very volatile Internet stocks available. Also, their marginal debt is very small compared to their assets [2].

5.3.b. Bogus Information on the Web

With all the information on the web, there is a great possibility that some of it is wrong or even outdated. Take for example an online site that has some of the options above such as graphs and news reports on the stock or bond in question. There is a possibility that the information could be wrong and thus artificially inflate or deflate the value of a stock. This has happened multiple times, and the results were not beneficial.

When the company is not doing as well as the stock price indicates, this can lead to a scare and an eventual drop in stock price. If every company did this then the stock market would crash. So, when one company's stock is inflated by a large amount, and the investors realize that the stock is not really worth that much, the investors sell and many people loose money.

A good example of this happened in 1999, when a company named PairGrain was valued at 8 and 17/32 [23]. However, the stock was priced at 18 dollars a share, a price significantly higher than the actual trading price. This information was posted on Yahoo! and Bloomberg.com. PairGrain rose to 11 and 1/8 before the information was considered bogus [23]. Many people were left holding shares that lost their value, which lead to a great loss of money. The people who purchased the stock were unaware of the discrepancy and thus this is a perfect example of faulty information presented on the web and its effect on the market [23].

Bulletin boards, newsgroups, and chat rooms are a common feature for on-line brokerages. Investors all over the United States can chat on-line while investing in the stock market. Bogus information is posted there everyday. For an inexperienced investor, that information could be taken seriously and the same thing could happen as in the PairGrain incident [17].

It would seem that the investors would not be so gullible toward the information on the web. However, according to a young investor from an article on CNET News [19]: "As a young investor you don't really know what to do, so you listen to your broker." Therefore, the bogus information that is on the web is taking seriously by numerous people and has a very large effect on the market and the investor.

5.3.b.i. Fraud and the Internet

With the PairGrain incident, there was an obvious mistake made by the two web sites. However, there are times when the false information on the web is purposely placed there to benefit the person who conjured it up. These types of Internet stock frauds are still present today and have a huge impact on the market.

This leads to the how the stock market depends on people's attitude: if there is a scare the price in stocks can sharply fall. If a good attitude is maintained, a healthy stock market results. When scares of this sort are presented to the public, a fall in the market is a strong possibility. Someone who recently buys a stock and hears of an incident like a fraud and might think the same of their stock will quickly sell. These types of effects are definitely possible whenever a crime is committed that is directed to the market or on-line market.

A good example of a stock fraud that caused a panic in the general market was with Cendant. Some officials were accused of valuing the company higher than it was actually worth. When news of this accounting discrepancy was made public, the company lost $15 billion off its market value in one day, which tainted the growth plans of one of the largest marketing companies [26]. When a sharp drop was noticed in Cendant's stock, the broader market declined as well. The investors were worried whether the stock prices in general were excessively high. Cendant stock fell nearly 46 percent, which made it the biggest looser of the day, drawing even more attention to the situation [26]. It was also the most active stock of the day with more than 108 million shares traded [26].

If an on-line company were to disclose information about was a possible discrepancy between stock values, the same outcome would be possible and is possible. An example of an Internet stock fraud is *The Future Superstock* newsletter incident [31]. *The Future Superstock* newsletter is distributed throughout the Internet and reports data on new companies and how they are doing financially. In one issue, the newsletter told its readers that certain 25 stocks would double or even triple their value. However, there was one thing that was left out from the newsletter. The writer of the newsletter Jeffery C. Bruss, was receiving millions of dollars in payment from the companies that were "going to" double or triple [31]. Bruss and 44 others were accused of deceiving investors. However, their means of deceit were not limited to the publication of the newsletter. There were other types of media used to plan the scam. They were accused of using junk e-mail, online newsletters, message board postings, and web sites. In all, they were accused of encouraging the investments of 235 small-company stocks. In turn for the company's promotion, they were required to pay $6.3 million and 2 million shares of stock [30].

There is no doubt that the market dropped a certain percentage due to this fraud. This just proves that fraud on the stock market will cause a definite change in the market's attitude and thus change the market itself. So on-line trading can cause an effect on the market, because it has an ever-growing percentage of the actual stock market's value. Thus a scare in the on-line market is also a scare in the markets.

After false information was posted causing artificial inflation and deflation in the stock market, there was much thought about whether some sort of monitoring was needed to help regulate the bogus information flooding the web. So in 1997, the Nasdaq market considered monitoring the sensitive financial data that can be found online. The device surveys the web to look for price-sensitive, false information. Its specified area is "chat rooms". It was developed by SRA, a Virginia-based software company, specifically for the Nasdaq [5].

This type of action to sequester the bad information on the web has had some effect, but there is still information that seeps through. Large markets use now on-line fraud prevention programs, just as the neighborhood watch programs are used for crime prevention. There is much information that leads people to believe that the reason why on-line trading affects the market is because of misinformed traders. This is true, but a different aspect of this is also true: the fact that on-line trading is geared mostly for the small investor. This has a very volatile effect on the market.

5.3.c. ECN Effects on the Market

With the increasing number of online sites no one thinks about how all of the buys match up with all the sells of a certain stock. They do not realize that their trades are not guided through the market in the traditional manner. The information is being sent through new types of electronic networks called ECNs (Electronic Communication Networks). ECNs are supposed to be a direct route to the ideal marketplace. They are supposed to bypass the professional traders that are considered the middlemen of the NASDAQ market, so that the prices of commissions can be considerably lower. However, there are many downsides that can ultimately affect the market. One of these downsides seen everyday on the market is the volatility of prices in Internet stocks [22].

Now that the networks account for 20 percent of the trading in the NASDAQ stocks there is cause for alarm for the market and the investors [22]. The alarm is caused by the fact that online trading is increasing market volatility and trading costs. This leads to the underlying reason behind the volatility: the ECNs. However, it will not be known if the ECNs are disrupting the market until the market takes a dive and the it makes it harder to sell, or sell at a good price. But the sudden fall caused by ECNs would most likely cascade to a large drop due to the uncertainty of the market. Therefore it is very difficult to conclude whether or not the ECNs are affecting the market in the described way.

5.3.c.i. Day Traders and ECNs

Another issue at hand is the day trader. While the ECNs make trading more efficient, the day trader is taking advantage of this. Day traders are investors who buy and sell many times a day, to make profit on small gains on large trades. ECNs only make it so much easier for the day trader to make hundreds of trades a day at a fraction of the cost. David Cushing, director of research at ITG Inc sums up the effects of ECNs on the market:

> ECNs are one of the most dramatic forces reshaping the equity markets; I think ECNs have a very valuable role in improving the efficiency of the market. The downside is, many of the benefits of ECNs have been co-opted by the professional day trader. Some of the ways they are being used right now are not in the market's best interest. [22]

The day trader and the average online trader are accounting for much of the problems brought on by ECNs. For example, if a trader places an order at a price well above the stock price, which happens very often, then other traders will see the dramatic increase and will lead to an increase that was not entirely valid.

The day-trader and the inexperienced on-line trader can both influence the market's volatility and thus contribute to the anxiety of other traders and make the market an even worse place to invest.

It seems that commissions to trade online are very low, but there are hidden costs for using the ECNs. Also, there seems to be times where trades are not executed at all or the time for trading is very long. This leads people to believe that the ECNs have other stops before they actually reach the market. It is not so much as the orders are stopped along the way, but what the orders must go through before they are executed.

Moreover, a problem that increases the volatility of the market even more is the fact that the ECNs fragment the market for NASDAQ. Even though the NASDAQ market as always has been fragmented because there is no central trading floor, the ECNs are making this problem become more serious. The problem with no central trading point is that the trades sometimes never reach each other. For example, take a person placing an order to sell a desired stock, while another person in a different fragment of the NASDAQ market wants to buy the same stock. However, because of the fragmented nature of the NASDAQ market, there is a good chance that these matching orders never reach each other. ECNs only look for specific orders in a certain place and thus the ECNs create more of a fragmented NASDAQ while trying to make the market a faster place [22].

Nowadays, the most spoken of cost for trading is the price of the commissions. However, with the high volatility of the NASDAQ market, the actual cost for most traders is the loss of money by a volatile stock that was traded. These types of costs are referred to as implicit costs. There have always been implicit costs, however, there has been a rise in implicit costs due to the ECNs.

With the large amount of small investors on-line, the amount of small trades is increasing. And because the ECNs charge other dealers to trade on their networks, the cost increases. It was shown that a majority of both Amazon.com and Ebay's trades were considered small (1,000 shares or less). With Amazon.com having roughly 3 out of 4 trades small and about 80% of Ebay's were small trades. Thus this makes these stocks so expensive to trade online [22].

Another reported problem with on-line investing is it has been reported that some companies use the data of the upcoming trades and buy the stock at a better price than the customer. This was supposedly taken care of so that employees of the online brokerages have no access to the company's data. For example, when a customer places a market order, the brokerage employee must execute the order within 30 seconds, but there is a possibility for the employee to wait and buy the better price for himself. And because the market is so volatile, the employee has a good chance of getting away with the act [22].

In an extreme case, where the market is falling and many major stocks are falling, online brokerages may not be able to accommodate the rate of liquidity that would be needed for many of their customers to pull out. The reasons for this being that ECNs do not commit any capital to maintain orderly markets in the stocks that they trade. According to NASDAQ, the average online brokerage has a 340-share block of stock at the best bid or offer [22]. So if the investor wants more than 340 shares, then the order will only be partly filled. However, the average market maker had 1,741 shares [22]. This means that the ECNs will not be able to get out in the case of a crash.

5.3.d. Integration of 24-Hour, World-Wide Trading

With all of the problems that are involved with the NASDAQ, there is another one that might add to the problem even more. This would be the 24 hour trading. There are two kinds of 24 hour trading. One, already available on some sites such as E*Trade, consists in the ability to place orders at all hours when the market is not open, the orders can still be placed and the order will be ready to be executed when the market opens in the morning.

The second type of 24 hour trading is the type where the market is open all 24 hours of the day. Many exchanges have been working to develop a computer exchange, so that there is no need for a market floor. This will bring about more trading, but will it contribute to the volatile market? The persons proposing the new technology claim that with an all computer system there will be no bias.

According to Frank G. Zarb, Chairman and CEO of the National Association of Securities Dealers Inc,

> "In a very few years, trading securities will be digital, global, and accessible 24 hours a day. People will be able to get stock price quotations instantly and instantly execute a trade anytime of day or night, anywhere on the globe, with stock markets linked and almost all-electronic."[32]

First, there are many considerations for the effects that a global market will have on the economy. One of the most obvious implications is the fact that the world is connected more now than it has ever been. For this reason, many companies want to be able to raise capital worldwide. Also, many of the companies want their stocks sold in places where their products are being sold. Not only that, but companies outside of the U.S. would like to trade in the U.S. markets. While many companies in the U.S. would like to trade other markets.

If full integration is implemented, it could stabilize the NASDAQ's volatility that is plaguing the market at this time. However, with full integration, could there be more possibilities for day-traders and novice traders to add to the volatility even more? And with full integration into a digital and global market, will there be more instances of crime and fraud that could jeopardize the stability of the market? These are the types of questions that skeptics are asking about the full integration of the stock market.

Frank G. Zarb claims that there will be a great increase in security due to the full integration [32]. With a good security service that will scan the market for crimes that can be committed, there will be a sense of comfort for the investors and thus will lead to a more steady market. As compared to today, where there is limited surveillance along with the fact that the market is very divided due to ECNs, this option seems to be the best for the market.

The integration of the global market will eventually bring about 24-hour trading. This will have to be the case. Because of the discrepancy in time between markets, say in China and the U.S., there would have to be at least an extended hour time for market trading to be at the same time. Also, many companies and industries are hoping for a 24-hour trading time. With these two factors, Zarb believes that eventually there will have to be 24-hour trading in the global market.

Zarb also has much to say about ECNs. He claims that the fees that ECNs charge for access to their buy and sell orders are unfair, because Market Makers in the NASDAQ cannot charge for transactions. He also comments on the fact that ECNs are indeed contributing to the market instability, but there is no real answer how to fix the problem. This is a short part from his speech on ECN's:

> The problem I see is that the proliferation of ECNs — there are nine now — could result in fragmentation, confusion, and higher costs in the market. I don't have a problem with the creation of these companies by investors to make money. That is the American way. But, how the ECN community will fit together with the total market and impact investors is an important question. We need to avoid fragmenting the market and ensure that we are all playing by the same rules. A broader, deeper market is good for investors because it increases liquidity and price transparency. [32]

The fact remains that the market needs to become one, with no fragmenting that will result in market volatility.

6.0 Conclusions

This project has looked at a number of ways the Worldwide Web has influenced the market. Its influence can be divided into two separate categories. The first is the ways the Worldwide Web impacts the online investor. The second is how the online brokerages affect the market. We also learned how to price options and design a program from this knowledge similar to some on-line calculators. To conclude, every one of these separate parts of the project can be unified to make one basic message about online investing and its influence on society.

6.1 Conclusions of the Impact of the Worldwide Web on the Investor

When we looked at the influence of the Worldwide Web on the investor, we ultimately find that the main purpose is to make investing on-line easier. Online brokerages compete to attract the customer in anyway they can. For example, by providing instant access to the market, offering numerous different order types, providing easy access to the online account, giving free gifts and sponsoring contests, and offering free access to data on securities. All of these options would not be available without the innovation of the Worldwide Web. The ease and somewhat security of the Web attracts many people to these online brokerages as well.

With the ease of investing online comes the ease of fraud and deception that can influence not only the investor but also the way that the market functions. False information on the web has impacted how people invest and sometimes, as we have seen, it leads to overall market impact. Thus there are two different ways the Worldwide Web impacts the investor. One of these ways is the presence of false information, and the online brokerages that are paving the path for a global, 24-hour market. However, not only do these things effect the investor, but also they ultimately effects the market.

6.2 Conclusions of the Impact of Online Brokerages on the Market

With the ease of online trading, more and more people are opening accounts and leaving the old brokerages behind. Now that online investing accounts for nearly 30% of the total market volume, a closer look into how these brokerages are accessing the trading floor must be considered. ECNs have been found to add to the volatility of the stock market because it creates a market that is not whole, instead it is fragmented which causes extreme volatility. We looked at how there is a move toward a global, 24-hour market that will integrate all of the ECNs to make one central trading floor. This movement could impact the market in a positive way by fixing all the negative aspects of a fragmented market. We also looked at how bogus information leads to panic and ultimately a drop in the market.

We can conclude from this research that what impacts the investor also impacts the market and thus the Web can have a beneficial effect on the market, but there is also the chance of the Web impacting the market in a negative way.

6.3 The Effects of Online Trading on Society

There are numerous effects that online trading have on society. For one, with the ease of online trading, more and more people that would normally not invest are now investing. Many of the new online investors are older or retired and thus need a place to invest their money for the future. This impacts how people spend their money in the future and how people manage their money.

Since the market is heading for a global, unified market, this will also have an effect on society. Not only will people know about our markets, but also other countries' markets, leading to a more unified financial world.

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```
import java.awt.*;
import java.awt.event.*;
import java.util.*;
import java.lang.*;

public class iqp extends Frame {

    Label l1 = new Label("Market Volatility");
    Label l2 = new Label("Exercise Price    ");
    Label l3 = new Label("Interest Rate     ");
    Label l4 = new Label("Fractional Time   ");
    Label l5 = new Label("Purchase Price    ");
    Label l6 = new Label("Dividend Rate     ");
    Label l7 = new Label("Time Steps        ");
    Label l8 = new Label("  Black-Scholes Model    ");
    Label l9 = new Label(" American Model     ");
    Label l10 = new Label("  European Model    ");
    Label l11 = new Label("      (Binomial Model)      ");
    Label l12 = new Label("      (Binomial Model)      ");
    Button b1 = new Button("  Call  ");
    Button b2 = new Button("  Put   ");
    Button b3 = new Button("  Call  ");
    Button b4 = new Button("  Put   ");
    Button b5 = new Button("  Call  ");
    Button b6 = new Button("  Put   ");

    TextField tf1 = new TextField(15);
    TextField tf2 = new TextField(15);
    TextField tf3 = new TextField(15);
    TextField tf4 = new TextField(15);
    TextField tf5 = new TextField(15);
    TextField tf6 = new TextField(15);
    TextField tf7 = new TextField(15);
    TextField tf9 = new TextField(20);

    public iqp() {
       setSize(200,700);
       setLayout(new FlowLayout());

       add(l5); add(tf5);
       add(l2); add(tf2);
       add(l4); add(tf4);
       add(l1); add(tf1);
       add(l3); add(tf3);
       add(l6); add(tf6);
       add(l7); add(tf7);

       add(l8); add(b1); add(b2); add(l10); add(l11); add(b3);
       add(b4); add(l9); add(l12); add(b5); add(b6); add(tf9);

       // set listeners
       b1.addActionListener(new B1());
       b2.addActionListener(new B2());
       b3.addActionListener(new B3());
       b4.addActionListener(new B4());
       b5.addActionListener(new B5());
       b6.addActionListener(new B6());


    }

    class B1 implements ActionListener {
       public void actionPerformed(ActionEvent e) {

               Compute();
                       }
       public double Normal(double x)
       {
               double a=.4361836, b=-.1201676, c=.937298, d=0;
               d=1/(1+.33267*Math.abs(x));
               if (x>0)
               return 1-Math.exp(-Math.pow(x,2.0)/2.0)*(a*d+b*Math.pow(d,2.0)+c*Math.pow(d,3.0))/Math.sqrt(2.0*3.1416);
               else
               {
                       x=-x;
                 return Math.exp(-Math.pow(x,2.0)/2.0)*(a*d+b*Math.pow(d,2.0)+c*Math.pow(d,3.0))/Math.sqrt(2.0*3.1416);
               }
       }

       public void Compute()
       {
```

```java
        double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, ct=0, d=0;

        String temp = tf1.getText();
        Double Sig = new Double(temp);

        temp = tf2.getText();
        Double X = new Double(temp);

        temp = tf3.getText();
        Double R = new Double(temp);

        temp = tf4.getText();
        Double T = new Double(temp);

        temp = tf5.getText();
        Double St = new Double(temp);

        temp = tf6.getText();
        Double D = new Double(temp);

        sig=Sig.doubleValue();
        x=X.doubleValue();
        r=R.doubleValue();
        t=T.doubleValue();
        st=St.doubleValue();
        d=D.doubleValue();
        d1=(Math.log(st / x)+((r-d)+.5*Math.pow(sig, 2.0))*(t)) / (sig*Math.sqrt(t));
        d2=d1-(sig*Math.sqrt(t));
        ct=Math.exp(-d*t)*st*Normal(d1) - (x*Math.exp(-r*(t))*Normal(d2));

        tf9.setText(Double.toString(ct));
    }
}

class B2 implements ActionListener {
    public void actionPerformed(ActionEvent e) {

        Compute();
    }
    public double Normal(double x)
    {
        double a=.4361836, b=-.1201676, c=.937298, d=0;
        d=1/(1+.33267*Math.abs(x));
        if (x>0)
        return 1-Math.exp(-Math.pow(x,2.0)/2.0)*(a*d+b*Math.pow(d,2.0)+c*Math.pow(d,3.0))/Math.sqrt(2.0*3.1416);
        else
        {
                x=-x;
        return Math.exp(-Math.pow(x,2.0)/2.0)*(a*d+b*Math.pow(d,2.0)+c*Math.pow(d,3.0))/Math.sqrt(2.0*3.1416);
        }
    }

    public void Compute()
    {
        double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, pt=0, d=0;

        String temp = tf1.getText();
        Double Sig = new Double(temp);

        temp = tf2.getText();
        Double X = new Double(temp);

        temp = tf3.getText();
        Double R = new Double(temp);

        temp = tf4.getText();
        Double T = new Double(temp);

        temp = tf5.getText();
        Double St = new Double(temp);

        temp = tf6.getText();
        Double D = new Double(temp);

        sig=Sig.doubleValue();
        x=X.doubleValue();
        r=R.doubleValue();
        t=T.doubleValue();
        st=St.doubleValue();
        d=D.doubleValue();
        d1=(Math.log(st / x)+((r-d)+.5*Math.pow(sig, 2.0))*(t)) / (sig*Math.sqrt(t));
        d2=d1-(sig*Math.sqrt(t));
        pt=Math.exp(-r*t)*x*Normal(-d2) - (st*Math.exp(-d*(t))*Normal(-d1));
```

```
            tf9.setText(Double.toString(pt));
    }
  }

  class B3 implements ActionListener {
    public void actionPerformed(ActionEvent e) {

            Compute();
    }


    public void Compute()
    {
            double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, pt=0, d=0, Up=0,Down=0;
            int n=0;
            int up=0, down=0;
            double[][] result = new double[300][300];

            String temp = tf1.getText();
            Double Sig = new Double(temp);

            temp = tf2.getText();
            Double X = new Double(temp);

            temp = tf3.getText();
            Double R = new Double(temp);

            temp = tf4.getText();
            Double T = new Double(temp);

            temp = tf5.getText();
            Double St = new Double(temp);

            temp = tf6.getText();
            Double D = new Double(temp);

            temp = tf7.getText();
            Integer N = new Integer(temp);

            sig=Sig.doubleValue();
            x=X.doubleValue();
            r=R.doubleValue();

            st=St.doubleValue();
            d=D.doubleValue();
            n=N.intValue();
            t=T.doubleValue()/n;
            Up=Math.exp(sig*Math.sqrt(t));
            Down=1 / Up;

            for(down=n;down>=0;down--)
            {
            for(up=0;up<down;up++)
            {
                    result[up][down]=Math.pow(Up, down-up)*Math.pow(Down, up)*st;
                    if (result[up][down]-x<0)
                            result[up][down]=0;
                    else
                            result[up][down]=result[up][down]-x;

            }
            }
            for(down=n;down>0;down--)
            {
            int i=0;
            double p1=0, q1=0;
            p1=(Math.exp((r-d)*t) - Math.exp(-sig*Math.sqrt(t))) / (Math.exp(sig*Math.sqrt(t)) - Math.exp(-
            sig*Math.sqrt(t)));
            q1=1-p1;
            for(i=0;i<down;i++)
            {
                    result[i][down]= Math.exp(-(r)*t)*(p1*result[i][down]+q1*result[i+1][down]);
                    if (result[i][down]>result[i][down-1])
                            result[i][down-1]=result[i][down];
            }
            }

            tf9.setText(Double.toString(result[0][0]));
     }
   }
class B4 implements ActionListener {
     public void actionPerformed(ActionEvent e) {
```

```
            Compute();
    }


    public void Compute()
    {
            double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, pt=0, d=0, Up=0,Down=0;
            int n=0;
            int up=0, down=0;
            double[][] result = new double[300][300];

            String temp = tf1.getText();
            Double Sig = new Double(temp);

            temp = tf2.getText();
            Double X = new Double(temp);

            temp = tf3.getText();
            Double R = new Double(temp);

            temp = tf4.getText();
            Double T = new Double(temp);

            temp = tf5.getText();
            Double St = new Double(temp);

            temp = tf6.getText();
            Double D = new Double(temp);

            temp = tf7.getText();
            Integer N = new Integer(temp);

            sig=Sig.doubleValue();
            x=X.doubleValue();
            r=R.doubleValue();

            st=St.doubleValue();
            d=D.doubleValue();
            n=N.intValue();
            t=T.doubleValue()/n;
            Up=Math.exp(sig*Math.sqrt(t));
            Down=1 / Up;

            for(down=n;down>=0;down--)
            {
            for(up=0;up<down;up++)
            {
                    result[up][down]=Math.pow(Up, down-up)*Math.pow(Down, up)*st;
                    if (x-result[up][down]<0)
                            result[up][down]=0;
                    else
                            result[up][down]=x-result[up][down];

            }
            }
            for(down=n;down>0;down--)
            {
            int i=0;
            double p1=0, q1=0;
            p1=(Math.exp((r-d)*t) - Math.exp(-sig*Math.sqrt(t))) / (Math.exp(sig*Math.sqrt(t)) - Math.exp(-
            sig*Math.sqrt(t)));
            q1=1-p1;
            for(i=0;i<down;i++)
            {
                    result[i][down]= Math.exp(-(r)*t)*(p1*result[i][down]+q1*result[i+1][down]);
                    if (result[i][down]>result[i][down-1])
                            result[i][down-1]=result[i][down];
            }
            }

            tf9.setText(Double.toString(result[0][0]));
    }
  }

class B5 implements ActionListener {
    public void actionPerformed(ActionEvent e) {

            Compute();
    }


    public void Compute()
```

```java
    {
            double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, pt=0, d=0, Up=0,Down=0;
            int n=0;
            int up=0, down=0;
            double[][] result = new double[300][300];

            String temp = tf1.getText();
            Double Sig = new Double(temp);

            temp = tf2.getText();
            Double X = new Double(temp);

            temp = tf3.getText();
            Double R = new Double(temp);

            temp = tf4.getText();
            Double T = new Double(temp);

            temp = tf5.getText();
            Double St = new Double(temp);

            temp = tf6.getText();
            Double D = new Double(temp);

            temp = tf7.getText();
            Integer N = new Integer(temp);

            sig=Sig.doubleValue();
            x=X.doubleValue();
            r=R.doubleValue();

            st=St.doubleValue();
            d=D.doubleValue();
            n=N.intValue();
            t=T.doubleValue()/n;
            Up=Math.exp(sig*Math.sqrt(t));
            Down=1 / Up;

            for(down=n;down>=0;down--)
            {
            for(up=0;up<down;up++)
            {
                    result[up][down]=Math.pow(Up, down-up)*Math.pow(Down, up)*st;
                    if (result[up][down]-x<0)
                            result[up][down]=0;
                    else
                            result[up][down]=result[up][down]-x;

            }
            }
            for(down=n;down>0;down--)
            {
            int i=0;
            double p1=0, q1=0;
            p1=(Math.exp((r-d)*t) - Math.exp(-sig*Math.sqrt(t))) / (Math.exp(sig*Math.sqrt(t)) - Math.exp(-
            sig*Math.sqrt(t)));
            q1=1-p1;
            for(i=0;i<down;i++)
            {
                    result[i][down]= Math.exp(-(r)*t)*(p1*result[i][down]+q1*result[i+1][down]);
                    result[i][down-1]=result[i][down];
            }
            }

            tf9.setText(Double.toString(result[0][0]));
    }
  }

class B6 implements ActionListener {
    public void actionPerformed(ActionEvent e) {

            Compute();
    }


    public void Compute()
    {
            double st=0, sig=0, x=0, r=0, t=0, d1=0, d2=0, pt=0, d=0, Up=0,Down=0;
            int n=0;
            int up=0, down=0;
            double[][] result = new double[300][300];

            String temp = tf1.getText();
```

```
            Double Sig = new Double(temp);

            temp = tf2.getText();
            Double X = new Double(temp);

            temp = tf3.getText();
            Double R = new Double(temp);

            temp = tf4.getText();
            Double T = new Double(temp);

            temp = tf5.getText();
            Double St = new Double(temp);

            temp = tf6.getText();
            Double D = new Double(temp);

            temp = tf7.getText();
            Integer N = new Integer(temp);

            sig=Sig.doubleValue();
            x=X.doubleValue();
            r=R.doubleValue();

            st=St.doubleValue();
            d=D.doubleValue();
            n=N.intValue();
            t=T.doubleValue()/n;
            Up=Math.exp(sig*Math.sqrt(t));
            Down=1 / Up;

            for(down=n;down>=0;down--)
            {
            for(up=0;up<down;up++)
            {
                    result[up][down]=Math.pow(Up, down-up)*Math.pow(Down, up)*st;
                    if (x-result[up][down]<0)
                            result[up][down]=0;
                    else
                            result[up][down]=x-result[up][down];

            }
            }
            for(down=n;down>0;down--)
            {
            int i=0;
            double p1=0, q1=0;
            p1=(Math.exp((r-d)*t) - Math.exp(-sig*Math.sqrt(t))) / (Math.exp(sig*Math.sqrt(t)) - Math.exp(-
            sig*Math.sqrt(t)));
            q1=1-p1;
            for(i=0;i<down;i++)
            {
                    result[i][down]= Math.exp(-(r)*t)*(p1*result[i][down]+q1*result[i+1][down]);
                    result[i][down-1]=result[i][down];
            }
            }

            tf9.setText(Double.toString(result[0][0]));
        }
    }
    public static void main(String[] args) {
        iqp a = new iqp();
        a.show();
    }
}
```