FINANCIAL ENGINEERING AND VBA

Presented by:

- Rachita Moondra (409)
- Aryan Singh Rajawat (410)
- Aarushi Shinde (411)
- Mansi Mandaliya (412)
- Ansh Jain (413)
- Simran Sharma (414)
- Juilee Jayade (415)
- Paraj Shah (416)

PROJECT OVERVIEW

- Introduction
- Assumptions
- Stock Price Simulation using Monte Carlo
- Cash or Nothing Binary Option Valuation
- Asset or Nothing Binary Option Valuation
- Expected Payoff of Binary Option
- Conclusion and Insights

BINARY OPTION

- **The basic premise behind a binary option is a simple yes or no proposition: Will an underlying asset be above a certain price at a certain time?**
- **Binary options are financial options that come with one of two payoff options if the contract is held until expiration.**
- **A fixed amount or nothing at all , having 2 possible settlements , justifying its name**

Advantages:

- Capped risks
- Better than average returns
- Known payouts
- Simplest financial assets to trade

Disadvantages:

- Capped gains
- Volatility of derivative-based binary options
- Limited choice

ADVANTAGES & DISADVANTAGES

ASSUMPTIONS

- **Stock : TCS**
- **Type of options : Asian**
- **Method for stock price simulation: Geometric Brownian Motion**
- **Historical volatility, dividend yield and historical returns: calculated from real monthly data and is assumed to be constant.**
- **Time period: 15 years**
- **Number of simulations : 125 * can be altered if needed**
- **It is assumed that there is no premium paid for the options.**

WHAT IS GEOMETRIC BROWNIAN MOTION?

- **A geometric Brownian motion is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion with drift.**
- **It is the most extensively used model of stock price behaviour and is used to model stock prices in the Black–Scholes model. The logarithm of a randomly fluctuating quantity follows a Brownian motion with drift in a geometric Brownian motion.**

$$S_t = S_0 \exp\left\{\left(\mu - \frac{1}{2}\sigma^2\right)t + \sigma W_t\right\}$$

S_t : price of underlying at time t

S_0 : price of underlying at time 0

μ : historical mean of the underlying

σ^2 :historical volatility

t : time to maturity

W_t : Standard Brownian Motion

STOCK PRICE SIMULATION USING MONTE CARLO

```
For i = 1 To simulations
    For startnumber = 1 To period
        Cells(16 + startnumber, 2) = startnumber
        stockprice(startnumber + 1) = stockprice(startnumber) * Exp((rfr - annualvol ^ 2 / 2) * dt + annualvol * Sqr(dt) * WorksheetFunction.NormSInv(Rnd()))
        Cells(16 + startnumber, 3) = stockprice(startnumber + 1)
        Worksheets("All iterations").Cells(2 + startnumber, 2 + i) = stockprice(startnumber + 1)
        Worksheets("All Iterations").Cells(2 + startnumber, 2) = startnumber
    Next startnumber
```

What is Monte Carlo Simulation?

- Monte Carlo Simulation is a method for simulating risk or uncertainty in a system by creating random variables.
- Probability distributions such as normal, log normal, and others are used to model the random variables or inputs. For creating pathways, several iterations or simulations are done, and the outcome is determined using appropriate numerical computations.
- It is the most reliable approach for analysing a model with unknown parameters or a dynamic complicated system. It's a probabilistic approach to system risk modelling.

CASH OR NOTHING BINARY OPTION VALUATION

- **Options that are all or nothing settle in cash.**
- **The buyer pays a premium for the option, and whether or not the cash settlement pays out relies entirely on whether the underlying asset closes over the strike price (in the money) on the expiration date.**
- **The payoff is set, regardless of how much in the money you are.**

Payoff Table

	$S_t \geq K$	$S_t \leq K$
Call	Q	0
Put	0	Q

Assumption:
Q is the cash payoff at maturity.

$$Qe^{-rt}\,N(d_2)$$
$$Qe^{-rT}\,N(-d_2)$$

Where,

$$d_1 = \frac{\ln\left(\frac{s}{x}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$
$$d_2 = d_1 - \sigma\sqrt{t}$$

and

s is the current spot price
r is the risk free interest rate
t is the expiry date in years
σ is the implied volatility
N is the standard normal cumulative distribution function

CASH OR NOTHING BINARY OPTION VALUATION

Payoff at time 15:

```
If stockprice(startnumber) > strikeprice Then
Cells(16 + i, 6) = cashpayoff
Cells(16 + i, 7) = 0
ElseIf stockprice(startnumber) < strikeprice Then
Cells(16 + i, 6) = 0
Cells(16 + i, 7) = cashpayoff
Else
Cells(16 + i, 6) = cashpayoff
Cells(16 + i, 7) = cashpayoff
End If
```

Call price:

```
    Cells(16 + i, 10) = Cells(16 + i, 6) * Exp(-rfr * period) *
    Cells(16 + i, 11) = Cells(16 + i, 7) * Exp(-rfr * period) *

WorksheetFunction.NormSDist(((WorksheetFunction.Ln(stockprice(startnumber) / strikeprice)
WorksheetFunction.NormSDist(-((WorksheetFunction.Ln(stockprice(startnumber) / strikeprice)

     (rfr - dividend + annualvol ^ 2 / 2) * period) /
      (rfr - dividend + annualvol ^ 2 / 2) * period) /

   (annualvol * Sqr(period))) - annualvol * Sqr(period)))
    (annualvol * Sqr(period))) - annualvol * Sqr(period)))
```

ASSET OR NOTHING BINARY OPTION VALUATION

- **Asset-or-nothing options settle when the underlying asset is physically delivered.**
- **Although digital options (also known as binary options) appear to be straightforward, they vary from conventional options in that they can be traded on unregulated sites. As a result, they may be more vulnerable to the risk of an illiquid underlying.**

PAYOFF TABLE

	$S_t \geq K$	$S_t \leq K$
Call	S_t	0
Put	0	S_t

Assumption:
Only 1 share is received as payoff

$$S_0 e^{-qT} N(d_1)$$
$$S_0 e^{-qT} N(-d_1)$$

Where,

$$d_1 = \frac{\ln\left(\frac{s}{x}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$
$$d_2 = d_1 - \sigma\sqrt{t}$$

and

s is the current spot price
r is the risk free interest rate
t is the expiry date in years
σ is the implied volatility
N is the standard normal cumulative distribution function

ASSET OR NOTHING BINARY OPTION VALUATION

Payoff at time 15:

```
If stockprice(startnumber) > strikeprice Then
Cells(16 + i, 8) = stockprice(startnumber)
Cells(16 + i, 9) = 0
ElseIf stockprice(startnumber) < strikeprice Then
Cells(16 + i, 8) = 0
Cells(16 + i, 9) = stockprice(startnumber)
Else
Cells(16 + i, 8) = stockprice(startnumber)
Cells(16 + i, 9) = stockprice(startnumber)
End If
```

Call price:

```
  Cells(16 + i, 12) = Cells(16 + i, 8) * Exp(-rfr * period) *
  Cells(16 + i, 13) = Cells(16 + i, 9) * Exp(-rfr * period) *

WorksheetFunction.NormSDist(((WorksheetFunction.Ln(stockprice(startnumber) / strikeprice) + (
WorksheetFunction.NormSDist(-(((WorksheetFunction.Ln(stockprice(startnumber) / strikeprice) +

 (rfr - dividend + annualvol ^ 2 / 2) * period) / (annualvol * Sqr(period)))
  (rfr - dividend + annualvol ^ 2 / 2) * period) / (annualvol * Sqr(period)))

     (annualvol * Sqr(period))) - annualvol * Sqr(period)))
      (annualvol * Sqr(period))) - annualvol * Sqr(period)))
```

INPUT

Stock Price	3434.6
Annual Volatility	20.559%
Period	15
dt	1
Simulations	125

Strike Price	3500
Risk-Free Rate	7.40%
Cash Amount	1700
No.of Shares for Asset Payoff at time T	1
Dividend Yield	1.21%

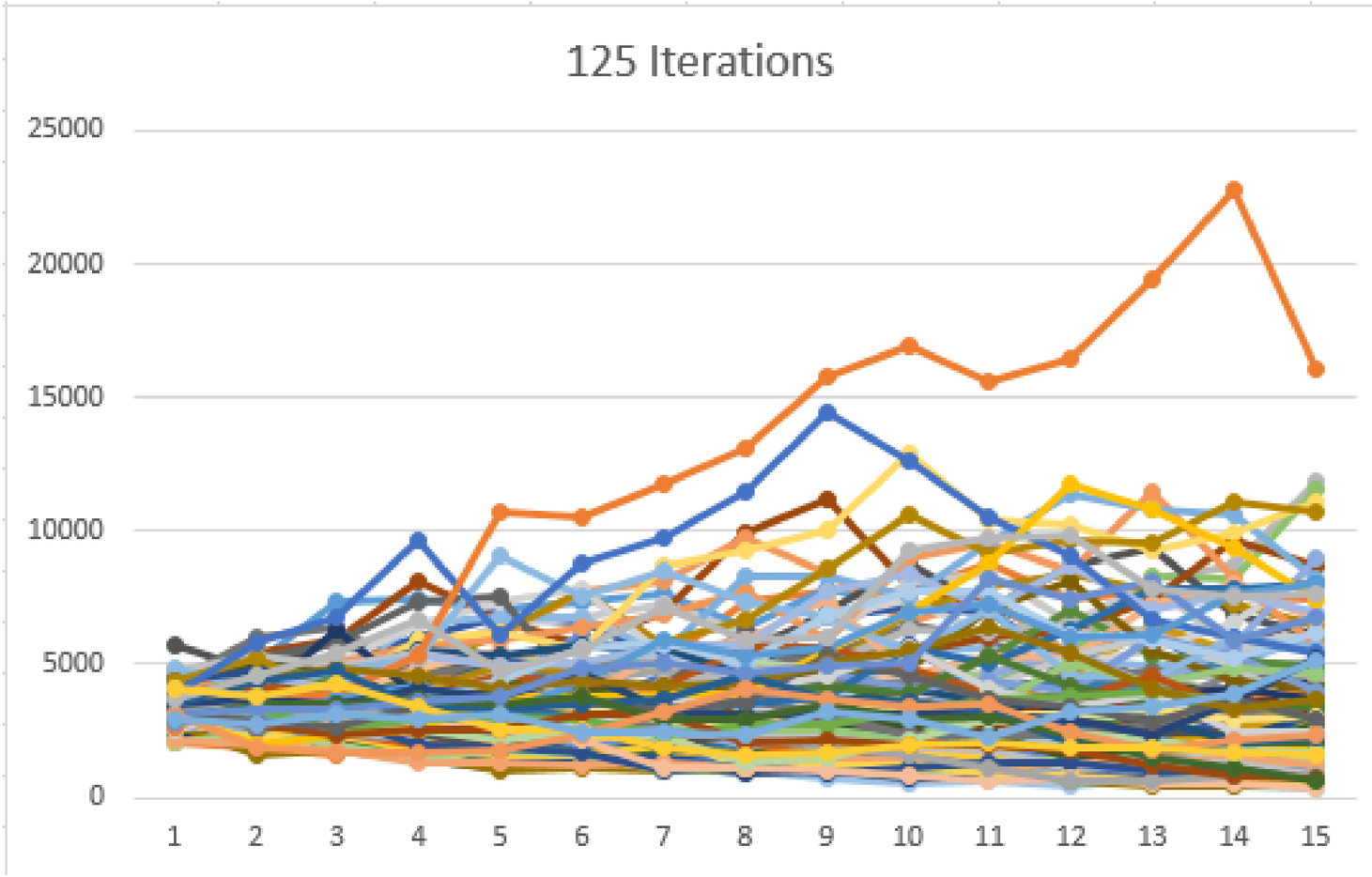
OUTPUT

Expected Option Price Table				
	Cash or Nothing Option		Asset or Nothing Option	
Option Type	Call	Put	Call	Put
Expected Price	**396.32**	**852.15**	**1615.17**	**960.97**

- **Table will change if macro is ran again.**
- **Volatility was calculated based on the historical data while returns were taken from online sources.**
- **Risk free rate based on current 15 year government bond yield.**
- **Inputs based on historical data of TCS for last 15 years**

CONCLUSION & INSIGHTS

- **The chart above shows the simulations of stock price we observed.**
- **Historically, since the stock price has increased, almost all simulations suggest that the stock price will increase in value.**
- **However, GBM is not a completely realistic model because volatility is assumed to be constant and stock prices often show jumps caused by unpredictable events or news.**



THANKYOU