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## EXOTIC OPTIONS

***Including Second Generation***

***Exotics***

**The Four Day Course**

### DAY ONE, (Optional)

*In the first day we lay the groundwork for option pricing theory, explain its assumptions and shortcomings, talk about estimating volatility and correlation and discuss risk measurement techniques.*

#### **Welcome and Introductions**

*Participants introduce themselves to the group*

#### **Motivation for using exotics**

*After all the negative publicity, why use exotics at all?*

- \* Customized hedging tools
- \* Investors talking a specific view
- \* Executive bonuses
- \* Swiss (and American) life insurance products
- \* As a part of a total solution (e.g. contingent premium options)
- \* Structured notes
- \* Volatility insensitive structures
- \* The impact of the exotic options market on the spot market (e.g. double barrier foreign exchange options)

## **How companies hedge**

*Real life examples from the field*

- \* Zero or low-cost hedging strategies for corporations
- \* Risk management to reduce a corporation's own risk vs. an insurance program to protect against an competitive disadvantage
- \* Credit enhancement using derivatives
- \* We look at companies such as Gillette, RJR Nabisco, Abitibi-Price and more

## **Developing a pricing methodology**

*An introduction to option pricing theory*

- \* Two ideas
    - the no arbitrage condition
    - the reverse engineering principle
  - \* Developing a model for the underlying
  - \* Option value = Implicit Value + Time Premium
  - \* The no arbitrage pricing principle
    - a simple European option
    - introducing volatility
    - a simple binomial tree with three nodes
  - \* A review of stochastic processes
    - The Black Scholes insight
  - \* The Black Scholes Framework
    - what are the key assumptions?
    - dealing with the assumptions behind most pricing models
    - constant volatility
    - constant interest rates
    - costless trading with no taxes or restrictions
- ("frictionless")
- unlimited borrowing and lending of capital is allowed at the same risk free rate
  - unlimited short sales of securities
  - no cash flows during the option's life
  - Black Scholes strengths and limitations

## **Pricing methods under the Black Scholes assumptions**

*A spreadsheet will be shown and given to the delegates which demonstrates how all these methods are equivalent*

- \* General approaches to pricing options
  - Closed Form Solutions
  - Numerical Techniques (Quadrature, Iterations)
  - Monte Carlo approaches and variance reduction techniques
  - Trees (Binomial, Trinomial and Quadrinary)
  - Approximations
- \* The advantages and disadvantages of the various methods

### **Advanced pricing - abandoning the Black Scholes assumptions**

*In this talk, we abandon the Black Scholes assumptions and see where this leads us.*

- \* What's wrong with Black-Scholes?
- \* Volatility smile and smirk (statistical study, before '87 vs. after '87)
- \* Probability of a stock market crash is close to zero, yet, they do happen
- \* Pricing using a binomial tree (review)
- \* Tree with discrete dividends
- \* Tree with a volatility term structure
- \* Implied volatility trees
- \* A method of computing Delta and Gamma with binomial trees
- \* Using discrete difference equations instead of continuous differential equations
  
- \* Mixing discrete in time and continuous in price space and vice-versa
- \* New research: pricing of Asian options with binomial trees.

### **Monte Carlo methods**

- \* Variance reduction techniques for Monte Carlo (Antithetic variables)
- \* The UWAN method
- \* Efficient generation of pseudo-random numbers (e.g. quasi-Monte Carlo sequences)
- \* The low discrepancy sequences (e.g. Halton and Sobol) and how to use them

### **More on Volatility and Correlation**

*How do market participants estimate these unobservable quantities?*

- \* Historical volatility
  - Which term should be used?
- \* Different methods of volatility estimation
  - Using closing prices
  - Using daily high and low prices
  - Using high, low, open and close prices
  - The "Parkinson" rule
  - Using exponential moving averages
- \* Implied volatility
  - Coping with the volatility "smile"
  - The term structure of volatility
- \* Measuring correlation - an even tougher problem

## **Developing a Framework for Accurate Risk measurement**

*Sensitivity analysis ("Greeks"), Scenario analysis and Value-at-risk*

- \* How to quantify the risk of an option
  - Delta: sensitivity to the asset price
  - Gamma: sensitivity of delta to the asset price
  - Vega: sensitivity to volatility
  - Theta: time premium
  - Rho: sensitivity to interest rates
- \* Scenario analysis
  - Which scenarios should you look at
  - Visualization and graphics
- \* The Group of Thirty (G30) recommendations
- \* Value at Risk (VAR)
  - Introduction
  - Several methods used (e.g. RiskMetrics)
  - Advantages and critiques

## DAY TWO

We are now ready to look at specific options. For each option, we cover

1. The definition and payoff function
2. Specific examples where it has been used
3. Its pricing. In many cases we show more than one methodology.
4. How to hedge it
5. What to do when the hedge fails
6. Who would use such an option
7. What are the potential benefits? What are the risks?
8. Other issues: data collection, pricing, liquidity, obtaining volatilities and correlations etc.

### Semi Exotic Options

#### **Bermudan Options - pricing and hedging techniques**

*Between American and European options*

- \* Applications for Bermudan options for bonds (e.g. callable bonds)
- \* Cancelable swaps
- \* Pricing and hedging of Bermudan options

#### **Digital / Binary Options**

*All or nothing options*

- \* Distinction between
  - CASH or NOTHING
  - ASSET or NOTHING
- \* Gap options
  - adaptations of Black-Scholes
  - cash or nothing options
  - asset or nothing options
- \* Applications and hedging of digital / binary options
- \* What is the Delta of a Binary option
- \* How to value Digital options
- \* The "dog leg" forwards

#### **Pay Later Options / Contingent Premium Options**

*Options whose premium is paid at expiration only under some circumstances*

- \* Applications of pay later options for hedgers
- \* Different types of contingent premium options
- \* Pricing pay later options as combination of digital and normal options

### **Delayed Options**

*Forward starting options struck at-the-money at some future date*

- \* Applications and delayed options for employee stock incentive plans
- \* Pricing of the delayed option as the present value of a normal option
- \* Importance of forward / forward volatility
- \* Delayed options and building a ratchet swap

### **Chooser Options - A cheap straddle**

*Ability to choose either a call or put in the future*

- \* European or American double
- \* A chooser is more expensive than a put or a call but less expensive than both
- \* The effect of the choice date on the price
- \* Pricing of chooser options:
  - equivalent portfolio strategy
  - adaptation of standard Black-Scholes
  - pricing of 'complex' chooser options
  - determination of American chooser options
- \* Pricing of "complex choosers"
  - The Rubinstein iterative approach
  - The Nelken quadrature approach

### **Power Options**

*Payoff to the holder is based on the underlying price raised to a power*

- \* Comparison to multiple holdings of normal options
- \* Application of power options: Libor squared notes

### **Log Options**

*Payoff to the holder is based on the log of the underlying price*

- \* Comparison of its Delta with a European option
- \* Valuation and hedging of Log Options

## Options on Options

### **Compound Options**

*Options-on-Options which allow the holder to buy or sell an "underlying" option*

- \* EUROPEAN on EUROPEAN, EUROPEAN on AMERICAN
- \* CALL on a CALL
- \* CALL on a PUT

- \* PUT on a CALL
- \* PUT on a PUT
- \* Pricing compound options:
  - Black-Scholes - the original compound option
  - Geske's approach for European options
  - Rubinstein's generalization
  - Nelken's quadrature method
- \* Applications of compound options (e.g. the Banker's Trust Installment Warrants)
- \* Which volatility should be used
- \* Hedging of compound options
  - Hedging with the underlying option
  - Hedging with the underlying asset

## Memory Independent Options

### **Cliquet or Ratchet Options**

*Allows you to lock in profits at fixed points in time*

- \* Definition and characteristics of cliquet options
- \* Pricing and hedging of cliquet options

### **Shout Options**

*These are similar to ratchet options with an additional choice*

- \* Pricing and hedging of shout options
- \* Difference between immediate payoff and reset strike
- \* Optimal vs. non-optimal shouts
- \* How banks make money because clients often shout before it is optimal to do so

## DAY THREE

### Semi-Memory Independent Options

#### **Barrier Options**

*These options become activated/extinguished when an underlying price crosses a barrier*

- \* Dealing with:
  - DOWN and OUT
  - DOWN and IN
  - UP and OUT
  - UP and IN
  - CALLS and PUTS
- \* Is it true that a knock-out plus a knock-in equal a European?
- \* "Nice" barriers vs. "nasty" barriers
- \* Discretely monitored barriers
- \* Pricing of barrier options:
  - revisions of Black-Scholes for barrier options
  - modified binomial processes
  - general pricing problems
  - impact of rebates on barriers
- \* Can barrier options be priced with trees?
- \* Legal issues: how can an investor be sure whether a barrier was touched?
- \* Discretely monitored barriers
  - Partial barriers
- \* Hedging barrier options
  - construction of equivalent portfolios
  - long a normal call and short a special put
  - when does this work and when does it fail
  - arbitrage relationships
  - risks of hedged positions
- \* Static hedging vs. dynamic hedging
  - a detailed example
  - when do they work and when do they fail

#### **Double Barrier Options**

*These options are extinguished in the underlying does not stay within a zone*

- \* Why are they not like two barrier options?
- \* How can they be priced
  - The Kunimoto and Ikeda method
  - Berger's extensions
- \* The effects of double barrier options on the spot market

## Window Options

*These are barrier options in which the barrier is only active during part of the life of the option*

- \* Defining the windows
  - What does the client need?
  - Single window, double window or multiple windows
  - Pricing and hedging

## One Touch Options

*The investor receives and all or nothing payoff if the underlying price ever crosses a barrier*

- \* The different types
  - Up and In, Down and In, Up and Out, Down and Out
  - Cash or Nothing
  - Asset or Nothing
  - Payoff at Hit vs. Payoff at Expiration
- \* If you don't know when the barrier will be hit, how can you estimate the present value of the payoff?

### Ladder Options

*Locking in profits at certain price levels*

- \* Ladder options defined
- \* Pricing and hedging of ladder options

### Asian Options (Average Price)

*Options on the average*

- \* The 'Asian' style options: what are they?
- \* Why they make sense
- \* How come their price is so low - reduced volatility of the average
  - \* Geometric vs. Arithmetic average
  - \* Importance of the "average so far"
  - \* Pricing of the Asian options:
    - why is it so difficult: the average of lognormals is NOT lognormal
      - problems with the stochastic process
      - analytical approximations
      - the Vorst solutions
- \* Continuous averaging and discrete averaging
- \* Hedging Asian options with normal options
- \* Hedging Asian options with the underlying (an example)

### **Average strike options**

*The strike of the option is determined by the average price*

- \* Applications of average strike options
- \* Pricing and hedging of average strike options
- \* Comparison of average price and average strike options

### **Lookback options**

*These "no regrets" options offer the best price on an asset*

- \* Applications and hedging with look back options
- \* Why are they so expensive?
- \* Pricing of lookback options
  - the Goldman-Sosin-Gatto equivalent portfolio
  - simple FX option plus 'strike bonus' option
- \* Impacts on option derivatives
- \* The black-hole in the pricing formula

### **Passport Options**

*The "perfect trader option". It allows you to trade in a specific contract, keep all the profits but suffer none of the losses*

- \* How to create an attractive contract
- \* Pricing and hedging the passport option

## DAY FOUR

### Options on many underlying assets

#### **Outperformance Options**

*Options which allow the holder to exchange one asset for another*

- \* Pricing using
  - The Margrabe or adjusted Black-Scholes Model
  - The B-Land simplification
- \* Determination of Greeks on two assets
- \* Hedging the exchange options for investors

#### **Rainbow Options**

*Options which allow the best performing asset in a market*

- \* Best of two or cash
- \* Monte Carlo techniques for more than two assets
- \* Estimating correlations
- \* Applications of rainbow options for investors

#### **Spread Options**

*These give you the spread between a refined product and an unrefined product*

- \* Crack spread options
- \* Trading on the Nymex
- \* Heating oil vs. crude oil
- \* White sugar vs. raw sugar
- \* Pricing them using a quadrinary tree

#### **Basket Options**

*Options which allow the holder to buy or sell a basket of underlying assets*

- \* Baskets of foreign currencies
- \* A comparison of a European on a Basket with a Basket of Europeans
- \* Diversification reduces volatility
- \* Pricing basket options as an application of Asian options
- \* How major corporations can use Basket options to reduce option premiums
- \* For further reductions in premiums, corporations use Asian options on the basket

### **Equity Linked Forex Options (Quanto)**

*A combination of equity and forex options rolled into one*

- \* The different types of options
  - FOREIGN EQUITY OPTION STRUCK in DOMESTIC CURRENCY
  - FIXED EXCHANGE RATE FOREIGN EQUITY OPTION (QUANTO)
  - EQUITY LINKED FOREIGN EXCHANGE RATE OPTION
- \* Pricing of quantos
  - a simple technique to 'quanto' any option
- \* Hedging quanto options
  - construction of hedged portfolio
  - impact of correlations of equity and foreign exchange

### **Interest Rate Options**

- \* What are the products
  - Swaptions
  - Captions
  - Floptions
  - Ratchet swaps
- \* Different valuation models: Black Derman and Toy (BDT), Heath Jarrow Morton (HJM), Vasicek etc.
- \* Advantages and disadvantages of the models
- \* Contingent premium caps and floors

### **Convertible bonds**

- \* Why use them
- \* Why they are not a bond plus an equity option
- \* Two factor model valuation techniques
- \* What are their special features
- \* The special risks of convertible bonds
- \* Mandatory convertibles

### **Structured notes and reverse engineering workshop**

*In this workshop, we examine several structures. For each structure we cover*

- \* Definition - what is the structure called
- \* Example - using a real life example
- \* Motivation - why would a borrower issue the note? why would an investor purchase the note? under what conditions, views or interest rates?
- \* Pricing - how is this structure priced
- \* Sensitivity - how will the note perform under various scenarios (parallel shifts, flattening or steepening of the yield curve etc.) What about volatility swings?

\* Hedging - how can the bank hedge the option embedded in the note? What solution can the bank provide to a client who has purchased this structure?

\* Alternatives - what other structures are there which offer similar behavior under various possible market conditions?

**Some of the products covered**

- Index amortizing Note
- Range floater
- Puttable Libor Note
- Yield Curve Flattening Note
- Callable Libor Note
- Multi Step Up Callable Bond
- Pay as you go Rally Cap
- Principal Protected Cap
- Strypes, Decs, Elks and Perks
- The E-Signs

**Course Ends**

- Conclusions
- The future of the exotic options market