

# Bringing Exotic Models Home

## Presentation to RMC 2010

Izzy Nelken  
*Super Computer Consulting, Inc.*  
3943 Bordeaux Drive  
Northbrook, IL 60062  
(847) 562-0600  
[www.supercc.com](http://www.supercc.com)  
[www.optionsprofessor.com](http://www.optionsprofessor.com)  
[info@supercc.com](mailto:info@supercc.com)

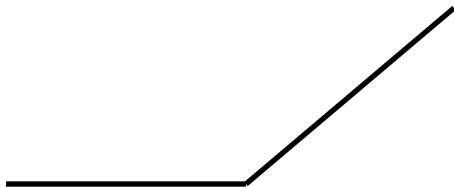
# Plan of talk

1. Digital/Binary Options
2. Contingent Premium Structures
3. Ratchet Options
4. Asian Options
5. Barrier Options

# Normal and Binary Options

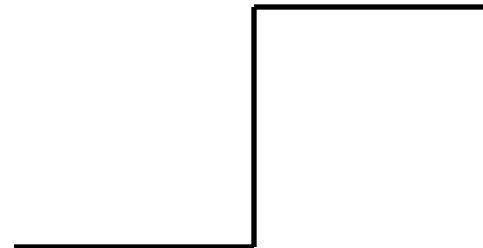
## Normal options

- Pay the difference between the stock and the strike
- “Hockey stick” diagram



## Binary options

- Pay a fixed amount if the option expires in the money
- Level diagram



# CBOE Binaries



*"CBOE's binary options provide a straightforward way for investors to act on their views of two of the most closely followed indexes in the world, the S&P 500 and the CBOE Volatility Index,"*

*"These products will appeal to the broad range of market participants, including individual investors, hedge funds and institutions, who have an opinion, one way or another, on future price movements in SPX or the VIX."*

*CBOE Chairman and CEO William J. Brodsky*

# BSZ Quote Page

CBOE - Delayed Market Quotes - Windows Internet Explorer

http://cboe.com/DelayedQuote/QuoteTable.aspx

File Edit View Favorites Tools Help

Trading Center

optionsXpress Online Options, Stock, & Futures Brokers

tradeMONSTER LEARN MORE

thinkorswim Member FINRA | SIPC | NFA TRADE NOW

BE A SMARTER TRADER. TAKE A SCHWAB WEBINAR charles SCHWAB

**BSZ** (CBOE BINA OPT S&P 500 INDX) **1073.87 -10.66**

Jan 31, 2010 @ 11:35 ET

Calls	Last Sale	Net	Bid	Ask	Vol	Open Int	Puts	Last Sale	Net	Bid	Ask	Vol	Open Int
10 Feb 1060.00 (BSZ1020B1060-E)	0.82	-0.03	0.57	0.70	150	300	10 Feb 1060.00 (BSZ1020N1060-E)	0.0	0.0	0.30	0.43	0	0
10 Feb 1070.00 (BSZ1020B1070-E)	0.0	0.0	0.50	0.63	0	0	10 Feb 1070.00 (BSZ1020N1070-E)	0.0	0.0	0.37	0.50	0	0
10 Feb 1075.00 (BSZ1020B1075-E)	0.79	0.0	0.46	0.59	0	350	10 Feb 1075.00 (BSZ1020N1075-E)	0.42	0.0	0.41	0.54	0	3
10 Feb 1080.00 (BSZ1020B1080-E)	0.0	0.0	0.41	0.54	0	0	10 Feb 1080.00 (BSZ1020N1080-E)	0.0	0.0	0.46	0.59	0	0
10 Mar 1025.00 (BSZ1020C1025-E)	0.0	0.0	0.69	0.81	0	0	10 Mar 1025.00 (BSZ1020O1025-E)	0.0	0.0	0.20	0.30	0	0
10 Mar 1050.00 (BSZ1020C1050-E)	0.0	0.0	0.60	0.73	0	0	10 Mar 1050.00 (BSZ1020O1050-E)	0.0	0.0	0.27	0.40	0	0
10 Mar 1075.00 (BSZ1020C1075-E)	0.0	0.0	0.50	0.62	0	0	10 Mar 1075.00 (BSZ1020O1075-E)	35.00	0.0	0.38	0.50	0	0
10 Mar 1100.00 (BSZ1020C1100-E)	0.0	0.0	0.36	0.49	0	0	10 Mar 1100.00 (BSZ1020O1100-E)	0.0	0.0	0.51	0.64	0	0

PLEASE NOTE: IT IS STRICTLY PROHIBITED TO DOWNLOAD DELAYED QUOTE TABLE DATA FROM THIS WEB SITE BY USING AUTO-EXTRACTION PROGRAMS/OUERIES

start | Windows Explorer | Microsoft PowerPoint | 07\_binary [Compatibl... | CBOE - Delayed Mark... | 10:36 AM

# Example

**Trading Center**

thinkorswim  
Member FINRA | SIPC | NFA  
TRADE NOW

optionsXpress  
Online Options, Stock,  
& Futures Brokers

tradeMONSTER  
LEARN MORE

optionshouse  
Start Saving Now

**BSZ1020B1075** (2010 Feb 1075.00 Call)      0.79    0.0    ●

**Price Data Table**  
Jan 31, 2010 @ 11:36 ET (DELAYED 15 MINUTES)

Last Sale	0.79	Tick	Down
Time of Last Sale	01/22/2010 16:00	Exchange	CBOE
Net Change	0.0	Previous Close	0.79
Open	0.0	High	0.0
Bid	0.46	Low	0.0
Ask	0.59	Volume	0
Open Interest	350	Expiration Date	02/19/2010

start | 2 Windows Explorer | Microsoft PowerPoint | 07\_binary [Compatibl... | CBOE - Delayed Mark... | 10:37 AM

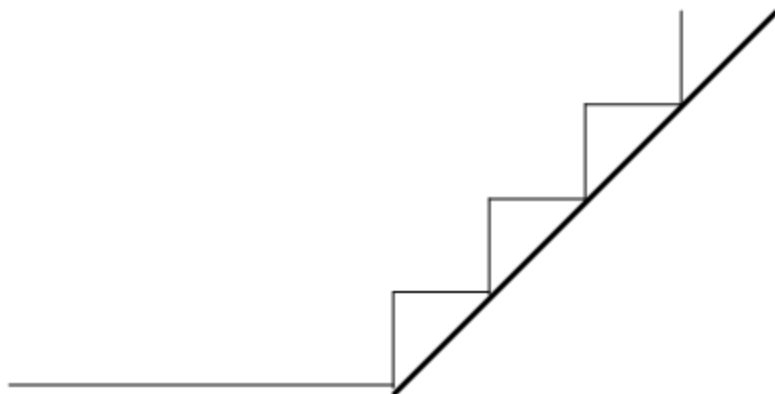
Clipboard Paste

Font: Times New Roman, 18, Bold, Italic, Underline, Text Color, Background Color

Paragraph: Bullets, Numbering, Indentation, Paragraph Spacing, Line and Paragraph Spacing, Text Wrapping

Styles: Normal, No Spacing, Heading 1, Heading 2, Change Styles

\* A European can be approximated by digitals as follows:



Clipboard Paste

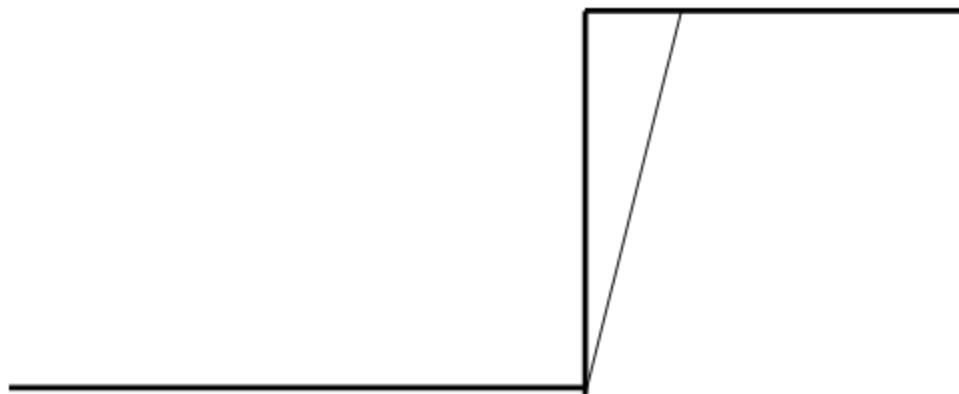
Font: Times New Roman, 18, Bold, Italic, Underline, Text Color, Background Color, Font Color

Paragraph: Bullets, Numbering, Indentation, Paragraph Spacing, Line and Paragraph Spacing, Text Wrapping, Text Direction

Styles: Normal, No Spacing, Heading 1, Heading 2, Change Styles

A digital can be approximated by Europeans.

|



# Replication

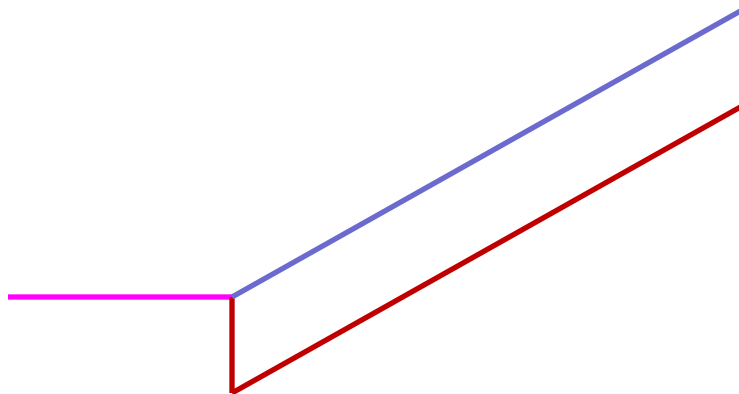
- The idea is to be
- Long one European at  $K$
- Short one European at  $K+1$
  
- Or in general
- Long  $1/e$  Europeans at  $K$
- Short  $1/e$  Europeans at  $K+e$
  
- Digital calls are hedged with a bull spread with a 20 tick difference unless volatility is lower than 10% in which case we move to two bull spreads with a 10 tick difference

# Delta

- Exact hedging close to the strike and close to expiration is impossible
- The “delta” is not defined

# Contingent Premium Options

- Long one European call option at strike  $K$
- Short  $f$  digital call options at strike  $K$
- Find  $f$  so the premiums will exactly match

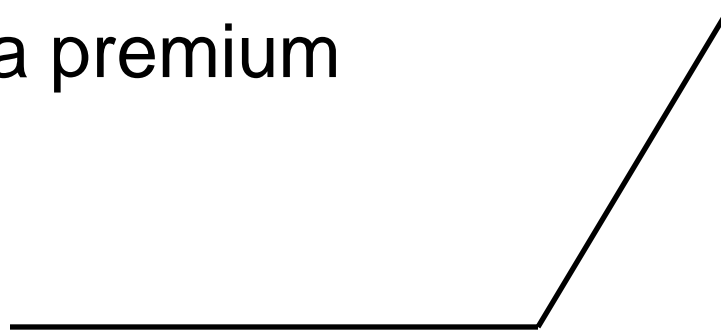


# Continent Premium - Explained

- You pay nothing at the beginning.
- In a sense, the investor is using digital options to “borrow” the premium from the future payout, whether or not it will exist.
- The advantage is that if you are wrong, you do not have to pay a premium.
- The disadvantage is that you will have to pay on the digital even if you are correct. Also, when you are correct, you receive less than you would have earned with a regular European.
- If the underlying closes just above  $K$ , the digital is in the money. The investor (who is short the digital) has to pay. The European pays almost nothing. The payment is roughly twice the original premium of the European
- As the underlying price increases, the European pays more and more, eventually catching up with the digital.
- At high levels, the European will pay more than the digital
- This is sold as an alternative to “buy a put, finance with a call”

# Hedging the Index

- Assume you own the S&P 500
- Hedging alternatives
  - Buy a Put option
  - You have the upside but protected from a drop
  - Paid a premium



# No premium paid

## Long put, short call

- Buy a put
- Sell a call

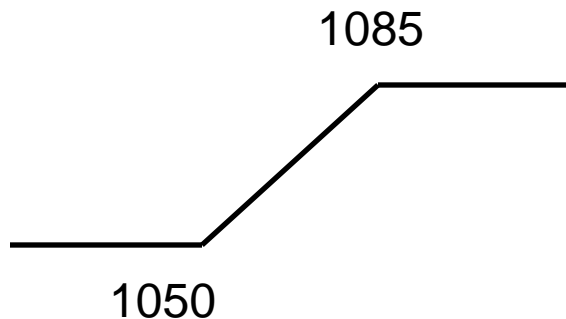
## Use contingent premium

- Buy a put
- Sell  $f$  digital puts against it

On 1/29/2010, the .SPX was at 1073.87, March expiration (trading at mid price)

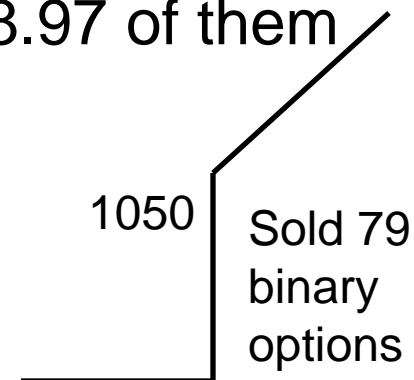
## Buy put, sell call

- Put at 1050  
Priced at 26.60 – 27.10  
Mid price 26.85
- Call at 1085  
Priced at 26.10 – 26.60  
Mid price 26.35



## Buy put, sell binary puts

- Put at 1050  
– Mid price 26.85
- BSZ put at 1050  
Priced at 0.27 – 0.40  
Mid price 0.34
- Sell 78.97 of them



Times New Roman 18

**B** *I* U abc x<sub>2</sub> x<sup>2</sup> Aa ab A

Font

☰ ☷ ☹ ☺ ☻ ☼ ☽ ☾ ☿ ☽ ☾ ☿ ☽ ☾ ☿

☰ ☷ ☹ ☺ ☻ ☼ ☽ ☾ ☿ ☽ ☾ ☿ ☽ ☾ ☿

Paragraph

AaBbCcDd

↑ Normal

AaBbCcDd

↑ No Spaci...

AaBbC

Heading 1

AaBbC

Heading 2

AA

Change Styles

Fi

ab ac Re

Se

## \* Different types of contingent premium options

In the standard contingent premium option, both the European and the digital have the same strikes.

The strike of the digital may be lower or higher than the strike of the European.

Suppose the strike of the digital is lower than that of the European.



# Ratchet Options

*Options whose payout can only go up, never down*

- Starts out as a normal call option.
- It has a set of fixing dates
- On every fixing date, the strike of the option is reset. Also, if there is any intrinsic value, it is locked in and will be paid on expiration.
- In France, these are called "Cliquet"

# Example

- Strike = \$100, Spot = \$100
- On the first fixing date the underlying is \$102. The strike is set to \$102 and the investor is guaranteed to receive at least \$2.00
- On the second fixing date the underlying is \$101. The strike is now set to \$101 and the investor does not lock in anything
- 
- On the third fixing date the underlying is \$105. The investor locks in \$4 and the new strike is reset to \$105.00
- 
- At expiry the underlying is \$106, the investor will receive the sum total
- $\$2 + \$4 + \$1 = \$7$

# Application

- Bonus computation for portfolio managers. Their bonus is tied to the performance of the fund. Assume we evaluate the performance quarterly and that our PM does well for two quarters but losses in the third and fourth. The PM will still get the bonus based on the first two quarters.

# Example

- Lincoln Benefit Life (a subsidiary of Allstate) has been marketing the Saver's Index Annuity
- You invest for eleven years
- Each year, the contract value is increased based on the increase of the SP500 times your participation rate (where the participation rate is not more than 1)
- The interest rate is capped by a maximal annual interest
- 
- After eleven years, you can withdraw or stay for another seven
- You can withdraw during the eleven years by paying a "surrender charge"
  
- Other names for similar structures:
  - Multiperiod Strike Reset Option (MSRO)
  - Stock Market Annual Reset Term (SMART)



## Annual Reset Crediting Strategy

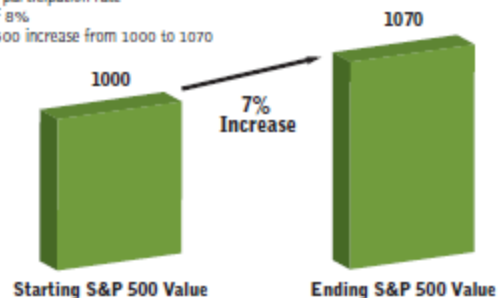
Ruth is looking for a simple and easy way to protect her money while she continues to enjoy her family and travel. Therefore, Ruth selected the Annual Reset Crediting Strategy. The Annual Reset Crediting Strategy allows Ruth to lock in credited interest annually each contract year. This strategy keeps things simple for Ruth.

### Annual Reset Crediting Strategy

Your credited interest is based on the percentage change in the S&P 500® value from the beginning of the contract year to the end of the contract year. For purposes of determining credited interest, the S&P 500 increase is multiplied by a participation rate of up to 100%, and subject to a floor of 0% and a cap that may change each contract year. Interest is credited annually and a new S&P 500 starting index point for the coming contract year is established.

#### The chart below assumes:

- First year of the contract
- \$100,000 single premium payment
- 100% participation rate
- Cap of 8%
- S&P 500 increase from 1000 to 1070



Ruth receives the full S&P 500 increase since it is below the cap of 8%. Based on the index increase, her contract value is

There are more important things that Ruth wants to pay attention to: her travels, her music, and her grandchildren.

“I’m looking for a reliable alternative to investing in the market that I don’t really have to think about.”

–Ruth

# Ratchet & Forward Start

- Ratchet options are composed of a sequence of “Forward Start” options
- e.g. A three month forward start option issued in three months
- The strike will be determined to be ATM three months from now
- The option expires three months after that (in six months)
  
- If dividends are zero, interest rates and volatility are constant then the price of a forward start option is equal to the price of a three month European option

# Asian Options

- *Options whose payoff is based on the average price*
- $\text{Max}(A-X, 0)$
- The average takes the role of the spot price in the payoff formula

## Annual Reset with **Monthly Averaging** Crediting Strategy

Tom and Eileen are extremely cautious when thinking about their retirement. They want to make sure that they are prepared for the future. Therefore, Tom and Eileen selected the Annual Reset with Monthly Averaging Crediting Strategy. The Monthly Averaging Crediting Strategy helps dampen the effect of a drop in the S&P 500® near the end of the contract year. This strategy tends to provide greater growth potential in flat or volatile market environments.

### Annual Reset with Monthly Averaging Crediting Strategy

At the end of each contract year your interest will be calculated by comparing the beginning S&P 500 value to the average value throughout the year (based on the S&P 500 values on the last day of each contract month). For purposes of determining credited interest, the S&P 500 increase is multiplied by a participation rate of up to 100%, and subject to a floor of 0% and a cap that may change each contract year.

#### The chart below assumes:

- First year of the contract
- \$100,000 single premium payment
- 100% participation rate
- Cap of 12%
- Starting S&P 500 index value of 1000
- Average monthly index value of 1065
- S&P 500 increase of 6.5%



**Tom and Eileen have big plans for their future. And they're doing the planning they need to see that their nest egg gets them there.**

“We plan on retiring, but we’d like our money to keep going to work every day.”

–Tom & Eileen

# Winterthur Insurance

- Issued life insurance in Switzerland. The payoff of the insurance policy is tied to the Swiss Market Index (SMI). Not to the level of the index but to the average
- If someone dies during a market crash, the policy still pays out

# Three important dates

- In Today
- Start Average
- Expiration (=End Averaging)

If today is before the start – “deferred averaging”

Then, we get to the start averaging date

Finally, we are already inside the averaging process

After a while, the payout is almost determined.

Gamma drops lower and lower (in contrast with Vanilla options)

# Pricing Models

- Most are based on Geometric Averaging
- $A = (x+y)/2$
- $G = \sqrt{xy}$

# Barrier Options

- *Options which become activated or extinguished if the underlying ever crosses a barrier*
- In addition to a strike price (denoted by  $X$ ), it also has a barrier level (denoted by  $B$ )
- Knock-in options : Become “activated” (or “alive”) if the underlying ever crosses the barrier
- Knock-out options : Become “extinguished” (or “die”) if the underlying ever crosses the barrier
- For a call option:
  - A down and out call with  $B \leq X$  is a “nice” barrier
  - An up and out call with  $B > X$  is a “nasty” barrier, RKO

# Rebate

- If a knock-out option gets knocked-out
- or
- a knock-in option fails to materialize
  
- the investor may receive a cash rebate

# Bull Spread vs. Barrier

- Buy a Call at 100
- Sell a Call at 120
- Buy an up and out Barrier call with a strike of 100, a barrier at 120 and a rebate of 20

# Barrier Breach

- An important question (sometimes a legal issue)
- Some banks (e.g. SBC Warburg) have the following policy:
- “No employee shall place or execute an order or initiate a spot transaction for the purpose of causing or preventing the occurrence of a barrier event. A violation of this policy is a serious offense that could result in dismissal”

# “flavors”

- Discretely monitored Barriers (e.g. the CAPs at the CBOE)
- Window options

# Replicating a Barrier

- Long a call
- Short a put with strike such that
- $\text{Call} - \text{Knock out} = \text{Put}$

# Strange Greeks

- The Greeks may be positive or negative depending on the strike and the barrier

# Thank You

- Thank you for coming!