Options Markets

Puts, calls and options strategies

Readings and problems

- Chapter 20: how options work, and how they are traded.
- Readings: Sections 20.1-20.5; skip 20.6
- Problems
  - All concept check questions
  - Problem sets 5(a,b,c), 6, 8, 10, 17, 20, 23, 28
- Some of the terms used in these notes are actually introduced in Chapter 21.
What is a derivative?

- Security with a value that depends on (“derives from”) something else (“the underlying”), such as
  - The price of another security.
  - A weather observation (temperature, rainfall)
  - An outcome or event (like a default)
- With a derivative, you can effectively go long or short (profit from a rise or fall) in the underlying without actual ownership.
  - In the case of weather or an event, there may be nothing to own.
- Derivatives include put and call options, forward and futures contracts, swaps, and so on.

Call options

- An American call option gives the holder the right (but not the obligation)
  - to buy the underlying security (the “underlying”)
  - at a specified price (the exercise or strike price)
  - on or before a specified expiration (maturity) date.
- These basic features of the option are fixed when the option is created.
- To exercise the option, you notify your broker.
- Call options on individual stocks are traded on many exchanges and their prices are widely reported.
- Next: options on Michael Kors Holdings
  - [www.cboe.com](http://www.cboe.com) > Quotes and Data > Delayed Quotes.
The expiration date (21 December 2013) is encoded: A=Jan, B=Feb, … L=Dec.

KORS options are available for many more strike prices and maturities (going out to January 2016).
The **KORS\13L21\80.0** call

- The owner of the call has the right can buy KORS stock ...
  - at the *strike/exercise* price $X = 80.00 ...
  - up to and including the *expiration* date $T = 21$ Dec 2013.
- The market price of a call is the *premium*.
  - This call last traded at $4.10
- Recall: The underlying, exercise price and maturity are fixed when the option is created.
  - The market price (premium) can change.

Exercise and intrinsic value

- KORS stock is priced at $S = 82.14$.
- If we already owned the **KORS\13L21\80.0** call,
  - we could exercise our option to buy at the exercise price $X = 80$
  - ... and then sell the stock for $82.14$
  - ... realizing a gain of $2.14$.
- The *intrinsic value* of the **KORS\13L21\80.0** call is $2.14$.
- The intrinsic value is not a net profit because we didn’t include the cost of purchasing the call.
If exercising the option would cause a loss, the intrinsic value is zero

- The KORS\13L21\85.0 call has $X = 85$
- If we exercise the option (buy KORS stock at $85) and then sell the stock for $82.14, we'd have a loss.
- To cover both cases, we write
- *Intrinsic value* = \( \max(S - X, 0) \)
- If \( S - X > 0 \) the call is in the money.

Market prices of calls

- For the *KORS\13L21\80.0* call:
  - The intrinsic value is $2.14
  - The market price (last trade) is $4.10
- Market prices are almost always above the intrinsic value.
  - We'll see why in Ch. 21.
- If we buy the call and exercise it immediately, we’ll have a profit of $2.14 - 4.10 = -2.04$, that is, a loss.
Payoffs to call options

- The call’s intrinsic value at expiration (date $T$) is the payoff. 
  \[ Payoff = \text{Max}(S_T - X, 0) \]
- The profit at expiration is 
  \[ Profit = Payoff - \text{Cost of call} \]
- Problem: A call option with $X = 30$ purchased for $4$. If the stock price at expiration is 32, what is the payoff? The profit?
  $32 - 30 = \$2$
  $4 - 4 = -\$2$

In-class problem

- What are the intrinsic values (as of today), the implied payoffs (at expiration), and the implied profits (at expiration) associated with the following calls?

<table>
<thead>
<tr>
<th>Current option price</th>
<th>Exercise price</th>
<th>Current stock price</th>
<th>Intrinsic value</th>
<th>Assumed stock price at expiration</th>
<th>Implied payoff</th>
<th>Implied profit / loss</th>
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<td>98</td>
<td>1</td>
<td>95</td>
<td>0</td>
<td>-2</td>
</tr>
</tbody>
</table>

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Exercise and expiration

- If the option is *American*
  - Owner can exercise at any time up to and including the expiration.
- If the option is *European*
  - Owner can exercise only on the expiration date.
- American and European options are traded in both Europe and “America”.
  - US-traded puts and calls on individual stocks are American options.
  - US-traded puts and calls on stock indexes are European options

Size

- Most prices related to options (exercise prices, premia, etc.) are quoted “per share”
- Most calculations (payoffs, profits, etc.) are also “per share”.
- But the actual *size* of the standard option contract is 100 shares.
  - If a call is quoted at $9, you would actually have to spend $900 to buy it.
The creation of calls

- Who do we buy a call from?
  - Calls are generally not issued by underlying company.
  - Exception: managerial options
- A call is created when someone sells it.
- Example ...

Example

- Suppose
  - MSFT is currently trading at $100 per share.
  - No 10 Dec MSFT 100 call options exist ($X = \$100$).
- The options exchange decides to list the call.
  - Trading is now permitted.
- Andy believes that MSFT will go up.
  - He tells his broker: buy a 10 Dec MSFT 100 call.
- Beth thinks that MSFT will stay where it is or go down.
  - She tells her broker: sell a 10 Dec MSFT 100 call.
The brokers “meet” on the exchange and negotiate a price of (e.g.) $2.
  - Andy pays Beth $2 (per share).

Then
  - Andy owns (“is long”) a call.
  - Beth is “short” a call.
    - She has written a call.
    - She has received $2:
      - If Andy decides to exercise the call,
        Beth must deliver MSFT stock (at $100/share).

Long positions (buyers) = short positions (sellers)
  - zero net supply
  - “Open interest” = total long position (or short position)

Covered or not?

- If Beth owns MSFT, her call is covered.
  - “Beth has written a covered call.”
- If Beth does not own MSFT, her call is uncovered.
  - If the option is exercised, she’ll have to buy the stock (at the then-current market price).

When you write a call, you don’t need to already own the underlying.

In analyzing options, the convention is that the call is uncovered (unless explicitly noted otherwise).
Payoffs and profits for the call writer

- Suppose we are short one call with $X = 100$
  - Ignore the premium we initially received for the call.
- At expiration:
  - If $S_T = 110 > X$, the call will be exercised against us.
    - We’ll buy the stock at $S_T$, deliver it, receive $X$:
      - Payoff is $-(S_T - X) = -(110 - 100) = -10$
  - If $S_T < X = 100$, option expires unexercised:
    - Payoff = 0
- Payoff = $-\max(S_T - X, 0)$
- Profit = Payoff + Premium received

What does Andy get out of this?
  - If MSFT goes to 110, his net profit is $110 - 100 - 2 = 8$ (per share)
What does Beth get out of this?
  - If MSFT stays at 100, the call expires worthless. She keeps the $2 premium.
  - At expiration, Beth can write another call option, etc.
Problem: How can Andy be sure that Beth will be able to deliver the shares?
  - Andy is bearing Beth’s credit risk.
Clearing houses

Without a clearing house, the option buyer bears the seller's credit risk.

![Diagram showing the transaction flow between Call Buyer and Call Seller](image)

At time of trade: call $premium
At exercise: $X stock

At the time of exercise, there is a chance that the call seller might default.

With exchange-traded options, the clearing house steps in the middle immediately after the price is agreed upon.

![Diagram showing the transaction flow between Call Buyer, Call Seller, and Option Clearing Corporation](image)

At time of trade: Negotiate price

The ownership claims are transferred through a legal process called *novation*.

After the transfer, the OCC is the counterparty to both the original buyer and the original seller.
Funding the clearing house

- Customers who have written options must post margin.
  - All customers must post the same margin irrespective of their own individual credit worthiness.
- Clearing fees.
- Can a clearing house fail?

Open interest

<table>
<thead>
<tr>
<th>Name</th>
<th>Last</th>
<th>Chan</th>
</tr>
</thead>
<tbody>
<tr>
<td>(KORS) MICHAEL KORS HOLDINGS</td>
<td><strong>$82.14</strong></td>
<td><strong>1.0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chain Type</th>
<th>Calls and Puts</th>
<th>Options Range</th>
<th>Near</th>
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<tr>
<td>Calls</td>
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<td></td>
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<tr>
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<tr>
<td>KORS\t13L6\81.0</td>
<td>2.90</td>
<td>0.55</td>
<td>2.90</td>
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</tbody>
</table>

Buyers of the 13L21\80 call are long 1,396 contracts; sellers of the call are short 1,396 contracts.
Open interest

- Before trading starts, open interest = zero.
- If neither the buyer nor the seller has a pre-existing position, a new trade will increase open interest.
- In general, trades might increase, decrease or transfer a position.
  - Open interest might rise, stay the same, or fall.
- After each trade, look at everyone in the market. Are they long or short?
- An example ...

Example: changes in open interest

<table>
<thead>
<tr>
<th>Trade</th>
<th>Buyer</th>
<th>Seller</th>
<th>Long</th>
<th>Short</th>
<th>Open Interest</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Andy</td>
<td>Beth</td>
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<td>B</td>
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</tr>
<tr>
<td>2</td>
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<td>David</td>
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<td>B+D</td>
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</tr>
<tr>
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<td>Fiona</td>
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<td>B+D+F</td>
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<tr>
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<td>Ilsa</td>
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<tr>
<td>6</td>
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<td>Haley</td>
<td>G+I+E</td>
<td>B+F+H</td>
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...
Embedded problem: Compute the open interest

<table>
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</tr>
<tr>
<td>6</td>
<td>Emily</td>
<td>Andy</td>
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<td>...</td>
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Problem: Compute the open interest

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<td>B</td>
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<tr>
<td>3</td>
<td>David</td>
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<td>B+C+C</td>
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<tr>
<td>4</td>
<td>Cathy</td>
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<td>C+B+B</td>
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<td>5</td>
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<td>Emily</td>
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<td>Emily</td>
<td>Andy</td>
<td>A+D</td>
<td>C+B</td>
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<td>...</td>
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</tbody>
</table>
Options trading

- Some options (like the KORS puts and calls) are traded on public exchanges
  - Expiration dates and strike prices are standardized.
  - The clearing house takes the credit risk.
- Some options are traded “over the counter”
  - This market is mainly institutional.
  - The features of the option are customized.
  - There is no clearing house.
  - To execute a trade, a customer calls a dealer and negotiates.
  - There is no trade reporting.

Recent events

- When the gov’t contemplated what to do with Bear, Lehman, AIG, there was great uncertainty about consequences of a default on their derivatives positions.
  - Who were the counterparties?
  - What was their net exposure?
- The Dodd-Frank bill mandated
  - Centralized clearing
  - Exchange trading
The expiration codes for puts have M=Jan, N=Feb ... X=Dec

The KORS\13X21\82.5 put

- Gives the holder the right to sell KORS stock at $82.50, expiring on 21 Dec 2013.
  - To exercise, notify your broker.
- The holder of the put can buy KORS in the market at $82.14, and (by exercising the put) sell at $82.50, for a gain of $0.36.
  - This put is “in the money”
- **Intrinsic value** = \( \text{Max}(X - S, 0) \)
Problem

- When XYZ stock is trading at 30, we pay $6 to purchase a put option with X=$35. At expiration, the price of the stock is $27.
  - Payoff? \(+¥35 - ¥27 = ¥8\)
  - Profit? \(¥8 - ¥6 = ¥2\)

In-class problem

- What are the intrinsic values (as of today), the implied payoffs (at expiration), and the implied profits (at expiration) associated with the following puts?

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<tr>
<th>Current option price</th>
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<th>Intrinsic value</th>
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<th>Implied payoff at expiration</th>
<th>Implied profit / loss</th>
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</thead>
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<td>50</td>
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<td>95</td>
<td>98</td>
<td>0</td>
<td>90</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
Analyzing options at expiration, $T$

- The payoff can be defined as the intrinsic value at expiration.
- For a call buyer:
  \[ \text{Payoff} = \max(S_T - X, 0) \]
  and
  \[ \text{Profit} = \text{Payoff} - \text{purchase price of call} \]
- In this section, assume that options are European
- Looking ahead to $T$ we know $X$ and purchase price of call
  - We don’t know $S_T$?
- Graph payoff and profit as a function of $S_T$

A call with $X=100$, purchased for $14$:
A call with X=100, purchased for $14:

Payoffs and profits to the call **seller** (writer)
Payoffs and profits to a put buyer

**FIGURE 20.4** Payoff and profit to put option at expiration

Payoffs and profits to a put seller (writer)

**FIGURE 20.5** Payoff and profit to put option at expiration
Summary: long/short puts/calls

Long a call

Long a put

Short a call

Short a put

Problem: the returns to options

- XYZ is currently at $50/share. We believe it will go to $60 in the near term. We have $5,000 to invest.
- We can put the entire amount in call options. A call option with X=55 is selling for $0.50.
  - What is the % return if XYZ goes to 60? 45%
- As an alternative, we can buy 200 shares of XYZ on 50% margin.
  - What is the % return if XYZ goes to 60? 45%
10,000 Call X = 55

\[ S = 50 \]

\[ 50 \times 10,000 = 500,000 \]

\[ (60 - 55) \times 10,000 = 50,000 \]

5,000 \[ \rightarrow \]

5,000 \[ \rightarrow \]

50,000 \[ +900\% \text{ gain} \] \[ \times 45 \]

58,500 \[ -5,500 = 9 \]

Margin

\[ \frac{200}{5} \]

\[ 5,000 \text{ loan} \]

\[ 5,000 \text{ NW} \]

\[ -10\% \text{ } 45 \text{ NW} \]

\[ \frac{7,000}{5,000} \]

\[ 4,000 \text{ NW} \]

\[ -20\% \text{ } 12,000 \]

\[ \frac{5,000}{7,000} \]

\[ 7,000 \text{ NW} \]

\[ +40\% \]
Answer: the returns to options (calls)

- What is the % return if XYZ goes to 60? 45?
- If we put all of our NW in options, we can buy $5,000/0.50 = 10,000$ options.
  (That is, we can buy options on 10,000 shares. This would represent 100 option contracts, since each contract is 100 shares.)
- If the stock goes to 60, the payoff to each option is $60 - 55 = 5$ (per share). Our total payoff is then 50,000. Our profits are 45,000. This is a gain of 900% on our original NW.
- If the stock goes to 45, the options expire worthless. We’ve lost $5,000 (a –100% return).

Answer: the returns to options (margin)

- As an alternative, we can buy 200 shares of XYZ on 50% margin.
  - What is the % return if XYZ goes to 60? 45?
- If we buy on margin, our initial balance sheet is:
  - Assets: 200 sh @ 50 = 10,000
  - Liabilities: 5,000 loan, 5,000 NW
- If the stock goes to 60:
  - Assets: 12,000
  - Liabilities: 5,000 loan, 7,000 NW
  - The profits are 2,000. Relative to the original net worth, this is a 40% return.
- If the stock goes to 45:
  - Assets: 9,000
  - Liabilities: 5,000 loan, 4,000 NW
  - The profits are –1,000. This is a –20% return.
Options strategies

- A strategy combines one or more of
  - Calls, puts, underlying (stock),
  - Short and/or long positions are allowed.
- All options are assumed to expire at time T.
- At expiration:
  - Payoff = Value of long holdings – cost of settling short holdings
  - Profits = Payoff – (cost of purchasing long positions – proceeds from establishing short positions)

Payoff and profit graphs (sources)

- The payoff and profit graphs here were produced with Campbell Harvey’s Java programs at [www.duke.edu/~charvey/applets/java.html](http://www.duke.edu/~charvey/applets/java.html)
  - These programs are unsigned. To run them you might have to change your java security settings.
  - Graphs of Options Combinations
  - Graphs of Options Combinations (Advanced)
  - Graphs of Options Calculations (Black-Scholes valuation)
- Alternative payoff-graphing spreadsheets are posted to:
  - [http://www2.gsu.edu/~fncjtg/Fi8000/dnldpayoff.htm](http://www2.gsu.edu/~fncjtg/Fi8000/dnldpayoff.htm)
- LIFFE Options: a guide to trading strategies describes over fifty option strategies (download at www.euronext.com)
Speculating and call options: SEC v. Zhenyu ___
(allegations from SEC litigation release)

- Bare Escentuals, Inc. ("Bare") is a San Francisco, California cosmetics company.
- Defendant Zhenyu ___ is the brother of Bare's former Director of Tax.
- After he overheard his sister discussing a then-secret acquisition of Bare [in Dec 2009], he [purchased] Bare stock and options.
- [he purchased a total of 280 call option contracts in both his and his father's accounts.]
- After the news that Bare was being acquired became public, Bare's stock price increased over 40 percent.
- Zhenyu sold his Bare securities for illicit profits of over $157,000.
Put options and speculation: SEC v. Brett ___; David ___; Aaron ___; and Stephen ___ (allegations from amended complaint)

- Sequenom determined that previously released test data from its Down syndrome screening test could no longer be relied upon.
- Aaron learned about this prior to Sequenom’s public release of the information and tipped his brother Stephen.
- Stephen tipped Brett.
- Cohen tipped David.
- David purchased Sequenom put options.
- On announcement, Sequenom’s stock price [dropped] by more than 75 percent.
- David sold his Sequenom position for profits of more than $570,000.
When Protecting An Investment Raises Risks


This year’s volatile stock market is driving investors to a trading technique designed to trim their losses. Yet it can also backfire on those who are in the market for the long term.

The practice -- known as a "stop-loss order" -- calls for an individual stock to be automatically sold when its share price falls by a certain percentage or hits a designated price.

[But] consider what happened to the Stockbusters investment club, a group of about 25 Dallas women that has been meeting and picking stocks together for two decades. Earlier this year, the club members studied and then agreed to buy two energy company stocks, XTO Energy Inc. and Chesapeake Energy Corp.
[The] members put in a stop-loss order calling for the shares to be automatically sold if the prices dropped by 10%. Before the next monthly meeting, both stocks had been sold. Both then rebounded within weeks and continued to gain. "That didn't go well," says Nanci Roberts, the club's treasurer.

Jeremy Siegel, finance professor at the Wharton School ... thinks long-term investors should avoid stop-losses altogether.

Instead, he recommends a different tack: buying a "put," an option to sell the stock at a certain price on a certain date.

A put option covering 100 shares will cost just a fraction of your stock investment, ... and it can act as a buffer against quick price swings. If the stock price actually falls, the put will rise in value and trim your losses, tempering the pain of a downturn. If the price climbs, you will have given up some profit as insurance against a short-term loss.

Buying a stock and selling a call: a covered call
Options Pay Dividends for Fund: 'Covered Calls' Are Used to Reap Income, Smooth Volatility.

- WSJ, “Fund Track”, 6 Oct 2010, Brendan Conway
- While a steady stream of dividends can help investors weather a rocky stock market, a second, lesser-known defensive way to generate revenue is to sell options on those holdings.
- The Neiman Large Cap Value Fund (trading symbol NEIMX) takes this approach with big, stable dividend-paying companies such as fast-food giant McDonald’s Corp. and oil major Chevron Corp.
- The fund, which was launched in 2003, sells "covered call" options on the shares, setting up a second stream of income.
Straddles on Apple and Google

- WSJ, “Options”, 1 Oct 2010, Brendan Conway
- Goldman Sachs derivatives strategists John Marshall and Maria Grant told clients this week that both Google Inc. and Apple Inc. options seem inexpensive a few weeks ahead of their earnings reports.
- Here is how a Google strategy works in an options "straddle": In this move, investors aim to profit from volatile moves in a stock. They buy a protective put and a bullish call at the same "strike" price, setting up for the stock to move in either direction.
- Over the past eight quarters, Google's stock has moved a median 5.6%, the Goldman strategists found.
- At Thursday's prices, the straddle cost 5.4% of Google's share price. Thus, investors willing to bet on an average-or-higher swing on earnings don't even need to make a judgment whether tougher times are ahead.

A short straddle

Profit
Traders Are Betting Microsoft Stays Put

- WSJ, “Options”, 7 Oct 2010, Brendan Conway
- One big trader bet that Microsoft's stock will shrug off the good and the bad alike in coming weeks, a period that includes a smartphone unveiling and the company's earnings report.
- The investor echoed the market's muted Microsoft sentiment with an options "short straddle," a move for traders who expect a stock to stay in a range. In this case, the trade covers a six-week period including the technology giant's Oct. 28 quarterly earnings report as well as the expected Oct. 11 unveiling of smartphones using a revamped Microsoft mobile-operating system.

Problem: What combination of stocks, bonds, puts and calls (long or short) would have this payoff structure?
Bullish vertical spread: Call(low X) – Call(high X)
Collar = Stock + out of the money put − out of the money call

A collar in Juniper Networks

- WSJ, 19 Oct 2010, Donna Kardos Yesalavich
- There was ... pronounced volume in December options on network-equipment maker Juniper Networks Inc.
- A "collar" trade appeared to take place in which a trader was positioning for protection to the downside by selling December $31 calls to buy December $30 puts.
- The December $30 puts, which were priced at $1.57, make money if Juniper falls below $28.43 by Dec. 17.
- The December $31 calls, meanwhile, traded at $2 and turn a profit if Juniper slips to $29 by Dec. 17.
- “If it gets up to $31, you've sold the call that gives someone else the right to buy the stock ... By selling that you use that premium to buy a put.”
Strangle = Call + Put (with high X)

Gold 'Fear' Traders Turn to Miners of the Metal

- Brendan Conway, WSJ, 14 July 2011
- Gold has soared on European sovereign-debt woes and the U.S. debt-ceiling debate, but the wilder trading in many cases has targeted the companies that mine the metal ...
- Gold's rise to a record Wednesday helped trigger a rush of options trading on the Market Vectors Gold Miners exchange-traded fund and on a handful of individual mining stocks ...
- The biggest single gold-miner ETF trade was premised on outsize swings in the mining ETF in either direction, however, ...
- Employing a "strangle" strategy, traders bought both calls and puts expiring in August. A sharp move in either direction yields profits if the contracts are held to expiration by the middle of next month.
Other options strategies include ...

- Condor
- Iron Condor
- Iron Butterfly
- Call strip
- Put strip
- Calendar spread
- Diagonal calendar spread
- Jelly Roll
- Call ladder
- Put ladder
- Box
- Two-by-one ratio call spread
- Two-by-one ratio put spread
- Long/short straddle vs. call
- Long/Short straddle vs. put
- ... and so on

Strategies with borrowing or investing

- A $1-par discount bond matures at $T$
- The interest rate is $r$
  - The current market price ("$B$") is the present value of $1$ at rate $r$.
- A short position in $B$ corresponds to borrowing at rate $r$.
  - Recall: in portfolio theory (Ch. 6), a negative weight on the risk-free security corresponds to borrowing.
- In the Java programs, the bond is called "Treasury bills"
A portfolio with 50 $1-par T-bills

A principal-protected note:

\[ Call(X = 10) - C(X = 12) + Bond(Par = 8) \]

(This is a bullish vertical spread plus a bond.)
Principal Protected Notes Based on the Value of the S&P 500 Index

Description
Citigroup issued $10.27 million of Principal Protected Notes Based on the Value of the S&P 500 Index on February 25, 2010 at $10 per note.

This Principal Protected Note (PPN) does not pay periodic coupons, but instead pays a single amount at maturity depending on the final level of the S&P 500 Index. It is called ‘principal protected’ because the minimum payout of the note at maturity is the initial issue price, so long as Citigroup does not default.

If the S&P 500 Index on August 21, 2015 is lower than or equal to 1,108.01, investors receive the principal of the notes, $10. If the S&P 500 Index on August 21, 2015 is higher than 1,108.01, in addition to the $10 principal, investors will receive a return equal to the percentage increase, above 1,108.01, in the S&P 500 Index, up to a maximum of 50.00%.

Valuation
This PPN linked to the S&P 500 Index can be valued as a combination of a zero-coupon note from Citigroup, one long-at-the-money call option on the the S&P 500 Index, and one short out-of-the-money call option on the the S&P 500 Index. For reasonable valuation inputs this note was worth $8.67 when it was issued on February 25, 2010, because the value of the options investors gave Citigroup plus the interest investors would have received on Citigroup’s par debt was worth $1.33 more than the options investors received from Citigroup.
Put-call parity (Recall: Protective put = Stock + put)
Alternative: \( Bond(Par = 50) + Call(X = 50) \)

\[
\text{Value} = \begin{cases} 
50 & \text{if } X = 50 \\
0 & \text{otherwise}
\end{cases}
\]

Put-Call Parity

\[
\text{Put} = Bond + call - \text{stock} - \text{Bond} + call - \text{put}
\]

\[
\text{Stock} + \text{Put} \quad \text{has the same payoff} \quad \text{Bond} + \text{Call}
\]

- Useful for constructing payoff structures.
  - We can rearrange it like an algebraic equation.
- Useful for valuation
  - Law of one price: If two portfolios have the same payoff they should have the same market price.
Stock = Bond + Call − Put

Securities that resemble options (or contain “embedded options”)

- Warrants
- Callable bonds
- Convertible bonds
Warrants

- A warrant is a call option issued by the corporation.
- At exercise, the corporation
  - receives the exercise price
  - issues new shares
- Exercise may dilute the pre-existing stock.
  - The Black-Scholes formula must be adjusted for this dilution.
- Warrants are often issued in conjunction with other securities (as a “sweetner” to the sale).
- Detachable warrants may be sold off separately from the other securities (and may trade separately).
- Executive and employee stock options are similar to warrants.

Callable bonds

- A callable bond can be repurchased by the issuer.
- ABC issues a $1,000 bond, callable in 5 years at $1,050.
  - After the issue, ABC holds a call option on the bond.
- The buyer of the bond is (implicitly) short the call.
- If I purchase ABC’s callable bond, I hold a portfolio consisting of
  - A $1,000 non-callable bond.
  - A short position in a call with an exercise price of $1,050.
  - This is a covered call.
- These two components do not normally trade separately.
  - The call might be exercised against me if the market price of the bond exceeds $1,050.
- A callable bond will sell for less than a non-callable bond.
Recall: a convertible bond is a bond that may be converted into stock (at the holders option).

- Conversion ratio is # shares per bond.
- Conversion price is \((\text{par value of bond})/(\# \text{ shares})\)

This option is neither a put nor a call: it is an exchange option.

- Convertible bonds are generally callable.
- Like warrants, conversion generally dilutes existing equity.

Next slide: Figure 20.12