Lecture 9
Options (Part 1)

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Derivatives

- Derivatives are securities that "derive" their value from the price of other securities
- Derivative are contingent claims because their payoffs depend on the value of other securities
- Options and futures are examples of derivatives
- Derivatives can be powerful tools for both hedging and speculation

Options

- A call option gives its holder the right to purchase an asset for a specified price, called the exercise or strike price, on or before some specified expiration date
- A put option gives its holder the right to sell an asset for a specified price, called the exercise or strike price, on or before some specified expiration date

American and European Options

- An American option can be exercised at any time before expiration or maturity date
- A European option can only be exercised at the expiration or maturity date

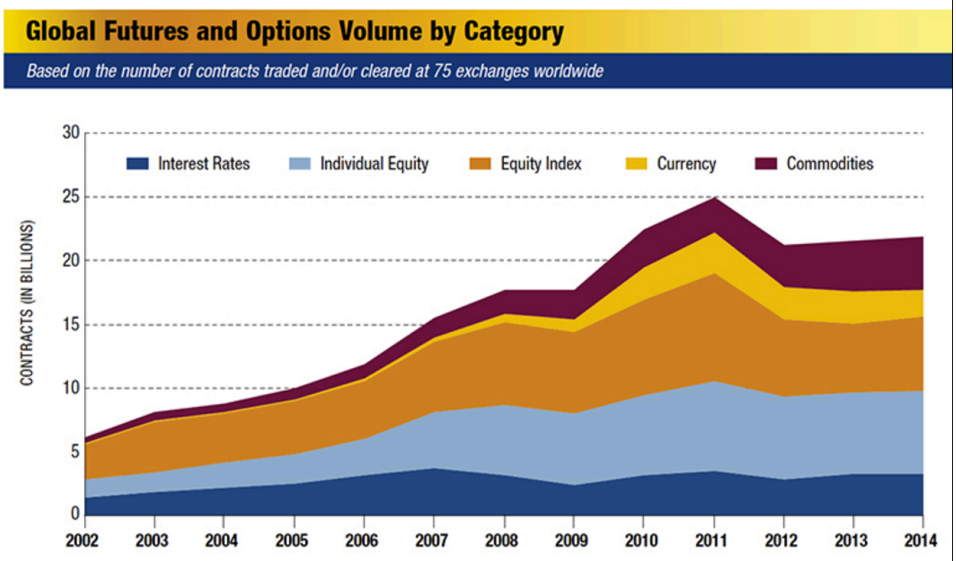
- In the US, most options are American style
- Examples of European options are index options and foreign currency options

Different Types of Options

- Stock Options
- Index Options
- Future Options
- Foreign Currency Options
- Interest Rate Options
- Precious Metal Options

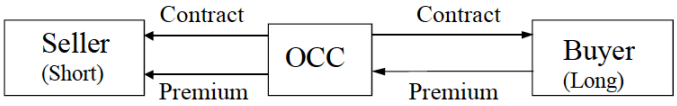
Option Markets

- Trading of standardized options contracts on a national exchange started in 1973 when the Chicago Board Options Exchange (CBOE) began listing call options
- In 2003, the International Securities Exchange in New York, displaced the CBOE as the largest options market
- Thailand Futures Exchange (TFEX) has been operating under the derivatives act since 2003
- In Asia, the Korea Exchange and India's National Stock Exchange are among the largest exchanges in terms of trading volumes of financial derivatives contracts



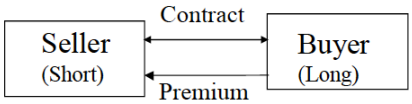
Option Markets

- Exchange-traded options



Standardized contracts that are less flexible, but more liquid market; Easy to reverse position; No counter party risk

- OTC (Over The Counter) options



Customized contracts; Illiquid market; Costly to reverse position; Counter party risk

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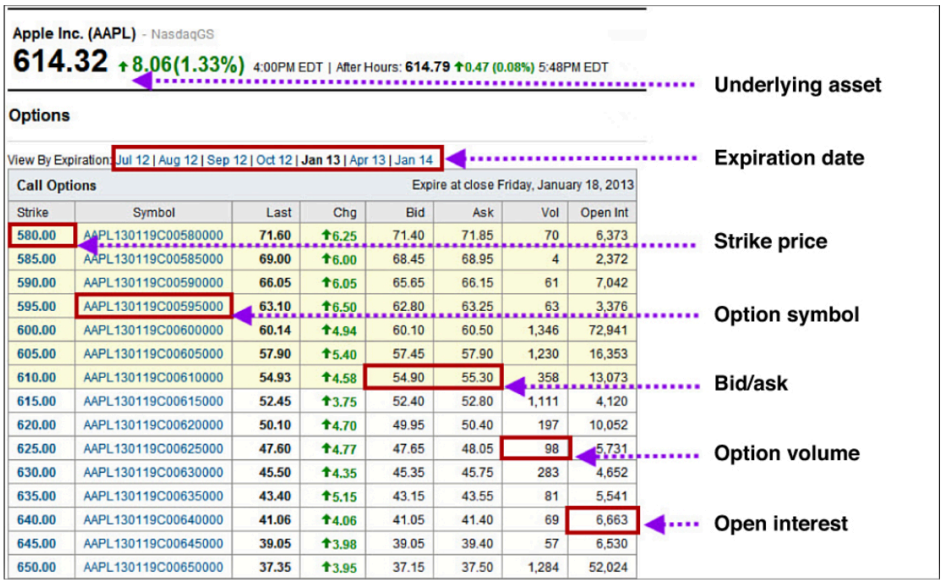
Options Contract

- The purchase price of the option option is called the premium
- Sellers (writers) of call options, who are said to write calls, receive premium income against the possibility that they will be required at some later date to deliver the asset in return for an exercise price less than the value of the market
- If the holder exercises the option, the option must make (call) or take (put) delivery of the underlying asset at the exercise or strike price on or before some specified expiration date
- If the holder does not exercise the option, the option simply expires and no longer has value



Strike	Symbol	Last	Chg	Bid	Ask	Vol	Open Int
580.00	AAPL130119C00580000	71.60	↑6.25	71.40	71.85	70	6,373
585.00	AAPL130119C00585000	69.00	↑6.00	68.45	68.95	4	2,372
590.00	AAPL130119C00590000	66.05	↑6.05	65.65	66.15	61	7,042
595.00	AAPL130119C00595000	63.10	↑6.50	62.80	63.25	63	3,376
600.00	AAPL130119C00600000	60.14	↑4.94	60.10	60.50	1,346	72,941
605.00	AAPL130119C00605000	57.90	↑5.40	57.45	57.90	1,230	16,353
610.00	AAPL130119C00610000	54.93	↑4.58	54.90	55.30	358	13,073
615.00	AAPL130119C00615000	52.45	↑3.75	52.40	52.80	1,111	4,120
620.00	AAPL130119C00620000	50.10	↑4.70	49.95	50.40	197	10,052
625.00	AAPL130119C00625000	47.60	↑4.77	47.65	48.05	98	5,731
630.00	AAPL130119C00630000	45.50	↑4.35	45.35	45.75	283	4,652
635.00	AAPL130119C00635000	43.40	↑5.15	43.15	43.55	81	5,541
640.00	AAPL130119C00640000	41.06	↑4.06	41.05	41.40	69	6,663
645.00	AAPL130119C00645000	39.05	↑3.98	39.05	39.40	57	6,530
650.00	AAPL130119C00650000	37.35	↑3.95	37.15	37.50	1,284	52,024

Notation

C_t: Price of Call Option at time t.

P_t: Price of Put Option at time t.

S_t: Price of Stock (or other asset) at t.

X: Exercise Price of Option.

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t (current time) T (Expiration Date)

Payoff/Profit of a Call

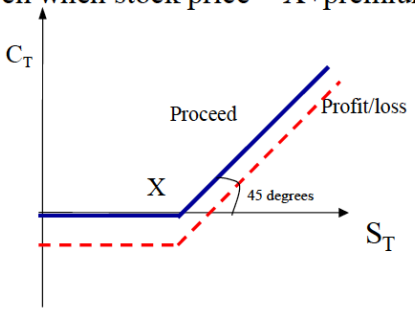
What is the payoff of a call at expiration, C_T?

Proceed = $S_T - X$ if $S_T > X$

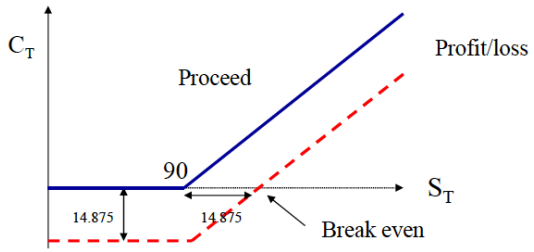
0 if $S_T \leq X$

Buy a call (long); profit loss= $\max(S_T - X, 0)$ – premium

Break even when stock price = X+premium

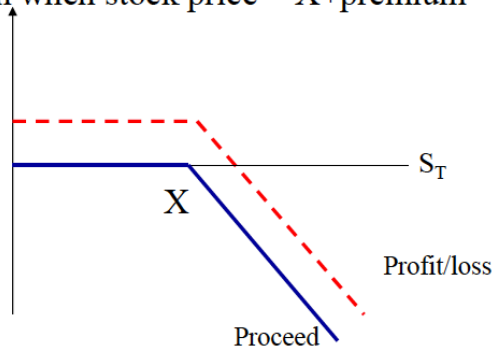


Long a January call option on
IBM: X=90 price = 14.875 (BKM Figure 20.2)



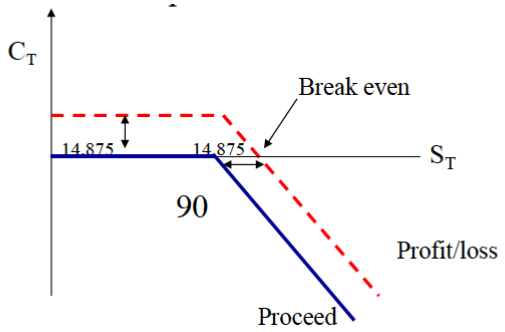
Payoff/Profit of a Call

Write (short) a call; proceed = $-\max(S_T-90,0)$
Profit/loss = proceed + premium
Break even when stock price = X+premium



Payoff/Profit of a Call

Short a January call option on IBM: X = 90 price = 14.875



Payoff/Profit of a Put

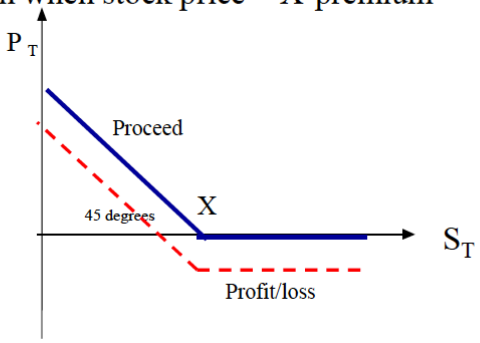
Payoff/proceed to a put holder at expiration

$P_T = 0$ if $S_T > X$

$X - S_T$ if $S_T \le X$

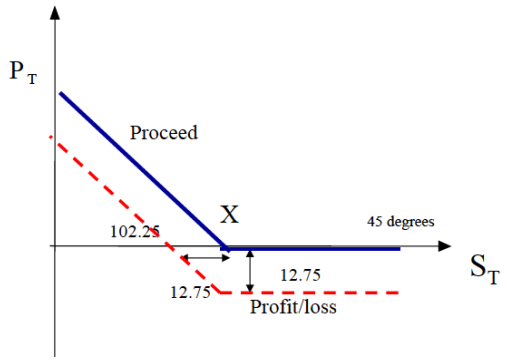
Buy a put: profit/loss=max(X- S_T,0)-premium

Break even when stock price = X-premium



Payoff/Profit of a Put

Long a February put option on IBM: X=115 price =12.75

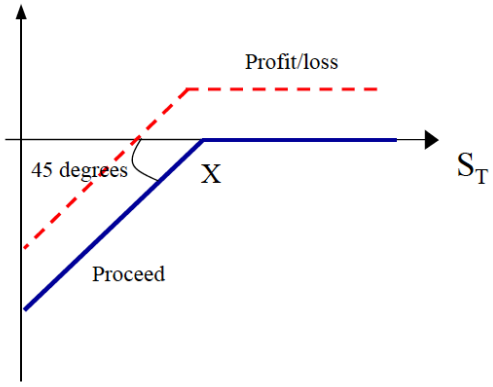


Payoff/Profit of a Put

Write (short) a put: Proceed = -max(X- S_T,0)

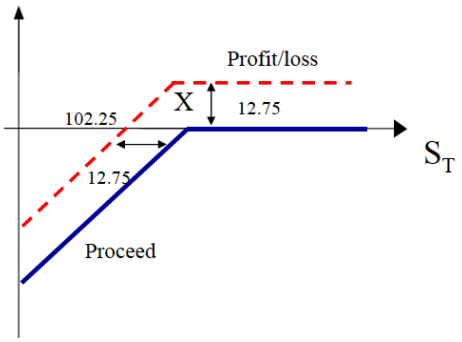
Profit/loss = proceed + premium

Break even when stock price = X-premium



Payoff/Profit of a Put

Short a February put option on IBM: X = 115 price = 12.75



ATM, OTM, and ITM

- An option is said to be in-the-money (ITM) when its immediate exercise would generate a positive cash-flow for its holder

→ Exercising the option would be profitable

- The option is said to be out-of-the-money (OMT) when its immediate exercise would generate negative cash flow

→ Exercising the option would not be profitable

- A put or call option is said to be at the money (ATM) when the exercise price equals the asset price

Quick Summary

- Short and long positions are mirror images of each other along the horizontal axis
- Long and short derivatives is a zero sum game; the gain to the long position equals the loss to the short position and vice versa
- Among buying a call, writing a put, writing a call and buying a put, which are bullish and which are bearish strategies? What are the differences between the strategies?

Strategies: Option versus Stocks

- Could a call option strategy be preferable to a direct stock purchase?
- Suppose you think a stock, currently selling for $100 will appreciate in value
- A 6-month call costs $10 (contract size is 100 shares) and the exercise price is $100
- You have $10000 to invest or you can buy T-bills that bear 3% interest

Options versus Stocks

- Strategy A: Invest entirely in stock. Buy 100 shares, each selling for $100.
- Strategy B: Invest entirely in at-the-money call options. Buy 1,000 calls, each selling for $10. (This would require 10 contracts, each for 100 shares.)
- Strategy C: Purchase 100 call options for $1,000. Invest your remaining $9,000 in 6-month T-bills, to earn 3% interest. The bills will be worth $9000*1.03=9270 at expiration.

Strategy Payoffs in 6 months

Portfolio	Stock Price					
	$95	$100	$105	$110	$115	$120
Portfolio *A*: All stock	$9,500	$10,000	$10,500	$11,000	$11,500	$12,000
Portfolio *B*: All options	0	0	5,000	10,000	15,000	20,000
Portfolio *C*: Call plus bills	9,270	9,270	9,770	10,270	10,770	11,270

Portfolio	Stock Price					
	$95	$100	$105	$110	$115	$120
Portfolio *A*: All stock	−5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
Portfolio *B*: All options	−100.0	−100.0	−50.0	0.0	50.0	100.0
Portfolio *C*: Call plus bills	−7.3	−7.3	−2.3	2.7	7.7	12.7

Rate of Return to Three Strategies

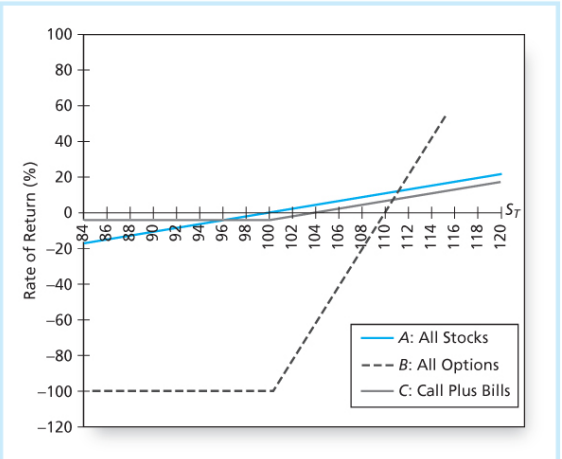


Figure 20.5 Rate of return to three strategies

Options versus Stocks

- The all-option portfolio, B, responds more than proportionately to changes in stock value; it is levered.
- Portfolio C, T-bills plus calls, shows the insurance value of options.
  - C's T-bill position cannot be worth less than $9270.
  - Some return potential is sacrificed to limit downside risk.

Strategy: Protective Put

- Options can be used for risk management, not just for speculation
- Puts can be used as a form of portfolio insurance against stock price declines
- Protective puts lock in a minimum portfolio value
- The cost of the insurance is the put premium
- A protective put strategy entails holding an asset and buying a put for portfolio insurance

Protective Put

- Hold market index (S&P 500)
- Buy a put option with premium = $10, X=800.

Strategy: Covered Call

- Covered call entails a purchase of a share of stock with a simultaneous sale of a call on that stock
- The call is "covered" because the potential obligation to deliver the stock is covered by the stock held in the portfolio
- A covered call position gives up some upside potential (any stock value above X) for income from call premium
- If you planned to sell the stock when the price rises above X anyway, the call imposes "sell discipline"
- Writing an option without an offsetting stock position is called by contrast "naked option writing"

Covered Call

Strategy: Straddle

- Long Straddle: Buy call and put at the same exercise price and maturity

Straddle

- The straddle is a bet on volatility
  - To make a profit, the change in stock price must exceed the cost of both options.
  - You need a strong change in stock price in either direction
- The writer of a straddle is betting the stock price will not change much

Strips and Straps

- Variations of straddles include strips and straps
  - A strip is two puts and one call on a security with the same exercise price and maturity date

- A strap is two calls and one put

Spreads

- A spread is a combination of two or more calls (or two or more puts) on the same stock with differing exercise prices or times to maturity
- Some options are bought, whereas others are sold, or written
- A money spread is the purchase of one option and the sale of another with a different exercise price
- A time spread is the sale and purchase of options with different expiration dates

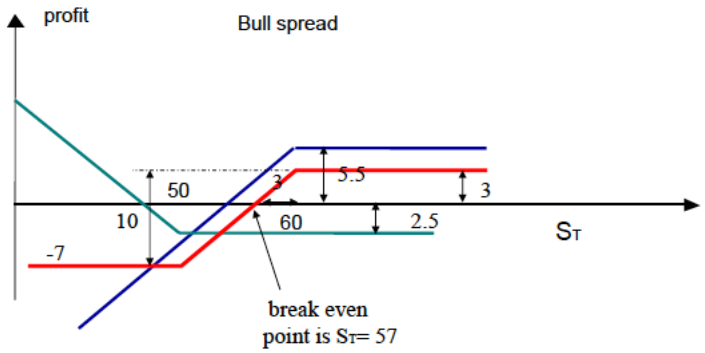
Bullish Spread

- Short call at X2 and long call at X1 for X1<X2

Bullish Spread

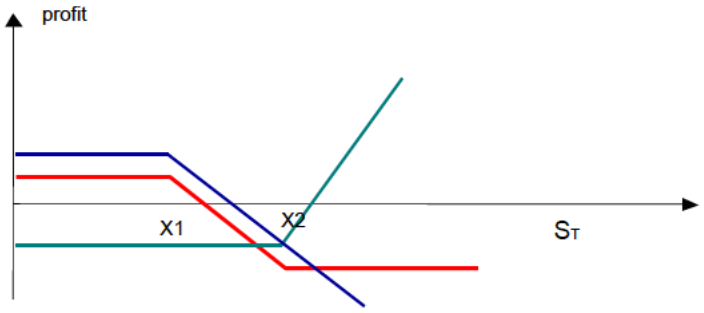
- Short put at X2 and long put at X1 for X1<X2
- Eg. Buy a put with X1 =$50 at $2.5 and sell a put with X2=$60 at $5.5

Bullish Spread



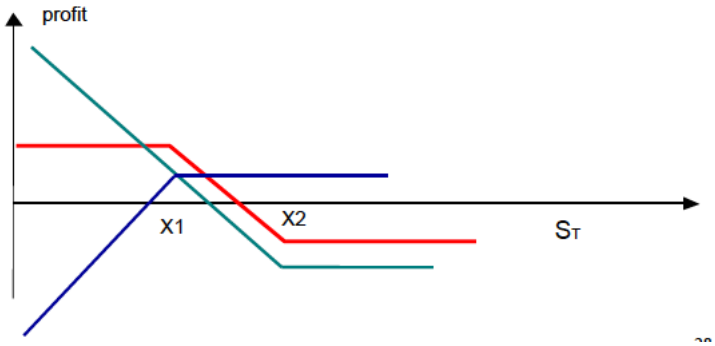
Bear Spread

- Short call at X1 and long call at X2 for X1<X2



Bear Spread

- Short put at X1 and long put at X2 for X1<X2



Collars

- A collar is an options strategy that brackets the value of a portfolio between two bounds.
- Buy a protective put to limit downside risk of a position.
- Fund put purchase by writing a covered call.
  - Net outlay for options is approximately zero.
- Limit downside risk by selling upside potential.

Collars

- Let $220,000 be your wealth goal to purchase a house. Your current wealth is $200,000 and let's say you are unwilling to risk losing more than $20,000.
- A collar that can help you realize $20,000 capital gain without risking a loss of $20,000 can be established by (1) purchasing 20000 shares of stock currently selling for $100 per share, (2) purchasing 2,000 put options (20 options contracts) with exercise price $90, and (3) writing 2,000 calls with exercise price $110.

Collars

Put-Call Parity

- As discussed earlier, a stock position with a covered put on the position provides a payoff with guaranteed minimum value but unlimited upside potential

- Buying a call with exercise price X and a risk free coupon bond that pays X at option expiry can also provide limited downside risk and unlimited upside potential

Put-Call Parity

- The payoff of the call plus bond is the same as buying a protective put on a stock
- Law of one price: Two investment strategies that have the same payoff in the future in all states of the world must have the same price today

With dividends

$$C_t = P_t + S_t - \frac{X}{(1+r_f)^{\tau}} - PV(\text{dividends})$$

Does not hold for American calls and puts that may be optimally exercised early

Put-Call Parity and Arbitrage

- IBM's current stock price is 110. A European call option on IBM with strike price 100 expiring in 6 months is priced at $15. The put price of the same strike price is $4. The interest rate for 6 months is 3%.
- Is there an arbitrage opportunity?
- Yes!

- How do we take advantage of this mispricing?

	Investment	S_T>100	S_T<100
Sell IBM put	4	0	-(100-S_T)
Buy IBM call	-15	S_T-100	0
Sell IBM stock	110	-S_T	-S_T
Lend money	-97.087	100	100
PV (100)			
Total	1.913	0	0

Option-like Securities: Callable Bonds

- The issuer has the option to buy back the bond at a predetermined price
- Callable bonds often have a call protection period
- Callable bond can be thought of as: straight bond+call option
- A callable bond should be selling at a lower price than a straight bond with the same cash flow

Convertible Bonds

- Gives the investor the right to return the bond and receive a predetermined number of stocks of the company
- The conversion ratio is the ratio of number of stocks the bond holder will receive per number of bonds
- Most convertible bonds are issued "deep out of the money"
- Conversion value is the value of the convertible bond if the bond is converted immediately
- Bond floor is the value the bond would have if it were not convertible into stock

Convertible Bonds

- Example: Bond A, maturity = 10 years, annual coupon = $80, conversion ratio = 20, current stock price = $30, value as straight debt = 967, value as convertible bond = 972.
- Conversion value =
- Bond floor =
- When the stock price is low such that the conversion value is much less than the bond value, the convertible bond price is close to the bond floor and it trades like a straight bond.

Warrants

- Call options issued by a firm
- When a warrant is exercised the firm issues a new share of stock and the total number of shares outstanding increases
- Warrants result in a cash flow to the firm when the warrant holder pays the exercise price
- Can be tailored to meet the needs of a firm
- Often issued in conjunction with other securities such as a bond or preferred stock as a sweetener
- Some employee stock options are warrants

Structured Warrants

- In many countries, selected financial institutions issue options on the shares of publicly listed securities.
- Such options are referred to as:
  - structured warrants (e.g. in Malaysia and Singapore),
  - derivative warrants (e.g. in Hong Kong and Thailand), or
  - equity-linked warrants (e.g. in Korea).

Exotic Options

- Asian Options
  - Payoff depends on the average price of the underlying asset during some portion of the option's lifetime
- Barrier Options
  - Payoff depends on whether the underlying asset price has crossed some "barrier"
- Lookback Options
  - Payoff depends on the minimum or maximum price of the underlying asset during the life of the option.
- Digital Options
  - Binary or "bet" options have fixed payoffs that depened on whether a condition is satisfied by the price of the underlying asset

Homework

- Chapter 20 # 7, 9, 10, 13, 26, 29