Background

- 2009-Date: Professor of Finance Practice, ASU
- 1998-2008: Bank of America/Countrywide
  Managing Director
  Managing Director
- Various positions in research, product management, sales and trading (Merrill Lynch; Security Pacific Merchant Bank; Imperial Credit and Franklin Savings)
- ASU Graduate (Ph.D. and MBA)
- 3 Books and 70 academic and professional publications
Derivatives and Markets

- **Derivative securities**
  - Financial instrument that offers a return based on the return of some underlying asset

- **Markets**
  - Exchange traded: standardization, traded on organized exchanges (CBOE, CBOT)
  - OTC: non-standardized, negotiated, traded anywhere else

- **Uses**
  - Hedging, speculation, or arbitrage
Forward Commitments

- Agreement between two parties in which one party, the buyer, agrees to buy from the other party, the seller, an underlying asset at a future date at a price established at the contract initiation.
- Main characterization: obligation by parties
- Types: forward contracts, futures contracts, swaps
Forward Contracts

- Purchase and sale of underlying asset (stocks, fixed income instruments and rates, currencies, commodities, etc.) at a later date at a price agreed upon today
- Non-standardized, customizable, OTC transactions between large financial institutions and/or corporations
- Private and largely unregulated market
Futures Markets

- Variation on a forward contract
- Public, standardized transaction that occurs on a futures exchange
  - Exchange determines expiration dates, underlying assets, size of the contracts, etc.
  - Default risk and the clearinghouse
    - Exchange is the counterparty in futures transactions

- Marking-to-market
  - Daily settlement where profits and losses are charged and credited to the short and long position each day

- Offsetting transactions
  - Ability to unwind positions prior to expiration
  - Take an opposite position to the original contract
Swaps

- Variation on a forward contract
- Agreement between two parties to exchange a series of future cash flows
  - Equivalent to a package of forwards
- At least one of the two cash flows are determined at a later date (plain vanilla interest rate swap)
  - Fixed and floating payments
    - Make known payments in exchange for something unknown
    - Conversion of one payment (say a fixed rate) to another (say a floating rate)
- Private, OTC transactions
Contingent Claims and the Option Market

- Contingent claims are derivatives where payoffs occur if a specific event happens.
- Options are financial instruments that give the option buyer the right, but not the obligation, to buy (CALL) [or sell (PUT)] an asset from [or to] the option seller at a fixed price on or before expiration.
  - Asymmetric payoffs
    - Buyer has the right, seller (or writer) has an obligation if the option is exercised
  - Strike or exercise price
  - Premium or option price
  - OTC and exchange traded options
The Good, The Bad, and The Ugly

- Purposes of Derivatives Markets
  - Risk management
    - Hedging: reduction or elimination of identifiable risks
    - Insurance
  - Price discovery and market efficiency: information about the prices of underlying assets
    - Commodity prices, volatility
  - Reduced transaction costs and leverage

- Criticisms
  - Complexity for un-sophisticated investors
  - Gambling critique
Arbitrage and Derivatives Pricing

- Arbitrage: equivalent assets or combination of assets sell for two different prices
- LOOP (law of one price)
  - Arbitrage will drive prices of equivalent assets to a single price so that no riskless profits can be earned.
Forward Markets and Contracts
Basics

- Long position: buyer in a forward contract
- Short position: seller in a forward contract

Settlement
  - Delivery
    - Long pays forward price to short
    - Short delivers underlying asset
  - Cash settlement
    - Pay net cash value on delivery date

Default risk

Termination prior to delivery
  - Offsetting position in a new forward (not necessarily zero price transaction; credit risk)
  - Cancellation
Dealers and End-Users

- Dealer: entity that makes a market in a financial instrument
  - Provides quotes (bid-ask spread) on the cost of and stands by as the counterparty to the transaction
  - Wholesaler of risk

- Engage in transactions with other dealers and end-users
  - End-users, such as corporations, generally has a risk-management problem
Equity Forwards

- Contract for the purchase/sale of an individual stock, portfolio, or index at a later date
  - Lock in a price today for a transaction in the future
  - Hedging
    - Need to sell stock/portfolio in several months
    - Concern that prices decline
    - Enter into a forward today to sell the assets to a dealer at expiration
    - Regardless of price moves, the selling price is locked in today
Fixed Income Forwards

- Forward contracts on bonds, bond portfolios and bond indices are similar in nature to equity forwards
  - Expiration vs. maturity
  - Coupons
  - Callability/convertibility
  - Default risk

- Zero-coupon bonds (T-bills)
  - Discount from par
  - Quoted in rates (discount), not price
  - Price conversion: $1 – [discount rate*(n/360)]

- Coupon bonds (T-notes and T-bonds)
  - Interest-bearing
  - Premium or discount
  - Price + Accrued Interest
FRAs

- Forward Rate Agreement: interest rate forward contract
- Eurodollar time deposits: deposits in dollars outside the US
  - Short-term unsecured loans
  - LIBOR: rate at which London banks lend dollars to other banks
  - 360-day add-on interest rate
  - Euribor: rate at which banks borrow euros
FRAs (con’t)

- Buyer of FRA (long): long the rate, benefits if rates increase
- Seller of FRA (short): short the rate, benefits if rates decrease
- Payoff (long):

\[
\text{Notional Principal} \left[ \frac{\text{Rate at Expiration} - \text{Forwardrate} \times /360}{1 + [\text{Rate at Expiration} \times /360]} \right]
\]

- \( n = \) days in maturity of underlying

- Two-rate notation
  - 1x3, 3x9, 6X12
Currency Forwards

- **Impetus:** move from pegged to floating exchange rates in late 1970s
  - Widely used by corporations and banks to manage foreign exchange risk
  - Currency forwards allow corporations to hedge
    - Lock in exchange rates today
    - Ex: receive euros, convert to dollars
      - Long euro, short dollars
      - Hedge: take a short forward (short euro, long dollars)
Pricing of Forward Contracts

Notation:

- $0 = \text{today, } T = \text{expiration, underlying asset } = S_{0(\text{or } t \text{ or } T)}$, forward $= F(0, T)$
  - Long value at maturity: $V_T = S_T - F(0, T)$
  - Short value at maturity: $V_T = F(0, T) - S_T$

- What is the value of a forward today?
  - $V_0 = S_0 - F(0, T)/(1+r)^T$, but

- A forward contract has a value of $F(0, T) = S_0(1+r)^T$
  - We can make adjustments to this basic formula for income paying assets, currencies and commodities

- Futures contracts are priced similarly
Review of Futures

- Public, standardized transactions on organized exchanges
  - Underlying asset, quality of asset, expiration dates (months and maturities), size of contract, price and position limits
    - Homogenization and liquidity = active secondary market
    - Ability to take offsetting positions
    - Clearinghouse
  - Marking to market: daily settlement of gains and losses between long and short positions
    - Long profits from price increases, short profits from price decreases
Margin and Marking to Market

- To open a position in the futures market, a party must deposit monies into a margin account with the clearinghouse.
  - Stock market margin = leverage (borrow up to 50%)
  - Futures margin = good faith or collateral (not borrowed)
    - Required by long and short positions
    - Set by clearinghouse and varies per futures contract
    - Gains and losses are charged or credited daily to the margin accounts by marking to market
  - Initial margin: amount deposited at beginning of the contract (usually less than 10% of contract value)
  - Maintenance margin: minimum margin balance that traders can hold before margin call
    - (1) deposit additional funds (variation margin) or (2) close out position
  - Settlement price: price at which marking to market occurs
## Marking to Market Example
### Long Position

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A note on margin calls: a price change exceeding the difference between the initial and maintenance margin will trigger a margin call. Marking to market occurs to collect losses and distribute gains in such a manner that losses are paid before becoming large enough to run the risk of default.
Some contracts impose limits on price changes that can occur from day to day: SP price limit

- Limit move: if transaction exceeds a price limit, price freezes at the limit
  - Limit up: price stuck at upper limit
  - Limit down: price stuck at lower limit
  - Locked limit: transaction cannot occur because price is beyond the limits
Closing Out the Position

- Three options:
  - Offsetting position: take identical, but opposite contract to existing position (>90% of all contracts)
  - Delivery: holder of oldest long contract to accept delivery
    - Accepts delivery and pays the previous day’s settlement price to the short
  - Cash settlement: Let position expire and margin accounts are settled for final marking to market

- Complications: high transactions cost for physical delivery, short can often determine when, what and where to deliver

- Exchange for physicals: arrangement of alternative delivery procedure acceptable to the exchange
The Players

- Locals: floor traders, liquidity providers, market makers
  - Scalper: buys and sells contracts, profit from changes in the spread
  - Day trader: holds a position longer than scalpers, but ends the day with zero inventory
  - Position trader: holds positions overnight
    - Day and position traders: attempt to profit from anticipated market movements
- Brokers: futures commission merchants
T-Bill Futures

- Based on a 90-day, $1 million T-bill
  - Recall: price = 1 – (disct rate*(n/360))
  - Example: rate = 6.25%; quoted futures price = 93.75, actual price = $1M*(1-(0.0625(90/360))) = $984,375
  - In T-bills, computing price changes is easy
    - 1 bp move = $25 price change
  - Trades on a M/J/S/D calendar
  - Cash settlement
  - Usurped by Eurodollar as the important short-term rate contract
Eurodollar Contracts

- CME contracts on 90-day, $1M notional principal of Eurodollars
- Prices are quoted in the same manner as T-bills
  - Cash settled
  - One of the most widely traded contracts because of use of LIBOR in swaps, FRAs and interest rate options
  - Unlike Eurodollar deposits, which have “add-on” interest, Eurodollar futures are quoted on a discount basis, like T-bills
T-Bond Contracts

- Very actively traded long term interest rate contracts on CBOT
  - Contract based on delivery of a T-bond with any coupon and at least 15 years to maturity.
    - Implies many bonds available for delivery
    - Short gets to determine which bond to deliver
      - Conversion factor puts all bonds on equal footing
      - Cheapest to deliver bond: Quoted price – (QFP * CF)
    - Contract = $100,000 par value of T-bonds
  - Physical delivery
  - Quoted in 32nds
Stock Index Futures Contracts

- S&P 500 Index contract (most highly traded)
  - Quoted in terms of price on the same order as the underlying index
  - Multiplier = $250 times futures price
  - M/J/S/D expirations (up to 2 yrs), but active trading limited to near term
  - Cash settled

- Other contracts
  - Mini S&P 500 ($50 multiplier)
  - S&P Midcap 400, Dow Index, Nasdaq 100, FTSE 100, Nikkei 225, etc.
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Swap Markets and Contracts
Swaps

- Agreement to exchange a series of cash flows
  - One payment generally determined by random outcome (rates, currencies, etc.)
  - One payment generally fixed
  - Long: party that receives floating
  - Short: party that receives fixed

- Generally involve a series of payments
  - Like a package of forward contracts

- Initial value of the swap is zero
Basics

- Settlement date: date on which parties make payments
  - Settlement period: time between settlement dates
  - Netting: generally parties agree to exchange only the net amount owed from one party to the other
  - Termination date: date of the final payment
  - OTC market, customized
  - Termination: cash settlement of market value, offsetting swap (default risk), sell swap, swaption
Currency Swaps

- Each party makes interest payments to the other in different currencies
- Four types of currency swaps
  - Fixed for fixed
  - Fixed for floating
  - Floating for fixed
  - Floating for floating
  - These can also be reversed in terms of currencies paid
  - We can also combine currency swaps to eliminate currency flows and obtain transactions in only one currency
US firm WEN want to open Wendy’s in London. Needs 8M British pounds to fund construction. Would like to issue fixed-rate pound-denominated bond, but not well known in United Kingdom. Issue in dollars and convert to pounds.

Issues $10M bond at 5.25%, swaps with NatWest in which NatWest will make payments to WEN in $/US at a fixed rate of 5.15%, and WEN will make payments to NatWest in pounds at a fixed rate of 5.00%. Payments on April 18 and October 18 of each year.

Swap: NatWest pays WEN 8M pounds; WEN pays NatWest $10M

Periodic payments: NW pays WEN (0.0515)(180/360)($10M) = $257,500; WEN pays NW (0.0500)(180/360)(8M) = 200,000 pounds

Maturity: NW pays WEN $10M; WEN pays NW 8M pounds

- Advantage: save on interest expense
- Disadvantage: assume some credit risk
Plain vanilla swap: interest rate swap in which one party pays a fixed rate and the other pays a floating rate

- Notional amounts must be equal for each party
  - For each payment (usually every 6 months) rates are multiplied by the fraction \( \text{N/360 or N/365} \), where \( N \) is the number of days in the settlement period
- No need to exchange notional principals since the swap is done in the same currency
- Netted transactions: if one party owes \$250\text{K} and the other owes \$245\text{K}, the party owing \$250\text{K} will pay the net difference (\$5\text{K})
- Never do both sides pay fixed in an IRS
Example

- Suppose on 4/18 that MSFT wants to borrow $50M for two years at a fixed rate of 5.75% (semiannual). Concern that rates will fall and wants to enter into a swap that will exchange fixed rate payments for floating rate payments. Approaches Citigroup and requests a quote to pay LIBOR + 25bps and receive a fixed rate of 5.45%.

- Fixed rates are based on 180/365 window while floating rates are quoted on 180/360 window. Currently LIBOR is a 5.25%.

- First floating payment from MSFT to C is $50M*(0.055)*(180/360) = $1.375M; this will change as LIBOR changes.

- First fixed payment from C to MSFT is: $50M*(0.0545)*(180/365) = $1.344M, this is the amount of all fixed payments.

- Net effect: MSFT pays 5.75%, pays LIBOR + 25bps, and receives 5.45% = LIBOR + 55bps.
Equity Swaps

- In an equity swap, the underlying rate is the return on a stock or index
  - Means that party making fixed rate payment could also have to make an floating rate payment based on the equity return
    - If return on the index is positive, the end-user typically compensates the dealer for that return
      - Dealer pays only fixed rate
    - If return on the index is negative, the dealer compensates the end-user for the fixed rate plus the shortfall in the index return
  - Payments not known until the end of the settlement period and can include div and cap gains
Equity Swaps (con’t)

- The fixed rate is set at the beginning of the swap and is based off of T/365 days, where T is the actual number of days in the settlement period
  - Payment = notional principal*fixed rate*(T/365)

- For the floating rate, it is determined by the HPR for the settlement period
  - Payment = notional principal*equity return

- Generally, equity swap payments are netted
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Option Markets and Contracts
Basics

- Buyer of an option has the right, but not the obligation to buy or sell an asset from the option writer at some future date for a price agreed upon today.
  - Call: right to buy a stock
  - Put: right to sell a stock
- Option price or premium
- Exercise (or strike) price: fixed price to buy or sell the underlying asset
- Expiration date and time to expiration
- Exercise: depends upon call or put
  - Call: long gives cash to short, who delivers the asset
  - Put: long sells asset to short, who delivers cash
More Basics

- European: exercise only on expiration
- American: exercise up to and including expiration
  - Generally, for each option, there are calls and puts, a variety of strike prices (X) and expiration dates that trade

Moneyness:
- ITM: Calls (S-X>0), Puts (X-S>0)
- ATM: Calls (S-X=0), Puts (X-S=0)
- OTM: Calls (S-X<0), Puts (X-S<0)

Option types
- Stocks, indices, bonds, currencies, interest rates, etc.
Interest Rate Options

- Option on which the underlying is an interest rate
  - Exercise rate
  - At exercise, the payoff is based on the difference between the underlying rate and the exercise rate
    - Differs from an FRA, since FRAs are commitments to make one interest payment and receive another at a future date
  - IRC: option holder has the right to make a known interest payment and receive an unknown interest payment
    - Underlying rate > exercise rate = ITM
  - IRP: option holder has the right to make an unknown interest payment and receive a known payment
    - Underlying rate < exercise rate = ITM
  - Payoff = notional principal*Max(0, UR-ER)(N/360): call
  - Payoff = notional principal*Max(0, ER-UR)(N/360): put
Caps, Floors and Collars

- Interest Rate Cap = combination of interest rate calls
  - Same ER, different exercise dates
  - Each component is a caplet

- Interest Rate Floor = combination of interest rate puts
  - See above

- Interest Rate Collar = combination of caps and floors
  - Long cap, short floor or long floor, short cap
    - Way to reduce upfront premium charges
Pricing Basics

- Payoff (call): \( \text{Max} (S_T - X, 0) \)
- Payoff (put): \( \text{Max} (X - S_T, 0) \)
  - Holds for European and American options at expiration
  - No arbitrage pricing requires that the option value holds to these payoffs
- The above are also called intrinsic value
  - Value of the option if exercised based upon current conditions
- Prior to expiration, options will usually sell for more than their intrinsic value (i.e., even if option is out of the money, the option has a non-zero premium).
  - The difference between the option price and the intrinsic value is the time value of the option.
Option payoffs and profits

Long Call

Short Call

Long Put

Short Put
Pricing Boundaries

- Minimum and Maximum values
  - $C \geq 0$, $P \geq 0$ (American and European)
  - $C \leq S$, $P \leq X/(1+r)^T$ or $P \leq X$

- Lower bounds
  - American:
    - $C \geq \text{Max}(S_T-X,0)$; $P \geq \text{Max}(X-S_T,0)$
  - European:
    - $C \geq \text{Max}(S_T-X/(1+r)^T,0)$
    - $P \geq \text{Max}(X/(1+r)^T-S_T,0)$
  - Issue: early exercise (non-dividend paying stocks)
    - Never exercise American calls early, so lower bound on an American is the same as a European
## What Effects Option Prices

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<td>$r$</td>
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</tr>
<tr>
<td>Dividend</td>
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Put-Call Parity

Because values of puts and calls are determined from the same underlying asset, there must be a relationship in the pricing of puts and calls

- No arbitrage…again
- Fiduciary call = \( c + \frac{X}{(1+r)^T} \)
- Protective put = \( S + p \)
## Put-Call Parity

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<tr>
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<tr>
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If No Arbitrage Holds…

- We have two assets with identical payoffs, regardless of what happens to prices

  \[ P-C \text{ Parity} = p+S = c+X/(1+r)^T \]

- Can use the relationship to construct synthetic puts and calls

- Effect of dividend payments
  - \[ p+S = c+X/(1+r)^T+PV(CF) \]
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Risk Management
Applications of Options Strategies
Option payoffs and profits

**Long Call**

**Short Call**

**Long Put**

**Short Put**
Covered Call

- Combination of a long stock and short call position

- \( V = S_T - \max(0, S_T - X) \)
  - If \( S \geq X \), \( V = S \); if \( X \geq S \), \( V = X \)
  - Profit = \( V_T - S_o + c \)

- Used for risk reduction, but also limits upside returns
  - Bullish strategy: losses on underlying are cushioned by option premium in a down market
Payoff Diagram: Covered Call
Looks like a short put

Covered Call Payoff

Stock Price

Payoff

profit on stock
profit on call
total profit
Protective Put

- Long position in put and stock
- Similar to a covered call, a protective put provides some downside risk protection
  - Maintains upside potential
  - Like an insurance contract, but costly

\[ V = S_T + \max(0, X - S_T) \]

- If \( S > X \), \( V = S \); if \( X \geq S \), \( V = X \)
- Profit = \( V_T - S_0 - p \)
  - Profits technically could be unlimited
  - Losses limited to put premium
Protective Put Payoff: Looks like a long call