ROBERT H. SMITH
SCHOOL OF BUSINESS

# Financial Management

*International Finance*



# RISK AND HEDGING

In this lecture we will cover:

- Justification for hedging
- Different Types of Hedging Instruments.
- How to Determine Risk Exposure.

Good references include:

Tucker, Alan. Financial Futures, Options, and Swaps. West Publishing, New York, 1991.

Lavent, Judy C. and A. John Kearney, "Identifying, Measuring, and Hedging Currency Risk at Merck".

Maloney, Peter J. "Managing Currency Exposure: The Case of Western Mining."

## Why Hedge: Reducing Risks

- Up to this point in the course, we have taken many types of risks as given.
  - ➢ Systematic risks are summarized by a firm's Beta.
  - ➢ We have examined how financial risk can increase the risk of the firm's stock by unleveraging and levering the firm's beta.

NOW:

- We now will examine how certain financial assets can be used to reduce the variance of the firm's cash flows.
- Reducing the risks of the firm's cashflows can be done for many different types of risk by buying or selling financial assets.

➢ This technique of entering into a transaction to reduce the variance of a firm's cash flows is called hedging.



## Exchange rates

- Price of one country's currency for another
  - Usually expressed in terms of U.S. dollars
- Direct terms
  - Quoted price is price in dollars of unit of foreign exchange
  - Example: $1.6095 = £1 or $0.7297 = 1 Euro
- Indirect terms
  - Quoted price is foreign currency price of U.S. dollar
  - Example: £.6213 = $1 or Euro1.3705 = $1
- Determinants
  - Inflation
  - Interest rates
  - Balance of payments
  - Regulation by central banks

## Relation of inflation and exchange rates

$$\frac{E(1+i_{BC})}{E(1+i_{\$})} = \frac{E(s_{BC/\$})}{s_{BC/\$}}$$

- Example: Suppose that inflation in Brazil during the year is equal to 4% and inflation in the U.S. is 10%. Assume that the 5BC is worth $1 at the beginning of the period. What should happen to the price of the BC relative to the $?



## I. INTERNATIONAL RISK

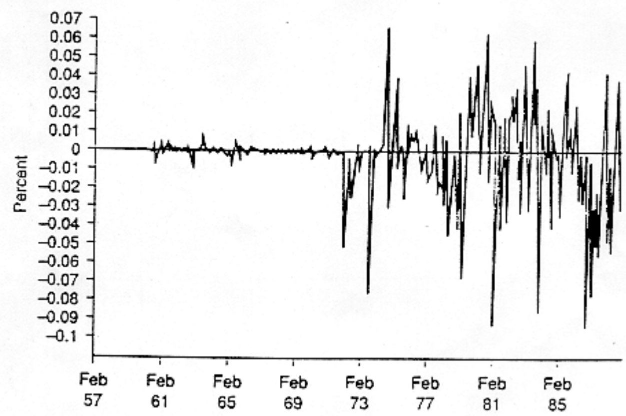
**A. Why Hedge: Plots of some variables**

1. Dollar/yen exchange rate
2. Interest rates
3. Prices
4. Conclusion: volatility has increased
   a. In turn increases demand for hedging

**Central Question:** If volatility decreases as a result from hedging, will firm value increase?

# Plots of Some Variables

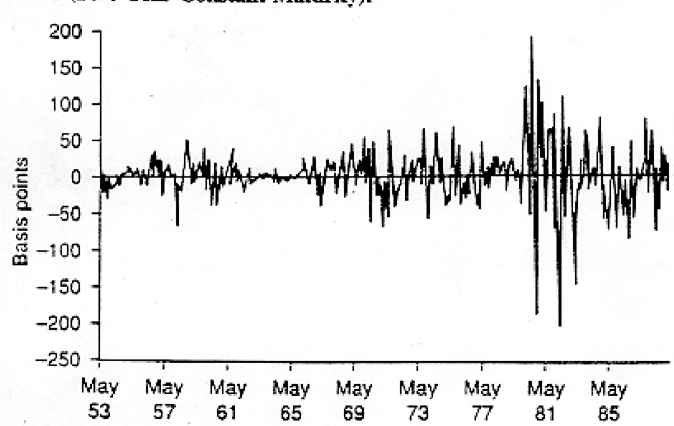
Figure 1-4. Exchange Rate Volatility: Percent Change in U.S. Dollar/Yen Exchange Rate.






# Interest rates

Figure 1-5. Interest Rate Volatility: First Difference in U.S. Treasury Yield (Five-Year Constant Maturity).



- Many standardized financial products exist to help firms hedge or reduce their risks. However, hedging can be accomplished using non-standardized specific contracts.

- For example, a contract with your dentist paying him an annual fixed fee in return is a hedge against any unforeseen, unknown dental bills. All insurance is a form of hedging.

- Risks that can be hedged easily using standard contracts include: currency risk
  - interest rate risks
  - input price risk (oil prices, orange juice, hogs, corn and other commodities),
  - movements in major stock indices.



## B. Is the value of the firm affected?

- If hedging is a good idea, it should increase the value of the firm.
- Value of the firm is given by after tax cash flows discounted by the appropriate rate for the firm.
- Will firm value increase? Will increase only by changing the numerator (increasing cash flows) or the denominator (decreasing systematic risk.)

## Should Firms Hedge?

**CON:**

- Risks being hedged are almost by definition nonsystematic risks.
- They can be diversified away by investors, who will therefore not attach any value to the firm diversifying the risks. That is, the denominator - the discount rate - should not be affected by hedging activities because they don't represent systematic risk.
- Another argument against hedging is that the firm **cannot** predict better than the market what will happen in currency markets - thus we should let investors hedge themselves.



**PRO:**

1. Removing unsystematic risk by the firm is cheaper than investors doing it -
   a. Especially internationally
   b. Transaction costs may be significant for individuals

# Reasons to Hedge (continued)

2. Financial distress
- Firms in financial distress face both direct costs (bankruptcy costs) and indirect costs (loss of customers, suppliers, and employees).
- Hedging can reduce the probability of financial distress and thereby lower the expected costs of distress.
- By lowering the probability of the firm getting into trouble, it makes customers, suppliers, etc. more willing to deal with the firm.

➢ This should increase cash flows and raise the value of the firm.



# Reasons to Hedge (continued)

3. Agency conflicts
- Previously discussed bondholder/stockholder conflicts. Firms that are stable with low probability of large variances in income have no worry about such conflicts. But firms with income that is highly variable are exposed to the costs of such conflicts (harder to monitor or see why cash flows are low).

➢ Reducing the variance of income by hedging may help to lower agency costs - and makes it easier to see if the "manager" messed up.

# II. How to hedge

A. Determine if you have Transaction exposure versus operating exposure

1. Transaction exposure

- Fixed contract denominated in fixed interest rates or foreign currency. Value of contract falls as interest rates rise or as price of foreign currency falls.

➢ "Easy" to Hedge: Hedge for exact amount. **Example of British Airways (upcoming slide).**



# II. How to hedge

2. Operating exposure: Normal business exposure - *ongoing.*

– Even if no fixed fee contracts in foreign currency, value of firm affected by changes in real exchange rates, prices of commodities, etc.

– This occurs because relative prices of goods are affected by changes in commodity prices or real exchange rates.

## Types of transactions

- Spot trades
  - Agreement on the exchange rate today for settlement in two days
  - Rate today is called spot rate
- Forward trades
  - Agreement on an exchange rate today for settlement in the future
  - Maturities for forward contracts are usually 1 to 52 weeks
  - Rate agreed upon for forward trade is forward rate
  - Banks write forward contracts
  - Tailor-made
- Futures markets



## III. Hedging Instruments:

**A. Forward contracts**

1. Agreement to buy an asset at specified price on a specified date.
2. Buyers and sellers obliged to deliver or take delivery. No money is exchanged until settlement. This may introduce default risk for some forward contracts.

Interbank forward market for currencies is about 4x as large as futures market for currency. Operates through Reuters screens, telex and telephone. The notional size of this market is estimated to be over $100 trillion dollars. Forward rates are quoted as a discount or premium relative to spot contracts. If the spot Yen is quoted as Y 124.2243/90 (the first number is the bid, the 90 refers to 124.2290, the ask. The one month forward would be quoted as 30/20. .0030 would be subtracted from the bid and .020 from the ask. You always widen the spread versus the spot, so if a smaller number is quoted first, you add to each to get the new spread.

## Example

- Boeing has an order from British Airways for a jet. Delivery in 6 months.
- Suppose Boeing lets British Air pay in pounds and the price is £10mm.
- Spot currency price is $1.6145/£
- Current dollar price is therefore $16.145mm. But delivery is in 6 months.
- Boeing can sell a 6 month forward contract for £10mm for $15.667mm right now. They now have zero risk exposure from any currency movements.

- Have they lost money by doing this?



## Lost Money??? No!

- Final profit or loss depends on what the spot rate is in 6 months.

- The spot rate could be $1.40/£ in 6 months in which case they have "gained" or it could be $1.70 in 6 months in which case they have "lost".

- On average the gains and losses should balance out, making hedging a zero gain activity.

➢ Do not consider a loss on the forward contract evidence of "bad" management.

# Forwards and Interest Rate Parity (IRP)

- IRP is an arbitrage condition that must hold after considering transaction costs and spreads and default risk. It relates the discount or premium on forward exchange to the term structure of interest rates on financial assets denominated in the two currencies involved in an exchange rate.
- This condition can be stated as the Interest Parity Theorem:

$$F(t,T) = S(t)\frac{[1+i]}{[1+i^*]}$$

where: F(t,T) is the domestic currency price of forward exchange,
S(t) is the domestic currency price of spot exchange.
i,(i*) interest rate on deposits in domestic (foreign) currencies
for the period in question – (above is <u>annual compounded version</u>).



# Interest rate parity

- Interest rate parity theorem implies that the *real* rate of interest between two countries be equal
  - Inflation may differ
  - How does this affect exchange rates?
- Example: Suppose you have a choice between two, one month investments of $1m:
  - Dollars
    - Interest is 6% per year
  - Favorite Foreign Currency
    - Spot price is $0.40/FC
    - Interest rate is 10% FC/Year
    - One month forward is $0.39869/FC
- Which would you choose?

## Dollar investment

- One month rate of interest is 0.50%

| Time 0 | Time 1 |
| --- | --- |
| Lend $1m | Obtain $1m (1.005) = $1,005,000 |



## Favorite Currency investment

– Interest rate is 0.83% per month

| Time 0 | Time 1 |
| --- | --- |
| Purchase $1 m worth of FC ($1m/.40)= FC2.5m | |
| Lend FC2.5m | Receive 2.5mFC (1.0083) = FC2,520,750 |
| Sell forward FC2,520,750 at $0.39869/FC | Receive FC2,520,750*(0.398969) = $1,005,000 |

# B. Futures

1. Agreement to buy an asset at specified price on a specified date. Traded on an exchange.
2. Standard contracts
   a. Fixed size, fixed maturity
   b. Exchange traded
   c. Liquid secondary market
   d. Low transaction costs

      Commission costs as low as .05% of value of contract.



# Futures (cont.)

3. Special features

a. Marking to market

Futures contract can be considered a series of one day forward contracts. At the end of each day, if the price of the contract has risen, the owner gets the increase deposited in her account; if the price has fallen, the price decrease is subtracted from her account.

b. Performance bond: margin

- When buying a contract, buyer must post a performance bond, i.e., deposit money in a margin account. The account will be credited and debited every day depending on the movements of the price of the futures contract.
- Notice that this margin account is not the same as a stock margin account in which a buyer is making a down payment and borrowing funds from the broker to complete the sale.

c. Clearing house

The clearing house is the counterpart for all transactions. This reduces transaction costs and default risk and makes the market more liquid.

d. Example of futures: Next Slide:

Works just like a series of daily forward contracts, so using previous pound example, we get the same result. Only difference is that every day we would have a small profit or loss.



## Example of futures contract

- Close of April 20, 1995
- Spot rate is $1.6095/ £
- Use British pounds
  - Contract is for £62,500
  - June95 settle is for 1.6106
  - Total value is $100,662.50
- Marking to market
  - Price change since previous day is -.0106
  - If you were long one contract, you had $662.5 (£62,500*-.0106) debited from your account

## Institutional Details

- The International Monetary Market (IMM) division of the Chicago Mercantile Exchange (CME) trades Deutschemarks, Eurodollars, Yen, Swiss Franc, and T-bill futures. The Index and Options Market (IOM) division of the CME trades equity futures including the S&P 500, the most active futures contract, along with the Nikkei 225 and the S&P 100. The Chicago Board of Trade (CBOT) trades U.S. T. Bond and Note futures along with commodity futures. Options on these futures contracts are also traded on the CBOT.

- However, the maturity of these contracts is generally short. Most contracts are for 1-3 months. Up to 18 month contracts on some commodities (OIL on the NYMEX are offered) but generally illiquid after 6 months.



## Differences among forwards & futures

1. Cash flow profile the same
2. Only difference is credit risk

- Forward contracts are riskiest because full payment comes at maturity.
- Futures contracts are essentially risk free because of marking to market and the performance margin that must be posted when the contract is bought. Also, the exchange stands ready to make good on any defaulted contract.
- Swaps (not covered in this course) are intermediate credit risk. They call for payments before maturity, but are not marked to market and do not have a clearing house.

# C. OPTIONS

- What are Options?
  - Options are the right or "option" for the holder to buy (Call Option) or sell (Put Option) at given contract terms.
    Common types of options: Calls, Puts, Warrants, Convertible portion of Convertible Debt. Option "like" features are found in many corporate securities.
  - In this note we will present the basics of option theory, show how options are valued *relative to* other securities and *use* option theory to value some corporate securities including warrants
  - Options are part of larger group of securities called <u>contingent claims</u> or <u>derivative securities</u>
  - Value of the value of these securities is contingent on value of underlying security (usually equity)



# Option Terminology

- **Call Option, C:** The right to **buy** a financial security or commodity at a fixed price (strike price) K at time T in the future.

➢ σ, S are underlying volatility and Price of the financial security (stock).

- **Put Option, P:** The right to **sell** a financial security or commodity at a strike price K at time T in the future.
  - Note 1: You can both buy and sell both types of options: call and put options.
- **Strike Price, K** : The amount you pay for the security or commodity when you exercise the option.

## Option Terminology

- **European Options:** Options that cannot be exercised before fixed exercise date.
- **American Options:** Option holder can choose to exercise before expiration.
  - Note 2: Call and Put options can be either American or European.



## Option Payoffs

- **Call Option:** The buyer has the choice or option of whether or not to buy in the future at a predetermined exercise price or strike price, K, at a predetermined date, T, - the exercise date.
- Buyer pays the call price, Ct, today to the seller - receives the option to buy in the future.

- **Call Option Payoffs:** ($S_T$ = Stock or asset price at exercise date T)

| | *At Contract Date* | *At Exercise* |
|---|---|---|
| Seller | + $C_t$ | - Max{ 0 , $S_T$ - K } |
| Buyer | - $C_t$ | + Max{ 0 , $S_T$ - K } |

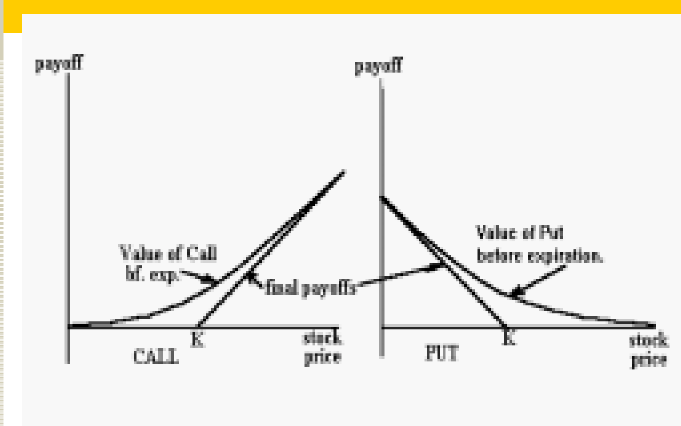
- **Put Option:** The buyer has the choice or option of whether or not to sell in the future at a predetermined exercise price or strike price, K, at a predetermined date, T, - the exercise date.
- Buyer pays the put price, Pt, today to the seller - receives the option to sell in the future.

- **Put Option Payoffs:** ($S_T$ = Stock or asset price at exercise date T)

| | *At Contract Date* | *At Exercise* |
|---|---|---|
| Seller | + $P_t$ | - Max{ 0 , K - $S_T$ } |
| Buyer | - $P_t$ | + Max{ 0 , K - $S_T$ } |



# Payoff graphs for Call and Put Options:




* Remember, an investor writing a call or a put receives the exact opposite payoffs.

## Factors affecting value of call

- The value of a call is contingent on certain characteristics of the underlying security:

C = f ($S_t$, $\sigma^2$, $K_T$, $\tau$, $r_f$)
where
S = Stock price (+ related to call price as the payoff increases with the stock price)
$\sigma^2$ = Variance of stock price (+ related as increased chance of exercise)
K = Exercise price (- related as lower probability of being exercised)
$\tau$ = Time til maturity (+ related as greater chance of exceeding exercise price)
$r_f$ = Risk free rate (+ related as present value of the delay of payment of exercise price becomes more valuable as interest rates rise)



## Black - Scholes Option Valuation:

- Going to continuous time we can derive the famous Black - Scholes option pricing formula:

(for non-dividend paying stocks, for constant proportional dividend paying stocks a variant of this formula applies.):

$$C = S_t N(d_1) - Ke^{-r\tau} N(d_1 - \sigma\sqrt{\tau})$$

$$where\ d_1 = \frac{\ln(S_t / Ke^{-r\tau})}{\sigma\sqrt{\tau}} + \frac{1}{2}\sigma\sqrt{\tau}$$

N(x) is the standard normal distribution function. (a standard function in spreadsheets). $\sigma$ = std. dev. of firms' stock return in continuous time, $\tau$ is the time to maturity of the options, $S_t$ = current stock price.

# Assumptions of Black-Scholes

- No restrictions on short selling
- Transactions costs and taxes are zero
- European option
- No dividends are paid
- Process describing stock price return is continuous
- Market has continuous trading
- Short-term interest rate is known and constant
- Stock returns are lognormally distributed



# Example using Black-Scholes

- Private Equipment Company (PEC), on October 4, 1994 has an April 49 call option with a closing value of $4. The stock itself is selling at $50. On October 4, the option had 199 days to expiration. The annual risk free rate is 7%.

- We can easily get four of the necessary components:
  - Stock price (S) is $50
  - Exercise price (K) is $49
  - Risk free rate ($r_f$) is 0.07
  - Time to maturity ($\tau$) = 199/365 = .545

- You would have to calculate $\sigma$, the standard dev. of the firm's stock price. How? Calculate standard deviation of stock's continuous return using daily data and annualize - continuous return = $\ln(S_t/S_{t-1})$

# Black-Scholes with Dividends

- Dividends are a form of "asset leakage". If dividend are paid repeatedly we adjust Black Scholes to allow constant proportional dividends:

$$C = S_{\delta} N(d_3) - Ke^{-rt} N(d_3 - \sigma\sqrt{t})$$

$$where\ \ d_3 = \frac{\ln(S_{\delta} / K) + [r + \sigma^2 / 2]t}{\sigma\sqrt{t}}$$

$$and\ \ S_{\delta} = Se^{-\delta t} \text{ and } \delta \text{ is a constant dividend yield.}$$



# Hedging with Options

- The Chicago Board Options Exchange (CBOE), division of the CBOT, trades S&P 100 (OEX) options along with S&P 500, T-Bonds, T-Notes and common stock options.

1. Call and put options give rights to buy or sell currency

   British pound March 195 call allows owner to purchase £31,250 at a cost of $1.95 per pound. The option is in the money because the spot price of the pound is $1.9990.

2. Futures options

   Option on a futures contract. If call option is exercised at the strike price, then owner gets a long position in the British pound futures contract where the price of the futures contract is the strike price.

3. Options useful when exposure is uncertain

   An example is bidding on a contract. If payment will be received in one year if you win the contract, then creating a position using forwards or futures could be costly if you don't win. Alternative is to buy a one year put option that allows you to sell the currency at the strike price.

# CONCLUSIONS

- Hedging can add value if costs of financial distress are significant.
- Transaction Hedges are straightforward to put together - same as "market value naive" hedge.
- Operational Hedges require determining a company's risk exposure.
- Key insight: take offsetting position so that hedge's value varies **inversely** with the contracts (currency or interest rate) exposure.