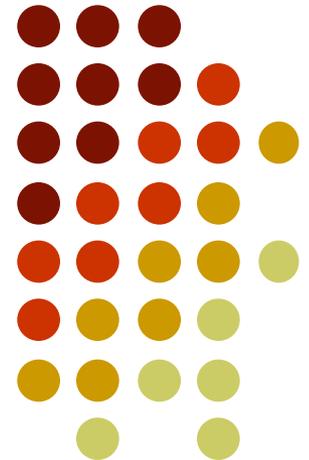
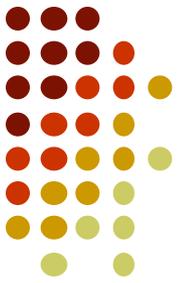


Hedging Strategies Using Futures

Chapter 3

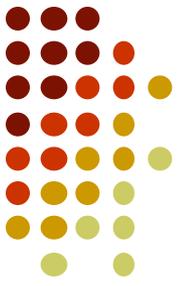


The Nature of Derivatives



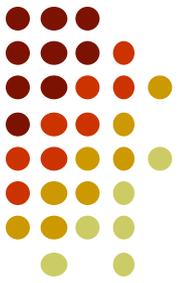
A derivative is an instrument whose value depends on the values of other more basic underlying variables.

Why Derivatives Are Important



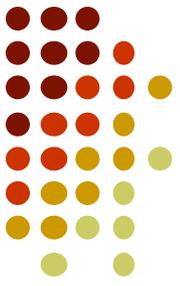
- Derivatives play a key role in transferring risks in the economy.
- There are many underlying assets: stocks, currencies, interest rates, commodities, debt instruments, electricity, insurance payouts, the weather, etc.
- Many financial transactions have embedded derivatives.
- The real options approach to assessing capital investment decisions, which values the options embedded in investments using derivatives theory, has become widely accepted.

Futures Contracts



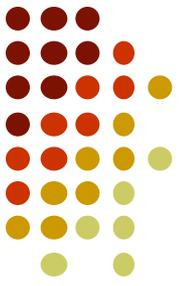
- A futures contract is an agreement to buy or sell an asset at a certain time in the future for a certain price.
- By contrast, in a spot contract there is an agreement to buy or sell the asset immediately (or within a very short period of time).

Exchanges Trading Futures



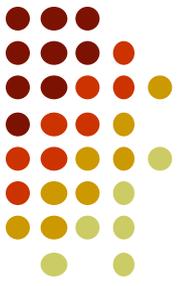
- CME (Chicago Mercantile Exchange) Group
- Intercontinental Exchange (electronic, based in Atlanta)
- NYSE Euronext (electronic, US-Europe exchange)
- Eurex (Europe, based in Germany)
- BM&FBovespa (Sao Paulo, Brazil)
- and many more (see list at end of book)

Futures Price



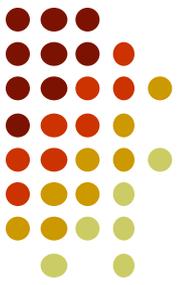
- The futures prices for a particular contract is the price at which you agree to buy or sell at a future time.
- It is determined by supply and demand in the same way as a spot price.
- But we will soon see that arbitrage strategies keep futures prices within certain bounds.

Electronic Trading



- Traditionally, futures contracts have been traded using the open outcry system where traders physically meet on the floor of the exchange.
- This has now been largely replaced by electronic trading, and high frequency algorithmic trading is becoming an increasingly important part of the market.

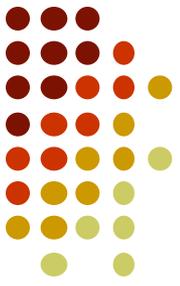
Examples of Futures Contracts



Agreement to:

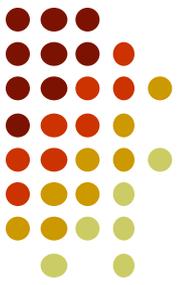
- buy 100 oz. of gold @ US\$1750/oz. in December.
- sell £62,500 @ 1.5500 US\$/£ in March.
- sell 1,000 bbl. of oil @ US\$85/bbl. in April (“bbl” = barrel)

Terminology



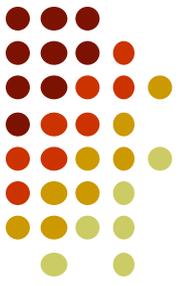
- The party that has agreed to *buy* has a *long* position.
- The party that has agreed to *sell* has a *short* position.

Example



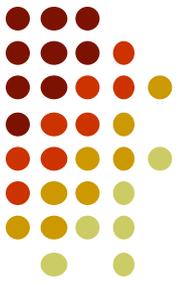
- January: an investor enters into a long futures contract to buy 100 oz of gold @ \$1,750 per oz in April.
- April: the price of gold is \$1,825 per oz
- What is the investor's profit or loss?

Over-the Counter Markets



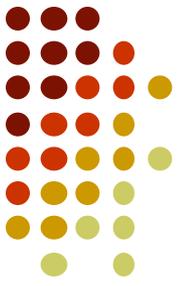
- The over-the counter market is an important alternative to exchanges.
- Trades are usually between financial institutions, corporate treasurers, and fund managers.
- Transactions are much larger than in the exchange-traded market.

Ways Derivatives are Used



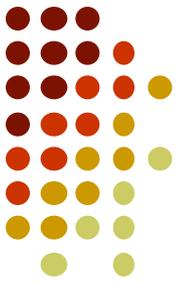
- To hedge risk.
- To speculate (take a view on the future direction of the market).
- To lock in an arbitrage profit.
- To change the nature of a liability.
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another.

Futures Contracts



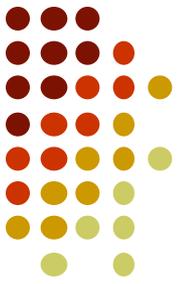
- Available on a wide range of underlyings
- Exchange traded
- Specifications need to be defined:
 - What can be delivered
 - Where it can be delivered
 - When it can be delivered
- Settled daily

Forward Contracts



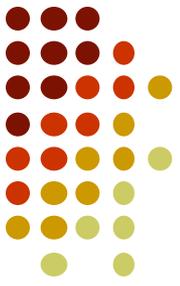
- Forward contracts are similar to futures contracts, except that they trade in the over-the-counter market.
- Forward contracts are popular on currencies and interest rates.

Forward Contracts vs Futures Contracts (Table 2.3, page 43)



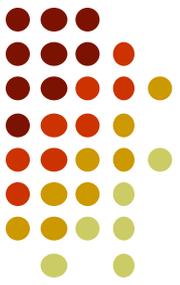
<i>Forward</i>	<i>Futures</i>
Private contract between two parties	Traded on an exchange
Not standardized	Standardized
Usually one specified delivery date	Range of delivery dates
Settled at end of contract	Settled daily
Delivery or final settlement usual	Usually closed out prior to maturity
Some credit risk	Virtually no credit risk

Options vs Futures/Forwards



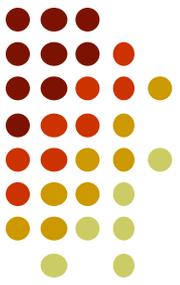
- A futures/forward contract gives the holder *the obligation* to buy or sell at a certain price.
- An option gives the holder *the right* to buy or sell at a certain price.

Hedging Examples



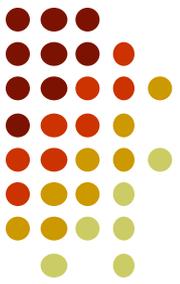
- A US company will pay £10 million for imports from Britain in 3 months and decides to hedge using a long position in a forward contract.
- An investor owns 1,000 shares currently worth \$28 per share.
- A two-month put with a strike price of \$27.50 costs \$1.
- The investor decides to hedge by buying 10 contracts.

Long & Short Hedges



- A long futures hedge is appropriate when you know you will purchase an asset in the future and want to lock in the price.
- A short futures hedge is appropriate when you know you will sell an asset in the future and want to lock in the price.

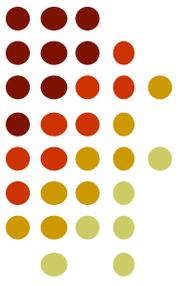
Arguments in Favor of Hedging



The general idea:

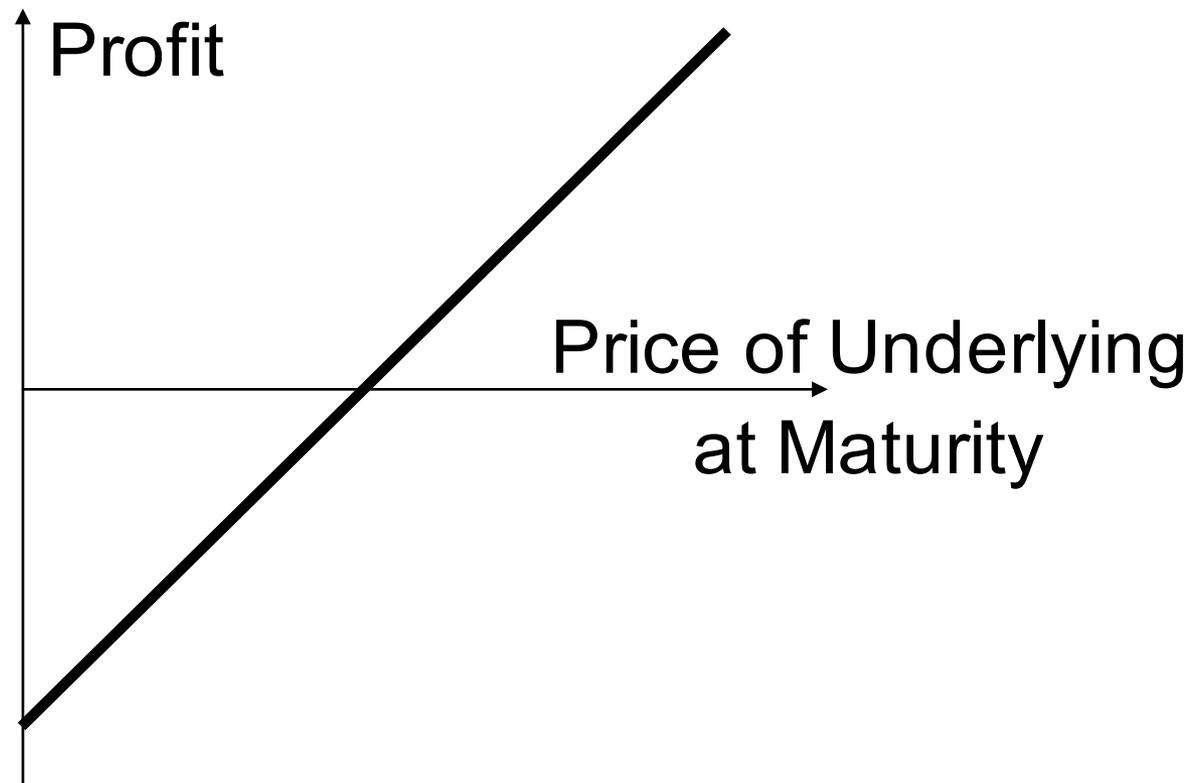
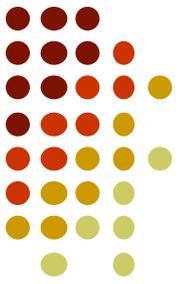
Companies should focus on the main business that they are in, and take steps to minimize risks arising from interest rates, exchange rates, and other market variables.

Arguments against Hedging

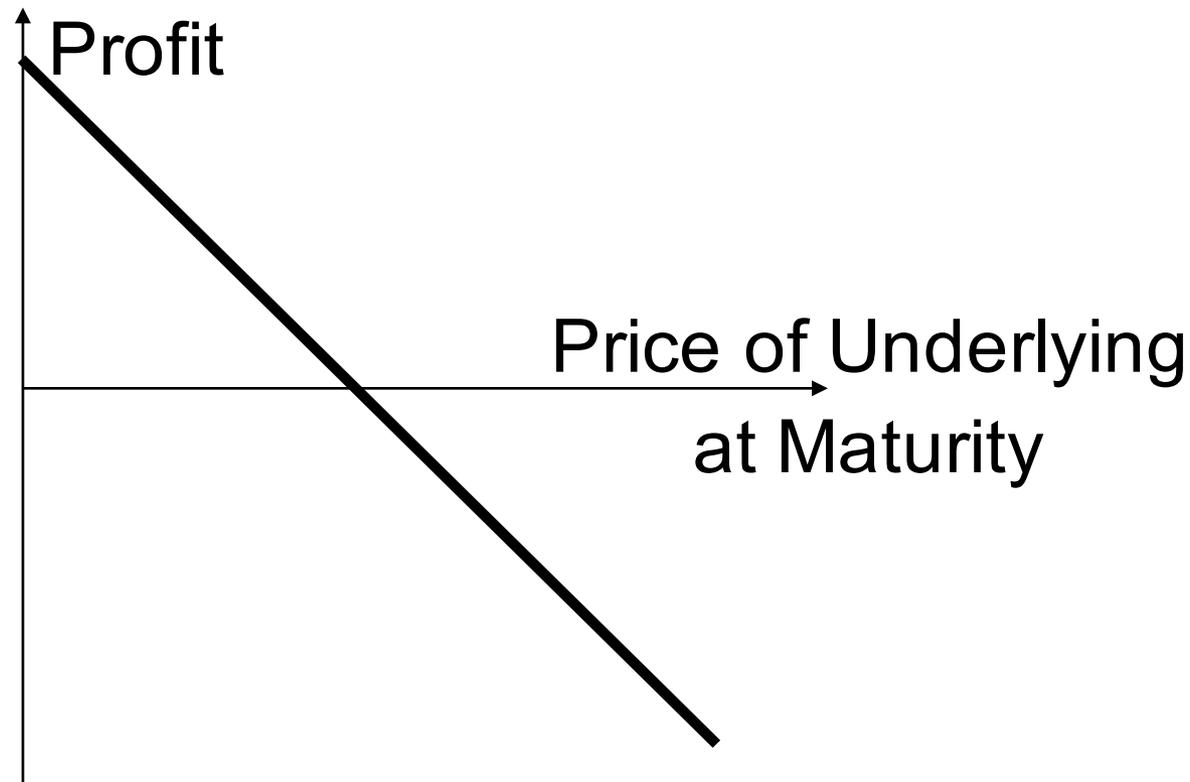
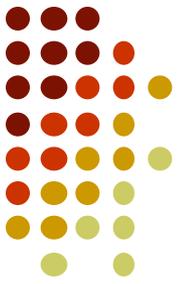


- Shareholders are usually well diversified and can make their own hedging decisions.
- It may increase risk to hedge when competitors do not.
- Explaining a situation where there is a loss on the hedge and a gain on the underlying can be difficult.

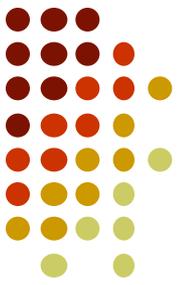
Profit from a Long Forward or Futures Position



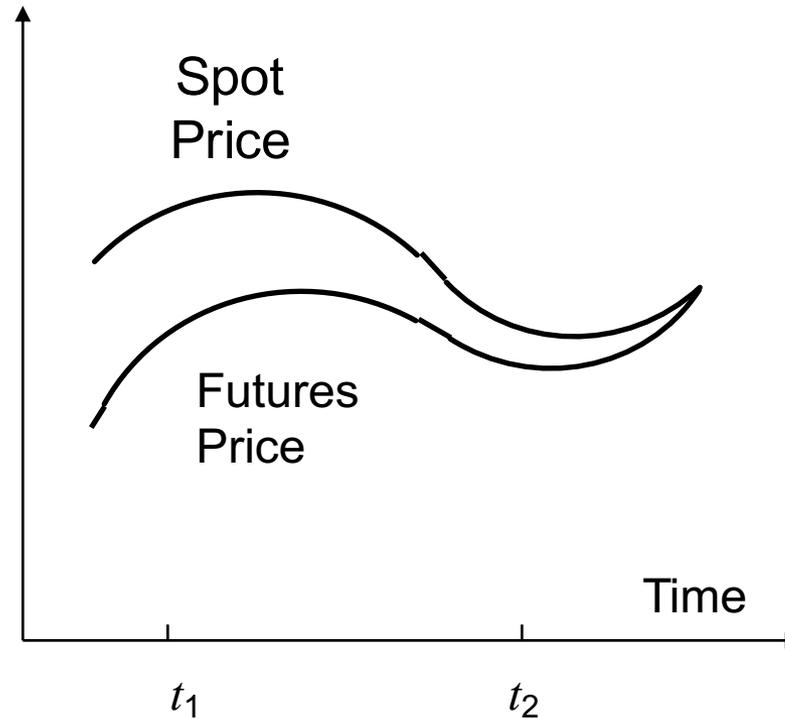
Profit from a Short Forward or Futures Position



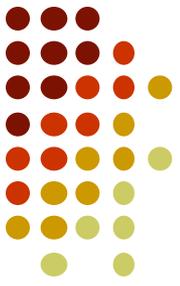
Convergence of Futures to Spot



(Hedge initiated at time t_1 and closed out at time t_2)

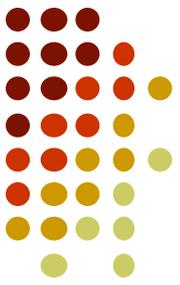


Basis Risk



- Basis is the difference between spot & futures prices.
- Basis risk arises because of the uncertainty about the basis when the hedge is closed out.

Long Hedge for Purchase of an Asset



- Define

F_1 : Futures price at time hedge is set up

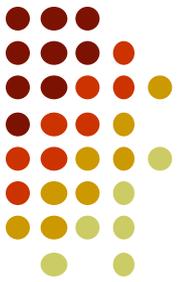
F_2 : Futures price at time asset is purchased

S_2 : Asset price at time of purchase

b_2 : Basis at time of purchase

Cost of asset	S_2
Gain on Futures	$F_2 - F_1$
Net amount paid	$S_2 - (F_2 - F_1) = F_1 + b_2$

Short Hedge for Sale of an Asset



✦ Define

F_1 : Futures price at time hedge is set up

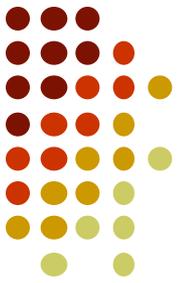
F_2 : Futures price at time asset is sold

S_2 : Asset price at time of sale

b_2 : Basis at time of sale

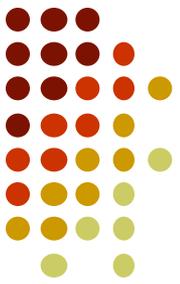
Price of asset	S_2
Gain on Futures	$F_1 - F_2$
Net amount received	$S_2 + (F_1 - F_2) = F_1 + b_2$

Choice of Contract



- Choose a delivery month that is as close as possible to, but later than, the end of the life of the hedge.
- When there is no futures contract on the asset being hedged, choose the contract whose futures price is *most highly correlated* with the asset price (or highest R^2 in regression).

Optimal Hedge Ratio



Proportion of the exposure that should optimally be hedged is

$$h = \rho \frac{\sigma_S}{\sigma_F}$$

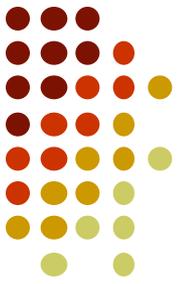
where

σ_S is the standard deviation of ΔS , the change in the spot price during the hedging period,

σ_F is the standard deviation of ΔF , the change in the futures price during the hedging period

ρ is the coefficient of correlation between ΔS and ΔF .

Optimal Number of Contracts



Q_A	Size of position being hedged (units)
Q_F	Size of one futures contract (units)
V_A	Value of position being hedged (=spot price time Q_A)
V_F	Value of one futures contract (=futures price times Q_F)

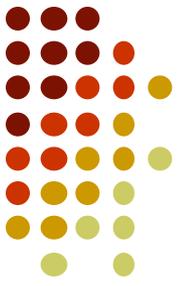
Optimal number of contracts if
no tailing adjustment

$$= \frac{h^* Q_A}{Q_F}$$

Optimal number of contracts
after tailing adjustment to allow
for daily settlement of futures

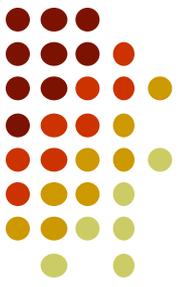
$$= \frac{h^* V_A}{V_F}$$

Example



- Airline will purchase 2 million gallons of jet fuel in one month and hedges using heating oil futures.
- From historical data $\sigma_F = 0.0313$, $\sigma_S = 0.0263$, and $\rho = 0.928$

$$h^* = 0.928 \times \frac{0.0263}{0.0313} = 0.7777$$



Example continued

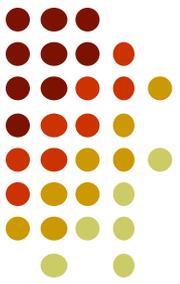
- The size of one heating oil contract is 42,000 gallons
- The spot price is 1.94 and the futures price is 1.99 (both dollars per gallon) so that

$$V_A = 1.94 \times 2,000,000 = 3,880,000$$

$$V_F = 1.99 \times 42,000 = 83,580$$

- Optimal number of contracts assuming no daily settlement $= 0.7777 \times 2,000,000 / 42,000 = 37.03$
- Optimal number of contracts after tailing $= 0.7777 \times 3,880,000 / 83,580 = 36.10$

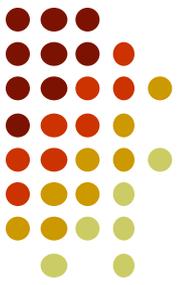
Example continued



Suppose you tailed the hedge. One month later, the oil (spot) price is up to \$2.45/gal and the futures price is \$2.63/gal.

- Without the futures contracts protection, how much would you have to pay today for the 2,000,000 gallons of oil?
- Compared to the spot price from one month ago, how much more do you need to pay now (in dollars)? And percentage-wise?
- What is your gain on the long futures contracts position? (in dollars)
- Combining the spot and futures market (i.e. expensive payment in the spot market but partially reduced by your gains on the futures), what is your net payment for oil today?
- How much more is your net payment today compared to what you would have paid one month ago had you purchased the oil immediately (spot market) back then?
- How much more is it percentage-wise?

Example continued

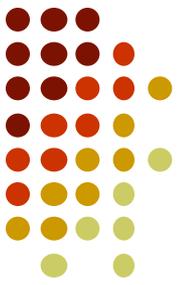


Suppose you tailed the hedge. One month later, the oil (spot) price is up to \$2.45/gal and the futures price is \$2.63/gal.

- Without the futures contracts protection, you would have to pay now
 $2,000,000 \times \$2.45 = \$4,900,000$.
- Compared to the spot price from one month ago, you must pay now
 $(2.45 - 1.94) \times 2,000,000 = \$4,900,000 - \$3,880,000 = \$1,020,000$.
- Percentage-wise, that translates into $\$1,020,000 / \$3,880,000 = 26\%$ more.
- The gain on the futures contracts is $36 \times (2.63 - 1.99) \times 42,000 = \$967,680$.
- You pay in the spot market \$4,900,000 but receive \$967,680 from the futures market, hence your net payment for oil is \$3,932,320.
- Compared to one month ago had you purchased the oil immediately (spot market) back then, it is an increase of $\$3,932,320 - \$3,880,000 = \$52,320$.
- Percentage-wise, it is a small increase of $\$52,320 / \$3,880,000 = 1.35\%$.

Hedging Using Index Futures

(Page 65)

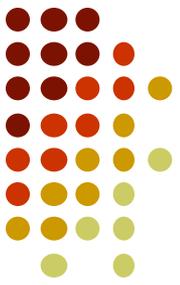


To hedge the risk in a portfolio, the number of contracts that should be shorted is:

$$\beta \frac{V_A}{V_F}$$

where V_A is the current value of the portfolio, β is its beta, and V_F is the current value of one futures (= futures price times contract size)

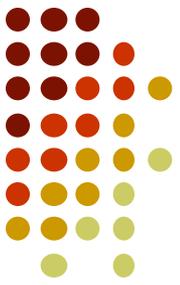
Example of index futures hedge



- Futures price of S&P 500 is 1,010
- Size of portfolio is \$5,050,000
- Spot price of S&P 500 is 1,000
- Beta of portfolio is 1.5
- One contract is on \$250 times the index

What position in futures contracts on the S&P 500 is necessary to hedge the portfolio?

Example of index futures hedge

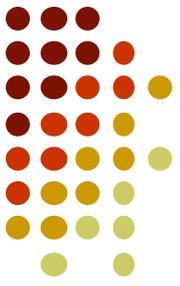


- One futures contract is for the delivery of \$250 times the market index.
- Therefore one must short

$$N^* = 1.5 \times 5,050,000 / (250 \times 1,010)$$

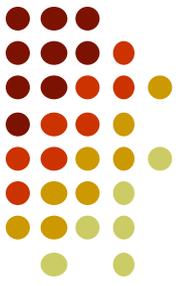
$$N^* = 30 \text{ index futures contracts.}$$

Example of index futures hedge



- Excluding dividends and ignoring the risk-free rate, assume that the S&P 500 index has now dropped to 900 and that the index futures price is now 902.
- What is the rate of return on the S&P 500? (% loss)
- What is the rate of return on your portfolio? (assume driven by β)
- What is your new portfolio value?
- What are your dollar gains on your short index futures position?
- What is your net total portfolio value once you add the gains from the futures contracts protection? How does it compare with the initial value of your portfolio?

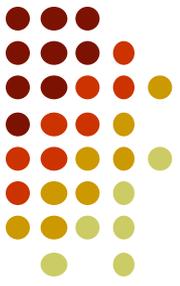
Example of index futures hedge



- The rate of return on the S&P 500 is $(900-1000)/1000$ so the index experienced a 10% loss.
- Assuming the portfolio returns are driven by β , the portfolio should experience a loss of $\beta(-10\%)$. Therefore the portfolio should return $1.5(-10\%) = -15\%$.
- The new portfolio value is the original value minus 15%. In other words, it is: $\$5,050,000 \times (1-.15) = \$4,292,500$.
- The dollar gains on the short index futures position are:
$$30 \times (1,010 - 902) \times 250 = \$810,000$$
- Your net combined total position is now therefore worth:
$$\$4,292,500 + \$810,000 = \$5,102,500$$

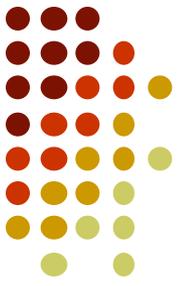
(slightly above the initial portfolio value: the hedge worked!)

Changing Beta



- In the previous slides we attempted to reduce the beta of the portfolio to zero, i.e. to eliminate the market risk completely.
- However, index futures contracts are sometimes used to *modify* beta to a value different from zero: either to reduce beta, or to increase beta.
- To reduce β to β^* , one must take a *short* position in index futures contracts. The number of contracts to short is $(\beta - \beta^*)V_A/V_F$.
- To increase β to β^* , one must take a *long* position in index futures contracts. The number of contracts to buy is $(\beta^* - \beta)V_A/V_F$.

Changing Beta: Number of Contracts



- Going back to the previous example, assume you instead would have wanted to decrease your portfolio β from 1.5 to 0.75.

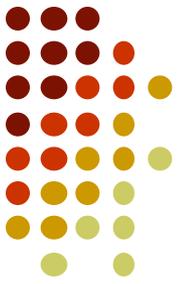
- You must therefore *short*

$$N^* = (1.5 - 0.75) \times 5,050,000 / (250 \times 1,010)$$

or

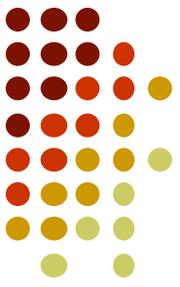
$$N^* = 15 \text{ index futures contracts.}$$

Changing Beta: Scenario and Check

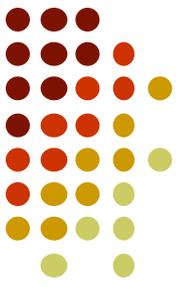


- Excluding dividends and ignoring the risk-free rate, assume that the S&P 500 index has now dropped to 900 and that the index futures price is now 902.
- What is the rate of return on the S&P 500? (% loss)
- What is the rate of return on your portfolio? (assume driven by β)
- What is your new portfolio value?
- What are your dollar gains on your short index futures position?
- What is your net total portfolio value once you add the gains from the futures contracts protection?
- What is your net total *return* overall? (net total portfolio value now divided by initial portfolio value, minus one)
- Divide your net total return by the S&P 500 return. Is it close to a beta of 0.75?

Changing Beta: Scenario and Check



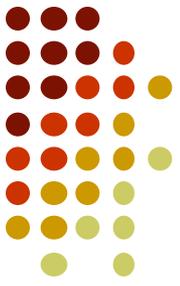
- The index experienced a 10% loss, same as before.
- The portfolio like before, returned $1.5(-10\%) = -15\%$.
- The new value is $\$5,050,000 \times (1-.15) = \$4,292,500$
- The dollar gains on the short index futures position are:
 $15 \times (1,010 - 902) \times 250 = \$405,000$
- Your net combined total position is now therefore worth:
 $\$4,292,500 + \$405,000 = \$4,697,500$
- Net total return is: $\$4,697,500/\$5,050,000 - 1 = -6.98\%$
- If we divide it by the market return to get our net effective beta, we obtain: $-6.98\%/-10\% = 0.70$ (close to our targeted beta of 0.75 !)



Why Hedge Equity Returns

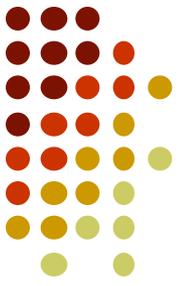
- Sometimes you may want to be out of the market for a while. Hedging avoids the costs of selling and repurchasing the portfolio.
- Suppose stocks in your portfolio have an average beta of 1.0, but you feel they have been chosen well and will outperform the market in both good and bad times. Hedging ensures that the return you earn is the risk-free return plus the excess return of your portfolio over the market.

Stack and Roll



- We can roll futures contracts forward to hedge future exposures.
- Initially we enter into futures contracts to hedge exposures up to a time horizon.
- Just before maturity we close them out and replace them with a new contract reflecting the new exposure.

Liquidity Issues (See Business Snapshot 3.2)



- In any hedging situation, there is a danger that losses will be realized on the hedge while the gains on the underlying exposure are unrealized.
- This can create liquidity problems.
- You might have a paper profit on the underlying asset but a loss on the futures contract that could trigger margin calls and therefore mandatory immediate cash outflows.