Chapter 4

Hedging Strategies Using Futures and Options

4.1 Basic Strategies Using Futures

While the use of **short** and **long** hedges can reduce (or eliminate in some cases - as below) both downside and upside risk. The reduction of upside risk is certaintly a limation of using futures to hedge.

4.1.1 Short Hedges

A **short hedge** is one where a short position is taken on a futures contract. It is typically appropriate for a hedger to use when an asset is expected to be sold in the future. Alternatively, it can be used by a speculator who anticipates that the price of a contract will decrease.

1. For example, assume a cattle rancher plans to sell a pen of feeder cattle in March based on the spot prices at that time. The rancher can hedge in the following manner. Currently,

- A March futures contract is purchases for a price of $150

- For simplicity, assume the rancher antipates (and does sell) selling 50,000 pounds (1 contract)

- Spot prices are currently $155

- What happens when the spot price is March decreases to $140?

  - Rancher loses $10 per 100 pounds on the sale from the decreased price

  - Rancher gains $10 by selling the futures contract for $150 and immediately buying (to close out) for $140

  - Effective price of the sale is $150

- What happens when the spot price is March increases to $160?

  - Rancher gains $10 per 100 pounds on the sale from the increased price

  - Rancher loses $10 by buying the futures contract for $150 and immediately selling (to close out) for $160

  - Effective price of the sale is $150

- The seller has effectively locked in on the price prior to the sale by offsetting gains/losses

2. Now assume the same for a speculator who takes a short position on a March futures contract at $150

- If the price falls to $140, the speculator sells for $150 and immediately buys for $140, leading to a gain of $10 per 100 pounds [$5,000 gain in value for one contract]

- If the price increases to $160, the speculator loses $5,000

4.1.2 Long Hedges

A **long hedge** is one where a long position is taken on a futures contract. It is typically appropriate for a hedger to use when an asset is expected to be bought in the future. Alternatively, it can be used by a speculator who anticipates that the price of a contract will increase.

1. For example, assume an oil producer plans on purchasing 2,000 barrels of crude oil in August for a price equal to the spot price at the time. The producer can hedge in the following manner by using crude oil futures from the NYMEX. Currently,

   - An August oil futures contract is purchases for a price of $59 per barrel
   - Spot prices are currently $60
   - What happens when the spot price in August decreases to $55?
     - Producer gains $4 per barrel on the purchase from the decreased price
     - Producer loses $4 by buying the futures contract for $59 and immediately selling (to close out) for $55
     - Effective price of the sale is $59
   - What happens when the spot price in August increases to $65?
     - Producer loses $6 per barrel on the purchase from the increased price
     - Producer gains $6 by selling the futures contract for $59 and immediately buying (to close out) for $65
     - Effective price of the sale is $59
   - The producer has effectively locked in on the price prior to the sale by offsetting gains/losses

2. Now assume the same for a speculator who takes a long position on a March futures contract at $59

- If the price increases to $65, the speculator sells for $59 and immediately buys for $65, leading to a gain of $6 per barrel [$12,000 gain in value for five contracts]

- If the price increases to $55, the speculator loses $12,000

4.2 Basis Risk

In practice, hedges are often not as straightforward as has been assumed in this course due to the following reasons

1. The asset to be hedged might not be exactly the same as the asset underlying the futures contract

- actual commodity, weight, quality, or amount might differ

2. The hedger might not be exactly certain of the when the asset will be bought or sold

3. Futures contract might need to be closed out before its delivery month

- many commodities do not have 12 deliery months

Basis is the difference between the cash price for the asset to be hedged and the futures price. If the hedged asset is identical to the commodity underlying the futures contract, the cash price and futures price should converge as delivery nears. Changes in basis price do not impact the futures contract but do impact the sales price for the producted to be hedged.

Below is a figure of the basis prices associated with Montana beef cows. Notice the following:

Average Monthly Basis, By Cwt Steers, Billings 2000 to 2010
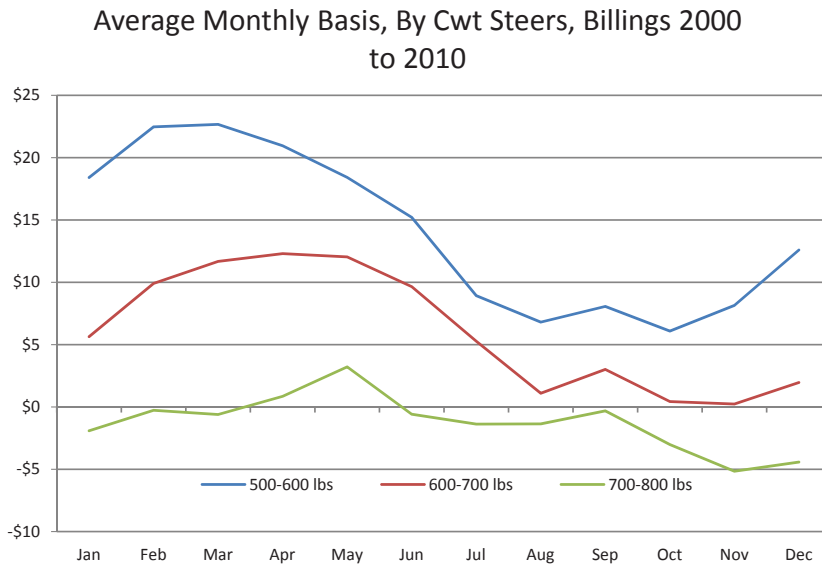
- Basis prices have strong seasonal patterns

- Basis prices are not known and provide an additional layer of risk above and beyond price in the futures market

- Basis risk is often be hedged through the use of forward contracts

- Basis volatility is relatively small compared to price volatility

4.3   Cross-Hedging

In the case when an asset is looking to be hedged and there is not an exact replication in the futures/options market, cross hedging can be employed.

For example, if an airline is concerned with hedging against the price of jef fuel, but jet fuel futures are not actively traded, they might consider the use of

heating oil futures contracts.

- **Hedge ratio** - The ratio of the size of a position in a hedging instrument to the size of the position being hedged.

  - When an asset to be hedged is exactly the same as the asset underlying the futures contract, the hedge ratio is equal to 1.0

  - The existence of **basis risk** often prevents this from happening

  - It is not always optimal to cross hedge (not is it usually possible) to hedge such that the hedge ratio equals 1.0

- **Mimimum Variance Hedge ratio** - The hedge ratio where the variance of the value of the hedged position is minimized

  - For example, in the case of using heating oil futures (HOF) to hedge jet fuel prices (JFP)

  - The optimal hedge ratio (h^*) can be computed as

$$h^* = \rho \frac{\sigma_{JFP}}{\sigma_{HOF}} \tag{4.1}$$

  where

$$
\begin{aligned}
\rho &= corr(\Delta HOF, \Delta JFP) & (4.2) \\
\sigma_{JFP} &= stdev(\Delta JFP) & (4.3) \\
\sigma_{HOF} &= stdev(\Delta HOF) & (4.4) \\
\Delta JFP &= JFP_t - JFP_{t-1} & (4.5) \\
\Delta HOF &= HOF_t - HOF_{t-1} & (4.6)
\end{aligned}
$$

  * What is the MVHR when $\rho = 0.928$, $\sigma_{JFP} = 0.0263$, $\sigma_{HOF} = 0.0313$? 0.778

* This implies that the airline should hedge by taking a position in heating oil futures that corresponds to 77.8% of its exposure.

– The Optimal number of contracts (N^*) can be computed as

$$N^* = h^* \frac{Q_{JFP}}{Q_{HOF}} \tag{4.7}$$

where Q_{JFP}=size of position being heged (Jet Fuel Prices) and Q_{HOF}=size of futures contract (Heating oil futures).

* heating oil contracts on NYMEX include 42,000 gallons

* assume the airline has exposure on 2 Million gallons of jet fuel.

* What is N^*? 37.03

4.4   An Aside on Statistics

For these statistical measures, assume we have two variables where $x_1 = (5, 7, 5, 4, 9, 6)$ and $x_2 = 420, 630, 330, 380, 800, 500)$

- **Mean**

$$\bar{x}_1 = \frac{1}{n} \sum x_{1i} = 16(5 + 7 + 5 + 4 + 9 + 6) = 6 \tag{4.8}$$

In excel, use AVERAGE function

- **Standard Deviation**

$$\sigma_{x_1} = \sqrt{\frac{\sum x_{1i} - \bar{x}_1^2}{n-1}} = \sqrt{\frac{1 + 1 + 1 + 4 + 9 + 0}{5}} = 1.789 \tag{4.9}$$

In excel, use STDEV function

- **Correlation**

$$\rho = \frac{\sum (x_{1i} - \bar{x}_1)(x_{2i} - \bar{x}_2)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 \sum (x_{2i} - \bar{x}_2)^2}} = 0.962 \tag{4.10}$$

In excel, use CORREL function

- **Linear Regression**

  To determine the intercept (a) and slope (b) in $y = a + bx$, use INTER-CEPT and SLOPE functions in excel. Note: R^2 from the regression is equal to the correlation, ρ.

4.5 Trading Strategies Using Options

Basic trading strategies include the use of the following:

- Take a position in the option and the underlying stock

- Spread: Take a position in 2 or more options of the same type (bull, bear, box, butterfly, calendar, and diagonal)

- Combination: Position in a mixture of calls and puts (straddle, strips, and straps)

4.5.1 Trading Strategies Involving Options

- A long position in a futures contract plus a short postiion in a call option (covered call) **(a)**

  The long position "covers" the investor from the payoff on writing the short call that becomes necessary if prices increase. Downside risk remains if prices drop.
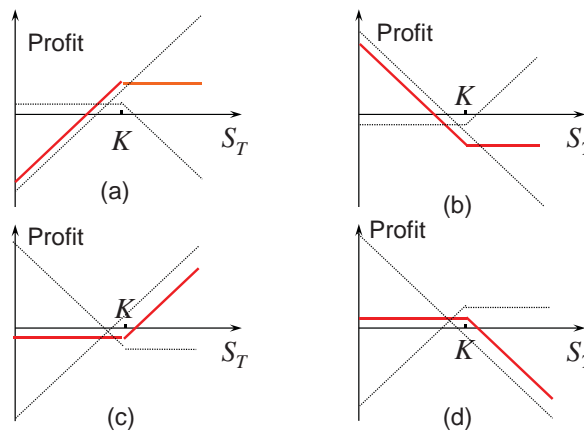
- A short position in a futures contract plus a long postiion in a call option **(b)**

- A long position in a futures contract plus a long position in a put option (protective put) **(c)**

- A short position in a put option witha short position in a futures contract

  (d)

The profits payoffs from these strategies is shown below.

Positions in an Option & the Underlying (Figure 11.1, page 250)

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Notice the similarities with these plots and that of the simple put and call strategies discussed in chapter 9. To illustrate, we define the **put-call parity** according to the equation below:

$$p + S_0 = c + K \exp^{-rt} + D \tag{4.11}$$

where p is the price of a European put, S_0 is the futures price, c is the price of a European call, K is the strike price for the call and put, and r is the risk-free interest rate, T is the time to maturity of both call and put, and D is the present value of the divends anticipated during the life of the options.

rl Price Range   Total Payoff
$\mathbb{S}_T$

4.5.2   Spreads

- **Bull Spreads** - Long and Short positions on a call option where strike price is higher on the short position $(K_2 > K_1)$.

  - Investor collects when prices increase somewhere between K_1 and K_2

  - This strartegy limits the investor's upside and downside risk

  - In return for giving up some upside risk, the investor sells a call option

  - Both options have the same expiration date

  - **The value of the option sold is always less than the value of the option bought** Note: Recall, a call price always decreases as the strike price increases

  - There are three types of bull spreads:

    1. Both calls are initially out of the money (lowest cost, most aggressive)

    2. Only One call is initially in the money

    3. Both calls are intially in the money (highest cost, most conservative)

- **Bear Spreads** - An investor hoping that the price will decline may benefit from a bear spread. Basic strategy is to buy and put with strike price (K_1) and sell another put with strike price (K_2), where $K_1 > K_2$.

  - In contrast, the strike price of the purchased put will cost more than the option that is sold.

Bull Spread Using Calls
(Figure 11.2, page 251)
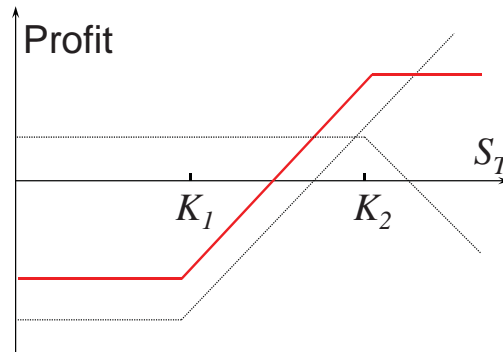
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- Limit upside protfit potential and downside risk

- Another type of bear spread involves buying a call with a high strike price and selling a call with a lower strike price.

• **Box Spreads** - A combination of a bull call spread with strike prices K_1 and K_2 and a bear put spread with the same two strike prices

  - The total payoff is always $K_2 - K_1$. The value of the spread is always the present value of that gap, $(K_2 - K_1)e^{-rt}$

  - If there is a different value (not equal to the present value), then there is an arbitrage opportunity

4.5.3 Combinations

- **Straddle** - Involves buying a call and put with the same strike price and expiration date

    - The bundle leads to a loss when the price is close to the strike price

    - The bundle leads to a gain when the price moves sufficiently in either direction

- **Strips and Straps**

    - Both of these strategies reward prices that deviate far from the strike price

    - Strip - a long position in a call and two puts with teh same strike price and expiration date

      A strip is a bet on a big move where a decrease in price is more likely

    - Strap - a long position in two calls and one put with teh same strike price and expiration date

      A strap is a bet on a big move where an increase in price is more likely

- **Strangles** - A put and a call with the same expiration date and different strike prices, with put strike price K_1 and a call strike price K_2, where $K_2 > K_1$.

    - Similar shape compared to straddle, however prices need to deviate more in a strangle in order for gains to be found

    - The farther apart the strike prices, the less the downside risk and the farther the price has to move for a gain to be realized