Chapter 10

Derivatives: Risk Management with Speculation, Hedging, and Risk Transfer
Introduction

- In this chapter on derivatives we cover:
  - Forward and futures contracts valuation.
  - Swaps valuation
  - Option valuation
  - Describe various hedging strategies.
  - The various uses of options in speculation, insurance of a portfolio, and the construction of structured notes.
Introduction

- Derivatives are instruments based on some underlying asset.
- Derivatives can be traded on an organized exchange, which is usually the case for futures and options.
- Derivatives can also be traded as private contracts, as is the case of forwards and swaps.
Forward and Futures Contracts

- Forward and futures contracts are made in advance of delivery.
- Forward and futures contracts imply a firm commitment to buy or sell at a future delivery date (maturity or expiration of the contract) at a set price.
- The price is set so that the buyer and the seller enter the contract without exchanging any payment at time of contracting. But a margin deposit could be required as guarantee.
Forward Contract

- A forward contract is a private agreement between two parties made “over the counter.”
- A forward contract can be customized in terms of size and delivery date.
- A forward contract cannot be resold.
- Forward contracts cannot be marked to market.
- The investor has to wait for the delivery date to realize the profit or loss on the position.
- Margins deposited as guarantee, if any, are set once, on the day of the initial transaction.
Futures Contract

- Futures contracts are traded on an organized futures exchange.
- Futures contracts are standardized in terms of size and maturity.
- There is usually no money exchanged when the contract is signed, but a margin is deposited as guarantee.
- Margins are set by the exchange, subject to periodic revision.
- The margin is determined by looking at the risk of a given contract.
## Exhibit 10.1: Major Differences between Forward and Futures Contracts

<table>
<thead>
<tr>
<th>Forward Contracts</th>
<th>Futures Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Customized contracts in terms of size and delivery dates.</td>
<td>1. Standardized contracts in terms of size and delivery dates.</td>
</tr>
<tr>
<td>2. Private contracts between two parties.</td>
<td>2. Standardized contract between a customer and a clearinghouse.</td>
</tr>
<tr>
<td>3. Difficult to reverse a contract.</td>
<td>3. Contract may be freely traded on the market.</td>
</tr>
<tr>
<td>4. Profit or loss on a position is realized only on the delivery date.</td>
<td>4. All contracts are marked to market; profits and losses are realized immediately.</td>
</tr>
<tr>
<td>5. Margins are set once, on the day of the initial transaction.</td>
<td>5. Margins must be maintained to reflect price movements.</td>
</tr>
</tbody>
</table>
Futures Contract

- Two types of margin are required:
  - **Initial margin**: deposit when client first enters a contract.
  - **Maintenance margin**: minimum level below which the margin is not allowed to fall once losses on the contract value have been taken into account.

- Contract positions are marked to market at the end of each day.
Futures Contract

- The procedure of marking to market implies that all the potential profits and losses are immediately realized.
- Contrary to forward contracts, futures contracts are seldom used to take physical delivery.
- Most investors reverse their position in the futures market before the contract expires.
Futures Contract — Types

- Currencies
  - Investors may transact major currencies in small amounts for reasonable transaction costs.
  - Moreover, the market is very liquid.
### Exhibit 10.2: Quotations for Currency Futures, February 18

<table>
<thead>
<tr>
<th>JAPANESE YEN FUTURES (CME) Yen 12.5m per Yen 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Mar</td>
</tr>
<tr>
<td>Jun</td>
</tr>
<tr>
<td>Sep</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STERLING FUTURES (CME) £62,500 per £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Mar</td>
</tr>
<tr>
<td>Jun</td>
</tr>
<tr>
<td>Sep</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SWISS FRANC FUTURES (CME) SFr125,000 per SFr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Mar</td>
</tr>
<tr>
<td>Jun</td>
</tr>
<tr>
<td>Sep</td>
</tr>
</tbody>
</table>

*Source: Financial Times, February 19, 1999*
Currency Futures - Question

Examine Exhibit 10.2 for March Sterling Futures contracts.

1) At what price did the March contract open?
2) At what price did the March contract close?
3) If someone had bought one March sterling contract at the close of February 17 at $1.6340 per £, would the person make a gain or loss?
Currency Futures – Answers

1) $1.6350 per £

2) $1.6320 per £

3) A loss = £62,500 x -$0.002/£ = - $125.00
Futures Contract — Types

- **Commodities**
  - a large variety are traded throughout the world: perishable goods (e.g. soybeans, live cattle), metals (e.g. copper, gold), energy (e.g. oil).
  - For each commodity, the quality and quantity of the product traded are specified, as well as location and terms of delivery.
Futures Contract — Types

- **Interest rate futures:**
  - e.g., Eurodollar and Treasury bond contracts.
  - Commercial banks and money managers use these futures to hedge their interest rate exposure, to protect their portfolio of loans, investments or borrowing against adverse movements in interest rates.
Futures Contract — Types

- **Stock futures:**
  - Futures are traded on stock indexes and on single stocks.
  - Gain (loss) on a stock index future = future price variation x Contract value multiple.
Exhibit 10.3: Quotations for Interest Rate Futures, February 18

<table>
<thead>
<tr>
<th>THREE-MONTH EURIBOR FUTURES (LIFFE) €1m, 100 – rate</th>
<th>Open</th>
<th>Sett Price</th>
<th>Change</th>
<th>High</th>
<th>Low</th>
<th>Estimated Volume</th>
<th>Open Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>96.985</td>
<td>96.980</td>
<td>-0.005</td>
<td>96.995</td>
<td>96.960</td>
<td>38,244</td>
<td>146,771</td>
</tr>
<tr>
<td>Jun</td>
<td>97.085</td>
<td>97.085</td>
<td>+0.005</td>
<td>97.100</td>
<td>97.070</td>
<td>29,048</td>
<td>134,205</td>
</tr>
<tr>
<td>Sep</td>
<td>97.115</td>
<td>97.115</td>
<td>+0.005</td>
<td>97.130</td>
<td>97.095</td>
<td>19,978</td>
<td>91,904</td>
</tr>
<tr>
<td>Dec</td>
<td>96.870</td>
<td>96.850</td>
<td>—</td>
<td>96.870</td>
<td>96.845</td>
<td>6,087</td>
<td>86,886</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTIONAL U.K. GILT FUTURES (LIFFE) £100,000, 100ths of 100%</th>
<th>Open</th>
<th>Latest</th>
<th>Change</th>
<th>High</th>
<th>Low</th>
<th>Estimated Volume</th>
<th>Open Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>117.27</td>
<td>116.98</td>
<td>-0.07</td>
<td>117.40</td>
<td>116.82</td>
<td>45,227</td>
<td>89,090</td>
</tr>
<tr>
<td>Jun</td>
<td>118.17</td>
<td>118.00</td>
<td>—</td>
<td>118.39</td>
<td>117.95</td>
<td>2,581</td>
<td>6,963</td>
</tr>
</tbody>
</table>

Source: Financial Times, February 19, 1999
Forward and Futures Valuation

- At expiration, the futures price converges to the spot price.
- Forward and futures contracts have a symmetrical payoff.
- Futures valuation models are based on an arbitrage between the current spot price $S$ and the current futures (forward) price $F$.
- These models determine the theoretical value for the basis:
  - $\text{Basis} = F - S$
  - or $\text{Basis} = \frac{F - S}{S}$ (on an annualized basis)
Forward and Futures Valuation

- The arbitrage is also often referred to as cash and carry.
- The bases for perishable goods depend on complex factors that are often difficult to forecast, including expected crop sizes and harvesting cycles.
Exhibit 10.5: Profits and Losses from Buying (“Long”) and Selling (“Short”) a Futures Contract

(a) Long position

Profit

Spot price at expiration

F

(b) Short position

Profit

Spot price at expiration

F

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Question

- The December futures contract of the Australian ASX index quotes at 4,025. The multiple is 25 Australian dollars (A$). The next day this contract quotes at 4,080. What is the gain/loss for an investor long in one contract?
Answer

- The gain in Australian dollars for the holder of one contract is equal to:
  
  \[
  \text{Gain} = (4,080 - 4,025) \times \text{A$25}
  \]
  
  \[
  \text{Gain} = \text{A$1,375}
  \]
Use of Forward and Futures

- Hedging — two possible types:
  - **Long Hedge:**
    - a long, or anticipatory, hedge generally involves buying futures contracts in anticipation of a spot purchase.
  - **Short Hedge:**
    - involves selling futures contracts to cover the risk on a position in the spot market.
    - This is the most common use of hedging in investment management.
Two major questions

- Two major questions must be answered when hedging a specified source of risk:
  - Which contract should I use?
  - What amount should I use?
The hedge ratio is defined as:

\[ \text{Hedge ratio} = \frac{N \times \text{Size} \times S}{V} \]
Hedging with Futures Contracts

- Because few futures contracts exist, investors must often engage in cross-hedging by using contracts that are close to the assets to be hedged.
- Optimal hedge ratio:

\[ h^* = \frac{Cov(R, R_F)}{\sigma_F^2} \]
Hedging with Futures Contracts

**Question:** Consider a portfolio invested in Australian stocks and the market value of the asset position is A$5,000,000. The ASX index is 4,500 and the futures contract has a multiple of A$25 and the hedge ratio is 0.65. How many contracts need to be sold?
Hedging with Futures Contracts

Answer:

\[ N = h \times \frac{V}{\text{Size} \times S} \]

\[ N = 0.65 \times \frac{5,000,000}{25 \times 4,500} \]

\[ N = 28.89 \]

\[ N = 29 \text{ contracts} \]
Hedging

- A hedge is seldom perfect for at least two reasons:
  - Basis risk
  - Correlation, or cross-hedge risk.
- Hedging strategies range from a simple approach using a unitary hedge ratio to a minimum-variance optimization approach.
Example

**Question:** How can an arbitrage be undertaken if the futures price is too high relative to the current spot price?
Example - Answer

- Borrow money to buy spot.
- Simultaneously sell the futures
- While carrying the spot asset, some income might be received.
- At maturity of the futures contract, use the spot to deliver on the futures contract.
Swaps

- Swaps are used extensively by banks to manage risk exposure on their assets and liabilities.
- Swaps can be regarded as a long-term package of periodic forward contracts.
- A swap is a contract whereby the two parties agree to a periodic exchange of cash flows.
- Each side of the swap is called a leg.
- On each swap payment date, the two cash flows are netted and a payment is made by the party owing money.
Swaps

- Swaps appear off-balance sheet.
- The swap market is an OTC market in which the major commercial and investment banks participate.
- There is no organized secondary swap market.
- This is problematic because swaps are long-term contracts.
Swaps

- An investor wishing to get out of a swap has three alternatives:
  - Agree on a voluntary termination with the original counterparty.
  - Write a mirror swap with the original counterparty.
  - Write a reverse swap in the market with another counterparty.
Swaps — Types

- **Currency:**
  - A contract to exchange streams of fixed cash flows denominated in two different currencies.

- **Interest Rate Swaps:**
  - A contract to exchange streams of cash flows in the same currency but based on two different interest rates (e.g. floating versus fixed).

- **Currency Interest Rate Swaps:**
  - A contract to exchange streams of cash flows in two different currencies, one with a fixed interest rate and the other with a floating interest rate.
Swaps – example

**Question:** An investor has entered a three-year interest rate swap for €1 million, receiving fixed at 5.75 percent and paying six-month Euribor. Payments are semiannual, and interest rates are computed linearly (i.e., the semiannual rate is obtained by dividing the annualized rate by 2). At some later reset date, the six-month Euribor is at 4.5 percent. What is the payment six months later?
Swaps – example

**Answer:** The investor receives a payment of

\[
Payment = \frac{(5.75 - 4.5)}{2} \times 1,000,000 \text{ euros}
\]

\[
Payment = 6,250 \text{ euros}
\]
Swaps — Uses

- The major motivations for using swaps are return and risk.
- Companies use swaps to reduce their financing costs (return motivation).
- They also use swaps to manage their long-term exposure to currency and interest rate risks, especially when they are faced with risks to existing assets and liabilities.
Swaps — Uses

- The idea is to use financing on a specific market in which a borrower has a comparative advantage and to transfer that advantage to another market or currency by making a swap at prevailing market conditions.
- The swap helps as a bridge across markets.
Exhibit 10.7: Valuing a Currency Swap as a Package of Forward Currency Contracts (in millions)
Swaps

- Risk management using swaps requires several steps:
  - Identify the source of uncertainty that could induce losses.
  - Measure the amount of exposure to this risk.
  - Identify the type of swaps that could best be used to hedge the risk.
  - Decide on the amount of hedging that should be undertaken.
## Exhibit 10.8

## Cash Flows

<table>
<thead>
<tr>
<th>Payments (in millions)</th>
<th>Yen</th>
<th>Dollar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before swap (dual currency and yen bonds)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 1: Interest</td>
<td>400$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Year 2: Interest</td>
<td>400$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Year 3: Interest</td>
<td>400$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Year 4: Interest</td>
<td>400$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Year 5: Interest</td>
<td>400$^A$</td>
<td>0</td>
</tr>
<tr>
<td>Year 5: Principal</td>
<td>10,000$^B$</td>
<td>100$^A$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>After swap (dual currency and yen bonds plus swap)</strong></th>
<th>Yen</th>
<th>Dollar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1: Interest</td>
<td>0</td>
<td>C</td>
</tr>
<tr>
<td>Year 2: Interest</td>
<td>0</td>
<td>C</td>
</tr>
<tr>
<td>Year 3: Interest</td>
<td>0</td>
<td>C</td>
</tr>
<tr>
<td>Year 4: Interest</td>
<td>0</td>
<td>C</td>
</tr>
<tr>
<td>Year 5: Interest</td>
<td>0</td>
<td>C</td>
</tr>
<tr>
<td>Year 5: Principal</td>
<td>0</td>
<td>100 + 100</td>
</tr>
</tbody>
</table>

$^A$ Cash flow from Bond A.

$^B$ Cash flow from Bond B.
Options

- A call (re: put) option gives the buyer of the option contract the right, but not the obligation, to buy (re: sell) a specified number of units of an underlying asset at a specified price, the strike price, at or before a specified date, the expiration date.

- In all cases, the seller, or writer, of an option is subject to the buyer’s decision to exercise or not the option.
Options

- A European option can only be exercised on the expiration date.
- An American option can be exercised any time up until the expiration date.
- In order to obtain the option, the buyer must pay a price, the option premium, that is received by the seller.
Options — Types

- **Currency Options:**
  - Over-the-counter currency options.
    - Can only be exercised at maturity
  - Spot currency options.
    - Are traded on some exchanges
  - Options on currency future contracts.
    - The CME trades options on its currency futures.
Options — Types

- Stock Options
  - On individual common stocks.
  - On stock indexes.
- Interest Rate Options
Exhibit 10.9: Currency Options Quotations, February 18

<table>
<thead>
<tr>
<th>Strike Price</th>
<th>Calls</th>
<th>Puts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mar</td>
<td>Apr</td>
</tr>
<tr>
<td>1.620</td>
<td>2.01</td>
<td>2.63</td>
</tr>
<tr>
<td>1.630</td>
<td>1.38</td>
<td>2.10</td>
</tr>
<tr>
<td>1.640</td>
<td>0.94</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Previous day’s volume, calls–puts 422. Previous day's open interest, calls 1,553, puts 19,754.

Source: Financial Times, February 19, 1999
Options — Payoff at expiration

- The buyer of a call benefits if the price of an asset is above the strike price at expiration.

- The buyer of a put benefits if the price of an asset is below the strike price at expiration.

- The option writer loses accordingly.
Exhibit 10.10

Profits and Losses from Various Positions

(a) Long position

(b) Short position

(c) Buy a call

(d) Sell a call

(e) Buy a put

(f) Sell a put

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Valuation

- Option values depend on:
  - Volatility
  - Asset price relative to strike price
  - Interest Rate
  - Time to Expiration
Exhibit 10.11: Call Option Intrinsic Value as a Function of Asset Price
Exhibit 10.12: Call Option Value as a Function of Asset Price
Uses of Options

- Covered call writing is the sale of a call option written on assets held in the portfolio. The option sale will generate income (the premium) if the option expires worthless, but the risk is that the assets will have to be delivered if the option is exercised.

- Buying options allows to capitalize on some expectations with limited downside risk.
Uses of Options (continued)

- Options provide a unique tool with which to insure portfolios. Insurance means that a portfolio is protected against a negative performance while it retains its positive performance potential.

- Structured notes