Chapter 20

Corporate Risk Management
Chapter 20 Contents

1. Five-Step Corporate Risk Management Process
2. Managing Risk with Insurance Contracts
3. Managing Risk by Hedging with Forward Contracts
5. Valuing Options and Swaps
Learning Objectives

1. Define risk management in the context of the five-step risk management process.
2. Understand how insurance contracts can be used to manage risk.
3. Use forward contracts to hedge commodity price risk.
4. Understand the advantages and disadvantages of using exchange traded futures and option contracts to hedge price risk.
5. Understand how to value option and how swaps work.
Principle Used in This Chapter

- **Principle 2**: There is a Risk-Return Tradeoff.
  
  - Business is inherently risky but a lot of risk that a firm is exposed to are at least partially controllable through use of financial contracts.
  
  - Corporations are devoting increasing amounts of time and resources to active management of their risk exposure.
Five Step Corporate Risk Management Process

1. Identify and understand the firm’s major risks.
2. Decide which type of risks to keep and which to transfer.
3. Decide how much risk to assume.
4. Incorporate risk into all the firm’s decisions and processes.
5. Monitor and manage risk that the firm assumes.
Step 1: Identify and Understand the Firm’s Major Risks

- Identifying risks relates to understanding the factors that drive the firm’s cash flow volatility. For example:
  - **Demand risk** - fluctuations in demand
  - **Commodity risk** – fluctuations in prices of raw materials
  - **Country risk** – unfavorable government policies
  - **Operational risk** – cost overruns in firm’s operations
  - **Exchange rate risk** – changes in exchange rates
Step 1: Identify/Understand Firm’s Major Risks (cont.)

Key Point from previous risk examples:

- All the listed sources of risk (except operational risk) are external to the firm.

- Risk management generally focuses on managing external factors that cause volatility in firm’s cash flows.
Step 2: Decide Which Type of Risk to Keep and Which to Transfer

- This is perhaps the most critical step.

- Risk is transferred (insured) at a cost. Consider how car insurance premiums change with deductibles.

- For example, oil and gas exploration and production firms have historically chosen to assume the risk of fluctuations in the price of oil and gas. However, some firms have chosen to actively manage the risk.
Step 3: Decide How Much Risk to Assume

- Figure 20-1 illustrates the cash flow distributions for three risk management strategies.

- The specific strategy chosen will depend upon the firm’s attitude to risk and the cost/benefit analysis of risk management strategies.
Figure 20.1
Cash Flow Distributions for Alternative Risk Management Strategies

Each of the three probability distributions corresponds to a different approach to managing firm risk. The High Risk strategy can be interpreted as the “does nothing to transfer risk” strategy. The Medium Risk strategy involves transferring some of the firm’s risk to outside parties using the tools of risk management discussed later. Finally, the Low Risk strategy represents the cash flow distribution that results when the firm engages in a risk management strategy whereby it offloads all the risks that it possibly can.

<table>
<thead>
<tr>
<th>Risk Scenario</th>
<th>Expected Cash Flow</th>
<th>Standard Deviation in Cash Flow</th>
<th>Probability of Not Being Able to Meet Capex, Dividend, and Principal and Interest Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk</td>
<td>$58.34 million</td>
<td>$3.14 million</td>
<td>0.00%</td>
</tr>
<tr>
<td>Medium Risk</td>
<td>$61 million</td>
<td>$12.33 million</td>
<td>11.46%</td>
</tr>
<tr>
<td>High Risk</td>
<td>$66.81 million</td>
<td>$21.44 million</td>
<td>16.53%</td>
</tr>
</tbody>
</table>


**Step 4: Incorporate Risk into All the Firm’s Decisions and Processes**

- In this step, the firm must implement a system for controlling the firm’s risk exposure.

- For risks that will be transferred, the firm must determine an appropriate means of transferring risk such as buying an insurance policy.
Step 5: Monitor and Manage the Risk the Firm Assumes

- An effective monitoring system ensures that the firm’s day-to-day decisions are consistent with its chosen risk profile.

- This may involve centralizing the firm’s risk exposure with a chief risk officer who assumes responsibility for monitoring and regularly reporting to the CEO and to the firm’s board.
Specific Vehicles for Managing Risk

Private Party Contracts
- Insurance Contracts.
- Forward Contract Hedges
  - Currencies and Commodity Prices
- Supplier Contracts
- Swaps (Interest Rates)

Exchange-Traded Contracts
- Futures Contracts
  - Currencies, Commodity Prices, Interest Rates
- Options
- Swaps (Interest rates)
Managing Risk with Insurance Contracts

• Insurance is a method of transferring risk from the firm to an outside party, in exchange for a premium.

• There are many types of insurance contracts that provide protection against various events.
<table>
<thead>
<tr>
<th>Type of Risk</th>
<th>Type of Insurance Contract Used to Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property damage to company facilities due to fire, storm, or vandalism.</td>
<td>Property insurance</td>
</tr>
<tr>
<td>Loss of business resulting from a temporary shutdown because of fire or other insured peril.</td>
<td>Business interruption insurance</td>
</tr>
<tr>
<td>Loss of income resulting from the disability or death of an employee in a key position.</td>
<td>Key person life insurance</td>
</tr>
<tr>
<td>Losses suffered by the officers and directors of the firm due to alleged errors in judgment, breaches of duty, and wrongful acts related to their organizational activities.</td>
<td>Directors and officers insurance</td>
</tr>
<tr>
<td>Losses due to on-the-job injuries suffered by employees.</td>
<td>Workers’ compensation insurance</td>
</tr>
</tbody>
</table>
Managing Risk by Hedging with Forward Contracts

- **Hedging** refers to a strategy designed to offset the exposure to price risk.

- **Example 20.1** Need for an exchange rate (currency) hedge.
  - You are plan to purchase 1 million Euros of product from a German supplier in which payment must be made in Euros in 6 months.
  - You may be concerned that if Euro strengthens it will cost you more in U.S. dollars. Such risk can be mitigated with forward contracts.
Using Forward Contracts to Manage (Hedge) Risk (cont.)

• **Forward contract** is a contract wherein a price is agreed-upon today for asset to be sold or purchased in the future.

• Since the price is locked-in today, risk from future price fluctuation is reduced.

• These contracts are privately negotiated with an intermediary such as an investment bank.
  – This introduces counterparty risk. (What if investment bank fails?)
Currency Example: Managing Risk by Hedging with Forward Contract (cont.)

• Thus in example 20.1, you could negotiate a rate today for Euros (say 1 Euro = $1.35) using a forward contract. Firm enters into contract with investment bank (IB).

• In 6-months, regardless of whether Euro has appreciated or depreciated, your obligation will be to buy 1 million Euros at $1.35 each or $1.35 million. You give IB US dollars and get Euro.

• Now you pay the German supplier in Euro.
 Currency Example: Hedging with Forward Contracts – The Results

- The following table shows potential future scenarios and the cash flows. Forward contract eliminates impact (risk) of exchange rate changes. Note that hedge eliminates upside gains and downside losses if Euro rises or falls.

<table>
<thead>
<tr>
<th>Future Exchange Rate of Euro</th>
<th>Cost with a Forward Contract</th>
<th>Cost without a Forward contract</th>
<th>Effect of Forward Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.20</td>
<td>$1.35 million</td>
<td>$1.20 million</td>
<td>Miss gain</td>
</tr>
<tr>
<td>$1.30</td>
<td>$1.35 million</td>
<td>$1.30 million</td>
<td>Miss gain</td>
</tr>
<tr>
<td>$1.40</td>
<td>$1.35 million</td>
<td>$1.40 million</td>
<td>Avoid Loss</td>
</tr>
<tr>
<td>$1.50</td>
<td>$1.35 million</td>
<td>$1.50 million</td>
<td>Avoid Loss</td>
</tr>
</tbody>
</table>
Example 2 – Analyzing Oil Price Risk and Hedging with Forward Contracts

XYZ operates a specialty refining company that refines crude oil and sells the refined by-products to the cosmetic and plastic industries.

The firm’s analysts estimate that it will need to purchase 1 million barrels of crude oil at the end of the current year to provide the feedstock for its refining needs for the coming year.

The 1 million barrels of crude will be converted into by-products at an average cost of $30 per barrel. XYZ will then sell the by-products for $165 per barrel.

The current spot price of oil is $125 per barrel, and XYZ has been offered a forward contract by its investment banker to purchase the needed oil for a delivery price in one year of $130 per barrel.

a. Ignoring taxes, if oil prices in one year are as low as $110 or as high as $140, what will be XYZ’s profits (assuming XYZ does not enter into forward contract)?

b. If XYZ were to enter into the forward contract to purchase oil for $130 per barrel, show how this would effectively lock in the firm’s cost of fuel today. This hedges the risk that fluctuating crude oil prices pose for XYZ’s profits for the next year.
Oil Hedge Analysis

**STEP 1: Picture the problem**

In one year the price of crude oil might be as high as $140 a barrel or as low as $110. Since the cost of 1 million barrels of crude is the firm's primary cost of doing business, the price of crude in one year will have a rather dramatic impact on firm profits if it is not managed or hedged.
Oil Hedge Contract Analysis
Short on Underlying means go long on hedging instrument

**STEP 2: Decide on a solution strategy**

Since the firm needs to purchase crude oil in one year, it can hedge this risk by entering into a forward contract whose payoff offsets any increase or decrease in the cost of crude oil (i.e., whose payoff varies in exactly the opposite direction as the price of crude). We learned in Figure 20.2 that by purchasing a forward contract for crude at a fixed delivery price (in this case $130), the firm can lock in its cost of crude. So, we need to enter into a long position (purchase a forward contract) for the delivery of crude in one year at the price of $130 that covers 1 million barrels (bbls) of oil.
# Oil Hedge outcome analysis

**STEP 3: Solve**

The following table contains the calculation of firm profits for: the case where the price of crude oil is not hedged (column E); the payoff to the forward contract (column F); and firm profits where the price of crude is fully hedged (column G):

<table>
<thead>
<tr>
<th>Price of Oil/bbl</th>
<th>Total Cost of Oil</th>
<th>Total Revenues</th>
<th>Total Refining Costs</th>
<th>Unhedged Annual Profits</th>
<th>Profit/Loss on Forward Contract</th>
<th>Hedged Annual Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$110</td>
<td>$(110,000,000)</td>
<td>$165,000,000</td>
<td>$(30,000,000)</td>
<td>$25,000,000</td>
<td>$(20,000,000)</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>115</td>
<td>(115,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>20,000,000</td>
<td>(15,000,000)</td>
<td>5,000,000</td>
</tr>
<tr>
<td>120</td>
<td>(120,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>15,000,000</td>
<td>(10,000,000)</td>
<td>5,000,000</td>
</tr>
<tr>
<td>125</td>
<td>(125,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>10,000,000</td>
<td>(5,000,000)</td>
<td>5,000,000</td>
</tr>
<tr>
<td>130</td>
<td>(130,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>5,000,000</td>
<td>0</td>
<td>5,000,000</td>
</tr>
<tr>
<td>135</td>
<td>(135,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>0</td>
<td>5,000,000</td>
<td>5,000,000</td>
</tr>
<tr>
<td>140</td>
<td>(140,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>(5,000,000)</td>
<td>10,000,000</td>
<td>5,000,000</td>
</tr>
</tbody>
</table>

Number of barrels: 1,000,000
Revenues: $165,000,000
Delivery price: $130.00
Oil Hedge Profit Analysis

**STEP 4: Analyze**
Where the price of crude is not hedged, firm profits vary from a loss of $5 million up to a profit of $25 million. However, where the cost of crude is fully hedged, firm profits are always $5,000,000. Figure 20.3 illustrates the gains and losses from hedging:

**Figure 20.3**
Gains and Losses from Hedging

![Diagram of profits and losses from hedging](image)

Price of crude oil in one year

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Partial Hedging: What Happens?

Consider the profits that XYZ might earn if it chooses to hedge only 80% of its anticipated 1 million barrels of crude oil under the conditions above.

Main issue is do you have residual upside and downside risk exposure?
### Step 3: Solution to partial hedge

#### 80% Hedged

<table>
<thead>
<tr>
<th>Price of Oil/bbl</th>
<th>Total Cost of Oil</th>
<th>Total Revenues</th>
<th>Total Refining Costs</th>
<th>Unhedged Annual Profits</th>
<th>Profit/Loss on Forward Contract</th>
<th>80% Hedged Annual Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B=Ax1m</td>
<td>C</td>
<td>D=$30x1m</td>
<td>E=C+B+D</td>
<td>=(A-$130)x1mx%Hedge</td>
<td>G=E+F</td>
</tr>
<tr>
<td>$110</td>
<td>$(110,000,000)</td>
<td>$165,000,000</td>
<td>$(30,000,000)</td>
<td>$25,000,000</td>
<td>$(16,000,000)</td>
<td>$9,000,000</td>
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<tr>
<td>115</td>
<td>(115,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$20,000,000</td>
<td>$(12,000,000)</td>
<td>8,000,000</td>
</tr>
<tr>
<td>120</td>
<td>(120,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$15,000,000</td>
<td>$(8,000,000)</td>
<td>7,000,000</td>
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<tr>
<td>125</td>
<td>(125,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$10,000,000</td>
<td>$(4,000,000)</td>
<td>6,000,000</td>
</tr>
<tr>
<td>130</td>
<td>(130,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$5,000,000</td>
<td>$—</td>
<td>5,000,000</td>
</tr>
<tr>
<td>135</td>
<td>(135,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$0</td>
<td>$4,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>140</td>
<td>(140,000,000)</td>
<td>$165,000,000</td>
<td>(30,000,000)</td>
<td>$(5,000,000)</td>
<td>$8,000,000</td>
<td>3,000,000</td>
</tr>
</tbody>
</table>
Step 4: Analysis of the Partial Hedge

• The total cost of crude oil increases as the price of crude oil increases.
• The unhedged annual profits range from a loss of $5 million to a gain of $25 million. With 80% hedging, losses are avoided and the firm ends with profits ranging from $3 million to $5 million. The forward contract obviously benefits the firm when the price of oil is higher than $130.
Limitations of Forward Contract

1. **Credit or default risk**: Both parties are exposed to the risk that the other party may default on their obligation.

2. **Sharing of strategic information**: The parties know what specific risk is being hedged.

3. It is hard to determine the market values of negotiated contracts as these contracts are not traded.

- These limitations of forward contracts can be addressed by using exchange-traded contracts such as exchange traded futures, options, and swap contracts.
Managing Risk with Exchange-Traded Derivatives

- A derivative contract is a security whose value is derived from value of underlying asset or security.
- In the examples considered on forward contract, the underlying assets were oil and currency.
- Exchange traded derivatives cannot be customized (like forward contracts) and are available only for specific assets and for limited set of maturities.
Futures Contracts

• A futures contract is a contract to buy or sell a stated commodity (such as wheat) or a financial claim (such as U.S. Treasuries) at a specified price at some future specified time.

• These contracts, like forward contracts, can be used to lock-in future prices.
Types of Futures Contracts

• Categories of futures contracts:
  – **Commodity futures** – are traded on agricultural products, metals, wood products, and fibers.
  – **Financial futures** – include: Treasuries, Eurodollars, foreign currencies, and stock indices.
  – **Energy futures** – Heating oil, kerosene, natural gas, electricity, crude oil, etc.
  – **Weather futures** – Temperature, Hurricanes, Frost, Snowfall, Rainfall

• Financial futures dominate futures market.
Hedging Risk in Futures Market – Cotton Needed for Product – Main Example

- ABC Cap and Gown company needs 520,000 pounds of cotton by the beginning of May 2012 in order to produce graduation outfits for the year.
- Today’s price of cotton (spot price) is $0.9032/lb.
- It would cost ABC $0.20/lb to warehouse the cotton for the 5 months until it’s needed for production.
- Cotton prices have ranged from $0.90 to $2.16 per pound in the past year.
- Cotton Futures trade on the NYMEX in 50,000 lb contract. The May 2012 contract is currently $0.9039.
- Initial Margin on each Cotton futures contract is $5,500 and contracts have a $5.00 tick.
Cotton Future Hedge – Problem Setup

1. Is ABC Cap and Gown company Long or Short in the underlying asset (Physical Cotton)?

2. Assume ABC waits until the end of April to buy cotton on the spot market. What is the impact on profits if cotton prices rise between now and the purchase date? If cotton prices fall? 

3. Assume ABC has a hedging policy of using the maximum number of futures contracts without over-hedging the position relative to the underlying.
   a. Will ABC Buy or Sell Futures contracts to hedge cotton needs? 
   b. How many contracts will ABC buy (go long) or sell (short)? 
   c. How many pounds of cotton will be unhedged?
Cotton Future Hedge – Solved Setup

1. ABC Cap and Gown company is **Short** in the underlying asset since it needs to buy cotton.

2. If ABC waits until the end of April to buy cotton on the spot market and cotton prices rise between now and the purchase date, ABC’s costs increase and its **profits will fall**. If cotton prices fall, **profits rise**.

3. Assume ABC has a hedging policy of using the maximum number of futures contracts without over-hedging the position relative to the underlying.
   a. Will ABC Buy or Sell Futures contracts to hedge cotton needs? Short in underlying means long in the hedge. Buy Cotton futures.
   b. How many contracts will ABC buy (go long) or sell (short)? $520,000/50,000 = 10.4$ contracts $= 10$
   c. How many pounds of cotton will be unhedged? $20,000$
Cotton Future Hedge – Initial Cash Flows, Margin Deposits and minimizing default risk

- ABC needs to buy (go long) 10 May 2012 Cotton Futures Contracts and will hedge 500,000 lbs of production costs. They will call their broker and buy 10 contracts at the quoted $0.9039 per pound.
  a. ABC will have to deposit $55,000 into a margin account with the NYMEX ($5,500 x 10 contracts)

Margin – Futures exchanges require participants to post collateral called margin. This reduces the likelihood of the NYMEX suffering losses by ABC defaulting.

- Each day, the NYMEX (exchange) will adjust ABC’s margin account to recognize daily profits and losses on the future contract position due to daily prices changes on the contract. (Marking to Market)
Cotton Future Hedge – Futures Prices (intuition) and tracking daily positions

- When ABC purchased 10 May 2012 Cotton Futures Contracts on November 30 at $0.9039 per pound, the price represented the market’s best rational guess on November 30 as what the price of cotton will be on the settlement date of April 23, 2012.

- Suppose the Cotton futures contract settles on Dec.1 at $0.9153/lb. The NYMEX will adjust ABC’s margin account to reflect daily profits (losses) due to price changes on the contract. (Marking to Market).
  a. Each long contract will gain $5.00 for every $0.0001 increase in the futures contract price.
  b. Daily price change = $0.9153 - $0.9039 = $0.0114 or 114 ticks.
  c. Daily profit = 10 x (114 x $5) = 10 x $570 = $5,700
Convergence of Futures to Spot
(Hedge initiated at time $t=0$ and closed out at time $t$, maturity is at time $T$)
Cotton Future Hedge – Closing the Futures Position (intuition and profit calculations)

- A futures contract is a legally enforceable obligation to buy or sell an item at a specified price and to make or take delivery on the specified date.
  - Forward contracts almost always result in physical delivery
  - Futures contracts are rarely settled with physical delivery. Instead, they are typically “netted out”. Close out immediately before expiry by taking an opposite position.

- Suppose on April 23, 2012 ABC closes the 10 future contracts at $0.8999/lb by selling 10 contracts just seconds before the contract closes and settles. The next morning, ABC purchases 520,000 lbs. of physical cotton at $0.9000/lb.
  a. How much did ABC effectively pay for the 500,000 lbs of “hedged” cotton?
  b. How much did ABC pay for the un-hedged cotton?
Cotton Future Hedge – Closing the Futures Position (intuition and profit calculations)

- ABC closed the position by selling at $0.8999 and opened the position by buying at $0.9039.
  
  $0.8999 - $0.9039 = - $0.0040 / lb loss.
  
  40 ticks x $5/tick x 10 contracts = $2,000 loss on futures.

- ABC essentially paid $0.9000 + $0.0040 per pound on the 500,000 “hedged” pounds of cotton = $0.94/lb.

- ABC paid exactly $0.9000 for the other 20,000 pounds.

- Total Paid = (500,000 x $0.9040) + (20,000 x $0.90)
  
  Total Paid = $472,000
  
  Average price per pound paid = $472,000/520,000
  
  Avg. price = $0.903846 Really close to initial futures price. Effectively, purchase price locked on 30 Nov.
Figure 20.4
Marking to Market on Futures Contracts

Upon initiating a futures contract the exchange will require the parties to the contract to post an initial margin. In this example the margin is roughly 16% of the $25,780 (= $2,578 × 10 contracts) value of the 10 contracts. In addition, the exchange requires that the firm not allow the margin account to drop below a maintenance margin level such that the margin account never goes to zero.

<table>
<thead>
<tr>
<th>Date</th>
<th>Margin Account Balance on 10 Contracts</th>
<th>Value of 1 Futures Contract</th>
<th>Change in 1 Futures Price</th>
<th>Change in Value of 10 Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Oct-09</td>
<td>4,000</td>
<td>2,578</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Oct-09</td>
<td>3,180</td>
<td>2,496</td>
<td>$(82)</td>
<td>$(820)</td>
</tr>
<tr>
<td>3-Oct-09</td>
<td>3,250</td>
<td>2,503</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>4-Oct-09</td>
<td>3,880</td>
<td>2,566</td>
<td>63</td>
<td>630</td>
</tr>
</tbody>
</table>
Hedging with Futures Contracts (misc.)

- If a specific asset is not available, the best alternative is to use an asset whose price changes are highly correlated with the asset.

- For example, hedging corn with soybean future if the prices of the two commodities are highly correlated.

- If a contract with exact duration is not available, the analysts must select a contract that most nearly matches the maturity of the firm’s risk exposure.
Option Contracts

- **Options** are rights (not an obligation) to buy or sell a given number of shares or an asset at a specific price over a given period.
- The option owner’s right to buy is known as a **call option** while the right to sell is known as a **put option**.
- **Exercise price**: The price at which the asset can be bought or sold.
- **Option premium**: The price paid for the option.
- **Option expiration date**: The date on which the option contract expires.
- **American option**: These options can be exercised anytime up to the expiration date of the contract.
- **European option**: These options can be exercised only on the expiration date.
Call Option Contracts (Example 1)

• For example, if you buy a call option on 100 shares of XYZ stock at a premium of $4.50 and exercise price of $40 maturing in 90 days.
  – You will pay $450 for the call option contract ($4.50 x 100 shares per contract)

• You can buy the XYZ stock at $40, even though the market price of the stock maybe above $40.

• If the stock price is below $40, you will choose not to use your option contract and will lose the premium paid.
Put Option Contracts (Example 2)

- For example, if you buy a put option on 100 shares of ABC stock at a premium of $10.50 and exercise price of $70 maturing in 90 days.
  - You will pay $1,050 = $10.50 \times 100$ shares for contract

- You can sell the ABC stock at $70, even though the market price of the stock maybe below $70.

- If the market price of stock is above $70, you will choose not to use your option contract and will lose the premium paid.
A Graphical Look at Option Pricing Relationships

- Figures 20-5 to Figures 20-8 graphically illustrate the expiration date profit or loss from the following option positions:
  - Buying a call option (figure 20-5)
  - Selling or writing a call option (figure 20-6)
  - Buying a put option (figure 20-7)
  - Selling or writing a put option (figure 20-8)
A Graphical Look at Option Pricing Relationships (cont.)

• The graphs are based on the following assumptions:

  – Exercise price for call and put options = $20
  – Call premium = $4
  – Put premium = $3
# A Graphical Look at Option Pricing Relationships (cont.)

<table>
<thead>
<tr>
<th></th>
<th>Buy Call</th>
<th>Write Call</th>
<th>Buy Put</th>
<th>Write Put</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Profit</strong></td>
<td>Unlimited</td>
<td>Premium</td>
<td>Exercise Price - Premium</td>
<td>Premium</td>
</tr>
<tr>
<td><strong>Maximum Loss</strong></td>
<td>Premium</td>
<td>Unlimited</td>
<td>Premium</td>
<td>Exercise Price - Premium</td>
</tr>
<tr>
<td><strong>Future Market Expectation</strong></td>
<td>Bullish</td>
<td>Bearish</td>
<td>Bearish</td>
<td>Bullish</td>
</tr>
<tr>
<td><strong>Break-even Point</strong></td>
<td>Exercise Price + Premium</td>
<td>Exercise Price + Premium</td>
<td>Exercise Price – Premium</td>
<td>Exercise Price – Premium</td>
</tr>
</tbody>
</table>

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Figure 20.5
Expiration Date Profit or Loss from Purchasing a Call Option
Suppose you purchase a call on Ford Motor Company (F) stock with an exercise price of $20 for a premium of $4. As long as the expiration date price of Ford’s common stock is less than the $20 exercise price, the call option will expire worthless. It is said to be “out of the money.” If the price of Ford’s stock on the expiration date is equal to $20 it is “at the money,” and if it is higher than $20 then the call option is “in the money” with a profit equal to the difference between the stock price and the exercise price.
Figure 20.6
Expiration Date Profit or Loss from Selling (Writing) a Call Option
In this example we assume that you sell or “write” a call option on Ford Motor Company (F) stock with an exercise price of $20 for which you are paid a premium of $4. If the price of Ford’s shares ends up below $20 per share, then the call option will expire worthless and the option writer (seller) will not face any financial obligation. However, if the price of Ford’s shares rises above $20, the owner of the option gets the difference in the stock price and the exercise price (a profit—see Figure 20.5) and the option writer faces a loss equal to this same difference.

![Diagram showing profit or loss based on stock price at option expiration.](image)

- **Maximum profit = $4**
- **Exercise or striking price = $20**
- **Break-even point (exercise price + premium) = $24**
- **Maximum loss = unlimited**
Figure 20.7

Expiration Date Profit or Loss on Holding a Put Option

Suppose you purchase a put option on Ford Motor Company (F) stock with an exercise price of $20 and for a premium of $3. As long as the expiration date price of Ford's shares remains above the $20 exercise price the put is worthless or "out of the money." Should the price of Ford's shares fall below $20 per share on the expiration date, then the put option holder will receive $1 for every dollar the price falls below $20, and once the price falls below $17, she will make a profit.

Maximum profits = $17

Break-even point (exercise price - premium) = $17

Maximum loss = $3

Exercise or striking price = $20

Stock price at expiration
Figure 20.8
Expiration Date Profit or Loss from Selling (Writing) a Put Option

Suppose you write or sell a put option on Ford Motor Company (F) stock with an exercise price of $20 for a premium of $3. Should the price of Ford’s shares drop below the $20 exercise price on the put option you have sold, you will then be obligated to pay the difference in the $20 exercise price and the stock price to the holder of the option (see Figure 20.7).

![Diagram showing profit or loss of writing a put option at expiration.]

- Break-even point = (exercise price - premium) = $17
- Maximum profit = $3
- Maximum loss = $17
- Exercise or striking price = $20
Checkpoint 20.2

Determining the Break-Even Point and Profit or Loss on a Call Option

You are considering purchasing a call option on CROCS, Inc. (CROX) common stock. The exercise price on this call option is $10 and you purchased the option for $3. What is the break-even point on this call option (ignoring any transaction costs but considering the price of purchasing the option—the option premium)? Also, what would be the profit or loss on this option at expiration if the price dropped to $9, if it rose to $11, or if it rose to $25?
Checkpoint 20.2

STEP 1: **Picture the problem**

Letting the vertical axis represent the profits or losses realized on the option's expiration date, and letting the horizontal axis represent the stock price on the expiration date, we can visualize the profit or loss on an option as shown below. Remember we are viewing the value of the option at expiration. To keep things simple, we will also ignore any transaction costs.

![Graph showing profit or loss vs. stock price at expiration]

STEP 2: **Decide on a solution strategy**

The solution is actually quite simple in this case. At the expiration date, the break-even point is equal to exercise price + premium.
Checkpoint 20.2

**STEP 3: Solve**

Thus, plugging into the formulas for the break-even point and the profit or loss we get:

Break-even point = exercise price + what you paid for the option

= $10 + $3 = $13

To calculate the profit or loss on an option at expiration, you merely need to calculate the put or call’s value at expiration, then subtract out what you paid for it. When CROCS is selling at $9 and the option was purchased for $3, Profit or Loss = call value – what you paid for the option:

= $0 – $3 = –$3.

Profit or Loss When CROCS is selling at $11 and the option was purchased for $3, Profit or Loss = call value – what you paid for the option:

= $1 – $3 = –$2.

When CROCS is selling at $25 and the option was purchased for $3, Profit or Loss = call value – what you paid for the option:

= $15 – $3 = $12.
Checkpoint 20.2: Check Yourself

• If you paid $5 for a call option with an exercise price of $25, and the stock is selling for $35 at expiration, what are your profits and losses? What is the break-even point on this call option?
### Step 1: Picture the Problem

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>Call Premium</th>
<th>Exercise Price</th>
<th>Exercised or Not</th>
<th>Profit or Loss</th>
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<td></td>
<td></td>
<td></td>
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</tr>
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<td>($5)</td>
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<td>$10</td>
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</table>

- **Maximum Loss** = \( \text{Max}(0, A-C)-B \)
- **Break Even Point**
- **Practice Premium**
Step 1: Picture the Problem (cont.)

Profit/Loss from buying Calls

Future Stock Price

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Step 2: Decide on a Solution Strategy

- Break-even Point = Exercise price + Premium

- Profit = (Stock price – Exercise price) – Premium
  - If (stock price – exercise price) is negative, the profit or losses is equal to $0 – Premium.
  - In other words, Profit = Max (0, or Stock Price – Exercise Price) – Premium.
Step 3: Solve

- Break-even Point = Exercise price + Premium
  \[ = \$25 + \$5 \]
  \[ = \$30 \]

- Profit (at stock price of $35)
  \[ = (\text{Stock Price} - \text{Exercise Price}) - \text{Premium} \]
  \[ = (\$35 - \$25) - \$5 \]
  \[ = \$5 \]
Step 4: Analyze

• The graph in Step 1 shows that the option buyer will start exercising the option once it crosses $25.

• The option buyer will earn $1 (before considering option premium) for every $1 that the stock price rises above $25.

• Since the option premium is $5, at a stock price of $30, the option position earns $5 that covers the premium and leads to a no profit/no loss situation.
## Reading Option Price Quotes

### Figure 20.9

**Option Price Quotes for Apple Computers (AAPL) on April 28, 2009**

Pricing information is provided for both call options, which represent the right to buy the shares of Apple, and put options, which carry with them the right to sell Apple shares. The data included in the graphic include the following: “Last Sale” identifies the price of the most recent transaction, “Bid” is what the counterparty is willing to buy the security for, “Ask” is what the counterparty is willing to sell the security for, “Volume” represents the number of option contracts traded that day, and “Open Int” is the total number of option contracts that have not yet been exercised, expired, or fulfilled by delivery.

### AAPL (APPLE INC)

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<th>Calls</th>
<th>Last Sale</th>
<th>Bid</th>
<th>Ask</th>
<th>Vol</th>
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<th>Bid</th>
<th>Ask</th>
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*Source: Chicago Board of Trade (CBOE), http://www.cboe.com/delayedquote/QuoteTable.aspx, accessed April 28, 2009.*