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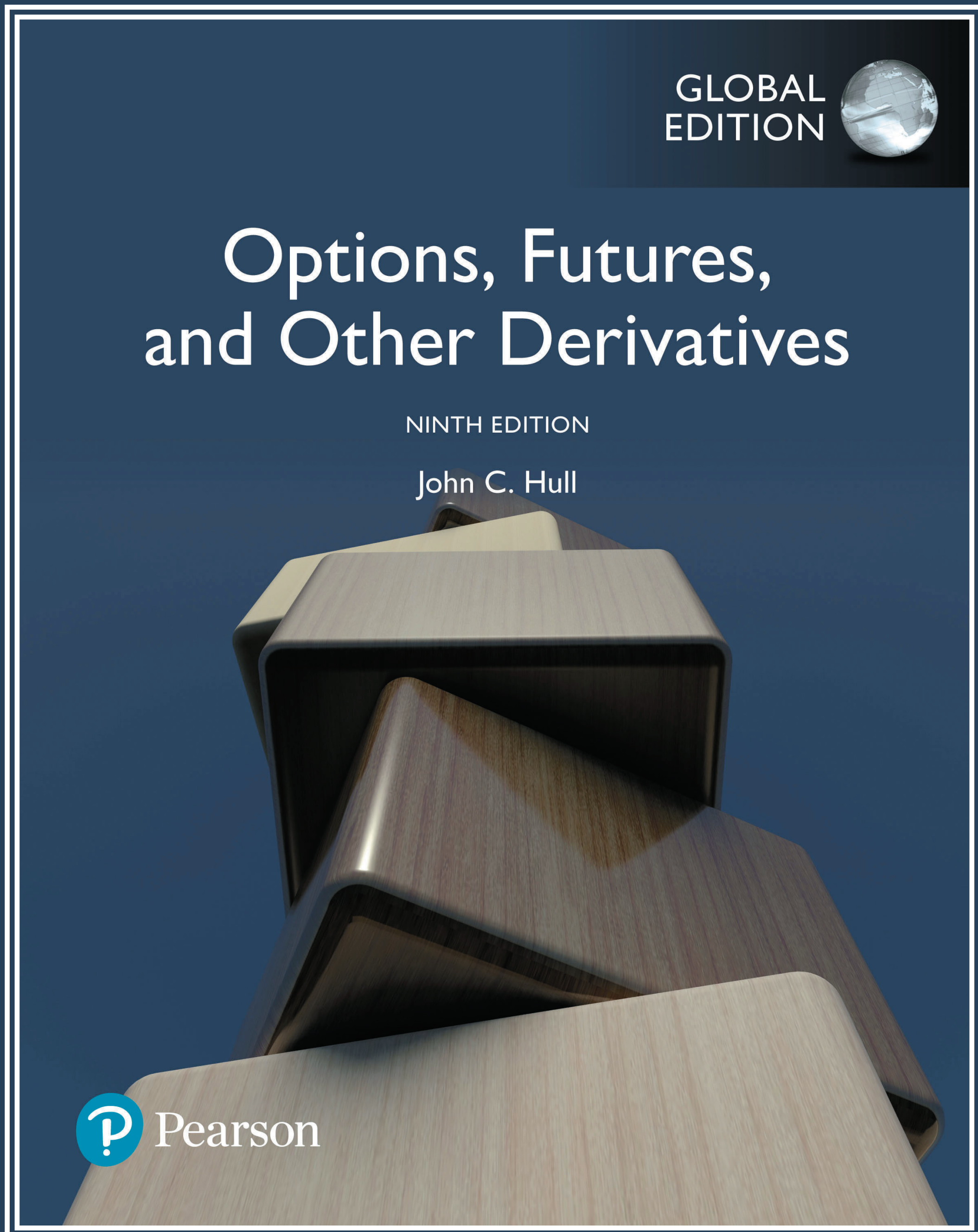

John C. Hull

Pearson

SOLUTIONS MANUAL

Options, Futures, and Other Derivatives

Ninth Edition
Global Edition

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and Risk Management
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Contents

Preface

This book contains solutions to the Practice Questions that appear at the ends of chapters in my book *Options, Futures, and Other Derivatives*, 9th edition, global edition. The questions have been designed to help readers study on their own and test their understanding of the material. They range from quick checks on whether a key point is understood to much more challenging applications of analytical techniques. Some prove or extend results presented in the book.

To maximize the benefits from this book readers are urged to sketch out their own solutions to the questions before consulting mine.

I welcome comments on either *Options, Futures, and Other Derivatives*, 9th edition, global edition or this book. My e-mail address is

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CHAPTER 1

Introduction

Problem 1.1.
What is the difference between a long forward position and a short forward position?

When a trader enters into a long forward contract, she is agreeing to *buy* the underlying asset for a certain price at a certain time in the future. When a trader enters into a short forward contract, she is agreeing to *sell* the underlying asset for a certain price at a certain time in the future.

Problem 1.2.
Explain carefully the difference between hedging, speculation, and arbitrage.

A trader is *hedging* when she has an exposure to the price of an asset and takes a position in a derivative to offset the exposure. In a *speculation* the trader has no exposure to offset. She is betting on the future movements in the price of the asset. *Arbitrage* involves taking a position in two or more different markets to lock in a profit.

Problem 1.3.
What is the difference between entering into a long forward contract when the forward price is \$50 and taking a long position in a call option with a strike price of \$50?

In the first case the trader is obligated to buy the asset for \$50. (The trader does not have a choice.) In the second case the trader has an option to buy the asset for \$50. (The trader does not have to exercise the option.)

Problem 1.4.
Explain carefully the difference between selling a call option and buying a put option.

Selling a call option involves giving someone else the right to buy an asset from you. It gives you a payoff of

$$-\max(S_T - K, 0) = \min(K - S_T, 0)$$

Buying a put option involves buying an option from someone else. It gives a payoff of

$$\max(K - S_T, 0)$$

In both cases the potential payoff is $K - S_T$. When you write a call option, the payoff is negative or zero. (This is because the counterparty chooses whether to exercise.) When you buy a put option, the payoff is zero or positive. (This is because you choose whether to exercise.)

Problem 1.5.
An investor enters into a short forward contract to sell 100,000 British pounds for US dollars at an exchange rate of 1.5000 US dollars per pound. How much does the investor gain or lose if the exchange rate at the end of the contract is (a) 1.4900 and (b) 1.5200?

(a) The investor is obligated to sell pounds for 1.5000 when they are worth 1.4900. The gain is (1.5000−1.4900) ×100,000 = \$1,000.

(b) The investor is obligated to sell pounds for 1.5000 when they are worth 1.5200. The loss is (1.5200−1.5000)×100,000 = \$2,000

Problem 1.6.
A trader enters into a short cotton futures contract when the futures price is 50 cents per pound. The contract is for the delivery of 50,000 pounds. How much does the trader gain or lose if the cotton price at the end of the contract is (a) 48.20 cents per pound; (b) 51.30 cents per pound?

(a) The trader sells for 50 cents per pound something that is worth 48.20 cents per pound. $\text{Gain} = (\$0.5000 - \$0.4820) \times 50{,}000 = \$900$.

(b) The trader sells for 50 cents per pound something that is worth 51.30 cents per pound. $\text{Loss} = (\$0.5130 - \$0.5000) \times 50{,}000 = \$650$.

Problem 1.7.
Suppose that you write a put contract with a strike price of \$40 and an expiration date in three months. The current stock price is \$41 and the contract is on 100 shares. What have you committed yourself to? How much could you gain or lose?

You have sold a put option. You have agreed to buy 100 shares for \$40 per share if the party on the other side of the contract chooses to exercise the right to sell for this price. The option will be exercised only when the price of stock is below \$40. Suppose, for example, that the option is exercised when the price is \$30. You have to buy at \$40 shares that are worth \$30; you lose \$10 per share, or \$1,000 in total. If the option is exercised when the price is \$20, you lose \$20 per share, or \$2,000 in total. The worst that can happen is that the price of the stock declines to almost zero during the three-month period. This highly unlikely event would cost you \$4,000. In return for the possible future losses, you receive the price of the option from the purchaser.

Problem 1.8.
What is the difference between the over-the-counter market and the exchange-traded market? What are the bid and offer quotes of a market maker in the over-the-counter market?

The over-the-counter market is a telephone- and computer-linked network of financial institutions, fund managers, and corporate treasurers where two participants can enter into any mutually acceptable contract. An exchange-traded market is a market organized by an exchange where the contracts that can be traded have been defined by the exchange. When a market maker quotes a bid and an offer, the bid is the price at which the market maker is prepared to buy and the offer is the price at which the market maker is prepared to sell.

Problem 1.9.
You would like to speculate on a rise in the price of a certain stock. The current stock price is \$29, and a three-month call with a strike of \$30 costs \$2.90. You have \$5,800 to invest. Identify two alternative strategies, one involving an investment in the stock and the other involving investment in the option. What are th potential gains and losses from each?

One strategy would be to buy 200 shares. Another would be to buy 2,000 options. If the share price does well the second strategy will give rise to greater gains. For example, if the share price goes up to \$40 you gain $[2,000\times(\$40-\$30)]-\$5,800=\$14,200$ from the second strategy and only $200\times(\$40-\$29)=\$2,200$ from the first strategy. However, if the share price does badly, the second strategy gives greater losses. For example, if the share price goes down to \$25, the first strategy leads to a loss of $200\times(\$29-\$25)=\$800,$ whereas the second strategy leads to a loss of the whole \$5,800 investment. This example shows that options contain built in leverage.

Problem 1.10.
Suppose you own 5,000 shares that are worth \$25 each. How can put options be used to provide you with insurance against a decline in the value of your holding over the next four months?

You could buy 50 put option contracts (each on 100 shares) with a strike price of \$25 and an expiration date in four months. If at the end of four months the stock price proves to be less than \$25, you can exercise the options and sell the shares for \$25 each.

Problem 1.11.
When first issued, a stock provides funds for a company. Is the same true of an exchange-traded stock option? Discuss.

An exchange-traded stock option provides no funds for the company. It is a security sold by one investor to another. The company is not involved. By contrast, a stock when it is first issued is sold by the company to investors and does provide funds for the company.

Problem 1.12.
Explain why a futures contract can be used for either speculation or hedging.

If an investor has an exposure to the price of an asset, he or she can hedge with futures contracts. If the investor will gain when the price decreases and lose when the price increases, a long futures position will hedge the risk. If the investor will lose when the price decreases and gain when the price increases, a short futures position will hedge the risk. Thus either a long or a short futures position can be entered into for hedging purposes.

If the investor has no exposure to the price of the underlying asset, entering into a futures contract is speculation. If the investor takes a long position, he or she gains when the asset's price increases and loses when it decreases. If the investor takes a short position, he or she loses when the asset's price increases and gains when it decreases.

Problem 1.13.
Suppose that a March call option to buy a share for \$50 costs \$2.50 and is held until March. Under what circumstances will the holder of the option make a profit? Under what circumstances will the option be exercised? Draw a diagram showing how the profit on a long position in the option depends on the stock price at the maturity of the option.

The holder of the option will gain if the price of the stock is above \$52.50 in March. (This ignores the time value of money.) The option will be exercised if the price of the stock is above \$50.00 in March. The profit as a function of the stock price is shown in Figure S1.1.

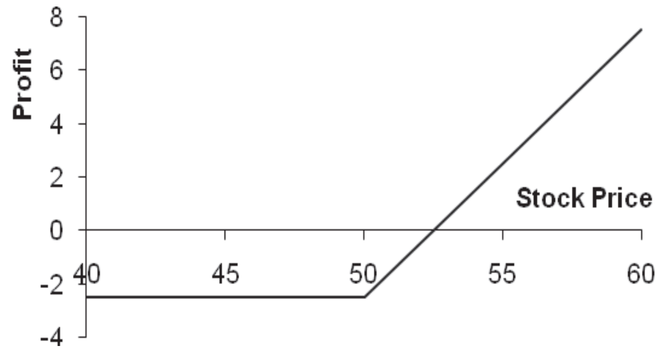

Figure S1.1: Profit from long position in Problem 1.13

Problem 1.14.
Suppose that a June put option to sell a share for $60 costs $4 and is held until June. Under what circumstances will the seller of the option (i.e., the party with a short position) make a profit? Under what circumstances will the option be exercised? Draw a diagram showing how the profit from a short position in the option depends on the stock price at the maturity of the option.

The seller of the option will lose money if the price of the stock is below $56.00 in June. (This ignores the time value of money.) The option will be exercised if the price of the stock is below $60.00 in June. The profit as a function of the stock price is shown in Figure S1.2.

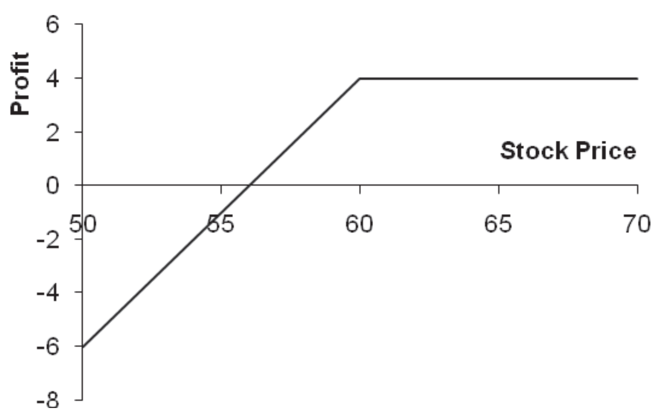

Figure S1.2: Profit from short position in Problem 1.14

Problem 1.15.
It is May and a trader writes a September call option with a strike price of $20. The stock price is $18, and the option price is $2. Describe the investor's cash flows if the option is held until September and the stock price is $25 at this time.

The trader has an inflow of $2 in May and an outflow of $5 in September. The $2 is the cash received from the sale of the option. The $5 is the result of the option being exercised. The investor has to buy the stock for $25 in September and sell it to the purchaser of the option for $20.

Problem 1.16.
A trader writes a December put option with a strike price of $30. The price of the option is $4. Under what circumstances does the trader make a gain?

The trader makes a gain if the price of the stock is above $26 at the time of exercise. (This ignores the time value of money.)

Problem 1.17.
A company knows that it is due to receive a certain amount of a foreign currency in four months. What type of option contract is appropriate for hedging?

A long position in a four-month put option can provide insurance against the exchange rate falling below the strike price. It ensures that the foreign currency can be sold for at least the strike price.

Problem 1.18.
A US company expects to have to pay 1 million Canadian dollars in six months. Explain how the exchange rate risk can be hedged using (a) a forward contract and (b) an option.

The company could enter into a long forward contract to buy 1 million Canadian dollars in six months. This would have the effect of locking in an exchange rate equal to the current forward exchange rate. Alternatively the company could buy a call option giving it the right (but not the obligation) to purchase 1 million Canadian dollars at a certain exchange rate in six months. This would provide insurance against a strong Canadian dollar in six months while still allowing the company to benefit from a weak Canadian dollar at that time.

Problem 1.19.
A trader enters into a short forward contract on 100 million yen. The forward exchange rate is $0.0090 per yen. How much does the trader gain or lose if the exchange rate at the end of the contract is (a) $0.0084 per yen; (b) $0.0101 per yen?

a) The trader sells 100 million yen for $0.0090 per yen when the exchange rate is $0.0084 per yen. The gain is 100×0.0006 millions of dollars or $60,000.
b) The trader sells 100 million yen for $0.0090 per yen when the exchange rate is $0.0101 per yen. The loss is 100×0.0011 millions of dollars or $110,000.

Problem 1.20.
The CME Group offers a futures contract on long-term Treasury bonds. Characterize the investors likely to use this contract.

Most investors will use the contract because they want to do one of the following:

a) Hedge an exposure to long-term interest rates.
b) Speculate on the future direction of long-term interest rates.
c) Arbitrage between the spot and futures markets for Treasury bonds.

This contract is discussed in Chapter 6.

Problem 1.21.
"Options and futures are zero-sum games." What do you think is meant by this statement?

The statement means that the gain (loss) to the party with the short position is equal to the loss (gain) to the party with the long position. In aggregate, the net gain to all parties is zero.

Problem 1.22.
Describe the profit from the following portfolio: a long forward contract on an asset and a long European put option on the asset with the same maturity as the forward contract and a strike price that is equal to the forward price of the asset at the time the portfolio is set up.

The terminal value of the long forward contract is:

$$S_T - F_0$$

where S_T is the price of the asset at maturity and F_0 is the delivery price, which is the same as the forward price of the asset at the time the portfolio is set up). The terminal value of the put option is:

$$\max(F_0 - S_T, 0)$$

The terminal value of the portfolio is therefore

$$S_T - F_0 + \max(F_0 - S_T, 0)$$

$$= \max(0, S_T - F_0]$$

This is the same as the terminal value of a European call option with the same maturity as the forward contract and a strike price equal to F_0. This result is illustrated in the Figure S1.3. The profit equals the terminal value of the call option less the amount paid for the put option. (It does not cost anything to enter into the forward contract.

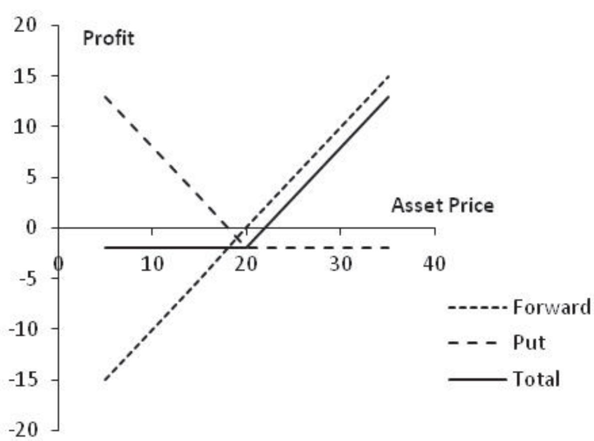

Figure S1.3: Profit from portfolio in Problem 1.22

Problem 1.23.
In the 1980s, Bankers Trust developed index currency option notes (ICONs). These are bonds in which the amount received by the holder at maturity varies with a foreign exchange rate. One example was its trade with the Long Term Credit Bank of Japan. The ICON specified

that if the yen–U.S. dollar exchange rate, S_T, is greater than 169 yen per dollar at maturity (in 1995), the holder of the bond receives \$1,000. If it is less than 169 yen per dollar, the amount received by the holder of the bond is

$$1,000 - \max\left[0,\ 1,000\left(\frac{169}{S_T} - 1\right)\right]$$

When the exchange rate is below 84.5, nothing is received by the holder at maturity. Show that this ICON is a combination of a regular bond and two options.

Suppose that the yen exchange rate (yen per dollar) at maturity of the ICON is S_T. The payoff from the ICON is

$$\begin{array}{lll} 1,000 & \text{if} & S_T > 169 \\ 1,000 - 1,000\left(\dfrac{169}{S_T} - 1\right) & \text{if} & 84.5 \le S_T \le 169 \\ 0 & \text{if} & S_T < 84.5 \end{array}$$

When $84.5 \le S_T \le 169$ the payoff can be written

$$2,000 - \frac{169,000}{S_T}$$

The payoff from an ICON is the payoff from:

(a) A regular bond
(b) A short position in call options to buy 169,000 yen with an exercise price of 1/169
(c) A long position in call options to buy 169,000 yen with an exercise price of 1/84.5

This is demonstrated by the following table, which shows the terminal value of the various components of the position

	Bond	*Short Calls*	*Long Calls*	*Whole position*
$S_T > 169$	1000	0	0	1000
$84.5 \le S_T \le 169$	1000	$-169,000\left(\frac{1}{S_T} - \frac{1}{169}\right)$	0	$2000 - \frac{169,000}{S_T}$
$S_T < 84.5$	1000	$-169,000\left(\frac{1}{S_T} - \frac{1}{169}\right)$	$169,000\left(\frac{1}{S_T} - \frac{1}{84.5}\right)$	0

Problem 1.24.
On July 1, 2011, a company enters into a forward contract to buy 10 million Japanese yen on January 1, 2012. On September 1, 2011, it enters into a forward contract to sell 10 million Japanese yen on January 1, 2012. Describe the payoff from this strategy.

Suppose that the forward price for the contract entered into on July 1, 2011 is F_1 and that the forward price for the contract entered into on September 1, 2011 is F_2 with both F_1 and F_2 being measured as dollars per yen. If the value of one Japanese yen (measured in US dollars) is S_T on January 1, 2012, then the value of the first contract (in millions of dollars) at that time is

$$10(S_T - F_1)$$

while the value of the second contract at that time is:

$$10(F_2 - S_T)$$

The total payoff from the two contracts is therefore

$$10(S_T - F_1) + 10(F_2 - S_T) = 10(F_2 - F_1)$$

Thus if the forward price for delivery on January 1, 2012 increased between July 1, 2011 and September 1, 2011 the company will make a profit. (Note that the yen/USD exchange rate is usually expressed as the number of yen per USD not as the number of USD per yen)

Problem 1.25.

Suppose that USD-sterling spot and forward exchange rates are as follows:

Spot	*1.5580*
90-day forward	*1.5556*
180-day forward	*1.5518*

What opportunities are open to an arbitrageur in the following situations?

a) *A 180-day European call option to buy £1 for $1.52 costs 2 cents.*
b) *A 90-day European put option to sell £1 for $1.59 costs 2 cents.*

Note that there is a typo in the problem in the book. 1.42 and 1.49 should be 1.52 and 1.59 in the last two lines of the problem s

(a) The arbitrageur buys a 180-day call option and takes a short position in a 180-day forward contract. If S_T is the terminal spot rate, the profit from the call option is

$$\max(S_T - 1.52, 0) - 0.02$$

The profit from the short forward contract is

$$1.5518 - S_T$$

The profit from the strategy is therefore

$$\max(S_T - 1.52, 0) - 0.02 + 1.5518 - S_T$$

or

$$\max(S_T - 1.52, 0) + 1.5318 - S_T$$

This is

$1.5318 - S_T$ when $S_T < 1.52$

0.0118 when $S_T > 1.52$

This shows that the profit is always positive. The time value of money has been ignored in these calculations. However, when it is taken into account the strategy is still likely to be profitable in all circumstances. (We would require an extremely high interest rate for $0.0118 interest to be required on an outlay of $0.02 over a 180-day period.)

(b) The trader buys 90-day put options and takes a long position in a 90 day forward contract. If S_T is the terminal spot rate, the profit from the put option is

$$\max(1.59 - S_T, 0) - 0.02$$

The profit from the long forward contract is

$S_T - 1.5556$

The profit from this strategy is therefore

$$\max(1.59 - S_T, 0) - 0.02 + S_T - 1.5556$$

or

$$\max(1.59 - S_T, 0) + S_T - 1.5756$$

This is

$S_T - 1.5756$ when $S_T > 1.59$

0.0144 when $S_T < 1.59$

The profit is therefore always positive. Again, the time value of money has been ignored but is unlikely to affect the overall profitability of the strategy. (We would require interest rates to be extremely high for \$0.0144 interest to be required on an outlay of \$0.02 over a 90-day period.)

Problem 1.26.
A trader buys a call option with a strike price of \$30 for \$3. Does the trader ever exercise the option and lose money on the trade. Explain.

If the stock price is between \$30 and \$33 at option maturity the trader will exercise the option, but lose money on the trade. Consider the situation where the stock price is \$31. If the trader exercises, she loses \$2 on the trade. If she does not exercise she loses \$3 on the trade. It is clearly better to exercise than not exercise.

Problem 1.27.
A trader sells a put option with a strike price of \$40 for \$5. What is the trader's maximum gain and maximum loss? How does your answer change if it is a call option?

The trader's maximum gain from the put option is \$5. The maximum loss is \$35, corresponding to the situation where the option is exercised and the price of the underlying asset is zero. If the option were a call, the trader's maximum gain would still be \$5, but there would be no bound to the loss as there is in theory no limit to how high the asset price could rise.

Problem 1.28.
"Buying a put option on a stock when the stock is owned is a form of insurance." Explain this statement.

If the stock price declines below the strike price of the put option, the stock can be sold for the strike price.

CHAPTER 2

Mechanics of Futures Markets

Problem 2.1.
Distinguish between the terms open interest and trading volume.

The *open interest* of a futures contract at a particular time is the total number of long positions outstanding. (Equivalently, it is the total number of short positions outstanding.) The *trading volume* during a certain period of time is the number of contracts traded during this period**.**

Problem 2.2.
What is the difference between a local and a futures commission merchant?

A *futures commission merchant* trades on behalf of a client and charges a commission. A *local* trades on his or her own behalf.

Problem 2.3.
Suppose that you enter into a short futures contract to sell July silver for $17.20 per ounce. The size of the contract is 5,000 ounces. The initial margin is $4,000, and the maintenance margin is $3,000. What change in the futures price will lead to a margin call? What happens if you do not meet the margin call?

There will be a margin call when $1,000 has been lost from the margin account. This will occur when the price of silver increases by 1,000/5,000 = $0.20. The price of silver must therefore rise to $17.40 per ounce for there to be a margin call. If the margin call is not met, your broker closes out your position.

Problem 2.4.
Suppose that in September 2015 a company takes a long position in a contract on May 2016 crude oil futures. It closes out its position in March 2016. The futures price (per barrel) is $88.30 when it enters into the contract, $90.50 when it closes out its position, and $89.10 at the end of December 2015. One contract is for the delivery of 1,000 barrels. What is the company's total profit? When is it realized? How is it taxed if it is (a) a hedger and (b) a speculator? Assume that the company has a December 31 year-end.

The total profit is ($90.50 − $88.30) × 1,000 = $2,200. Of this ($89.10 − $88.30) × 1,000 or $800 is realized on a day-by-day basis between September 2015 and December 31, 2015. A further ($90.50 − $89.10) × 1,000 or $1,400 is realized on a day-by-day basis between January 1, 2016, and March 2016. A hedger would be taxed on the whole profit of $2,200 in 2016. A speculator would be taxed on $800 in 2015 and $1,400 in 2016.

Problem 2.5.
What does a stop order to sell at $2 mean? When might it be used? What does a limit order to sell at $2 mean? When might it be used?

A *stop order* to sell at $2 is an order to sell at the best available price once a price of $2 or less is reached. It could be used to limit the losses from an existing long position. A *limit order* to sell at $2 is an order to sell at a price of $2 or more. It could be used to instruct a broker that a short position should be taken, providing it can be done at a price more favorable than $2.

Problem 2.6.
What is the difference between the operation of the margin accounts administered by a clearing house and those administered by a broker?

The margin account administered by the clearing house is marked to market daily, and the clearing house member is required to bring the account back up to the prescribed level daily. The margin account administered by the broker is also marked to market daily. However, the account does not have to be brought up to the initial margin level on a daily basis. It has to be brought up to the initial margin level when the balance in the account falls below the maintenance margin level. The maintenance margin is usually about 75% of the initial margin.

Problem 2.7.
What differences exist in the way prices are quoted in the foreign exchange futures market, the foreign exchange spot market, and the foreign exchange forward market?

In futures markets, prices are quoted as the number of US dollars per unit of foreign currency. Spot and forward rates are quoted in this way for the British pound, euro, Australian dollar, and New Zealand dollar. For other major currencies, spot and forward rates are quoted as the number of units of foreign currency per US dollar.

Problem 2.8.
The party with a short position in a futures contract sometimes has options as to the precise asset that will be delivered, where delivery will take place, when delivery will take place, and so on. Do these options increase or decrease the futures price? Explain your reasoning.

These options make the contract less attractive to the party with the long position and more attractive to the party with the short position. They therefore tend to reduce the futures price.

Problem 2.9.
What are the most important aspects of the design of a new futures contract?

The most important aspects of the design of a new futures contract are the specification of the underlying asset, the size of the contract, the delivery arrangements, and the delivery months.

Problem 2.10.
Explain how margin accounts protect investors against the possibility of default.

A margin is a sum of money deposited by an investor with his or her broker. It acts as a guarantee that the investor can cover any losses on the futures contract. The balance in the margin account is adjusted daily to reflect gains and losses on the futures contract. If losses are above a certain level, the investor is required to deposit a further margin. This system makes it unlikely that the investor will default. A similar system of margin accounts makes it unlikely that the investor's broker will default on the contract it has with the clearing house member and unlikely that the clearing house member will default with the clearing house.

Problem 2.11.
A trader buys two July futures contracts on frozen orange juice. Each contract is for the delivery of 15,000 pounds. The current futures price is 160 cents per pound, the initial

margin is $6,000 per contract, and the maintenance margin is $4,500 per contract. What price change would lead to a margin call? Under what circumstances could $2,000 be withdrawn from the margin account?

There is a margin call if more than $1,500 is lost on one contract. This happens if the futures price of frozen orange juice falls by more than 10 cents to below 150 cents per pound. $2,000 can be withdrawn from the margin account if there is a gain on one contract of $1,000. This will happen if the futures price rises by 6.67 cents to 166.67 cents per pound.

Problem 2.12.
Show that, if the futures price of a commodity is greater than the spot price during the delivery period, then there is an arbitrage opportunity. Does an arbitrage opportunity exist if the futures price is less than the spot price? Explain your answer.

If the futures price is greater than the spot price during the delivery period, an arbitrageur buys the asset, shorts a futures contract, and makes delivery for an immediate profit. If the futures price is less than the spot price during the delivery period, there is no similar perfect arbitrage strategy. An arbitrageur can take a long futures position but cannot force immediate delivery of the asset. The decision on when delivery will be made is made by the party with the short position. Nevertheless companies interested in acquiring the asset may find it attractive to enter into a long futures contract and wait for delivery to be made.

Problem 2.13.
Explain the difference between a market-if-touched order and a stop order.

A market-if-touched order is executed at the best available price after a trade occurs at a specified price or at a price more favorable than the specified price. A stop order is executed at the best available price after there is a bid or offer at the specified price or at a price less favorable than the specified price.

Problem 2.14.
Explain what a stop-limit order to sell at 20.30 with a limit of 20.10 means.

A stop-limit order to sell at 20.30 with a limit of 20.10 means that as soon as there is a bid at 20.30 the contract should be sold providing this can be done at 20.10 or a higher price.

Problem 2.15.
At the end of one day a clearing house member is long 100 contracts, and the settlement price is $50,000 per contract. The original margin is $2,000 per contract. On the following day the member becomes responsible for clearing an additional 20 long contracts, entered into at a price of $51,000 per contract. The settlement price at the end of this day is $50,200. How much does the member have to add to its margin account with the exchange clearing house?

The clearing house member is required to provide $20 \times \$2,000 = \$40,000$ as initial margin for the new contracts. There is a gain of $(50{,}200 - 50{,}000) \times 100 = \$20{,}000$ on the existing contracts. There is also a loss of $(51,000 - 50,200) \times 20 = \$16,000$ on the new contracts. The member must therefore add

$$40,000 - 20,000 + 16,000 = \$36,000$$

to the margin account.

Problem 2.16.
Explain why collateral requirements will increase in the OTC market as a result of new regulations introduced since the 2008 credit crisis.

Regulations require most standard OTC transactions entered into between derivatives dealers to be cleared by CCPs. These have initial and variation margin requirements similar to exchanges. There is also a requirement that initial and variation margin be provided for most bilaterally cleared OTC transactions.

Problem 2.17.
The forward price on the Swiss franc for delivery in 45 days is quoted as 1.1000. The futures price for a contract that will be delivered in 45 days is 0.9000. Explain these two quotes. Which is more favorable for an investor wanting to sell Swiss francs?

The 1.1000 forward quote is the number of Swiss francs per dollar. The 0.9000 futures quote is the number of dollars per Swiss franc. When quoted in the same way as the futures price the forward price is $1/1.1000 = 0.9091$. The Swiss franc is therefore more valuable in the forward market than in the futures market. The forward market is therefore more attractive for an investor wanting to sell Swiss francs.

Problem 2.18.
Suppose you call your broker and issue instructions to sell one July hogs contract. Describe what happens.

Live hog futures are traded by the CME Group. The broker will request some initial margin. The order will be relayed by telephone to your broker's trading desk on the floor of the exchange (or to the trading desk of another broker). It will then be sent by messenger to a commission broker who will execute the trade according to your instructions. Confirmation of the trade eventually reaches you. If there are adverse movements in the futures price your broker may contact you to request additional margin.

Problem 2.19.
"Speculation in futures markets is pure gambling. It is not in the public interest to allow speculators to trade on a futures exchange." Discuss this viewpoint.

Speculators are important market participants because they add liquidity to the market. However, contracts must be useful for hedging as well as speculation. This is because regulators generally only approve contracts when they are likely to be of interest to hedgers as well as speculators.

Problem 2.20.
Explain the difference between bilateral and central clearing for OTC derivatives.

In bilateral clearing the two sides enter into an agreement governing the circumstances under which transactions can be closed out by one side, how transactions will be valued if there is a close out, how the collateral posted by each side is calculated, and so on. In central clearing a CCP stands between the two sides in the same way that an exchange clearing house stands between two sides for transactions entered into on an exchange

Problem 2.21.

What do you think would happen if an exchange started trading a contract in which the quality of the underlying asset was incompletely specified?

The contract would not be a success. Parties with short positions would hold their contracts until delivery and then deliver the cheapest form of the asset. This might well be viewed by the party with the long position as garbage! Once news of the quality problem became widely known no one would be prepared to buy the contract. This shows that futures contracts are feasible only when there are rigorous standards within an industry for defining the quality of the asset. Many futures contracts have in practice failed because of the problem of defining quality.

Problem 2.22.

"When a futures contract is traded on the floor of the exchange, it may be the case that the open interest increases by one, stays the same, or decreases by one." Explain this statement.

If both sides of the transaction are entering into a new contract, the open interest increases by one. If both sides of the transaction are closing out existing positions, the open interest decreases by one. If one party is entering into a new contract while the other party is closing out an existing position, the open interest stays the same.

Problem 2.23.

Suppose that on October 24, 2015, a company sells one April 2016 live-cattle futures contracts. It closes out its position on January 21, 2016. The futures price (per pound) is 121.20 cents when it enters into the contract, 118.30 cents when it closes out its position, and 118.80 cents at the end of December 2015. One contract is for the delivery of 40,000 pounds of cattle. What is the total profit? How is it taxed if the company is (a) a hedger and (b) a speculator? Assume that the company has a December 31 year end.

The total profit is

$$40{,}000\times(1.2120-1.1830) = \$1{,}160$$

If the company is a hedger this is all taxed in 2016. If it is a speculator

$$40{,}000\times(1.2120-1.1880) = \$960$$

is taxed in 2015 and

$$40{,}000\times(1.1880-1.1830) = \$200$$

is taxed in 2016.

Problem 2.24.

A cattle farmer expects to have 120,000 pounds of live cattle to sell in three months. The live-cattle futures contract traded by the CME Group is for the delivery of 40,000 pounds of cattle. How can the farmer use the contract for hedging? From the farmer's viewpoint, what are the pros and cons of hedging?

The farmer can short 3 contracts that have 3 months to maturity. If the price of cattle falls, the gain on the futures contract will offset the loss on the sale of the cattle. If the price of cattle rises, the gain on the sale of the cattle will be offset by the loss on the futures contract. Using futures contracts to hedge has the advantage that the farmer can greatly reduce the uncertainty about the price that will be received. Its disadvantage is that the farmer no longer gains from favorable movements in cattle prices.

Problem 2.25.
It is July 2014. A mining company has just discovered a small deposit of gold. It will take six months to construct the mine. The gold will then be extracted on a more or less continuous basis for one year. Futures contracts on gold are available with delivery months every two months from August 2014 to December 2015. Each contract is for the delivery of 100 ounces. Discuss how the mining company might use futures markets for hedging.

The mining company can estimate its production on a month by month basis. It can then short futures contracts to lock in the price received for the gold. For example, if a total of 3,000 ounces are expected to be produced in September 2015 and October 2015, the price received for this production can be hedged by shorting 30 October 2015 contracts.

Problem 2.26.
Explain how CCPs work. What are the advantages to the financial system of requiring all

standardized derivatives transactions to be cleared through CCPs?

A CCP stands between the two parties in an OTC derivative transaction in much the same way that a clearing house does for exchange-traded contracts. It absorbs the credit risk but requires initial and variation margin from each side. In addition, CCP members are required to contribute to a default fund. The advantage to the financial system is that there is a lot more collateral (i.e., margin) available and it is therefore much less likely that a default by one major participant in the derivatives market will lead to losses by other market participants. There is also more transparency in that the trades of different financial institutions are more readily known. The disadvantage is that CCPs are replacing banks as the too-big-to-fail entities in the financial system. There clearly needs to be careful oversight of the management of CCPs.

CHAPTER 3

Hedging Strategies Using Futures

Problem 3.1.
Under what circumstances are (a) a short hedge and (b) a long hedge appropriate?

A *short hedge* is appropriate when a company owns an asset and expects to sell that asset in the future. It can also be used when the company does not currently own the asset but expects to do so at some time in the future. A *long hedge* is appropriate when a company knows it will have to purchase an asset in the future. It can also be used to offset the risk from an existing short position.

Problem 3.2.
Explain what is meant by basis risk when futures contracts are used for hedging.

Basis risk arises from the hedger's uncertainty as to the difference between the spot price and futures price at the expiration of the hedge.

Problem 3.3.
Explain what is meant by a perfect hedge. Does a perfect hedge always lead to a better outcome than an imperfect hedge? Explain your answer.

A *perfect hedge* is one that completely eliminates the hedger's risk. A perfect hedge does not always lead to a better outcome than an imperfect hedge. It just leads to a more certain outcome.

Consider a company that hedges its exposure to the price of an asset. Suppose the asset's price movements prove to be favorable to the company. A perfect hedge totally neutralizes the company's gain from these favorable price movements. An imperfect hedge, which only partially neutralizes the gains, might well give a better outcome.

Problem 3.4.
Under what circumstances does a minimum-variance hedge portfolio lead to no hedging at all?

A minimum variance hedge leads to no hedging when the coefficient of correlation between the futures price changes and changes in the price of the asset being hedged is zero.

Problem 3.5.
Give three reasons why the treasurer of a company might not hedge the company's exposure to a particular risk.

(a) If the company's competitors are not hedging, the treasurer might feel that the company will experience less risk if it does not hedge. (See Table 3.1.) (b) The shareholders might not want the company to hedge because the risks are hedged within their portfolios. (c) If there is a loss on the hedge and a gain from the company's exposure to the underlying asset, the treasurer might feel that he or she will have difficulty justifying the hedging to other executives within the organization.

Problem 3.6.
Suppose that the standard deviation of quarterly changes in the prices of a commodity is \$0.65, the standard deviation of quarterly changes in a futures price on the commodity is \$0.81, and the coefficient of correlation between the two changes is 0.8. What is the optimal hedge ratio for a three-month contract? What does it mean?

The optimal hedge ratio is

$$0.8 \times \frac{0.65}{0.81} = 0.642$$

This means that the size of the futures position should be 64.2% of the size of the company's exposure in a three-month hedge.

Problem 3.7.
A company has a \$20 million portfolio with a beta of 1.2. It would like to use futures contracts on a stock index to hedge its risk. The index futures is currently standing at 1080, and each contract is for delivery of \$250 times the index. What is the hedge that minimizes risk? What should the company do if it wants to reduce the beta of the portfolio to 0.6?

The formula for the number of contracts that should be shorted gives

$$1.2 \times \frac{20,000,000}{1080 \times 250} = 88.9$$

Rounding to the nearest whole number, 89 contracts should be shorted. To reduce the beta to 0.6, half of this position, or a short position in 44 contracts, is required.

Problem 3.8.
In the corn futures contract, the following delivery months are available: March, May, July, September, and December. State the contract that should be used for hedging when the expiration of the hedge is in a) June, b) July, and c) January

A good rule of thumb is to choose a futures contract that has a delivery month as close as possible to, but later than, the month containing the expiration of the hedge. The contracts that should be used are therefore

(a) July

(b) September

(c) March

Problem 3.9.
Does a perfect hedge always succeed in locking in the current spot price of an asset for a future transaction? Explain your answer.

No. Consider, for example, the use of a forward contract to hedge a known cash inflow in a foreign currency. The forward contract locks in the forward exchange rate — which is in general different from the spot exchange rate.

Problem 3.10.
Explain why a short hedger's position improves when the basis strengthens unexpectedly and worsens when the basis weakens unexpectedly.

The basis is the amount by which the spot price exceeds the futures price. A short hedger is long the asset and short futures contracts. The value of his or her position therefore improves as the basis increases. Similarly, it worsens as the basis decreases.

Problem 3.11.
Imagine you are the treasurer of a Japanese company exporting electronic equipment to the United States. Discuss how you would design a foreign exchange hedging strategy and the arguments you would use to sell the strategy to your fellow executives.

The simple answer to this question is that the treasurer should

1. Estimate the company's future cash flows in Japanese yen and U.S. dollars
2. Enter into forward and futures contracts to lock in the exchange rate for the U.S. dollar cash flows.

However, this is not the whole story. As the gold jewelry example in Table 3.1 shows, the company should examine whether the magnitudes of the foreign cash flows depend on the exchange rate. For example, will the company be able to raise the price of its product in U.S. dollars if the yen appreciates? If the company can do so, its foreign exchange exposure may be quite low. The key estimates required are those showing the overall effect on the company's profitability of changes in the exchange rate at various times in the future. Once these estimates have been produced the company can choose between using futures and options to hedge its risk. The results of the analysis should be presented carefully to other executives. It should be explained that a hedge does not ensure that profits will be higher. It means that profit will be more certain. When futures/forwards are used both the downside and upside are eliminated. With options a premium is paid to eliminate only the downside.

Problem 3.12.
Suppose that in Example 3.2 of Section 3.3 the company decides to use a hedge ratio of 0.8. How does the decision affect the way in which the hedge is implemented and the result?

If the hedge ratio is 0.8, the company takes a long position in 16 December oil futures contracts on June 8 when the futures price is \$88.00. It closes out its position on November 10. The spot price and futures price at this time are \$90.00 and \$89.10. The gain on the futures position is

$$(89.10 - 88.00) \times 16{,}000 = 17{,}600$$

The effective cost of the oil is therefore

$$20{,}000 \times 90 - 17{,}600 = 1{,}782{,}400$$

or \$89.12 per barrel. (This compares with \$88.90 per barrel when the company is fully hedged.)

Problem 3.13.
"If the minimum-variance hedge ratio is calculated as 1.0, the hedge must be perfect." Is this statement true? Explain your answer.

The statement is not true. The minimum variance hedge ratio is

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

It is 1.0 when $\rho = 0.5$ and $\sigma_S = 2\sigma_F$. Since $\rho < 1.0$ the hedge is clearly not perfect.

Problem 3.14.
"If there is no basis risk, the minimum variance hedge ratio is always 1.0." Is this statement true? Explain your answer.

The statement is true. Using the notation in the text, if the hedge ratio is 1.0, the hedger locks in a price of $F_1 + b_2$. Since both F_1 and b_2 are known this has a variance of zero and must be the best hedge.

Problem 3.15
"For an asset where futures prices for contracts on the asset are usually less than spot prices, long hedges are likely to be particularly attractive." Explain this statement.

A company that knows it will purchase a commodity in the future is able to lock in a price close to the futures price. This is likely to be particularly attractive when the futures price is less than the spot price.

Problem 3.16.
The standard deviation of monthly changes in the spot price of live cattle is (in cents per pound) 1.2. The standard deviation of monthly changes in the futures price of live cattle for the closest contract is 1.4. The correlation between the futures price changes and the spot price changes is 0.7. It is now October 15. A beef producer is committed to purchasing 200,000 pounds of live cattle on November 15. The producer wants to use the December live-cattle futures contracts to hedge its risk. Each contract is for the delivery of 40,000 pounds of cattle. What strategy should the beef producer follow?

The optimal hedge ratio is

$$0.7 \times \frac{1.2}{1.4} = 0.6$$

The beef producer requires a long position in $200000 \times 0.6 = 120,000$ lbs of cattle. The beef producer should therefore take a long position in 3 December contracts closing out the position on November 15.

Problem 3.17.
A corn farmer argues "I do not use futures contracts for hedging. My real risk is not the price of corn. It is that my whole crop gets wiped out by the weather." Discuss this viewpoint. Should the farmer estimate his or her expected production of corn and hedge to try to lock in a price for expected production?

If weather creates a significant uncertainty about the volume of corn that will be harvested, the farmer should not enter into short forward contracts to hedge the price risk on his or her expected production. The reason is as follows. Suppose that the weather is bad and the farmer's production is lower than expected. Other farmers are likely to have been affected similarly. Corn production overall will be low and as a consequence the price of corn will be relatively high. The farmer's problems arising from the bad harvest will be made worse by losses on the short futures position. This problem emphasizes the importance of looking at the big picture when hedging. The farmer is correct to question whether hedging price risk while ignoring other risks is a good strategy.

Problem 3.18.
On July 1, an investor holds 50,000 shares of a certain stock. The market price is $30 per share. The investor is interested in hedging against movements in the market over the next month and decides to use the September Mini S&P 500 futures contract. The index is currently 1,500 and one contract is for delivery of $50 times the index. The beta of the stock is 1.3. What strategy should the investor follow? Under what circumstances will it be profitable?

A short position in

$$1.3 \times \frac{50,000 \times 30}{50 \times 1,500} = 26$$

contracts is required. It will be profitable if the stock outperforms the market in the sense that its return is greater than that predicted by the capital asset pricing model.

Problem 3.19.
Suppose that in Table 3.5 the company decides to use a hedge ratio of 1.5. How does the decision affect the way the hedge is implemented and the result?

If the company uses a hedge ratio of 1.5 in Table 3.5 it would at each stage short 150 contracts. The gain from the futures contracts would be

$$1.50 \times 1.70 = \$2.55$$

per barrel and the company would be $0.85 per barrel better off than with a hedge ratio of 1.

Problem 3.20.
A futures contract is used for hedging. Explain why the daily settlement of the contract can give rise to cash flow problems.

Suppose that you enter into a short futures contract to hedge the sale of an asset in six months. If the price of the asset rises sharply during the six months, the futures price will also rise and you may get margin calls. The margin calls will lead to cash outflows. Eventually the cash outflows will be offset by the extra amount you get when you sell the asset, but there is a mismatch in the timing of the cash outflows and inflows. Your cash outflows occur earlier than your cash inflows. A similar situation could arise if you used a long position in a futures contract to hedge the purchase of an asset at a future time and the asset's price fell sharply. An extreme example of what we are talking about here is provided by Metallgesellschaft (see Business Snapshot 3.2).