

CHAPTER 1

Introduction

Short Concept Questions

- 1.1 A derivative is an agreement to enter into a future transaction. Its value depends on (or derives from) other more basic variables.
- 1.2 Derivatives trade on exchanges and in the over-the-counter (OTC) market)
- 1.3 Standardized derivatives between two financial institutions trade on swap execution facilities and are cleared through central counterparties. All trades must be reported to a central repository.
- 1.4 The OTC market is much bigger.
- 1.5 In a long forward, the trader is agreeing to buy an asset for a certain price at a certain future time. In a short forward, contract the trader is agreeing to sell an asset for a certain price at a certain future time.
- 1.6 Forward contracts trade in the over-the-counter market. Futures contracts trade on exchanges.
- 1.7 In the forward contract, the trader is committing to a future trade. In an option, the trader has the right but not the obligation to carry out the future trade.
- 1.8 Hedging involves reducing an existing risk. Speculation involves having a view on the market and taking a risk. Arbitrage involves locking in a profit by trading in two different markets.
- 1.9 Bid is the price at which a market maker is prepared to buy. Ask is the price at which the market maker is prepared to sell.
- 1.10 He speculated on future movements in equity indices and invented fictitious trades to give the appearance that he was an arbitrageur.

Practice Questions

1.11

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.)

1.12

- (a) The investor is obligated to sell pounds for 1.3000 when they are worth 1.2900. The gain is $(1.3000 - 1.2900) \times 100,000 = \$1,000$.
- (b) The investor is obligated to sell pounds for 1.3000 when they are worth 1.3200. The loss is $(1.3200 - 1.3000) \times 100,000 = \$2,000$

1.13

(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.
 $\text{Loss} = (\$0.5130 - \$0.5000) \times 50,000 = \$650.$

1.14

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.

1.15

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.

1.16

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.

1.17

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.

1.18

If a trader has an exposure to the price of an asset, a hedge with futures contracts can be used. If the trader will gain when the price decreases and lose when the price increases, a long futures position will hedge the risk. If the trader 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 trader has no exposure to the price of the underlying asset, entering into a futures contract is speculation. If the trader takes a long position, there is a gain when the asset's price increases and a loss when it decreases. If the trader takes a short position, there is a loss when the asset's price increases and a gain when it decreases.

1.19

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.

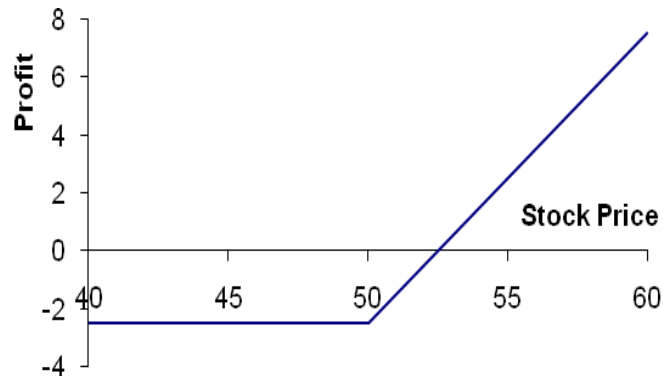


Figure S1.1: *Profit from long position in Problem 1.19*

1.20

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.

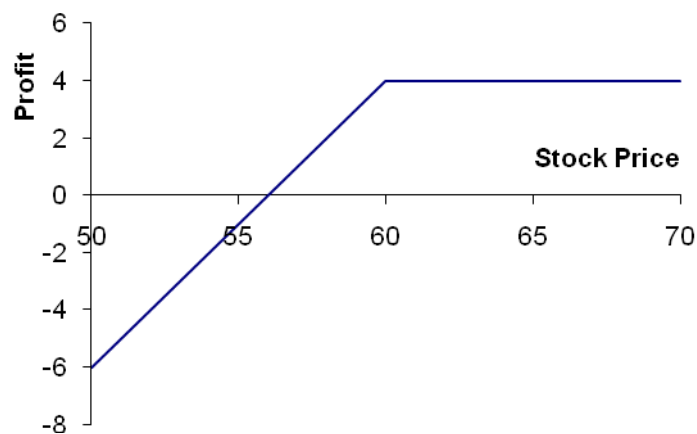


Figure S1.2: *Profit from short position in Problem 1.20*

1.21

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 trader has to buy the stock for \$25 in September and sell it to the purchaser of the option for

\$20.

1.22

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.)

1.23

A long position in a four-month put option on the foreign currency 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.

1.24

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.

1.25

- 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.

1.26

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.

1.27

The statement means that the gain (loss) to one side equals the loss (gain) to the other side. In aggregate, the net gain to the two parties is zero.

1.28

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,

$$\begin{aligned} S_T - F_0 + \max(F_0 - S_T, 0) \\ = \max(0, S_T - F_0) \end{aligned}$$

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 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.)

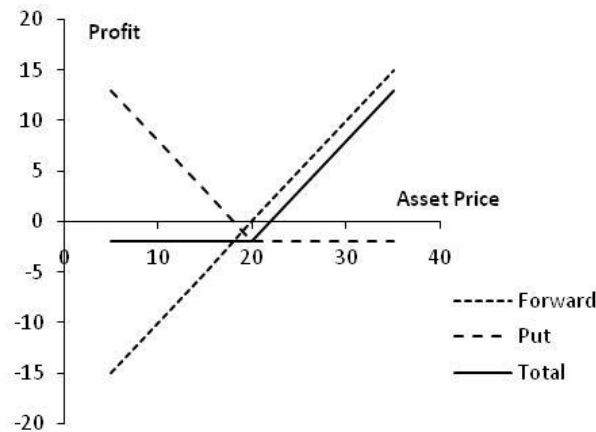


Figure S1.3: Profit from portfolio in Problem 1.28

1.29

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

$$\begin{aligned} &1,000 && \text{if } S_T > 169 \\ &1,000 - 1,000 \left(\frac{169}{S_T} - 1 \right) && \text{if } 84.5 \leq S_T \leq 169 \\ &0 && \text{if } S_T < 84.5 \end{aligned}$$

When $84.5 \leq S_T \leq 169$ 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.

	<i>Bond</i>	<i>Short Calls</i>	<i>Long Calls</i>	<i>Whole position</i>
$S_T > 169$	1,000	0	0	1,000
$84.5 \leq S_T \leq 169$	1,000	$-169,000 \left(\frac{1}{S_T} - \frac{1}{169} \right)$	0	$2,000 - 169,000/S_T$
$S_T < 84.5$	1,000	$-169,000 \left(\frac{1}{S_T} - \frac{1}{169} \right)$	$169,000 \left(\frac{1}{S_T} - \frac{1}{84.5} \right)$	0

1.30

Suppose that the forward price for the contract entered into on July 1, 2021, is F_1 and that the forward price for the contract entered into on September 1, 2021, 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, 2022, 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, 2022, increased between July 1, 2021, and September 1, 2021, 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.)

1.31

- (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

$$\max(S_T - 1.22, 0) - 0.02$$

The profit from the short forward contract is

$$1.2518 - S_T$$

The profit from the strategy is therefore

$$\max(S_T - 1.22, 0) - 0.02 + 1.2518 - S_T$$

This is

$$\begin{array}{ll} 1.2318 - S_T & \text{when } S_T < 1.22 \\ 0.0118 & \text{when } S_T > 1.22 \end{array}$$

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

$$\max(1.29 - S_T, 0) - 0.02$$

The profit from the long forward contract is

$$S_T - 1.2556$$

The profit from this strategy is therefore

$$\max(1.29 - S_T, 0) - 0.02 + S_T - 1.2556$$

This is

$$S_T - 1.2756 \quad \text{when } S_T > 1.29$$

$$0.0144 \quad \text{when } S_T < 1.29$$

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.)

1.32

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.

1.33

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.

1.34

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

1.35

- The upfront cost for the stock alternative is \$31,650. The upfront cost for the option alternative is \$2,170.
- The gain from the stock alternative is $\$40,000 - \$31,650 = \$8,350$. The total gain from the option alternative is $(\$400 - \$320) \times 100 - \$2,170 = \$5,830$.
- The loss from the stock alternative is $\$31,650 - \$30,000 = \$1,650$. The loss from the option alternative is \$2,170.

1.36

Arbitrage involves carrying out two or more different trades to lock in a profit. In this case, traders can buy shares on the TSX and sell them on the NYSE to lock in a USD profit of $50 - 60/1.21 = 0.41$ per share. As they do this, the NYSE price will fall and the TSX price will rise so that the arbitrage opportunity disappears.

1.37 (Excel file)

Trader A makes a profit of $S_T - 1,000$ and Trader B makes a profit of $\max(S_T - 1,000, 0) - 100$ where S_T is the price of the asset in one year. Trader A does better if S_T is above \$900 as indicated in Figure S1.4.

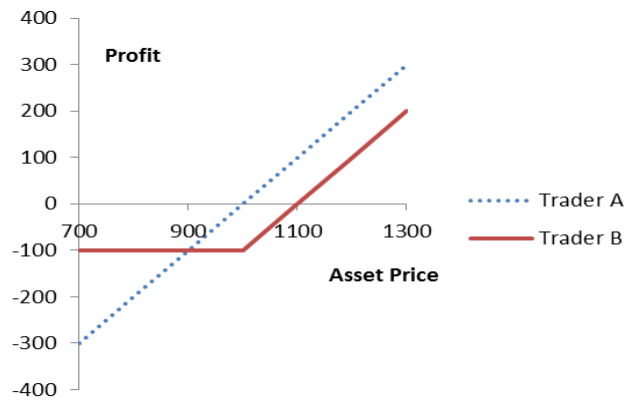


Figure S1.4: Profit to Trader A and Trader B in Problem 1.37

1.38

The investor has agreed to buy 100 shares of the stock for \$40 in July (or earlier) if the party on the other side of the transaction chooses to sell. The trade will prove profitable if the option is not exercised or if the stock price is above \$37 at the time of exercise. The risk to the investor is that the stock price plunges to a low level. For example, if the stock price drops to \$1 by July, the investor loses \$3,600. This is because the put options are exercised and \$40 is paid for 100 shares when the value per share is \$1. This leads to a loss of \$3,900 which is only a little offset by the premium of \$300 received for the options.

1.39

The company could enter into a forward contract obligating it to buy 3 million euros in three months for a fixed price (the forward price). The forward price will be close to but not exactly the same as the current spot price of 1.1500. An alternative would be to buy a call option giving the company the right but not the obligation to buy 3 million euros for a particular exchange rate (the strike price) in three months. The use of a forward contract locks in, at no cost, the exchange rate that will apply in three months. The use of a call option provides, at a cost, insurance against the exchange rate being higher than the strike price.

1.40 (Excel file)

This is known as a bull spread (see Chapter 12). The profit is shown in Figure S1.5.

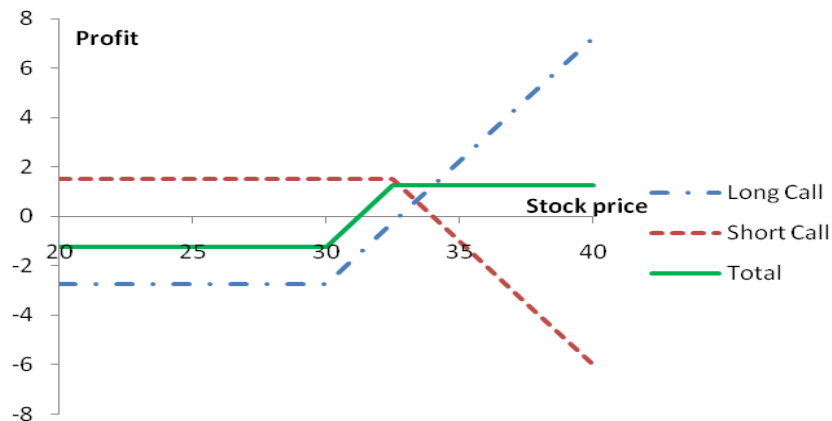


Figure S1.5: Profit in Problem 1.40

1.41

The arbitrageur should borrow money to buy a certain number of ounces of gold today and short forward contracts on the same number of ounces of gold for delivery in one year. This means that gold is purchased for \$1,200 per ounce and sold for \$1,300 per ounce. Interest on the borrowed funds will be $0.03 \times \$1,200$ or \$36 per ounce. A profit of \$64 per ounce will therefore be made.

1.42

The second alternative involves what is known as a stop or stop-loss order. It costs nothing and ensures that \$29,000, or close to \$29,000, is realized for the holding in the event the stock price ever falls to \$290. The put option costs \$2,130 and guarantees that the holding can be sold for \$29,000 any time up to December. If the stock price falls marginally below \$290 and then rises the option will not be exercised, but the stop-loss order will lead to the holding being liquidated. There are some circumstances where the put option alternative leads to a better outcome and some circumstances where the stop-loss order leads to a better outcome. If the stock price ends up below \$290, the stop-loss order alternative leads to a better outcome because the cost of the option is avoided. If the stock price falls to \$280 in November and then rises to \$350 by December, the put option alternative leads to a better outcome. The investor is paying \$2,130 for the chance to benefit from this second type of outcome.

1.43

Suppose S_T is the price of oil at the bond's maturity. In addition to \$1,000, the Standard Oil bond pays:

$$\begin{array}{lll} S_T < \$25 & : & 0 \\ \$40 > S_T > \$25 & : & 170(S_T - 25) \\ S_T > \$40 & : & 2,550 \end{array}$$

This is the payoff from 170 call options on oil with a strike price of 25 less the payoff from 170 call options on oil with a strike price of 40. The bond is therefore equivalent to a regular bond plus a long position in 170 call options on oil with a strike price of \$25 plus a short position in 170 call options on oil with a strike price of \$40. The investor has what is termed a bull spread on oil. This is discussed in Chapter 12.

1.44

You sell the treasurer a put option on GBP with a strike price of 1.19 and buy from the treasurer a call option on GBP with a strike price of 1.25. Both options are on one million pounds and have a maturity of six months. This is known as a range forward contract and is discussed in Chapter 17.