

Chapter 13: Financial Derivatives

1 Forwards and Futures

Futures contracts are traded in exchanges.

Forward contracts are agreements by two parties.

These specify the price and quantity a transaction to be carried out at some specified time in the future.

In contrast, a transaction which occurs immediately is called a spot transaction.

A trader who purchases a security (or commodity) in a futures contract is said to have a *long position*.

A trader who sells a security (or commodity) in a futures contract is said to have a *short position*.

1.1 Three Functions of Futures Contracts

This section explains theoretical definitions of three types of futures market transactions: arbitrage, speculation, and hedging.

1.1.1 Arbitrage

In an arbitrage transaction, the arbitrageur takes profits without any risk, using a difference in prices of securities of essentially the same assets.

Example: spot and futures markets for gold.

The price of gold in the spot market is referred to as the *spot price*. Suppose that the spot price S_t of gold is \$400 per ounce today at t . In the futures market at t , suppose that the price of gold to be delivered in one year (F_t) is \$440 per ounce. If the one year interest rate i_t is 8 percent, an arbitrageur can make profits in the following way. At time t , he borrows \$400, buys one ounce of gold in the spot market, and sells one ounce of gold in the futures market to be delivered in one year. In one year, at time $t + 1$, he delivers one ounce of gold, receives \$440, and pays back $\$400(1 + i_t) = \432 . He obtains \$8 without any risk at $t + 1$.

In this example, there are two assets which are essentially the same.

One asset is gold and the other asset is a risk free bond. In terms of dollars, the rate of return on gold is $(F_t/S_t) - 1$.

The rate of return on risk free bonds is i_t .

$$\frac{F_t}{S_t} - 1 = i_t \quad (1)$$

An arbitrageur can make profits without any risk by buying the asset with a higher rate of return and selling the asset with a lower rate of return. I

In an equilibrium (demand is equal to supply), (1) must hold. Given S_t and i_t , F_t is determined by (1).

P.1. Explain how a person who owns one ounce of gold can make profits without risk when the price of gold to be delivered in one year is \$410 per ounce in the futures market at t .

1.1.2 Speculation

Speculation is a transaction to make profit from an anticipated change in price. Speculation transactions increase the overall risk of an investor's portfolio.

Example: Suppose that a speculator expects the spot price of gold to fall, so that his expected spot price (S_{t+1}^e) is smaller than F_t . Then he will take a short position in gold, that is, he will sell gold in the futures market without holding the gold to be delivered at time t . At time $t + 1$, he will buy gold in the spot market and delivers the gold as specified in the futures contract. If the speculator anticipates $S_{t+1}^e > F_t$, then he will take a long position.

1.1.3 Hedging

Hedging involves taking a position in one market to offset an exposure to risk in another market. Hedging reduces the overall risk of an investor's portfolio.

Example: If a gold watch producer makes a contract to produce gold watches in the future, she is exposed to the risk of future fluctuations in the price of gold. This risk can be offset by purchasing gold in the futures market.

As another example, if a gold mine owner needs to wait until she has accumulated a full bar, she can sell gold in the futures market.

1.2 How Banks Hedge Against Interest-Rate Risk with Futures Contracts

In order to see how banks use futures contracts to hedge against interest-rate risk, suppose that a bank starts to operate today. The bank's only asset is a two year fixed interest rate loan of \$100 million and its only liabilities are one year CDs. This bank is subject to interest-rate risk because if the market interest rate rises in one year, then the bank needs to pay a higher interest rate to attract depositors when the current CDs expire. The bank's problem is that it has to refinance the \$100 million in one year at an uncertain interest rate. The bank can fix the interest rate for refinancing the loan by selling one year Treasury Bills in the futures market (note that selling bonds is equivalent to borrowing money).

This year, the bank sells Treasury Bills in the futures market. In the next year, the bank will use funds obtained by issuing CDs to buy Treasury Bills in the spot market and deliver the Treasury Bills as specified in the futures contract. If the interest rate is high, then the spot price is low. Thus the bank makes profits in the futures contract, offsetting the higher interest rate that it has to pay for CDs.

2 Options

An *option contract*: an agreement that allows the purchase or sale of a specified quantity of an asset at a specified price (*strike price*) until the *expiration date*.

In an option contract, the seller (*writer*) of the option basically provides insurance to the buyer (*holder*) of the option. The holder pays a *premium* to the writer at the time he buys the contract.

There are two types of option contracts.

1. The holder of a *call option* has the right to buy the security at the strike price from the writer, but not an obligation.
2. The holder of a *put option* has the right to sell the security at the strike price from the writer.

Example: If a securities dealer (who hold inventories of securities to link buyers and sellers) wants to be insured against loss if the price of a security that he holds falls, then he can purchase a put option for the security.

When an option contract is exercised, the writer suffers a loss.

A call option is exercised only when the spot price of the security is higher than the strike price. Hence the writer of the call option is forced to sell the security to the holder at a price lower than the market price.

A put option is exercised only when the spot price of the security is lower than the strike price. On the other hand, the writer makes a profit if the option contract is not exercised by the expiration date.

2.1 How Banks Hedge Against Interest-Rate Risk with Option Contracts

By hedging with a futures contract, a bank protects itself against a loss if interest rates rise. But a futures contract prevents the bank from making a profit if interest rates fall. A bank may wish to be insured against a loss if interest rates rise but may wish to keep profits if interest rates fall. For this purpose, the bank can buy an option contract for government bonds.

Let us consider again the example given above. The bank starts to operate today, holding a two-year fixed interest rate loan as its only asset and acquiring funds solely by issuing one-year CDs.

Recall that this bank is subject to interest-rate risk because if the market interest rate rises in one year, then the bank needs to pay a higher interest

rate to attract depositors when the current CDs expire. The bank's problem is that it has to refinance the \$100 million in one year at an uncertain interest rate. The bank can insure against the event of the high interest rate for refinancing the loan by holding an option to sell one year Treasury Bills.

This year, the bank buys a put option for Treasury Bills. In the next year, if the interest rate is high, then the bank will exercise the option. It will use funds obtained by issuing CDs to buy Treasury Bills in the spot market and deliver the Treasury Bills as specified in the put option contract. If the interest rate is high, then the spot price is low. Thus the bank makes profits in the futures contract, offsetting the higher interest rate that it has to pay for CDs. On the other hand, if the interest rate is low, then the bank will let the put option expire.