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# DERIVATIVE INVESTMENTS

*Study Session 17*

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Approximate Weight on Exam	5%
Study Notes Reference	Book 5, Pages 130–199

## DERIVATIVE MARKETS AND INSTRUMENTS

Cross-Reference to CFA Institute Assigned Reading #73

A *derivative* is a security that *derives* its value from the value of or return on another asset or security.

A *contingent claim* has a payoff in the future only if certain events happen. Option contracts are contingent claims and also derivative securities.

A *forward commitment* is just that, a contractual commitment to buy or sell an asset in the future or take or make a loan in the future. Futures, swaps, and forward contracts are forward commitments and also are derivative securities.

Forwards and swaps are typically originated by dealers and have no active secondary market. Futures contracts are originated by and traded in a futures exchange. Some options contracts are traded on an organized options exchange and others are originated by dealers and do not trade in a secondary market.

### Overview of Derivative Contracts

- In a *forward contract* one party agrees to buy, and the counterparty to sell, a physical asset or a security at a specific price on a specific date in the future. If the future price of the asset increases, the buyer (at the older, lower price) has a gain, and the seller a loss.

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- A *futures contract* is a forward contract that is standardized and exchange-traded. Futures contracts differ from forward contracts in that futures are traded in an active secondary market, are regulated, are backed by the clearinghouse, and require a daily settlement of gains and losses.
- A *swap* is equivalent to a series of forward contracts. In the simplest swap, one party agrees to pay the short-term (floating) rate of interest on some principal amount, and the counterparty agrees to pay a certain (fixed) rate of interest in return. Swaps of different currencies and equity returns are also common.
- An option to buy an asset at a particular price is termed a *call option*. The seller of the option has an *obligation* to sell the asset at the agreed-upon price, if the call buyer chooses to exercise the right to buy the asset.
- An option to sell an asset at a particular price is termed a *put option*. The seller of the option has an *obligation* to purchase the asset at the agreed-upon price if the put buyer chooses to exercise the right to sell the asset.

### Arbitrage

Arbitrage opportunities arise when assets are mispriced. Trading by arbitrageurs will continue until they affect supply and demand enough to bring asset prices to efficient (no-arbitrage) levels.

There are two arbitrage arguments that are particularly useful in the study and use of derivatives:

- The first is based on the “law of one price.” Two securities or portfolios that have identical cash flows in the future, regardless of future events, should have the same price. If A and B have identical future payoffs and A is priced lower than B, buy A and sell B.
- The second type of arbitrage is used when two securities with uncertain returns can be combined in a portfolio that will have a certain payoff. If a portfolio consisting of A and B has a certain payoff, the portfolio should yield the risk-free rate.

## FORWARD MARKETS AND CONTRACTS

Cross-Reference to CFA Institute Assigned Reading #74

### Forward Contracts

A *deliverable* forward contract for an asset specifies that the long will pay a certain amount at a specific future date to the short, who will deliver the underlying asset. Neither party pays at contract initiation.

A *cash settlement* forward contract does not require actual delivery of the underlying asset, but instead requires a cash payment to the party that is disadvantaged by the difference between the market price of the asset and the contract price at the settlement date.

Early termination of a forward contract can be accomplished by entering into a new forward contract with the opposite position, at the then-current forward price. This early termination will fix the amount of the gains or losses on the forward contract as of the termination date.

Forward contracts are described by the type of asset that must be purchased or sold under the terms of the contract. Equity forwards require delivery or cash settlement based on the value of a stock, a specific portfolio of stocks, or a stock index.

Currency forwards are widely used to hedge exchange rate risk and require delivery of a specified amount of a particular currency with a contract price in another currency.

Bond forwards are often written on zero-coupon bonds with payoffs to the long that increase if rates decrease. A related type of forward contract is a forward rate agreement where increasing rates increase the payoff to the long position.

#### Forward Rate Agreements

A *forward rate agreement* (FRA) can be viewed as a forward contract to borrow/lend money at a certain rate at some future date, although it is a cash settlement contract. The long position in an FRA is the party that would borrow the money (long the loan with the contract “price” being the interest rate on the loan). If the floating rate at contract expiration is above the rate specified in the forward agreement, the long position will profit; the contract can be viewed as the right to borrow at below-market rates.

The London Interbank Offered Rate (LIBOR) is a short-term rate based on the rates at which large London banks will lend U.S. dollars to each other. *Euribor* is a similar rate for borrowing and lending in euros.

The payment at settlement on an FRA is the present value of the difference in interest costs between a riskless loan at the market rate and one made at the rate specified in the contract. The difference in rates is multiplied by the notional amount of the contract to get the difference in interest due at the end of the loan term. Since this hypothetical loan would be made at contract settlement,

the interest savings or excess interest costs would be paid later, at the end of the loan term. For this reason, the payment at settlement is the present value of the interest difference, discounted at the rate prevailing at settlement.

The general formula for the payment to the long at settlement is:

$$\text{(notional principal)} \left[ \frac{\left( \text{floating rate at settlement} - \text{forward rate} \right) \left[ \frac{\text{days}}{360} \right]}{1 + \text{floating rate at settlement} \left[ \frac{\text{days}}{360} \right]} \right]$$

## FUTURES MARKETS AND CONTRACTS

Cross-Reference to CFA Institute Assigned Reading #75

### Futures vs. Forwards

#### Key Differences Between Futures and Forwards

<i>Forwards</i>	<i>Futures</i>
Private contracts	Exchange-traded
Unique customized contracts	Standardized contracts
Default risk is present	Guaranteed by clearinghouse
Little or no regulation	Regulated
No margin deposit required	Margin required and adjusted

### Margin

There are three types of futures margin (initial, maintenance, and variation).

The first deposit is called the *initial margin*. Initial margin must be posted before any trading takes place. Initial margin is fairly low and equals about one day's maximum fluctuation in the contract value. The margin requirement is low because at the end of every day there is a *daily settlement* process called marking to market.

In *marking to market*, any losses for the day are removed from the trader's account, and any gains are added to the trader's account. Thus, any gains or losses in the value of the futures position (futures contract) are realized each day.

If the margin balance in the trader's account falls below a certain level (called the *maintenance margin*), the trader will get a *margin call* and must deposit more cash or securities (called the *variation margin*) into the account to bring the margin balance back up to the initial level. If the margin balance increases above the initial margin amount, the investor can withdraw funds from the account in the amount of the excess above the initial margin requirement.

### Futures Contract Basics

Futures contracts specify the quality and quantity of the underlying asset, the delivery or settlement date in the future, and the place of delivery. The futures exchange decides which contracts will be traded, determines the minimum price change, and sets limits on daily price moves.

The Futures Clearing Corporation specifies margin requirements and acts as the counterparty to every trade. Standardization makes the futures contracts quite liquid, so to close out a futures position prior to settlement, a trader can just enter into an opposite futures position. The cumulative mark to market in the futures account will have already accounted for any gains or losses on the position prior to the date of the *offsetting or closing trade*.

Most futures contracts are terminated by offsetting trades. Delivery of the asset, cash settlement at contract expiration, or an off-exchange delivery called *exchange for physicals* are the other methods of terminating a futures position.

Some bond futures contracts provide valuable delivery options to the short which include what bond to deliver and when during the expiration month to deliver.

## OPTION MARKETS AND CONTRACTS

Cross-Reference to CFA Institute Assigned Reading #76

### Option Terminology and Basics

*Call option:*

- Long position: *right to buy* the underlying stock at a specific price on a future date.
- Short position: *obligation to sell* the stock to the buyer of the call option.

*Put option:*

- Long position: *right to sell* the underlying stock at a specific price on a future date.
- Short position: *obligation to buy* the stock from the buyer of the put option.

The *strike price (X)* represents the exercise price specified in the contract.

The seller or short position in an options contract is sometimes referred to as the *writer* of the option.

*Stock options* are typically on 100 shares of stock.

*American options* allow the owner to exercise the option at any time before or at expiration.

*European options* can only be exercised at expiration. For two otherwise identical options, an American option has more flexibility than the European option, so it is worth at least as much and typically more.

#### Money and Intrinsic Value

An option that would provide a positive payoff if exercised is said to be *in the money*. The *intrinsic value* of an option is the amount that it is in the money, and zero otherwise. The difference between the price of an option (called its premium) and its intrinsic value is termed its *time value*.

The following table summarizes the moneyness of options based on the stock's current price,  $S$ , and the option's exercise strike price,  $X$ .

<i>Money</i>	<i>Call Option</i>	<i>Put Option</i>
In-the-money	$S > X$	$S < X$
At-the-money	$S = X$	$S = X$
Out-of-the-money	$S < X$	$S > X$

- In general, an option is more valuable when its time to expiration is longer and when the price of the underlying asset is more volatile.
- Call options increase in value when the asset price increases, the exercise price is lower, or when the risk-free rate is higher.
- Put options increase in value when the asset price is lower, the exercise price is higher, or when the risk-free rate is lower.

- Both put and call options have greater value when the volatility of the price of the underlying asset is greater.

### Interest Rate Options vs. Forward Rate Agreements (FRAs)

For interest rate options, the exercise price is an interest rate, and payoffs depend on a reference rate such as LIBOR. Interest rate options are similar to FRAs because there is no deliverable asset and they are settled in cash, in an amount based on a notional amount and the difference between the strike rate and the reference rate.

The combination of a long interest rate call option plus a short interest rate put option has the same payoff as an FRA. One difference is that interest rate option payoffs are made after the option expiration date at a date corresponding to the end of the loan period specified in the contract (30-day, 60-day, 90-day LIBOR, etc.). Recall that FRAs pay the present value of this interest difference at settlement.

### Other Types of Options

*Commodity options* are on physical underlying assets, such as gold.

*Index option* payoffs are based on the difference between the strike price and the index, times a specified multiplier.

*Options on futures* give the long the right to enter into a futures position at the futures price specified in the option contract.

### Minimum and Maximum Option Values

#### Lower and Upper Bounds for Options

<i>Option</i>	<i>Minimum Value</i>	<i>Maximum Value</i>
European call	$c_t \geq \text{Max}[0, S_t - X / (1 + \text{RFR})^{T-t}]$	$S_t$
American call	$C_t \geq \text{Max}[0, S_t - X / (1 + \text{RFR})^{T-t}]$	$S_t$
European put	$p_t \geq \text{Max}[0, X / (1 + \text{RFR})^{T-t} - S_t]$	$X / (1 + \text{RFR})^{T-t}$
American put	$P_t \geq \text{Max}[0, X - S_t]$	$X$

### Put-Call Parity

*Put-call parity* means that portfolios with identical payoffs must sell for the same price to prevent arbitrage. A fiduciary call (composed of a call option and a risk-free bond that will pay  $X$  at expiration) and a protective put (composed of a share of stock and a long put) both have identical payoffs at maturity. Based on this fact and the law of one price, we can state that, for European options:

$$C + X / (1 + \text{RFR})^T = S + P$$

Each of the individual securities in the put-call parity relationship can be expressed as:

$$\begin{aligned} S &= C - P + X / (1 + \text{RFR})^T \\ P &= C - S + X / (1 + \text{RFR})^T \\ C &= S + P - X / (1 + \text{RFR})^T \\ X / (1 + \text{RFR})^T &= S + P - C \end{aligned}$$

The single securities on the left-hand side of the equations all have exactly the same payoffs at expiration as the portfolios on the right-hand side. The portfolios on the right-hand side are the “synthetic” equivalents of the securities on the left. Note that the options must be European-style and the puts and calls must have the same exercise prices for these relations to hold.

The four relations all must hold to prevent arbitrage; if there is a profitable arbitrage opportunity, *all of these relations* will be violated. If the equality does not hold, buy the “cheap” side of the equation and sell the other “expensive” side. This will produce an immediate *arbitrage profit*.

### SWAP MARKETS AND CONTRACTS

Cross-Reference to CFA Institute Assigned Reading #77

One way to view a swap contract is as an exchange of loans. A simple fixed-for-floating rate swap is equivalent to one party borrowing from another at a fixed rate and the other party borrowing the same amount from the first party and paying a floating rate of interest on the loan. If the loans are in different currencies, it's a currency swap; if one of the loans requires the payment of a rate determined by the return on a stock, portfolio, or index, it is termed an equity swap.

### Characteristics of Swap Contracts

- No payment required by either party at initiation except the principal values exchanged in currency swaps.
- Custom instruments.
- Not traded in any organized secondary market.
- Largely unregulated.
- Default risk is a critical aspect of the contracts.
- Institutions dominate.

### Methods of Terminating a Swap

- Mutual termination.
- Offsetting swap contract.
- Resale to a third party.
- Exercising a swaption—an option to enter into an offsetting swap.

### Currency Swaps

In a currency swap, one party makes payments denominated in one currency, while the payments from the counterparty are made in a second currency. Typically, the notional amounts of the contract, expressed in both currencies, are exchanged at contract initiation and returned at the contract termination date in the same amounts. The periodic interest payments in each of the two currencies can be based on fixed or floating rates.

The cash flows that would occur in a currency swap are as follows:

- Unlike an interest rate swap, the notional principal actually changes hands at the beginning of the swap.
- Interest payments are made without netting. *Full interest payments in two different currencies are exchanged at each settlement date.*
- At the termination of the swap agreement (maturity), the counterparties return the notional amounts. *Notional principal is swapped again at the termination of the agreement.*

### Plain Vanilla Interest Rate Swaps

The *plain vanilla interest rate swap* involves trading fixed interest rate payments for floating-rate payments (paying fixed and receiving floating).

The parties involved in any swap agreement are called the *counterparties*.

- The counterparty that wants variable-rate interest agrees to pay fixed-rate interest and is thus called the *pay-fixed* side of the swap.
- The counterparty that receives the fixed payment and agrees to pay variable-rate interest is called the *receive-fixed* or *pay-floating* side of the swap.

Let's look at the cash flows that occur in a plain vanilla interest rate swap.

- Since the notional principal swapped is the same for both counterparties and is denominated in the same currency units, there is no need to actually exchange the cash.
- The determination of the variable interest rate is at the beginning of the settlement period, and the cash interest payment is made at the end of the settlement period. This is called payment in *arrears*. Since the interest payments are in the same currency, there is no need for both counterparties to actually transfer the cash. The difference between the fixed-rate payment and the variable-rate payment is calculated and paid to the appropriate counterparty. *Net interest is paid by the party who owes it.*
- At the conclusion of the swap, only the final net payment is made, since the notional principal was not swapped.

You should note that swaps are a zero-sum game. What one party gains, the other party loses.

#### Interest Rate Swap Terminology

- The time frame covered by the swap is called the *tenor* of the swap.
- The *settlement dates* are when the interest payments are to be made.
- The amount used to calculate the payment streams to be exchanged is called the *notional principal*.
- The floating rate quoted is *generally LIBOR flat* or LIBOR plus a spread.

#### Swap Interest Payments

The basic formula for the net fixed-rate payment in an interest rate swap is:

$$\left( \begin{array}{c} \text{net fixed-rate} \\ \text{payment} \end{array} \right)_t = \left( \begin{array}{c} \text{swap fixed} \\ \text{rate} - \text{LIBOR}_{t-1} \end{array} \right) \left( \frac{\text{number of days}}{360} \right) \left( \begin{array}{c} \text{notional} \\ \text{principal} \end{array} \right)$$

- If this number is positive, the fixed-rate payer *owes* a net payment to the floating-rate party.
- If this number is negative, then the fixed-rate payer *receives* a net payment from the floating-rate party.

In a swap, the floating-rate payment is made based on what the floating rate was at the *beginning* of the settlement period. Hence, when a swap is negotiated (beginning of first period), the net cash payment at the end of the first period is already known. However, the cash flows for all other periods are indeterminate as of the start of the swap and are based on future values of the floating rate.

### Equity Swaps

In an equity swap, the return on a stock, a portfolio, or a stock index is paid each period by one party in return for a fixed payment. The return can be the capital appreciation or the total return including dividends on the stock or portfolio. The payment is calculated as the percentage return on the equity over the period times the notional amount of the swap.

In an equity swap, the first payment (and the others) are unknown and the fixed-rate payer may actually pay more than the fixed rate if the equity return is negative over the period. It may help to remember that the party that pays equity returns would receive a fixed return on the equity portfolio combined with the swap, regardless of the equity portfolio performance.

### RISK MANAGEMENT APPLICATIONS OF OPTION STRATEGIES

Cross-Reference to CFA Institute Assigned Reading #78

The key here is your ability to interpret option payoff diagrams. It is absolutely critical that you understand each option payoff diagram and be able to make the appropriate computations for option payoffs and the payoffs for the included option strategies (e.g., a covered call).

- Buyer of a call option—long position.
- Writer (seller) of a call option—short position.
- Buyer of a put option—long position.
- Writer (seller) of a put option—short position.

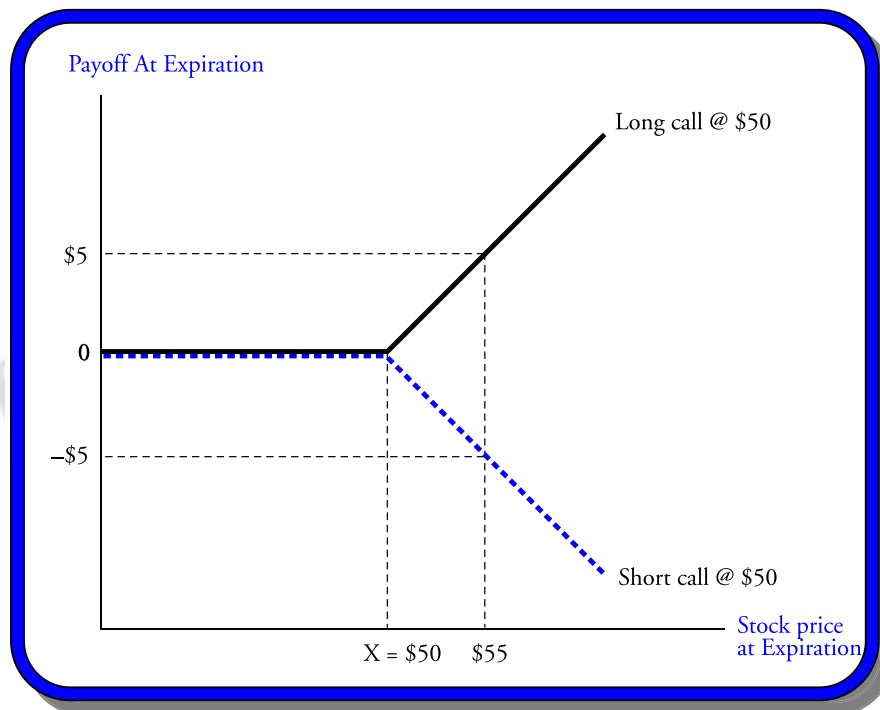
### Call Option Payoff Diagrams

The following graph illustrates the payoff at expiration for a call option as a function of the stock price, for both buyers and writers. Note that this differs from the *profit diagram* that follows in that the profit diagram reflects the initial cost of the option (the *premium*). Remember that the option buyer pays

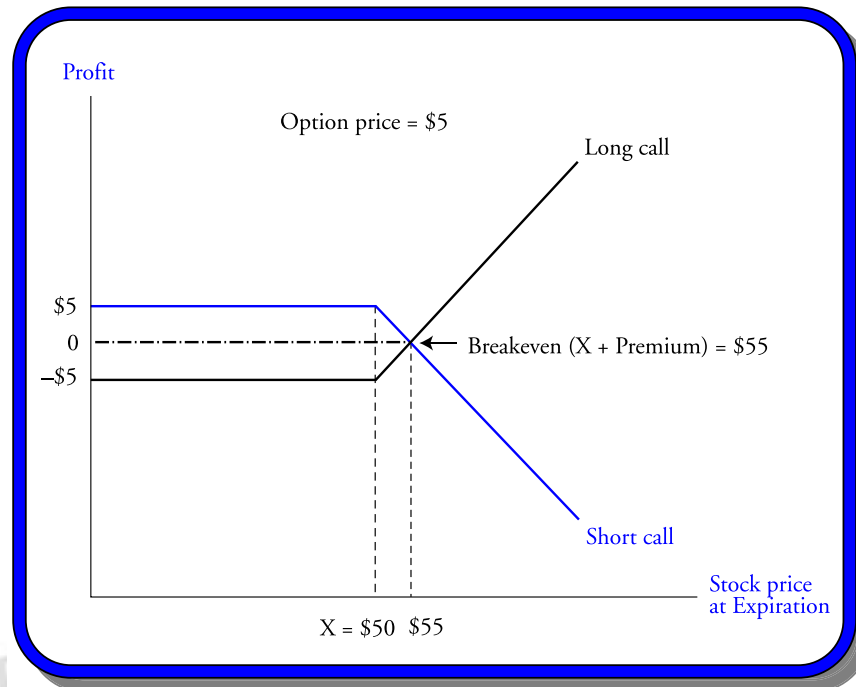
the premium to the option seller and if the option finishes out of the money, the writer keeps the premium and the buyer loses the premium. Options are considered a *zero-sum game* because whatever amount the buyer gains, the seller loses, and vice versa.

intrinsic value of a call option = $\max[0, S - X]$ intrinsic value of a put option = $\max[0, X - S]$
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Call Option Payoff Diagram



Profit/Loss Diagram for a Call Option



For a *call option*:

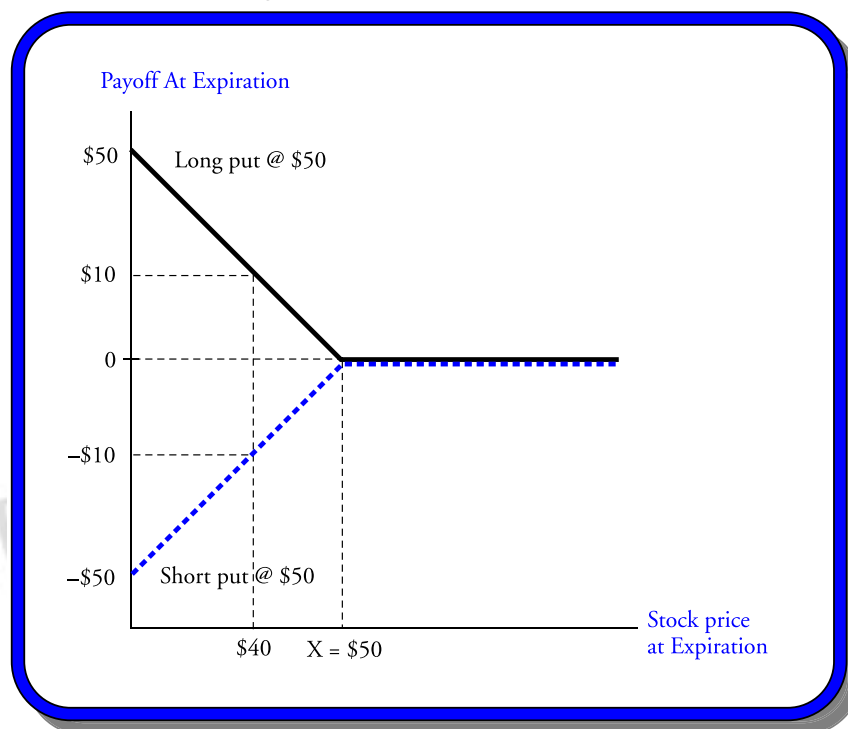
$$\text{breakeven}_{\text{call}} = \text{strike price} + \text{premium}$$

	<i>Call Option</i>	
	<i>Maximum Loss</i>	<i>Maximum Gain</i>
Buyer (long)	Premium	Unlimited
Seller (short)	Unlimited	Premium
Breakeven	X + premium	

### Put Option Diagrams

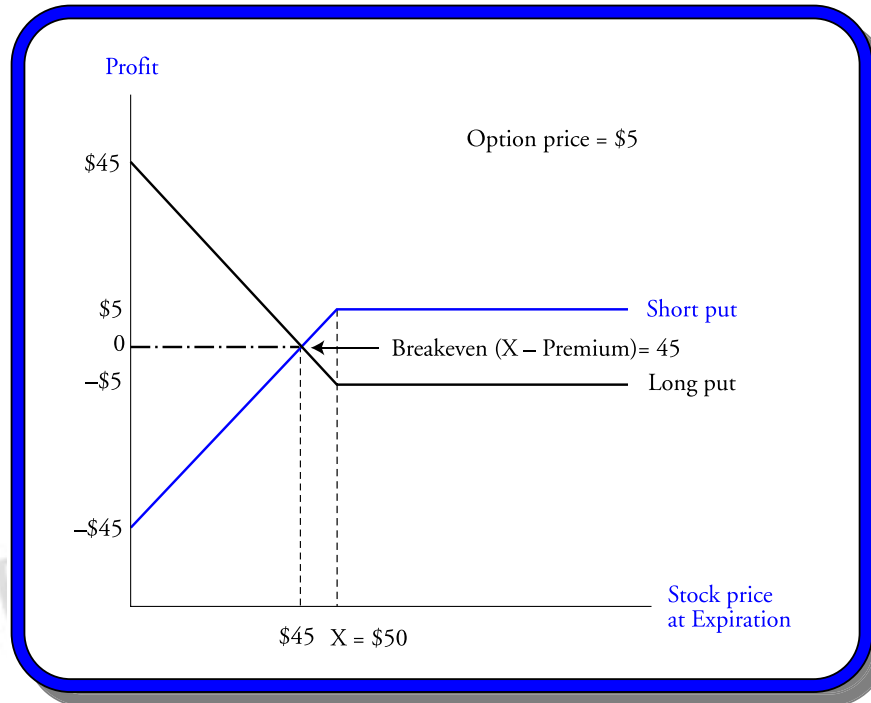
The following graph illustrates the payoff at expiration for a put option as a function of stock price, for both buyers and writers.

Put Option Payoff Diagram



Note that in the *profit diagram* that follows, the cost of the option (the *premium*) is included.

**Profit/Loss Diagram for a Put Option**



For a *put option*:

$$\text{breakeven}_{\text{put}} = \text{strike price} - \text{premium}$$

	<i>Put Option</i>	
	<i>Maximum Loss</i>	<i>Maximum Gain</i>
Buyer (long)	Premium	X - premium
Seller (short)	X - premium	Premium
Breakeven	X - premium	

**Covered Calls, Protective Puts**

A *covered call* is the combination of a long stock and a short call. The term *covered* means that the stock covers the inherent obligation assumed in writing the call. Why would you write a covered call? You feel the stock's price will not

go up any time soon, and you want to increase your income by collecting some call option premiums. This strategy for enhancing income is not without risk. The call writer is trading the stock's upside potential above the strike price for the call premium.

A *protective put* is an investment management technique designed to protect a stock from a decline in value. It is constructed by buying a stock and put option on that stock. Any gain on the stock at option expiration is reduced by the put premium paid. The combined (protective put) position will produce profits at option expiration only if the stock price exceeds the sum of the purchase prices of the stock and the put. If the stock price at option expiration is below the put's strike price, the put payoff will limit the maximum loss to the difference between the cost of the position and the strike price of the put.

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