CHAPTER 7: THE OPTION PERSPECTIVE

Some of the most important recent developments in financial theory have concerned the valuation of *options* to acquire or dispose of other assets. The modern theory of option pricing begins with the development in 1973 of the Black-Scholes model of the value of an option to buy common stock. This model has become one of the major paradigms in modern financial theory.[1]

Our principal interest in option theory involves not the mathematical formula for determining an option's value, but instead the insight, also originating with Fischer Black and Myron Scholes, that much can be learned about various securities, including common stock and bonds, by seeing these securities as containing options, and exploring the factors that makes those options more or less valuable. Option theory tells us, for example, that in some circumstances common stock is really more like an option than like a fractional share in a business. Option theory also tells us that some corporate actions -- such as large, risky investments -- are good for stockholders but bad for creditors, because they increase the value of the stock (seen as an option) and decrease the wealth of the party that has sold the option (in this case, creditors).

If so, then stockholders can behave *strategically* or *opportunistically* -- for example, by making risky investments that benefit themselves at the expense of creditors -- even if those investments have a negative net present value for the company. Option theory also offers insight into when the stockholders' incentives to take such actions are especially strong.

Identifying incentives to act strategically is the first step in transaction planning. If you know when stockholders and creditor interests will diverge, you can structure a transaction to reduce the divergence, and write a contract that limits the other side's ability or incentive to act strategically. Such transaction planning can increase company value, with the gains split between shareholders and creditors. Anticipating and controlling strategic behavior is among the principal ways that advisors can add value when they participate in business transactions. And option theory is central to understanding how to anticipate strategic behavior.

With this brief introduction as motivation for why option theory is worth studying, we begin in Section A by introducing simple options on common stock in their standard context. Section B discusses the factors that affect option value. Section C

[1] Fischer Black & Myron Scholes, *The Pricing of Options and Corporate Liabilities*, 81 J.Pol.Econ. 637 (1973); see also Robert Merton, *Theory of Rational Option Pricing*, 4 Bell J.Econ. 141 (1973).

applies the option perspective to two important situations: the conflict between shareholders and creditors over the firm's investment strategy; and efforts to develop compensation contracts that give managers the right risk-taking incentives.

A. The Basics of Put and Call Options

A *call option* is a contract that gives the holder the right to *buy* an underlying asset -- for example, a share of common stock -- at a fixed price, on or before a specified date. A *put option* gives the holder the right to *sell* an underlying asset at a fixed price on or before a specified date. The fixed price for buying or selling the underlying asset is called the option *strike price* or *exercise price*. The last date when the option can be exercised is called its *maturity date* or *expiration date*. The seller of the option is also known as an *option writer*. The price that the option buyer pays to the option writer for the option is called the *option premium*.

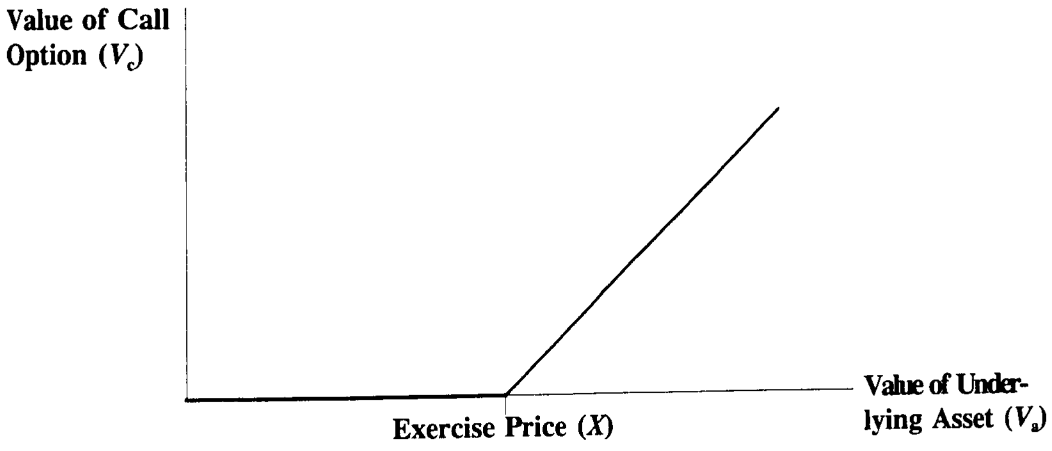
If the price of the underlying security *exceeds* the exercise price of a call option, the call option is *in the money*. If this relationship still holds at expiration, the call option holder will exercise the option and make a profit. Suppose, for example, that you hold a call option to buy IBM stock at $70, and on the expiration date, IBM sells for $77 per share. You can make an immediate $7 profit by exercising your option to buy the stock for $70, and then selling the stock in the market for $77.

If the price of the underlying security is *less than* the call option exercise price, the call option is *out of the money*. If this relationship holds at expiration, the option holder will let the call option expire without exercising it. For example, if you hold a call option to buy IBM stock at $70, and on the expiration date, IBM sells for $63 per share, the call option is worthless. You would not exercise an option to buy IBM for $70 when you can buy IBM for $63 in the market.

If the price of the underlying security *exactly equals* the exercise price of a call option, the call option is *at the money*. If this relationship holds at expiration, you would be indifferent (before transaction costs) between exercising and not exercising. Either way, you make no profit and incur no loss.

Figure 7-1 shows the relationship *at expiration* between the value of a call option V_c and the value of the underlying asset V_a. The call option is worth zero whenever the the underlying asset is worth less than the exercise price X: that is, whenever $V_a < X$. As the value of the underlying asset increases above the exercise price X, the call option gains value dollar for dollar: Its value is $V_c = V_a - X$.

Figure 7-1
Value of Call Option *at Expiration*

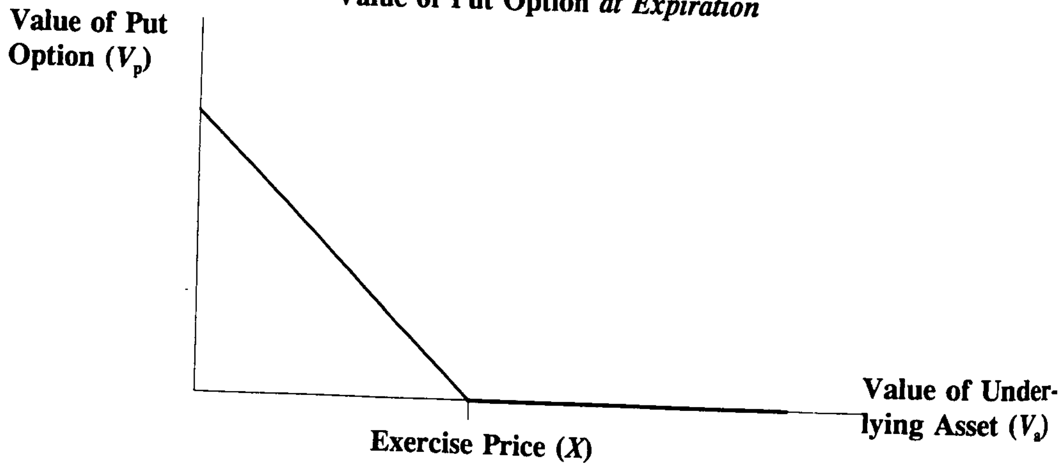


For a put option, these relationships are reversed. A put option is *in the money* if the price of the underlying security is *less than* the option exercise price. If this relationship still holds at expiration, the put option holder will exercise the option and make a profit by selling the underlying security for more than its market value. Suppose, for example, that you hold a put option to sell IBM stock at $70, and on the expiration date, IBM sells for $63 per share. You can make an immediate $7 profit by buying IBM for $63 in the market, and then using the put option to sell IBM to the option writer for $70.

If the price of the underlying security *exceeds* the put option exercise price, the put option is *out of the money*. If this relationship holds at expiration, the put option will expire worthless. You would not sell IBM stock for $70 using a put option if you can sell it for $77 in the market. Finally, if the price of the underlying security equals the put option exercise price, the put option is *at the money*. If this relationship holds at expiration, you would be indifferent (before transaction costs) between exercising and not exercising.

Figure 7-2 shows the relationship *at expiration* between the value of a put option (V_p) and the value of the underlying asset (V_a). The put option is worth zero whenever the the underlying asset is worth *more* than the exercise price X: that is, whenever $V_a > X$. As the value of the underlying asset *decreases* below the exercise price X, the put option gains value dollar for dollar: Its value is $V_p = X - V_a$.

Figure 7-2
Value of Put Option *at Expiration*



For both puts and calls, the option holder exercises if doing so is profitable, and lets the option expire otherwise. Before expiration, when the value of the underlying security at expiration is uncertain, the *expected value* of a call or put option is positive. In some states of the world, the holder gains by exercising the option; in all others, the holder throws the option away and breaks even. The option writer, in contrast, can only lose and never gain at expiration. The option writer's compensation comes up front, when the writer sells the option. In an efficient market, the sale price will equal the expected value of the option to the holder.

The next reading discusses how investors use publicly traded put and call options, as substitutes for or complements to investing in the underlying common stock.

MYRON SCHOLES, OPTIONS -- PUTS AND CALLS,
in *Encyclopedia of Investments*
559-578 (Marshall Blume & Jack Friedman eds.1982)

Since 1973, call options and, more recently, put options have been trading on organized secondary markets. Investors have become familiar with the characteristics of these contracts, which are relatively simple contracts with set maturity dates and exercise prices. They may be unaware, however, that other commonly traded securities are first cousins to options. Warrants, executive stock options, and even the common stock and bonds of a corporation are examples of securities that are closely related to put and call options.

The common stock of a corporation with bonds in its capital structure is [a call] option because the shareholders have the right to buy back the assets of the firm from the bondholders by paying off the face amount of the debt (its fixed price) at the maturity of the bond (the expiration date of the contract). Since many financial instruments have characteristics similar to those of put and call options, a detailed knowledge of put and call options may be helpful in understanding these other contracts, and vice versa. . . .

[A put] option contract is similar to an insurance policy. The asset being insured is the underlying common stock. Investors insure against possible loss in return on the holdings of common stock by buying put options on their stock; a put option with the same exercise price as the current stock price insures against a decline in the stock price for the term of the put option. Loss . . . is limited to the premium paid for the put option; on a fall in price the investor puts the stock to the put seller, the insurer, and receives the exercise price in return. Naturally, if the stock increases in price, the put is not exercised; the insurance is not used. . . .

As an insurance policy on a home insures against the loss from a fire, holding put options on common stock insures against the loss from a drop in the price of the stock. Using options, investors can sell off part of the risk -- insure part of the risk of common stock investments. The sellers of options, like insurers generally, expect that the option premiums will cover the costs of the insurance they sell to the buyers of the options. If [the option price is] actuarially fair, neither the buyer nor the seller expects to earn an above-normal rate of return at the expense of the other side of the trade.

. . . [O]ptions have been confused with futures contracts and with forward contracts. The confusion arises because the terms are similar. Several concepts [first] used in the marketing of futures contracts were [adapted] for use in the trading of options. Buyers of futures [or forward] contracts for July wheat have *bought* the July wheat, although they will not take delivery until July. . . . Buyers of [call] options for July IBM, in contrast, have not bought IBM, but only the *right to buy* IBM at a fixed price. . . .

Since buyers match sellers and no new money is raised by corporations, [future and option] contracts have been compared to side bets and to gambling, contracts without an economic purpose. Futures and options both have economic purposes; they help investors with portfolio planning, thereby facilitating the functioning of the primary and secondary markets in the [underlying] commodities or securities. . . .[a]

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[a] The critics of option trading, to whom Scholes is responding, argue that options *can* be used to insure a stock portfolio against loss, but they don't *have to* be used this way. For example, one can buy a put option without owning the underlying stock. In contrast, you can't buy fire insurance on a house you don't own. Buying a put option on stock you don't own can be seen as a side bet on the future performance of the stock, in which the option buyer wagers against the option seller. Transaction costs

Reduction of Risk in Investment Portfolios

The attractive characteristics of options become evident when options are combined with other securities. Combining options with other securities transforms the returns and risks of an option into the returns and risks of an investment strategy: options combine with other investments to produce patterns of returns for a portfolio of investments.

There are several important ways to limit the risk of investing in securities. Diversification is one of the main ways to limit the risk of holding securities. The larger the number of assets held in a portfolio, the smaller will be an investor's exposure to the risks of any one of the securities within the portfolio; the risk of the portfolio approaches the risk of the market portfolio. Another approach to limiting the risk of holding securities is to invest a percentage of the assets in bonds. By holding a larger fraction of the portfolio in bonds or money market funds, the investor unlevers the portfolio. The percentage changes in the value of the total portfolio will be less than the percentage changes in the value of the risky securities. With options, investors can limit risk by insuring against adverse changes in the prices of their holdings of securities, or against adverse changes in the value of a portfolio of assets. . . .

Use as Investment Insurance

Put options as insurance. A put option is like a term insurance policy in which the term or maturity is the length of time between the purchase of the put and its expiration date; the item being insured is the value of the underlying stock. The face value of the policy, or the maximum claim that is paid in the event that the underlying stock becomes worthless, is equal to the number of shares specified in the contract times the exercise price. For partial losses, the amount received is equal to the number of shares times the difference between the exercise price and the market price of the underlying security at the time that the put is exercised.

Moreover, depending upon the relation between the strik[e] price and the price of the underlying stock when the put is purchased, the put option will have features quite similar to an insurance policy with a deductible amount. If investors own 100 shares of stock with a market value of $100 per share, and if they buy a put with a strik[e] price of $100, they insure totally against any decline in the price of the stock during the life of the option. If, however, investors buy instead a put on the stock with an exercise price of $90 per share, they are not insured against the first 10 point decline (i.e., the

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aside, the wager is a zero-sum game. Once we include transactions costs, the wager is negative sum. Critics of options trading believe that most trading involves this sort of negative-sum gamble. In contrast, supporters like Scholes believe that most options trading involves investor efforts to adjust the risk and return characteristics of an investment portfolio, with the potential for net gains in *risk-adjusted* value.

first $1,000 in losses), although they are covered against any additional losses resulting from a decline below $90; therefore, the put has a $1,000 deductible. It is even possible to buy the insurance with a negative deductible: The investor purchases a put option with an exercise price of $110, thereby insuring against the event that the stock price does not appreciate by at least 10 percent. Unlike traditional insurance, however, the investor can buy the insurance without owning the asset.

Call options as insurance. Call options are also akin to insurance policies. Consider the following investment strategy: (1) Buy one share of a non-dividend-paying security; (2) take out a [loan under which you must] pay $X, the strik[e] price, at the maturity of the option, *t* months in the future. The loan, if prepaid, is prepayable at face value; (3) buy a put option on one share of the stock with a strik[e] price of $X and an expiration date *t* months in the future. If, at the end of *t* months, the stock [is worth] $$V_a$ per share, the value of the position would be as follows. If V_a were less than *X*, the put would be exercised [and] the stock delivered, for $X. The face amount of the loan, $X, however, must be repaid. The net value of the position is zero. On the other hand, if V_a were greater than *X*, the put would expire, the stock would be sold for $$V_a$, and the loan [would be] repaid from the sale of the stock. The net value of the position would be $($V_a$ - *X*). . . .

Suppose the investment strategy [instead] consisted of buying a call option on one share of the stock with an exercise price of $X and an expiration date *t* months in the future. If, at the end of *t* months, the stock were selling for $$V_a$ per share, with V_a less than *X*, the call would expire unexercised; the value of the position would be zero. If V_a, however, were larger than *X*, the call would be exercised, paying $X for the stock, [and then] selling the stock for $$V_a$; the value of the position would be $($V_a$ - *X*). [The payoff is exactly the same].

Since the payoffs to both strategies are the same for every possible price of the underlying security at the maturity of the contracts, the two are functionally equivalent: *Call options are equivalent to [(i) owning] the underlying security; [(ii) being obligated to repay] a term loan with a face value of $X; plus [(iii) owning] an insurance policy against declines in the stock price below $X per share*. While the leverage component of a call option is its most commonly known characteristic, the insurance characteristic distinguishes call-option strategies from simple stock strategies such as buying stocks on margin. . . .

[Selected] Glossary

Black-Scholes	Pricing model for options used by practitioners.
call option	Right to buy a security for a fixed price on or before a given date.
exercise value	Value of the option if it was to be exercised.
expiration date	Last day on which the option can be exercised.

fully covered	Writing an option on stock held by the writer.
futures contract	Buying an asset today for delivery in the future.
hedging	Reducing risk by selling an asset similar to the one held.
in-the-money call	Stock price is above the strik[e] price of the option.
in-the-money put	Stock price is below the strik[e] price of the option.
leverage	Borrowing money to buy an asset.
naked option	Writing an option to deliver a security that is not owned.
option buyer	One who has the right to exercise the option.
option writer	Person who sells the right of exercise to the buyer of the option.
out-of-the-money	For a call option, the stock price is below the strik[e] price; for a put option, the stock price is above the strik[e] price.
premium	Price paid for the option to the writer by the buyer.
put option	Right to sell a security for a fixed price on or before a given date.
strik[e] price	Price at which the option can be exercised.

B. The Factors that Determine Option Value

The Scholes reading describes some of the investment strategies that can be pursued using options. We turn next to the factors that determine the value of an option. We will consider only call options, but the same factors determine the value of put options. For simplicity, we assume that all cash flows from the underlying asset will be received after the option expires. Thus, the call option holder can capture all the cash flows from the underlying asset at expiration, and has no reason to exercise before the expiration date.

At expiration, valuing a call option is easy. The value of an in-the-money call option equals the value of the underlying asset V_a minus the exercise price X. The value of an out-of-the-money call option is zero. Valuing the option become complex, though, when there is time remaining until expiration, and the value of the underlying asset *at expiration* is uncertain. Before expiration, an out-of-the-money option has value because the option *may* become in-the-money by the time it expires.

Five fundamental factors determine call option value:

(1) The *current* value V_a of the underlying asset;

(2) The exercise price X;

(3) The risk-free rate of interest r_f, which tells us the time value of money;

(4) The variability in the value of the underlying asset, measured by the standard deviation of price σ_a; and

(5) The time t remaining until the option expires.

We will consider each factor in turn.

1. Current Value

Other things equal, the value of a call option increases with an increase in the current value V_a of the underlying asset. In an efficient market, the higher today's asset price is, the higher the *expected* price at expiration. And the higher the asset price at expiration, the more the *option* will be worth. Today's value and the value at expiration are linked, *for both the option and the underlying asset*, by the time value of money.

An increase in current asset value V_a will make a call option worth more even if the option is out of the money. An increase in current value makes it more likely that the option will be in the money at expiration. *How much* more likely the option is to be in the money, and how far in the money it is likely to be, depends on how far out of the money the option currently is, the time t remaining until expiration, and the standard deviation σ_a of the asset's value.

2. Exercise Price

The lower the exercise price X, the more likely a call option is to be in the money at expiration, and the further in the money it will be. Thus, an option with a *lower* exercise price is worth more than an otherwise identical option with a higher exercise price. Option value depends largely not on current value alone, nor exercise price alone, but the difference between the two: $V_a - X$. If $V_a < X$, the option is out of the money. The further out of the money the option is, the less it is worth. If $V_a > X$, the option is in the money. The further in the money the option is, the more it is worth.

3. Time Value of Money

To exercise a call option, the option holder must pay the option writer the exercise price $X on the expiration date. To have $X available at expiration, the option holder today needs only a smaller amount, which can be invested to return $X on the expiration date. That amount is simply the present value of $X:

$$PV(\$X \text{ at time } t) = \$X/(1 + r_f)^t$$

The longer the time until expiration, and the higher the interest rate r_f, the more valuable the option, because the holder needs less money today to be able to exercise the option at expiration.[2] The size of the discounting effect depends on the likelihood that the option will be exercised, since only then is the exercise price paid. The more likely an option is to be exercised, the more important the factors -- r_f and t -- that determine the present value of the exercise price.

4. Variability in Asset Value

A central factor in valuing an option is the variance in value of the underlying asset. The *greater* the variance in the value of the underlying asset, *holding constant the value of the asset*, the more the option is worth. At first glance, this seems counterintuitive. For the asset itself, higher systematic risk means that investors demand a higher expected rate of return. Thus, an increase in systematic risk, *holding constant the expected cash flows from the asset*, means that those cash flows have a lower *discounted present value*. But when an option on that asset is being sold, an increase in variance *increases* the value of the option.

This is due to the differences between the payoff to the holder of a call option and the payoff to the holder of the underlying asset. Consider first an option which is *at the money in present value terms*. The two curves in Figure 7-3 show the probability distributions of the value *at expiration* of the stock of two companies, Stableco and Variableco. Each has an expected value at expiration of $X. The heavy black line shows the payoff at expiration to a call option with an exercise price of $X -- the gain on exercise of the option and sale of the underlying common stock.

By "at the money *in present value terms*" we mean that the expected value of each company's stock *at expiration* equals the option exercise price. The Stableco and Variableco options illustrated in Figure 7-3 are slightly out-of-money giving the term its usual meaning, which ignores the time value of money. If an asset's expected value is $X sometime in the future, its current value must be less than $X.

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[2] The present value formula works for any time period -- day, week, month, or year. If the time period is measured in, say, months, then the risk-free interest rate is the *monthly* rate.

To keep the example simple, we will assume that the extra variance in Variableco stock results solely from *unsystematic* risk. Thus, Stableco and Variableco stock will will sell at the same price in an efficient market.

Variableco stock has both greater upside and greater downside than Stableco stock. A call option holder, though, only cares about the upside. In bad states of the world, the option holder will let the option expire worthless. The holder *cannot do worse than zero*, no matter how badly the stock performs. Holding a Variableco option, rather than Variableco stock, preserves the extra upside and eliminates the extra downside. This makes the Variableco option worth more than a Stableco option, even though the stocks are worth the same and the options have the same exercise price and expiration date.

In Figure 7-3, the option holder neither gains nor loses if the share price is below the exercise price. The only part of the probability distribution that matters is the part where the share price at expiration exceeds the exercise price. Greater variance in the value of the underlying common stock shifts *that portion of the distribution* to the right. This increases the probability of a high stock price and, therefore, of a high option value.

Figure 7-3
Effect of Variance in Asset Value on Option Value

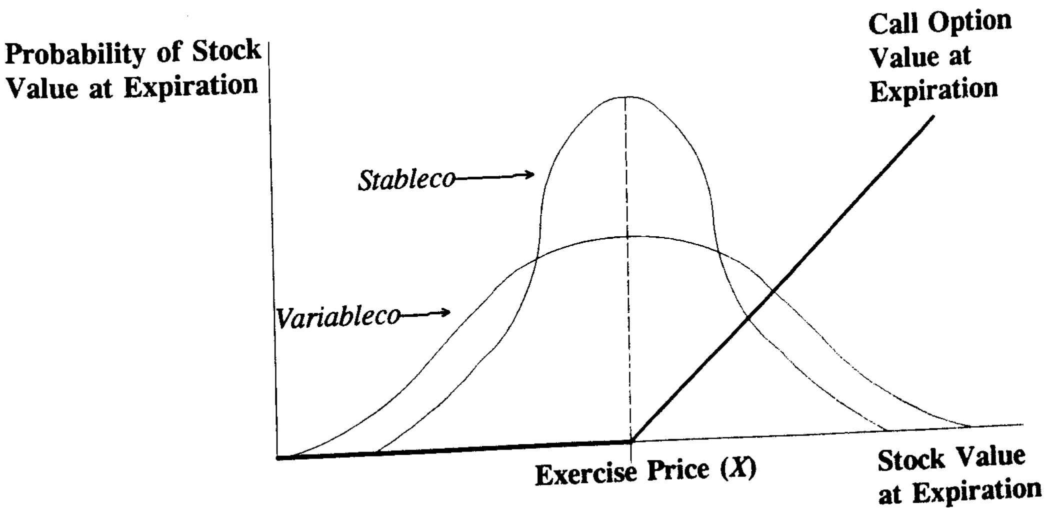
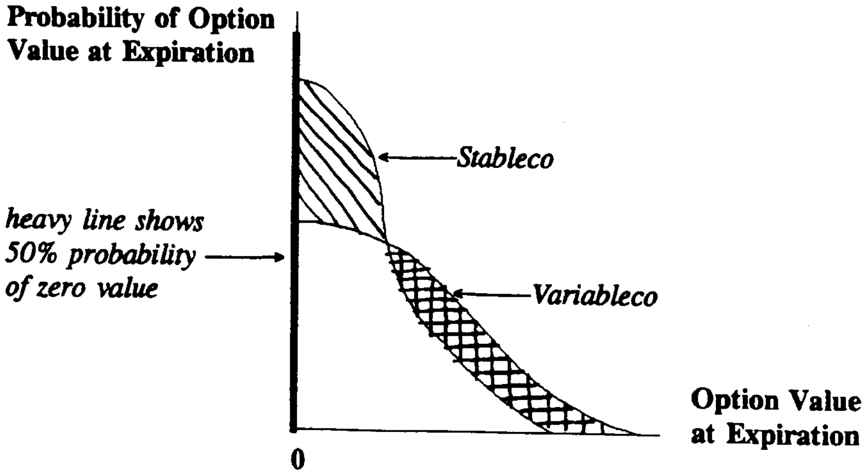


Figure 7-4 shows the probability distribution of value at expiration *for the option holder*. The left half of the bell curves in Figure 7-3 has been collapsed to the heavy black line at a value of zero, because zero is the option holder's outcome whenever the stock price at expiration is less than or equal to the exercise price $X.

In Figure 7-4, the mean of the option holder's probability distribution curve is greater for Variableco than for Stableco. The striped area under the Stableco curve and the cross-hatched area under the Variableco curve are equal in size -- they represent equal probabilities. But the cross-hatched area is at a higher price than the striped area. Thus, the Variableco stock has a higher expected value than the Stableco option.

Figure 7-4
Option Value Probability Distribution



The same result -- greater stock price means greater option value -- holds *even more strongly* for an option that is out of the money in present value terms. It also holds, *though less strongly*, for an an option that is in the money in present value terms. The holder of such an option sees all of the increased upside, and *only some* of the increased downside. Thus, the Variableco option is still worth more than the Stableco option. But as we steadily reduce the exercise price toward zero, the difference in value becomes less and less. In the extreme case where the option is so deep in the money that it is almost certain to be exercised, the option value will equal the stock value V_a minus the present value of the exercise price $PV(\$X)$. Since Stableco and Variableco have the same stock price, their options will also have the same value in this extreme case. In effect, as an option becomes deeper and deeper in the money, its return characteristics approach those of the underlying asset.

The effect of increased variance on option value is more complex if the increased variance results from *systematic*, rather than unsystematic, risk. For an option that is at the money or out of the money in present value terms, the same analysis applies. Investors will now pay less for Variableco stock than for Stableco stock, because Variableco promises the same expected return but has higher systematic risk. But investors will still pay more for a Variableco option, because the option holder sees only the greater upside. The positive effect on value of the greater upside potential outweighs the negative effect of the increase in systematic risk.

For an option that is *in the money* in present value terms, we need more information to know how option value changes as systematic risk increases. The increase in systematic risk will make the option worth less; the increase in total variance will make the option worth more. The sign of the change in value will depend on which effect is larger. The deeper in the money the option is, the more stock-like the return on the option, and thus the weaker the second, value-increasing factor will be.

Finally, if the systematic variance of the underlying asset increases and expected return also increases just enough so that the *value* of the underlying asset doesn't change, the value of a call option on the asset increases, *even if* the option is in the money. This is the situation considered in the Black-Scholes option pricing model, which gives option value as a function of the variance of the underlying asset, holding asset value constant.

To summarize: An increase in variance, *holding asset value constant*, increases call option value. If we instead hold *expected return* constant, then: (i) an increase in *unsystematic risk* increases option value; (ii) an increase in systematic risk increases the value of an option that is *at the money* or *out of the money* in present value terms; and (iii) an increase in systematic risk has an uncertain effect on the value of an option that is *in the money* in present value terms. The further out of the money a call option is, the stronger the effect of asset value variance on option value. Conversely, the deeper in the money an option is, the weaker the variance effect. The value of a deep-in-the-money option tracks the value of the underlying asset, nearly dollar for dollar.

This relationship between variance and option value yields an insight that will be of substantial value. Suppose you are a Stableco shareholder and have to decide whether it will make a major acquisition. After studying the issue, you decide not to make the acquisition because the expected return is insufficient to compensate Stableco for the associated risk. Would your conclusion change if you held an option on Stableco's stock rather than the stock itself? A change in risk has a very different impact on an option holder than it does on the holder of the underlying security. We will return to this point in Section C of this Chapter.

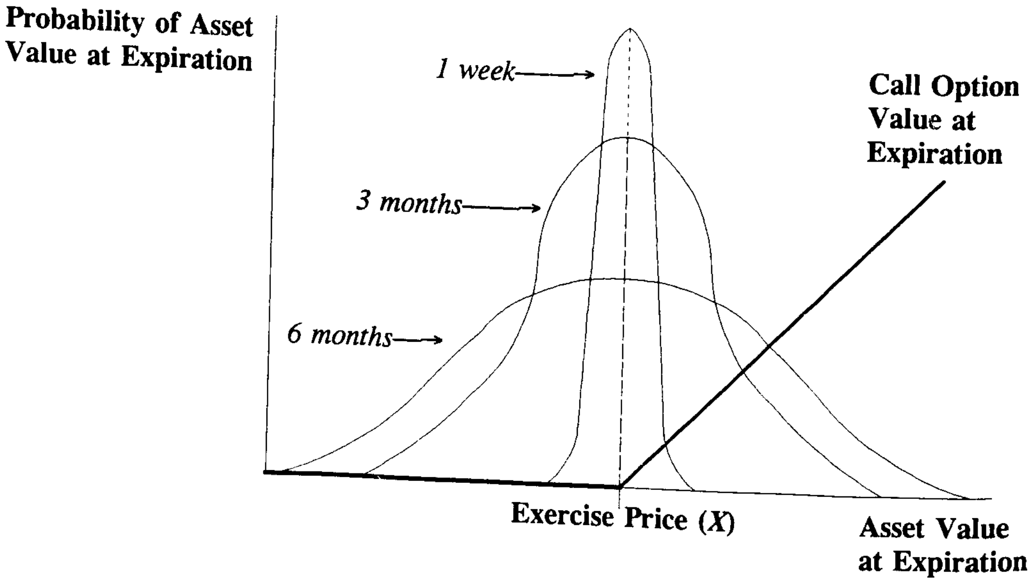
5. Time Remaining Until Expiration

The last factor that affects call option value is time remaining until expiration. Time to expiration affects option value in two ways. The first, considered in subsection 3, involves the need to discount the exercise price to present value. The second effect involves variability in the value of the underlying asset. The longer the time remaining until expiration, the more time there is for the value of the underlying asset to change.

If asset values follow a random walk over time, the variance in expected value on a future date is proportional to the time between today and the future date. The standard deviation is proportional to the *square root* of the time remaining. All that is needed to change the distribution of expected future returns for Stableco into a distribution more like Variableco is to increase the time remaining until expiration.

Figure 7-5 shows the effect of time to expiration on the distribution of expected value of the underlying asset *at expiration*. If the option expires in a week, the probability distribution is very narrow. There isn't enough time for much to happen to change asset value. Thus, a deep out-of-the-money option will be nearly worthless. As the time to expiration increases, the probability distribution flattens out more and more. This makes an option, especially an out-of-the-money option, worth more. More specifically, in the Black-Scholes option pricing formula, the standard deviation of the return on the underlying asset σ_a is estimated for a specified time period (such as one month or one year), and then multiplied by $t^{1/2}$.

Figure 7-5
Effect of Time to Expiration on Option Value



C. Applying the Option Perspective

Understanding the factors that affect option value, can help in understanding a broad range of events. Many common relationships can be recharacterized as involving the grant and receipt of an option. This can provide insight into the factors that bear on the value of the interests held by each party to the relationship and, as a result, each party's incentives. We will use this perspective often in later chapters. Here we offer two examples: (i) the conflict between bondholders and stockholders; and (ii) the conflict between management and stockholders.

1. An Option Perspective on the Conflict Between Debt and Equity

Assume that Firm *X* has a capital structure made up of only debt and equity, and that the debt has a specified face value and is repayable on a specified date in a single lump sum. The value of the equity then equals the firm's total value minus the value of the debt. If the debt is not repaid when due, the firm will go into bankruptcy, with the result (we will assume for simplicity) that the stockholders are wiped out and the debtholders become the owners of the firm. Thus, the value of the debt on the repayment date is either: (i) its face value if it is repaid; or (ii) the value of Firm *X*'s assets if the debt is not repaid and the debtholders take over the firm.

This arrangement can be recharacterized as an option. The stockholders can be seen as having sold an *unlevered* firm *X* to the debtholders in return for: (i) the proceeds from issuing the debt; (ii) a management contract; and (iii) most importantly, a call option to repurchase the unlevered firm by paying off the debt (face value plus interest). On the repayment date, if the firm's assets are worth more than the repayment price, the stockholders will "exercise their option" to repurchase the unlevered firm by repaying the debt. If the firm's assets are worth less than the repayment price, the equity holders won't exercise their option. They do this by defaulting on the debt.

Given this recharacterization of the relationship between debtholders and equity holders as involving a call option, how do the factors that determine option value affect the incentives of both parties? We would expect the debtholders to negotiate an interest rate that reflects their view of the risk of default at the time the terms of the debt are negotiated. But now consider the stockholders' incentives once the debt has been sold. The stockholders hold, in effect, a call option on an unlevered firm *X*. A major determinant of the value of that option is the variance in the future value of firm *X*. The stockholders thus have an incentive to cause firm *X* to make *riskier* investments than would be optimal for an unlevered firm.

Stockholders in a highly levered firm (say a firm worth $100, with outstanding debt with a face value of $90) hold a slightly in-the-money call option. The stockholders get all of the increased upside potential from taking a large risk. Much of the increased downside is borne by the debtholders, who suffer all losses that drop the firm's value below $90. A highly risky project that has zero net present value, and thus doesn't change the value of the firm as a whole, will increase the value of the stock and decrease the value of the debt.

This can be shown with a simple numerical example. Suppose that Firm *X* has assets of $100, all invested in Treasury bills, and outstanding debt of $90. If the firm keeps its funds in Treasury bills, it will be able to pay the debt for sure, so the debt will be worth $90 and the stock will be worth $10. Suppose though, that the stockholders find a project that requires a $100 investment, and has a 50% chance of returning $200 and a 50% chance of returning $0. The expected return on the $100 investment is $100.

The expected payoff to the stockholders from this investment is strongly positive. If the investment pays off, they repay the debt and are left with stock worth $110. If the investment doesn't pay off, the stockholders default on the debt and are left with $0. Since both outcomes are equally likely, the expected payoff is $55. This is shown in Table 7-1:

Table 7-1
Value of Levered Firm's Stock and Debt Before and After a Risky Investment

	Before Risky Investment	After Risky Investment
Stock Value	$ 10	(.50 × $110) + (.50 × $0) = $ 55
Debt Value	$ 90	(.50 × $90) + (.50 × $0) = $ 45
Firm Value	$100	(.50 × $200) + (.50 × $0) = $100

The stockholders' gain, though, is the debtholders' loss. If the investment pays off, the debtholders receive $90. If the investment doesn't pay off, they are left with a claim on a worthless firm, worth $0. Since both outcomes are equally likely, the expected payoff is $45. This is also shown in Table 7-1.

Bond Covenants. The debtholders will anticipate such risk-increasing behavior when the terms of the debt were negotiated. They will demand some combination of (i) covenants that limit the stockholders' ability to make risky gambles, and (ii) an interest rate that reflects the anticipated increase in risk (taking the covenants into account). If the stockholders want to limit the interest rate they must pay, they will agree to covenants that prohibit the firm from, for example, substantially altering its investment portfolio, incurring additional debt, or taking other actions that would increase the risk of default. The more highly levered the firm, the more important such covenants will be.

The option perspective focuses attention on the importance of variance in the value of the underlying asset. Thus, it highlights the stockholders' incentives to take risks, and hence the debtholders' need for protection, by contract, a higher interest rate, or some of both.[3] A similar analysis is possible with respect to the conflict between preferred and common stockholders.

One might think that, if the debtholders are compensated through a higher interest rate for risk-increasing behavior by stockholders, the two parties would be indifferent between a high interest rate loan that allowed such strategic behavior, or a lower interest rate loan plus strong covenants. In fact, the problem is not zero sum. Often, an option holder can gain from a risky investment even if the investment has a negative net present value. Thus, viewed *ex ante*, covenants that limit strategic behavior can increase the total value of the firm. Stockholders benefit from this increase in firm value. The lower interest rate on the firm's debt more than offsets the lost opportunity to act strategically once debt has been issued.

Many terms in debt contracts are standardized, but opportunities for innovation remain. For example, the growth in leveraged buyouts and leveraged recapitalizations in the 1980s led to the development of "event risk" covenants, which give bondholders the right to "put" their bonds back to the issuing firm if the firm takes one of the leverage-increasing actions described in the covenant.[4] But many early event risk covenants were not very effective, perhaps because the legal and financial advisors who developed them did not fully understand the stockholders' incentives to increase leverage. Identifying the options implicit in the relationship, and how those implicit options affect

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[3] Option-sensitive efforts to analyze bond covenants include Clifford Smith & Jerold Warner, *On Financial Contracting: An Analysis of Bond Covenants*, 7 J.Fin.Econ. 117 (1979), reprinted in *The Modern Theory of Corporate Finance* 167 (Clifford Smith ed. 2d ed. 1990); Kose John & Avner Kalay, *Costly Contracting and Optimal Payout Constraints*, 37 J.Fin. 457 (1982); Avner Kalay, *Stockholder-Bondholder Conflict and Dividend Constraints*, 10 J.Fin.Econ. 211 (1982) (evaluating American Bar Foundation, *Corporate Debt Financing Project: Commentaries on Model Debenture Indenture Provisions* (1971)).

[4] See, e.g., Leland Crabbe, *Event Risk: An Analysis of Losses to Bondholders and "Super Poison Put" Bond Covenants*, 46 J.Fin. 689 (1991); Steven Zimmer, *Event Risk Premia and Bond Market Incentives for Corporate Leverage*, Fed. Reserve Bank N.Y.Q.Rev. 15 (Spr.1990). These covenants are also called "poison put" covenants because they can be structured to increase the cost of a hostile takeover, whether or not accompanied by an increase in leverage.

the parties' incentives, could have offered a systematic way to identify the actions that an event-risk covenant should cover.

Strategic Behavior in Bankruptcy. The option perspective on the conflict between debt and equity is especially important when a firm is in or near bankruptcy. In a bankrupt firm, there are conflicts not only between stockholders and debtholders, but also between senior creditors, who are entitled to be paid first, and junior creditors, who get what's left over after the senior creditors are paid. Often, the common stock and one or more classes of junior debt may be worthless, or nearly so, if the firm were liquidated or sold today. This gives them strong incentives to delay a liquidation or sale, in the hope that the firm's prospects will improve. In effect, stockholders and junior debtholders hold an out-of-the-money call option on the firm's assets, and want to stretch out the time to maturity of their option.

The incentives for some classes of claimants to delay do much to explain why bankruptcy is often a costly and protracted process. In most cases, the value of the *firm* is maximized by a quick restructuring and exit from bankruptcy. But that might wipe out stockholders and junior creditors. As a result, they may litigate (or threaten to litigate) every issue in order to delay the resolution of the bankruptcy. Unfortunately, bankruptcy law leaves ample room for protracted litigation. Scholars have argued that society would be better served by a bankruptcy process that emphasized speed, and limited the parties' ability to delay the needed financial restructuring. *Ex ante*, shareholders and creditors would be better off under such a system because bankruptcy costs would be lower.[5]

Fiduciary Duty and Conflicts of Interest. Option analysis can also illustrate when particular actions involve a conflict of interest. For example, a risky investment, normally a matter of unreviewable business judgment, may take on a different light when a company's ability to pay its debt is uncertain. By increasing the risk of default, the investment benefits stockholders at the expense of debtholders.

Judges have begun to appreciate the implications of option theory for the fiduciary duties of the directors. In a recent case, Delaware Chancellor William Allen explicitly used option theory to argue that directors of a firm at or near insolvency should maximize the value of the firm as a whole, rather than the value of its stock.

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[5] See, e.g., Mark Roe, *Bankruptcy and Debt: A New Model for Corporate Reorganization*, 83 Colum.L.Rev. 527 (1983).

CREDIT LYONNAIS BANK NEDERLAND, N.V. vs. PATHE COMMUNICATIONS CORP.

1991 WL 277613, at n.55 (Del.Ch.1991)

The possibility of insolvency can do curious things to incentives, exposing creditors to risks of opportunistic behavior and creating complexities for directors. Consider, for example, a solvent corporation having a single asset, a judgment for $51 million against a solvent debtor. The judgment is on appeal and thus subject to modification or reversal. Assume that the only liabilities of the company are to bondholders in the amount of $12 million. Assume that the array of probable outcomes of the appeal is as follows:

[Outcome]	**Expected Value**
25% chance of affirmance ($51mm)	$12.75 million
70% chance of modification ($4mm)	$ 2.8 million
5% chance of reversal ($0)	$ 0
Expected Value of Judgment on Appeal	$15.55 million

Thus, the best evaluation is that the current value of the equity is $3.55 million. ($15.55 million expected value of judgment on appeal − $12 million liability to bondholders). Now assume an offer to settle at . . . $17.5 million. By what standard do the directors of the company evaluate the fairness of [this offer]?

The creditors of this solvent company would be in favor of accepting . . . [the offer to] avoid the 75% risk of insolvency and default. The stockholders, however, . . . very well may be opposed to acceptance of the $17.5 million offer [even though] the residual value of the corporation would increase from $3.5 to $5.5 million. This is so because the litigation alternative, with its 25% probability of a $39 million outcome to them ($51 millon − $12 million = $39 million) has an expected value to the residual risk bearer of $9.75 million ($39 million × 25% chance of affirmance), substantially greater than the $5.5 million available to them in the settlement. . . .

[I]t seems apparent that one should in this hypothetical accept the best settlement offer available providing it is greater than $15.55 million, and one below that amount should be rejected. But that result will not be reached by a director who thinks he owes duties directly to shareholders only. It will be reached by directors who are capable of conceiving of the corporation as a legal and economic entity. Such directors will recognize that in managing the business affairs of a solvent corporation in the vicinity of insolvency, circumstances may arise when the right (both the efficient and the fair) course to follow for the corporation may diverge from the choice that the stockholders (or the creditors, or the employees, or any single group interested in the corporation) would make if given the opportunity to act. Thus, the option perspective can support a rule that gives directors' fiduciary duties to debtholders when a firm approaches insolvency.

A subsequent case, *Geyer v. Ingersoll Publications Co.*, 1992 WL 136,473 (Del.Ch.1992), relies on *Lyonnais Bank* in holding that directors owe fiduciary duties to creditors as soon as a firm becomes insolvent, even if the firm has not yet filed for bankruptcy. This, though, doesn't fully resolve the tension between maximizing value to the corporation, and maximizing value to the shareholders. Chancellor Allen's hypothetical, after all, involved a solvent corporation.

2. An Option Perspective on Management Incentive Compensation

An option perspective can also be useful in examining the conflict between managers and stockholders. It is commonplace to recognize that managers and stockholders have different incentives with respect to some firm decisions. Stockholders desire profit maximization. Managers, however, desire that combination of salary, perquisites, and profit maximization that yields *them* the most value. Absent corrective forces, managers will engage in less profit maximization than the stockholders would prefer.

Managers are also often more risk-averse than diversified shareholders. There are two principal reasons. First, managers typically have a large investment in firm-specific human capital. Taking more risk exposes this human capital to greater risk, since the managers are more likely to lose their jobs if the company gets into financial trouble. Second, managers' financial assets are often concentrated in the firm they manage. Thus, managers may be more risk averse than stockholders would prefer. The concentration of human and financial capital in a single firm also makes the managers averse to both systematic and firm-specific risk, while diversified stockholders care only about systematic risk.[6]

One way to make managers more interested in profits is to give them stock in the firm. Too little stock, and managers won't care enough about profits. Too much stock, though, will make the managers less financially diversified and may make them too risk averse.

Firms can also offer managers stock options, instead of or in addition to stock. Options will also enhance the profit incentive, and can make the managers more willing

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[6] See Eugene Fama, *Agency Problems in the Theory of the Firm*, 88 J.Pol.Econ. 288 (1980).

to accept risk. Too many options, though, and the managers may develop too great an affinity for risk. This may partly explain why management stock options are often issued with an exercise price equal to the current market price, and a long time (often 10 years) until expiration, so the options are deep in the money in present value terms. This gives managers incentives that are something of a hybrid between stock and an out of the money option.

A further possibility is leveraging the firm, say through a leveraged buyout. This makes stock take on more of the characteristics of a call option. By reducing the fraction of invested capital that is in the form of equity, leverage also makes it feasible to give managers a larger percentage stake in the residual value of the firm.

Complexities like these make designing a good management compensation package a difficult task. But understanding the option characteristics of stock, and how options can be used as part of the compensation mix is an essential tool. Option theory is central to understanding managers' attitudes toward risk, and how manager and shareholder interests may diverge.[7]

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[7] For a recent effort to incorporate some of these complications into the theory of managerial compensation, see M.P. Narayanan, *Compensation Contracts and Managerial Myopia* (U.Mich.Bus.Sch. working paper 92-10, 1992).

Problems to Accompany Chapter 7

1. Figure 7-1 shows the return at expiration to the *holder* of a call option on common stock, as a function of the value of the stock at expiration. Draw the return at expiration to the *seller* of a call option on common stock, with an exercise price of $X, as a function of the value of the stock at expiration.

2. Draw the return at expiration to the seller of a put option on common stock, with an exercise price of $X, as a function of the value of the stock at expiration.

3. In order to get your feet wet in the world of option finance you have decided to buy both a call and a put on the same stock. The stock sells for $40 per share. The call option has an exercise price of $45 and the put has an exercise price of $35. Both expire in 6 months. Draw a graph of the value at expiration of this package of options, as a function of the value of the stock at expiration. Label as many points as you can.

4. What beliefs about future changes in the price of the underlying common stock would lead an investor to adopt the strategy described in problem 3?

5. Draw the return at expiration to an investor who both (i) holds a call option on an asset with an exercise price of $X, and (ii) has sold a put option on the same asset, with the same exercise price and expiration date, as a function of the value at expiration of the underlying asset.

6. Explain why holding the option position described in problem 5, and also having on hand enough money to pay the exercise price at expiration, is *equivalent* to owning the underlying asset, if there are no cash distributions on the underlying asset between now and the expiration date.

7. Alpha Company common stock currently sells for $40 per share. Alpha has just issued $100 million of 8% convertible debentures due in ten years at a price equal to their principal value of $1000. The debentures pay interest annually. Each debenture is convertible, on the maturity date of the debentures, into 20 shares of Alpha common stock. Describe the Alpha convertible debentures as a combination of nonconvertible debentures and a call option on Alpha common stock. Specify the exercise price and expiration date of the option.

8. You are a consultant to the Ministry of Finance of the newly democratized nation of Freedonia. The government is anxious to implement its new privatization program. Privatization of state owned companies will be conducted by distributing 20% of the shares in each company to its current employees, and selling the remaining 80% to the highest bidders. To attract investor interest, the shares will carry, for 10 years after issuance, a guaranteed minimum annual dividend of 4.5% of the initial price of the shares. There may also be a bonus dividend which will be set by the board of directors based on the success of each company and its need for new funds to invest in the business. Each share will be entitled to one vote on the election of directors and other matters on which shareholders are entitled to vote. To prevent disparities in personal wealth from appearing too quickly, the government will have the right to repurchase the shares within 10 years after issuance for three times the initial sale price. Holders of these "Freedonia shares" will have a claim on the firm's assets which is junior to that of all other creditors.

Break the Freedonia shares into two or more component parts, so that each part resembles a simple security -- common stock, preferred stock, debt, or option -- that is commonly traded in the U.S. That is, construct a bundle of component securities that offer the same expected payoff as the Freedonia shares.

9. Suppose, in Table 7-1, that the risky investment being considered by Firm *X* has a 30% chance of returning $250, and a 70% chance of being a total loss.

a) What is the expected return from this investment?

b) What is the expected gain for the stockholders of Firm *X* from making this investment?

c) What is the expected loss to the debtholders of Firm *X* from making this investment?

d) What is the expected value of Firm *X* if it makes this investment?